CBCS SCHEME

USN | | | | | | | | | | |

BEC403

Fourth Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025

Control Systems

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

<table>
<tr><th colspan="3">Module – 1</th><th>M</th><th>L</th><th>C</th></tr>
<tr><td>Q.1</td><td>a.</td><td>Compare open loop and closed loop control system with practical example.</td><td>06</td><td>L2</td><td>CO1</td></tr>
<tr><td></td><td>b.</td><td>For the system shown in Fig.Q1(b). Find the transfer function $G(s) = \frac{\theta_2(s)}{T(s)}$ consider $J_1 = 1$ kgm^2, $K_1 = 1$ Nm/rad, $K_2 = 1$ Nm/rad, $B_1 = 1$ Nm/rad/sec, $B_2 = 1$ Nm/rad/sec.

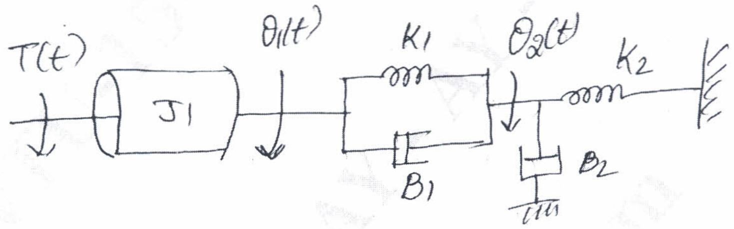


Fig.Q1(b)</td><td>06</td><td>L2</td><td>CO1</td></tr>
<tr><td></td><td>c.</td><td>Draw the mechanical network for the system shown in Fig.Q1(c). Write the equations of performance and draw its analogous circuit based one force voltage analogy.

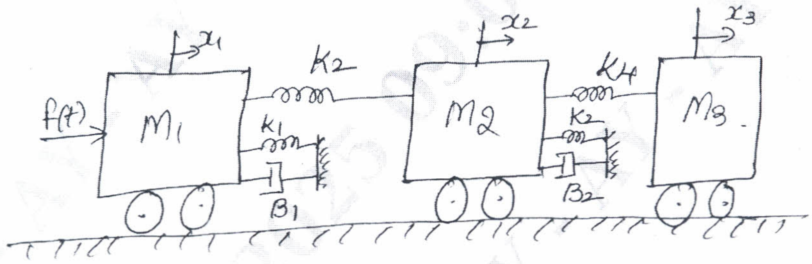


Fig.Q1(c)</td><td>08</td><td>L2</td><td>CO1</td></tr>
<tr><th colspan="6">OR</th></tr>
<tr><td>Q.2</td><td>a.</td><td>The circuit shown in Fig.Q2(a) is called lead-lag filter. Find the transfer function $\frac{V_2(s)}{V_1(s)}$ when $R_1 = 100\ \Omega$, $R_2 = 200\ K\Omega$, $C_1 = 1\ \mu F$ and $C_2 = 0.1\ \mu F$.

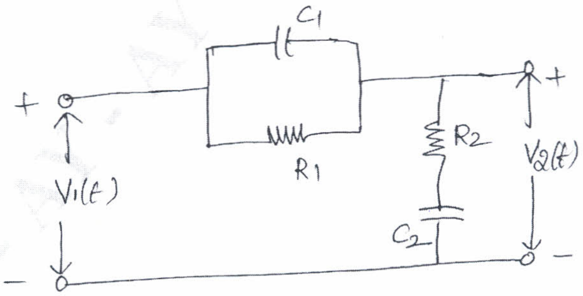
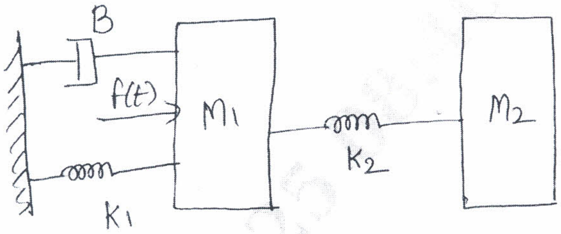
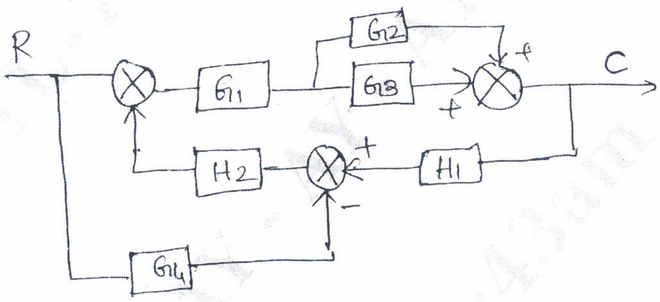
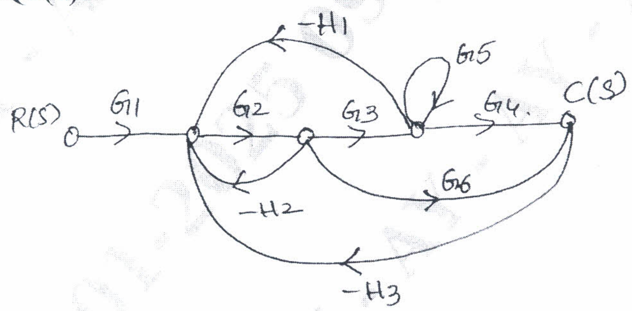
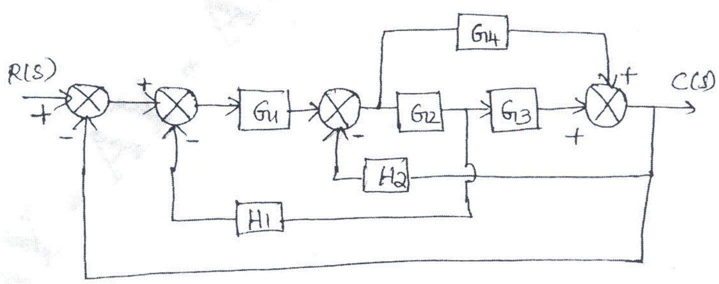
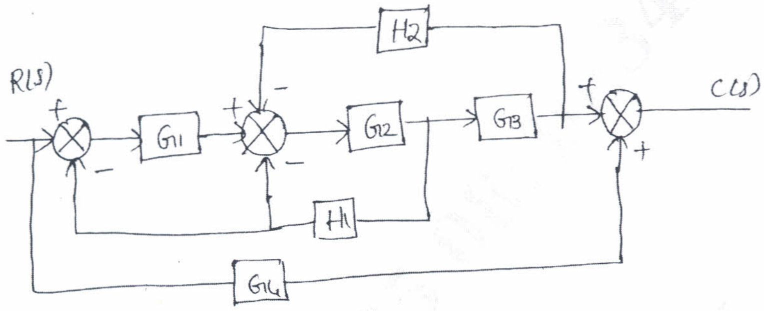
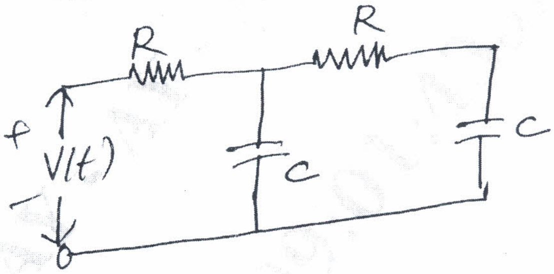


Fig.Q2(a)</td><td>10</td><td>L3</td><td>CO1</td></tr>
</table>

	b.	What are the variables and elements of translational motion? For the mechanical system shown in Fig.Q2(b). (i) Write the differential equations of performance. (ii) Draw and write loop and nodal equations based on F-V and F-I analogous networks.  Fig.Q2(b)	**10**	**L2**	**CO2**
		Module – 2			
Q.3	**a.**	Give any six block diagram reduction rules to find the transfer function of the system.	**04**	**L1**	**CO2**
	b.	For the system represented in the given Fig.Q3(b), determine transfer function C(s)/R(s).  Fig.Q3(b)	**06**	**L2**	**CO1**
	c.	Find the overall transfer function of the system whose signal flow graph is shown in Fig.Q3(c).  Fig.Q3(c)	**10**	**L2**	**CO2**
		OR			
Q.4	**a.**	Interpret the transfer function by converting the block diagram into signal flow graph.  	**10**	**L2**	**CO2**

	b.	Obtain the transfer function for the block diagram shown in Fig.Q4(b) using block diagram reduction technique.  Fig.Q4(b)	**10**	**L2**	**CO2**
		Module – 3			
Q.5	**a.**	Make use of the response curve of 2^{nd} order under-damped system to define and derive the expression for (i) peak time (ii) peak overshoot (iii) rise time	**10**	**L2**	**CO3**
	b.	Find K_p, K_v and K_a for a system having $G(s)=\frac{s+10}{s(s^3+7s^2+12s)}$. Also, evaluate the steady state error, when the I/P r(t) is given by: (i) $r(t)=5u(t)$ (ii) $r(t)=2t\,u(t)$ (iii) $r(t)=4t^2u(t)$	**10**	**L2**	**CO3**
		OR			
Q.6	**a.**	Derive an expression for the under damped response of a second order feedback control system for step input.	**10**	**L2**	**CO2**
	b.	Explain the static error constant and derive the expressions.	**06**	**L2**	**CO2**
	c.	Analyze the effect of PD controller for 2^{nd} order control system with appropriate equations.	**04**	**L2**	**CO2**
		Module – 4			
Q.7	**a.**	The open loop transfer function of a unity feedback system is given by $G(s)=\frac{K}{s(s+3)(s^2+s+1)}$. Find the valve of K that will cause sustained oscillation and hence find the oscillation frequency.	**08**	**L2**	**CO3**
	b.	Sketch the root locus plot for a negative feedback control system whose open loop transfer function is given by $G(s)H(s)=\frac{K}{s(s+1)(s+2)(s+3)}$. For all values of K ranging from 0 to α. Find the value of K for closed loop stability.	**12**	**L3**	**CO3**
		OR			
Q.8	**a.**	For the characteristic equations given below, determine number of roots with positive real part: i) $s^6+s^5+3s^4+2s^3+5s^2+3s+1=0$ ii) $s^8+s^7+4s^6+3s^5+14s^4+11s^3+20s^2+9s+9=0$	**10**	**L2**	**CO4**

	b.	Show that the part of root locus of a system with $G(s)H(s) = \dfrac{K(s+3)}{s(s+2)}$ is a circle having center (–3, 0) and radius at $\sqrt{3}$.	**10**	**L3**	**CO3**
		Module – 5			
Q.9	**a.**	Construct the bode plot for the transfer function $G(s) = \dfrac{80}{s(s+2)(s+20)}$. Determine GM and PM, ω_{pc}, ω_{gc}.	**10**	**L2**	**CO3**
	b.	Obtain the state transmition matrix for the following system: $\begin{bmatrix} x_1^{'} \\ x_2^{'} \end{bmatrix} = \begin{bmatrix} -1 & -0.5 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u$	**10**	**L2**	**CO5**
		OR			
Q.10	**a.**	Using Nyquist stability criteria investigate the stability negative feedback control system whose open loop transfer function is given by $G(s)H(s) = \dfrac{100}{(s+1)(s+2)(s+3)}$. Assume $\omega_g = 1.253$ rad/sec.	**10**	**L2**	**CO5**
	b.	Obtain the state model of electrical network shown in Fig.Q10(b), by choosing $V_1(t)$ and $V_2(t)$ as state variables.  Fig.Q10(b)	**10**	**L3**	**CO5**

* * * * *