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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (R,S) (FT/WP)(S3 PT) Examination November 2025 (2019 Scheme)

Course Code: ECT307

Course Name: CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

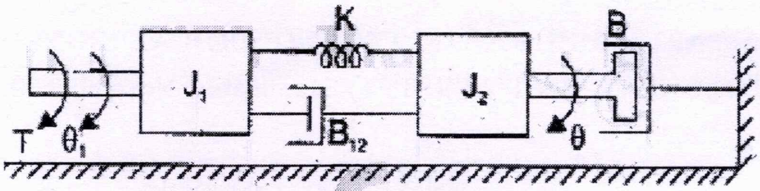
1	Compare open loop and closed loop control systems.	3
2	Draw the signal flow graph for the following algebraic equations. $x_1 = ax_0+ex_2+fx_3$, $x_2 = bx_1+hx_4$, $x_3 = cx_2+gx_3$, $x_4 =dx_3$	3
3	Sketch the time response of a second order system to unit step input for different values of ς.	3
4	Derive the expression for steady state error of a closed loop control system.	3
5	Compare PI, PD and PID controllers.	3
6	Discuss the effects of adding poles and zeros to a transfer function.	3
7	Draw the bode plot for transfer function G(s) = 1+sT	3
8	Write note on lag compensator.	3
9	Obtain the state space representation of the differential equation $a\frac{d^2x(t)}{dt^2} + b\frac{dx(t)}{dt} + cx(t) = u(t)$	3
10	Derive the expression for transfer matrix from state space model.	3

PART B

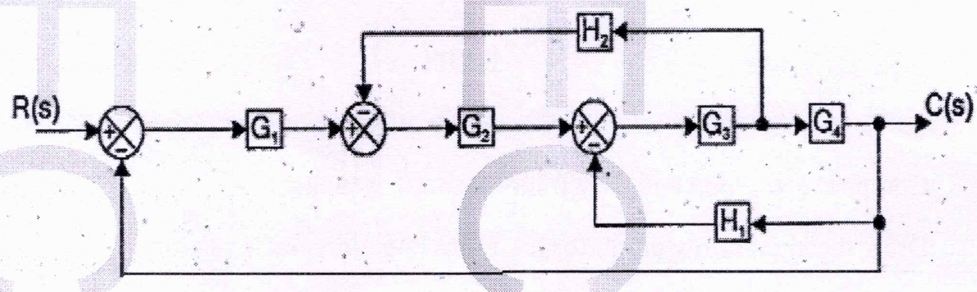
(Answer one full question from each module, each question carries 14 marks)

Module -1

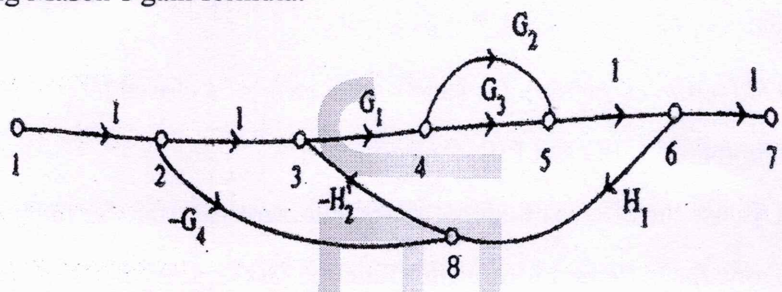
11	a)	Obtain the transfer function of a series RLC circuit.	5
	b)	Determine the transfer function of the mechanical rotational system shown in figure.	9



12 a) Compute $\frac{C(s)}{R(s)}$ using block diagram reduction rules. 6



b) State Mason's gain equation and obtain the transfer function of the given system using Mason's gain formula. 8



Module -2

13 a) Derive the expression for time response of an underdamped second order system. 8

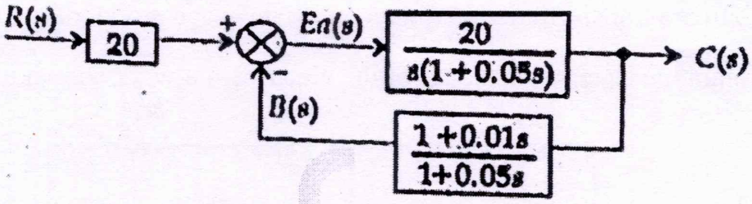
b) A unity feedback system is characterized by an open loop transfer function 6

$G(s) = \frac{K}{s(s+1)(0.1s+1)}$ and r(t) = 10t. If K= 2, determine steady state error.

Find the minimum value of K for $e_{ss}(t) < 0.1$ for a unit ramp input.

14 a) Discuss the correlation between time domain and frequency domain response of control systems. 6

b) Determine the actuating signal $E_a(s)$ for the system shown in figure. Also find the position error constant for unit step input. 8



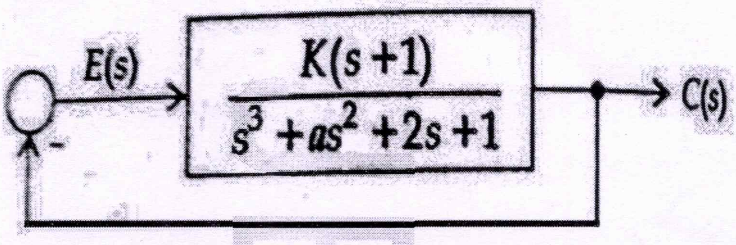
Module -3

15 a) Describe the terms absolute stability and relative stability 5

b) Sketch the root locus for the open-loop transfer function of a unity feed back control system given below and determine (i) the value of K for $\varsigma = 0.5$ (ii) the value of K for marginal stability 9

$$G(s) = \frac{K}{s(s+1)(s+3)}$$

16 a) Determine the value of K and a so that the system shown in figure oscillates at a frequency of 2 rad/sec. 8



b) Define root locus. Describe the procedure for plotting root locus. 6

Module -4

17 a) State and explain Nyquist stability criteria. 4

b) Sketch the Bode plot for the following transfer function and determine the system gain K if the gain cross over frequency of the system is 10 rad/sec. 10

$$G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}$$

18 Design a suitable lead compensator for a unity feedback system with 14

$G(s) = \frac{K}{s(s+1)}$ so as to satisfy the following specifications.

(i) The phase margin of the system $\geq 45°$.

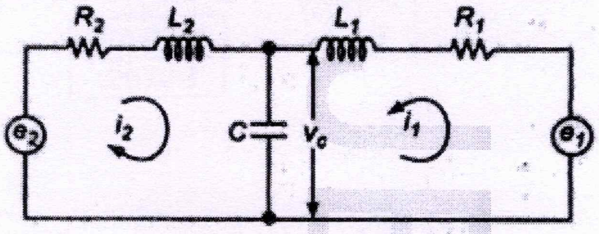
(ii) Steady state error for unit ramp input $\leq 1/15$

(iii) Gain cross over frequency of the system must be less than 7.5 rad/sec

Module -5

19 a) Compare transfer function model and state space model of control systems. 4

b) Obtain the state space model of the electrical network shown in figure. 10



20 a) List the properties of state transition matrix. 8
Compute the state transition matrix when $A = \begin{bmatrix} -1 & 1 \\ 0 & 2 \end{bmatrix}$

b) Analyze the controllability and observability of a system represented by the state space model. 6

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

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