University Institute of Engineering & Technology

(Recognised Under Section 2(f) and 12B of UGC)

Kurukshetra University, Kurukshetra

THEORY EXAMINATION – JULY 2021	
B.TECH – ECE	**SEMESTER – VI**

TIME – 4 Hrs.

M.M. -75

PAPER - EC-302

SUBJECT- Control System Engineering

INSTRUCTIONS TO BE FOLLOWED

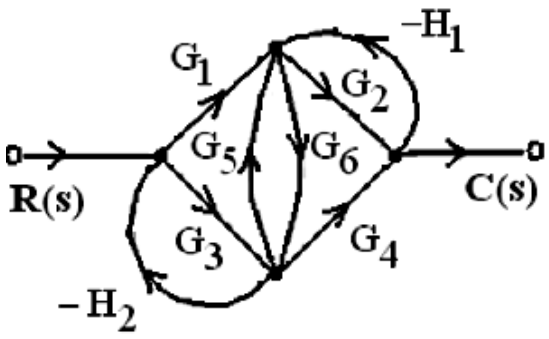
- **The candidates will be required to attempt All questions in Part-A and Part-B (Compulsory Sections). Attempt any four questions from Part-C selecting at least one from each unit.**
- **Allotted time for examination is 4 hours that includes time for downloading the question paper, writing answers, scanning of answer sheets and uploading the sheets on the Attendance Sheet Cum Answer Sheet Uploading google form.**
- **The PDF files should be saved as Roll No. and Subject Code.**
- **Maximum Page Limit should be 36 (Thirty Six) for attempting the question paper on A4 sheets which could be downloaded and printed from the sample sheets given in the UIET Website.**
- **Over-attemptation should be avoided.**
- **Handwriting should be neat and clean and diagrams should be clear and contrasted.**
- **The candidate should not write their Mobile No. otherwise Unfair Means Case will be made.**
- **While attempting the paper, the candidate will use blue/black pen only.**
- **Before attempting the paper, the candidate will ensure that he/she has downloaded the correct question paper. No complaint for attempting wrong question paper by the candidate will be entertained.**
- **Candidate must ensure that he/she has put his/her signature on each page of the answer sheet used by him/her. Answer sheet without the signature of the candidate will not be evaluated.**
- **Attempt parts A, B & C separately. Do not inter-mix them. Write neatly & mention the question number clearly.**

PART-A (15 Marks)

Q. No. – 1 Answer the following questions. 15x1=15

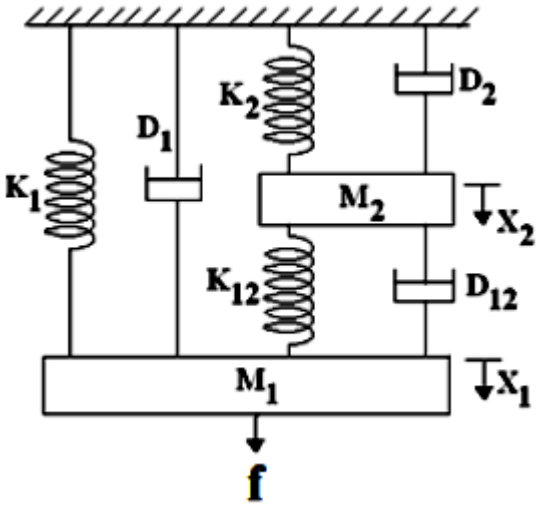
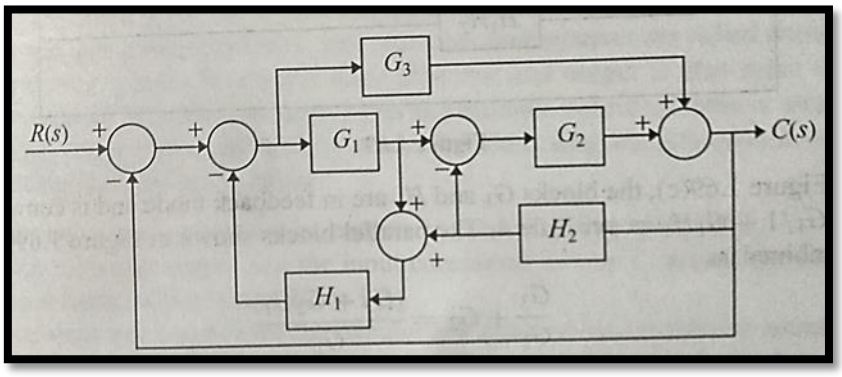
(i)	What is the steady state value of the unit step response of the system given by $d^2y(t)/dt^2 + 16dy(t)/dt + 15y(t) = du(t)/dt + 3u(t)$?
(ii)	The governing equation of a first order LTI system is $dy(t)/dt + 2y(t) = u(t)$. Calculate the settling time?
(iii)	Evaluate the zeros of the transfer function of the system whose governing equation is $d^2y(t)/dt^2 + 5dy(t)/dt + 4y(t) = d^2u(t)/dt^2 + 2du(t)/dt - 3u(t)$?
(iv)	A second order system is governed by $d^2y(t)/dt^2 + 4dy(t)/dt + 6y(t) = u(t)$. Calculate the frequency (in rad/s) of oscillations in the unit step response of the system?
(v)	The open loop transfer function of a negative feedback closed loop system be $\frac{K}{S^3 + 2S^2 + 2S}$ Calculate the angles (in °) made by the asymptotes with the positive real axis and the point of intersection of the asymptotes?
(vi)	The open loop transfer function of a negative feedback closed loop system is $\frac{K}{S^2 + 6S}$ For what value of 'K' the closed loop system is stable? 'K' is a real valued parameter.
(vii)	In order to draw the Bode Plot what is the corner frequency (in rad/s) of the system whose transfer function is $\frac{1}{S^2+3S+6}$?
(viii)	As frequency is varied from 0 to ∞, the Nyquist plot of $\frac{1}{S+2}$ is a semi-circle whose radius is?
(ix)	As the frequency is varied from 0 to ∞, the Nyquist plot of $\frac{S+10}{S+2}$ lies in which quadrant of the complex plane?
(x)	Measurement conducted on a system when it is subjected to a unit step input, show the system response as $C(t) = 1+0.2e^{-60t} - 1.2\ e^{-10t}$. Calculate the damping ratio of the system?
(xi)	Consider a plant whose transfer function is $\frac{1}{S(S+4)}$. It is desired that a lead compensator is used to design a unity negative feedback closed loop system with this plant. If a maximum phase lead angle of 30^0 be provided at a frequency of 5 rad/s, then calculate the approximate value of T?
(xii)	Calculate the steady state error for a step input applied to a unity feedback system with open loop transfer function as $G(s) = \frac{10}{S^2+14S+50}$?
(xiii)	Name only one technique to reduce the steady state error in a system?
(xiv)	What is the value of gain at gain cross over frequency?
(xv)	Evaluate the STM for the given system matrix as $A= \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

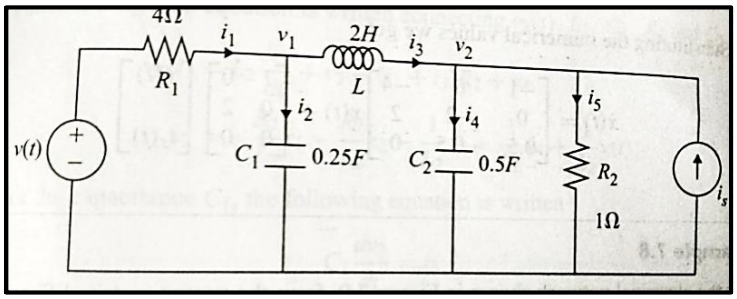
PART-B (20 Marks)

	UNIT-I	
2	Find the overall transfer function by using Mason's gain formula for the signal flow graph shown below?  	**5**
	UNIT-II	
3	The closed loop transfer function is given by $$G(s) = \frac{1.68}{S^3 + 12.3S^2 + 3.74S + 1.68}$$ Determine the response of the system when unit step is applied at the input?	**5**
	UNIT-III	
4	Determine the stability of the system for K =1 and K =2 using Nyquist Plot , whose open loop transfer function is given as: $$\boldsymbol{G(S)H(s) = \frac{K(S+1)}{(S+0.5)(S-2)}}$$	**5**
	UNIT-IV	
5	For the system described by the state equation $$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.5 & 1 & 2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$ If the control signal is given by u = [-0.5 -3 -5]x + v then calculate the eigen values of the closed loop system?	**5**

PART-C (40 Marks)

	UNIT-I	
6	Determine the system equations for the system as shown in figure below?	**10**

		
7	For the given block diagram find the overall transfer function using the block diagram reduction technique ? 	**10**
	UNIT-II	
8	(i) Find the dynamic error coefficients of a unity feedback system whose open loop transfer function $$\boldsymbol{G(S) = \frac{10}{S(0.1S+1)}}$$ When the system is subjected to input r(t) = $A_0+A_1t + (A_2/2)t^2$? (ii) The open loop transfer function of a unity feedback system is given by $$G(S) = \frac{K}{(S+2)(S+4)(S^2+6S+25)}$$ Using Routh Criterion discuss the stability of the closed loop system as function of 'K'. Determine the values of 'K' and 'ω' which will cause sustained oscillations?	**5.** **5.**
9	Sketch the root locus of the open loop transfer function $\frac{K(S^2+6S+25)}{S(S+1)(S+2)}$ as 'K' varies from 0 to ∞?	**10**
	UNIT-III	
10	Describe the correlation between time and frequency response using necessary expressions?	**10**
11	Consider the following transfer function and sketch the BODE plot and determine the gain cross over frequency and determine the position error constant?	**10**

	$G(s) = \dfrac{3000}{(S+2)(1+s/10)(S+50)}$	
	UNIT-IV	
12	For the electrical network form the state equations and state model? 7. 	**10**
13	The open loop transfer function of an uncompensated system is $$\boldsymbol{G(s) = \frac{5}{S(S+2)}}$$ Design a lead compensator for the system so that the static velocity error constant $K_v \geq 20$ Sec^{-1}, the phase margin is at least 55^0 and the gain margin is at least 12dB?	**10**