DEPARTMENT OF MECHATRONICS

IV SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

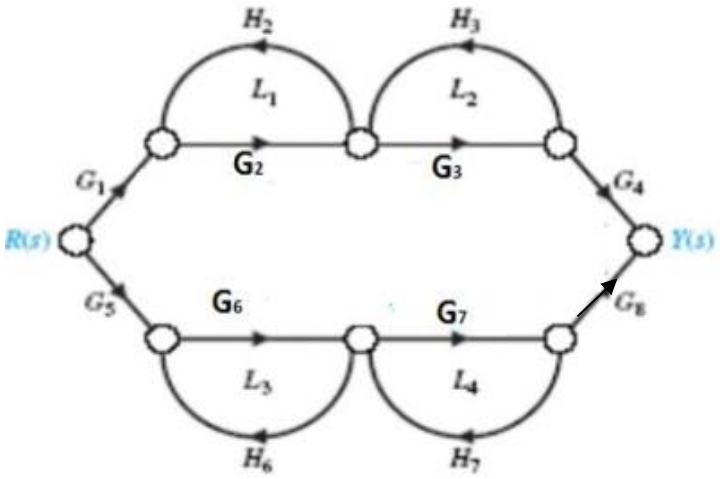
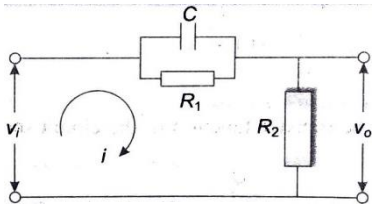
END SEMESTER [JUNE 2022]

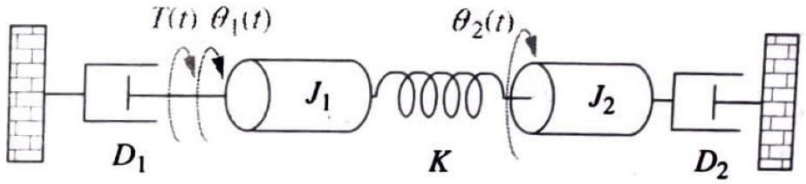
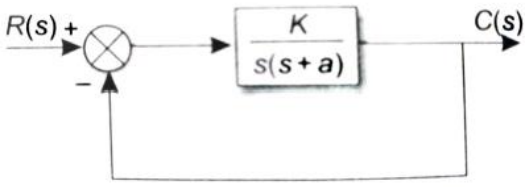
SUBJECT: LINEAR CONTROL THEORY [MTE 2253]

DATE & TIME: 16-06-2022, 9am-12pm **MAX. MARKS: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Data not provided may be assumed and justified.

Q. No		M	CO	PO	LO	BL
1A	Determine the transfer function for the Signal flow graph shown in Fig. 1A. Also, mention the steps.  Fig. 1A	**5**	**1**	**1**	**1**	**3**
1B	Determine the transfer function of a system described by $2\frac{dc(t)}{dt}$ + c(t) = r(t-2), where r(t) and c(t) are the input and output respectively.	**2**	**1**	**1**	**1**	**3**
1C	Determine the transfer function of the electrical circuit shown in Fig. 1C  Fig. 1C	**3**	**1**	**1**	**1**	**3**

2A	Write equations of motion for Fig. 2A. through Inspection method.  Fig. 2A	**2**	**1**	**1**	**1**	**3**
2B	Sketch the Bode plot for the transfer function G(s) = $\frac{100}{s(1+s)(1+0.5s)}$.	**5**	**4**	**1**	**1**	**3**
2C	For a unity feedback system whose open-loop transfer function is G(s) = $\frac{50}{(1+0.1s)(1+2s)}$, determine the Position, Velocity and Acceleration error constants.	**3**	**2**	**1**	**1**	**3**
3A	A feedback control system is described by Open loop system G(s) = $\frac{10}{s(1+0.2s)(1+0.01s)}$; H(s) = 1 Determine: a) Gain cross-over, Phase cross-over frequency b) Gain margin, and phase margin	**4**	**4**	**1**	**1**	**3**
3B	Convert the Differential equation given below into State Space Model: $\frac{d^3y}{dt^3} + 9\frac{d^2y}{dt^2} + 26\frac{dy}{dt}$ + 24y = 24 u	**4**	**4**	**1**	**1**	**3**
3C	State any two differences between a Lag compensator and a Lead compensator.	**2**	**3**	**1**	**1**	**3**
4A	Determine the value of **K** and ***a*** to satisfy the frequency domain specifications; M_r = 1.04, and ω_r = 11.55 rad/sec, for the system shown IN Fig.4A.  Fig. 4A	**3**	**3**	**1**	**1**	**3**
4B	Determine the stability of the Closed-loop system using RH–criterion, the characteristic equation of the system is $3s^4 + 10s^3 + 5s^2 + 5s + 2 = 0$	**2**	**2**	**1**	**1**	**3**
4C	Sketch the Root locus of control system having open-loop transfer function	**5**	**3**	**1**	**1**	**3**

	G(s)H(s) = $\frac{K}{83.33\ (s+0.001)(s+2)(s+6)}$					
5A	Convert the State Space model given below into Differential equation: $\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\\ \dot{X}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -5 & 7 & -3\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}$ U $Y = \begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix}$	**2**	**4**	**1**	**1**	**3**
5B	Draw the electronics circuit of PID Controller, and derive its final control law in terms of error.	**5**	**4**	**1**	**1**	**3**
5C	Find the steady state error of First order system with Integral mode subjected to Unit Step signal. Also, mention the characteristics of PD controller.	**3**	**4**	**1**	**1**	**3**