

Reg No.: _____

Name: _____

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

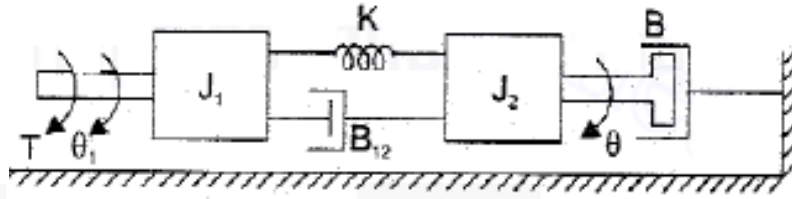
PART A*(Answer all questions; each question carries 3 marks)*

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 ζ . | 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 |

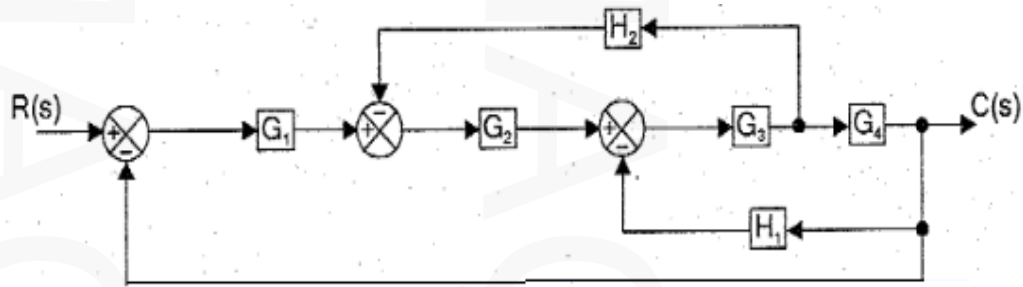
PART B*(Answer one full question from each module, each question carries 14 marks)***Module -1**

- | | | |
|----|---|---|
| 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 |



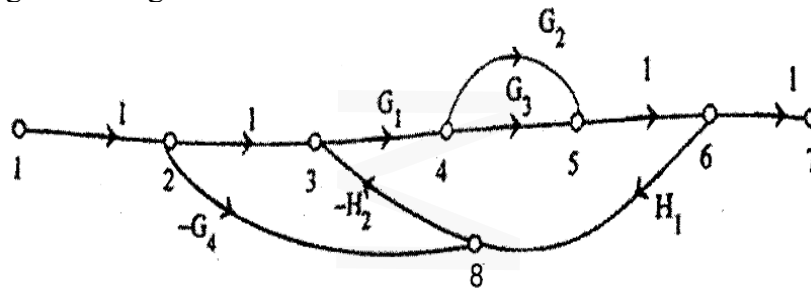
- 12 a) Compute $\frac{C(s)}{R(s)}$ using block diagram reduction rules.

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.
- b) A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{K}{s(s+1)(0.1s+1)}$ and $r(t) = 10t$. If $K=2$, determine steady state error.

8

6

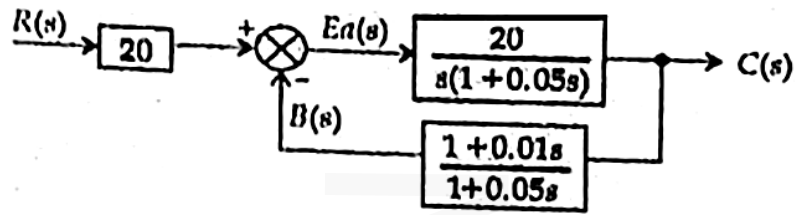
Find the minimum value of K for $e_{ss}(t) < 0.1$ for a unit ramp input.

- 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

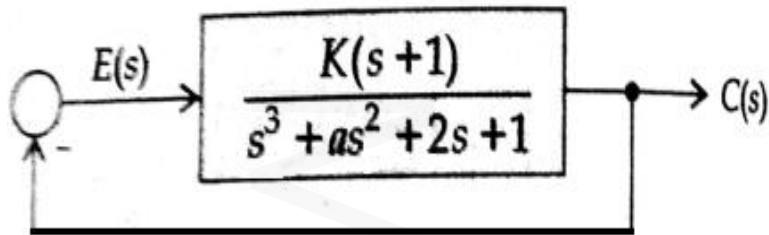


Module -3

- 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 $\zeta = 0.5$ (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

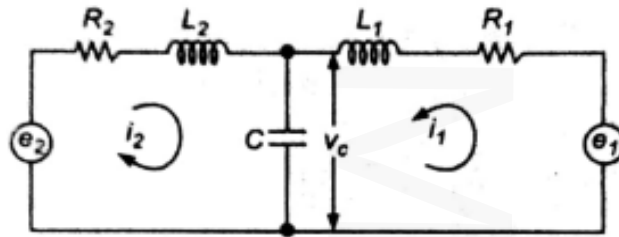
$$G(s) = \frac{Ks^2}{(1 + 0.2s)(1 + 0.02s)}$$

- 18 Design a suitable lead compensator for a unity feedback system with $G(s) = \frac{K}{s(s+1)}$ so as to satisfy the following specifications. 14

- (i) The phase margin of the system $\geq 45^\circ$.
- (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

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

$$Y = [1 \quad 0 \quad 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$
