CBCS SCHEME

USN ☐☐☐☐☐☐☐☐☐☐

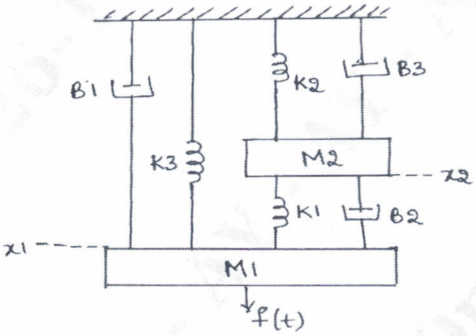
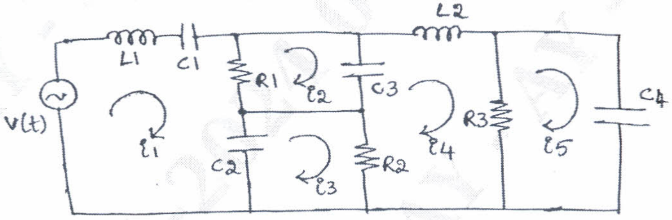
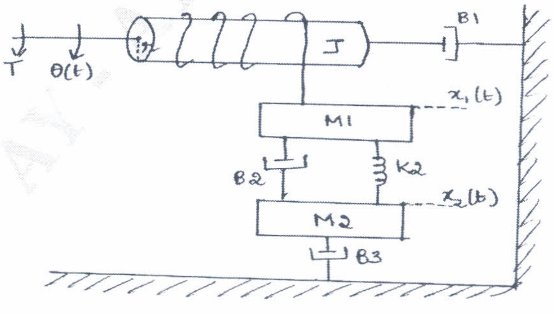
BEC403

Fourth Semester B.E./B.Tech. Degree Supplementary Examination, June/July 2024

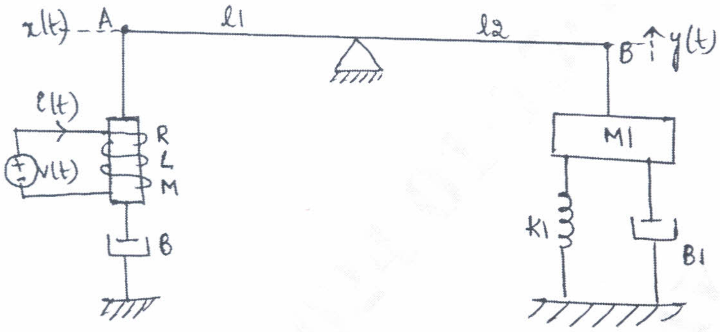
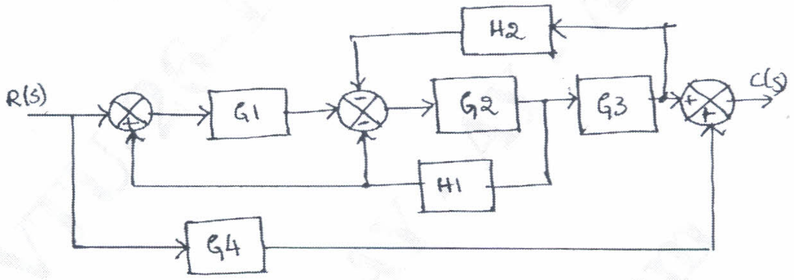
Control Systems

Time: 3 hrs. Max. Marks: 100

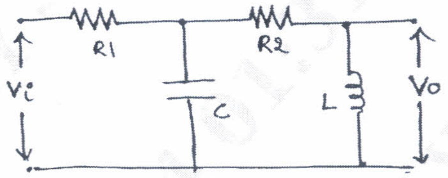
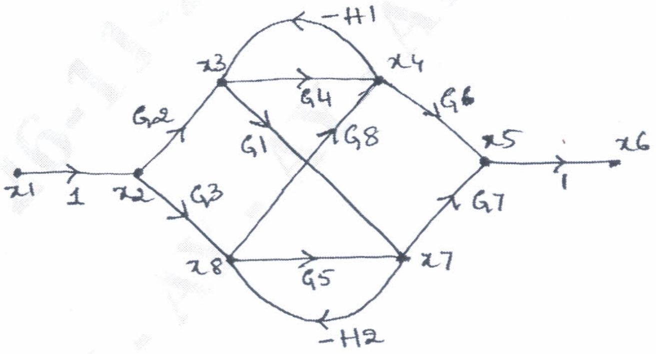
Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	**M**	**L**	**C**
Q.1	**a.**	For the mechanical system shown in Fig.Q1(a), (i) Draw the nodal equivalent circuit (ii) Write the differential equations governing its dynamic behaviour (iii) Write the force voltage and force current analogous electrical networks along with equations.  Fig.Q1(a)	**10**	**L3**	**CO3**
	b.	Compare open loop and closed loop control system with example.	**10**	**L1**	**CO2**
		OR			
Q.2	**a.**	The force voltage analogy of the translational mechanical system is given below Fig.Q2(a). Obtain its analogous mechanical system. Also write the differential equations governing the mechanical system.  Fig.Q2(a)	**10**	**L4**	**CO4**
	b.	For the mechanical shown in Fig.Q2(b), i) Construct the nodal equivalent circuit and write the differential equations governing its dynamic behaviour. ii) Develop force voltage and force current analogous circuit. Also write the differential equations governing the system.  Fig.Q2(b)	**10**	**L3**	**CO4**

Module – 2

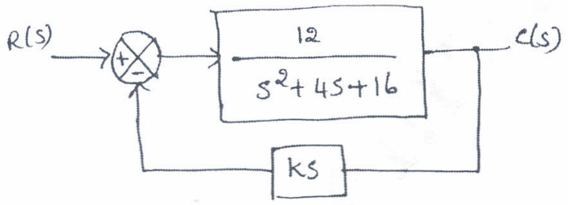
Q.3	**a.**	For the electro-mechanical system shown in Fig.Q3(a), determine the transfer function Y(s)/V(s).  Fig.Q3(a)	**10**	**L3**	**CO4**
	b.	Apply block diagram reduction technique to find the transfer function C(s)/R(s) for the system shown in Fig.Q3(b).  Fig.Q3(b)	**10**	**L3**	**CO4**

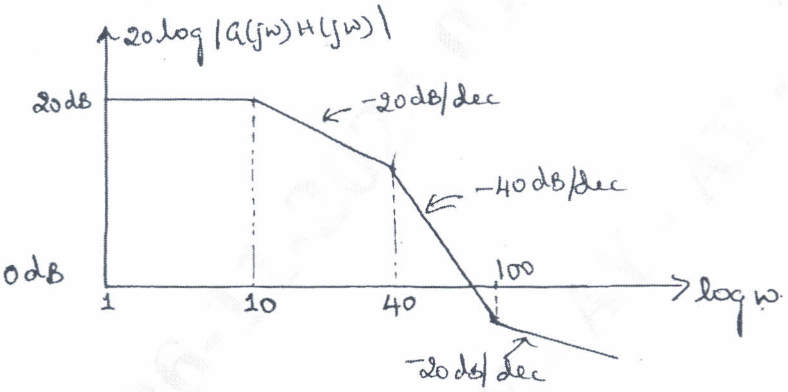
OR

Q.4	**a.**	Construct the signal flow graph for the electrical network shown in Fig.Q4(a) and obtain the transfer function using Mason's gain formula.  Fig.Q4(a)	**10**	**L3**	**CO4**
	b.	For the signal flow graph shown in Fig.Q4(b), determine the transfer function x_6 / x_1 using Mason's gain formula.  Fig.Q4(b)	**10**	**L3**	**CO4**

Module – 3

Q.5	**a.**	Derive the expression for output response for a second order under-damped system with step input. Also plot the response and comment on the stability.	**10**	**L2**	**CO1**

	b.	A feedback control system shown in Fig.Q5(b) has a damping factor of 0.8. Determine the constant K and all time domain specifications.  Fig.Q5(b)	**06**	**L3**	**CO3**
	c.	A control system with open loop transfer function $\frac{K(s+2)}{s^2+10s+20}$ produces 20% steady state error with step input. Determine the value of constant K.	**04**	**L3**	**CO4**
		OR			
Q.6	**a.**	Derive the expressions for peak response time t_p and peak overshoot M_p of an underdamped second order control system subjected to step input.	**08**	**L2**	**CO2**
	b.	The open loop transfer function of a feedback control system is $\frac{K}{s+1}$. Determine the error series and steady state error when inputs are (i) $r(t) = a + bt + ct^2 + de^{-t}$ (ii) $r(t) = \sin 0.1t$	**08**	**L3**	**CO3**
	c.	Write short notes on proportional plus derivative control (PD Control).	**04**	**L1**	**CO1**
		Module – 4			
Q.7	**a.**	Find the range of K for which the system with closed loop transfer function $\frac{K}{s(s^2+s+1)(s+2)+K}$ is stable. For what K, the system oscillates and what is the corresponding frequency of oscillation.	**06**	**L3**	**CO3**
	b.	Construct the root locus of a control system with characteristic equation $(s^2 + 2s + 2) + K(s + 4) = 0$. Determine the stability of closed loop system. Show that a part of the root locus is a circle of radius $\sqrt{10}$ units with centre at (-4 , 0).	**14**	**L3**	**CO4**
		OR			
Q.8	**a.**	A unity feedback system has open loop transfer function of $\frac{K(s+13)}{s(s+3)(s+7)}$ (i) Determine the range of K for which the system is stable. (ii) Determine the range of K such that it has roots more negative than $s = -1$	**08**	**L3**	**CO3**
	b.	Construct the root locus of a control system with open loop transfer function of $\frac{K}{s(s+3)(s^2+2s+2)}$. Determine the stability of closed loop system.	**12**	**L3**	**CO4**
		Module – 5			
Q.9	**a.**	The closed loop transfer function of a feedback control system is $\frac{100}{s^2+8s+100}$ Determine resonant peak and resonant frequency.	**04**	**L3**	**CO4**

	b.	Open loop transfer function of a unity feedback control system is $\frac{80}{s(s+2)(s+20)}$ Draw the Bode plot and determine the gain margin, phase margin, gain cross over frequency and phase crossover frequency.	**10**	**L3**	**CO4**
	c.	Determine the transfer function of a given system whose Bode Magnitude plot is shown in Fig.Q9(c).  Fig.Q9(c)	**06**	**L3**	**CO4**
		OR			
Q.10	**a.**	Construct the Nyquist plot for a control system with open loop transfer function $\frac{K(s+1)}{s(s-1)}$. From the plot, determine the stability of closed loop system.	**08**	**L3**	**CO4**
	b.	The transfer function of a control system is given by $\frac{Y(s)}{U(s)}=\frac{s^2+3s+4}{s^3+2s^2+3s+2}$ Obtain state model using signal flow grpah.	**06**	**L3**	**CO3**
	c.	Obtain state model by direct decomposition method for a system with transfer function $\frac{Y(s)}{U(s)}=\frac{5s^2+6s+8}{s^3+3s^2+7s+9}$	**06**	**L3**	**CO3**

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