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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (S,FE) (FT/WP/S3PT) Examinations June 2026 (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 Obtain the electrical equivalency showing circuit and expression corresponding to the given mechanical expression $f = m * a$. where, f is the force, m is the mass and a is the acceleration (3)

2 Compare the features of open loop and closed loop control systems. Give example. (3)

3 A unity feedback control system having the following forward path transfer function is fed by unit step function. (3)

$$G(s) = \frac{144}{s(s+12)}$$

Determine its 1) natural frequency and 2) damping ratio

4 Determine the transfer function and hence order of a system described by the following: (3)

i) it has two zeros at $s = -2$ and $s = 1$,

ii) type number is 2

iii) it contains poles at $s = -1$ and $s = \pm 2j$

5 For the given characteristic equation, comment on the system stability and find the number of roots in right half of s-plane. (3)

$$F(s) = s^5 + s^4 + 10s^3 + 72s^2 + 152s + 240 = 0$$

6 Explain the effect of addition of zeros in a system to its root locus and system stability. (3)

7 Define the terms phase margin and gain margin. Give the value of gain margin in dB for marginally stable system? (3)

8 Starting with the principle of argument, Explain Nyquist stability criterion. (3)

9 Define state transition matrix. Mention any four properties of it. (3)

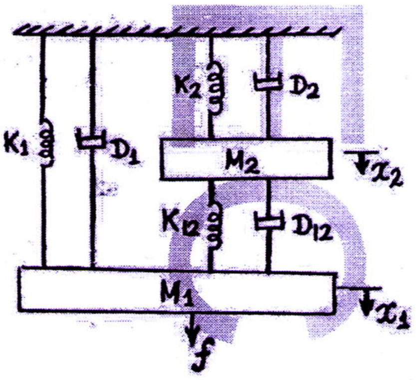
10 Define the terms controllability and observability of a system. (3)

PART B

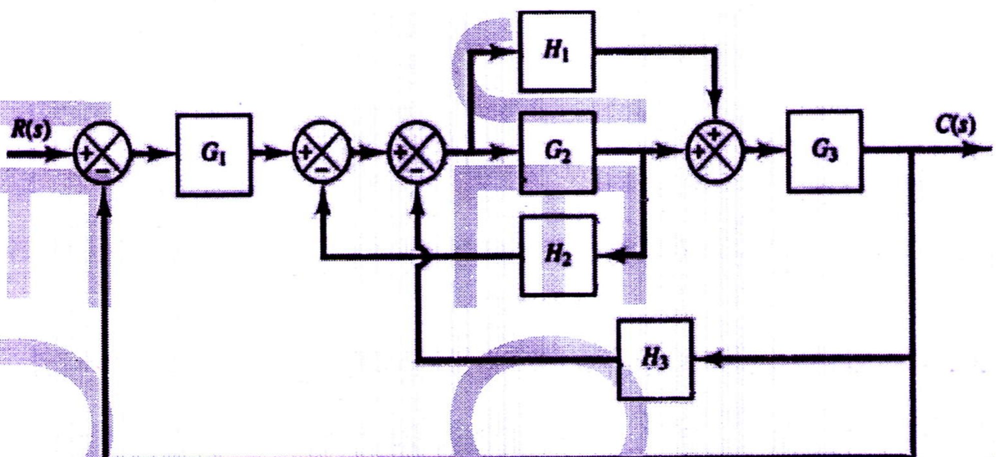
(Answer one full question from each module, each question carries 14 marks)

Module -1

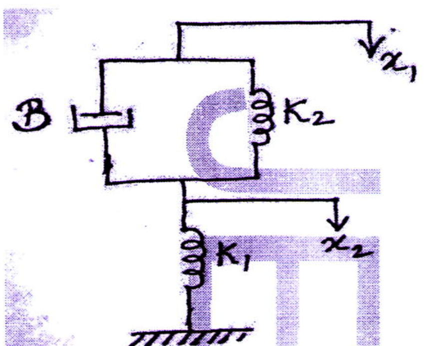
11 a) Obtain the differential equations governing the mechanical system shown below and draw the *force-voltage* electrical analogous circuit (7)



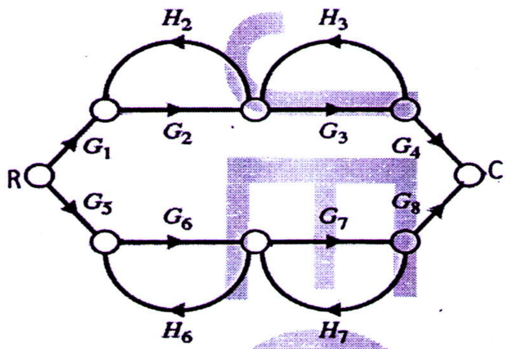
b) Find the transfer function of the given system using block diagram reduction method. (7)



12 a) Obtain the differential equations governing the mechanical system shown below and draw the *force-voltage* electrical analogous circuit. (7)



b) Obtain overall transfer function for the given system using Mason's gain formula (7)



Module -2

13 a) A unity feedback system has the following open loop transfer function, where **K** and **T** are constants. Determine the factor by which **K** should be multiplied so that damping ratio is increased from 0.3 to 0.9. (8)

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

b) The open loop transfer function of a unity feedback system is given as follows. (6)

$$G(s) = \frac{100}{s^2(s+4)(s^2+3s+12)}$$

Find the static error coefficients and steady state error of the system when subject to an input given by $r(t) = 2 + 5t + 2t^2$

14 a) A feedback system is described by the following transfer functions. The damping factor of the system is 0.8. Determine the value of K, maximum overshoot, peak time and settling time of the system. (8)

$$G(s) = \frac{12}{s^2+4s+16} \text{ and } H(s) = Ks.$$

b) Obtain the steady state error for a unit ramp input of the unity feedback systems with the following closed loop transfer function: (6)

$$\frac{C(s)}{R(s)} = \frac{\omega_n{}^2}{s^2 + 2\,\delta\omega_n s + \omega_n{}^2}$$

Module -3

15 a) With block schematic diagram, Explain PI and PD controllers. Mention the advantages of PID controllers. (5)

b) Sketch root locus for the given open loop transfer function (9)

$$G(s)H(s) = \frac{K}{s(s+4)(s^2+4s+20)}$$

Find the value of K for marginal stability.

16 a) A unity feedback system with forward transfer function is given here. Using R.H criteria, determine values of **K** for system stability. Also find the frequency of sustained oscillation in rad/sec. (5)

$$G(s) = \frac{K}{s(1+0.6s)(1+0.4s)}$$

b) Sketch the root locus for the given open loop transfer function and find the value of K and ω for marginal stability where $K>0$. (9)

$$G(s)H(s) = \frac{K}{s(s+3)(s+5)}$$

Module -4

17 a) Apply Nyquist stability criterion and find gain margin of the system with open loop transfer function given by (4)

$$G(s)H(s) = \frac{10}{(s+1)(s+2)(s+3)}$$

Also find the maximum values of ***K*** for which the system is just stable.

b) A unity feedback control system with given G(s), Draw the Bode plot. Find the gain margin and phase margin. Also check for the stability. (*Use semi-log sheet*) (10)

$$G(s) = \frac{40}{s(s+2)(s+5)}$$

18 a) Explain the design procedure of phase lag compensator using Bode plot method. (5)

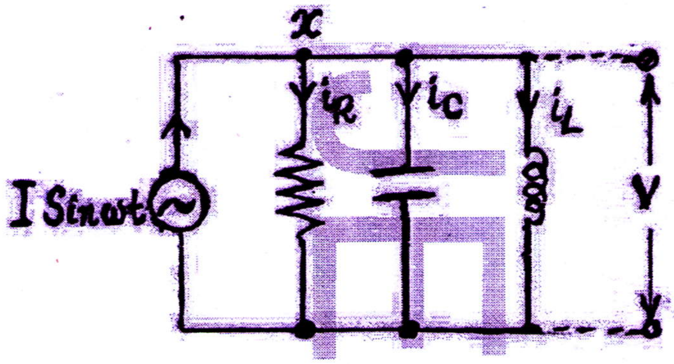
b) Draw Nyquist plot and hence determine the stability of closed loop system whose open loop transfer function is (9)

$$G(s)H(s) = \frac{s+2}{(s+1)(s-1)}$$

Also comment on the open loop stability.

Module -5

19 a) Obtain the state model for the electrical network shown. (6)



b) Determine the transfer function for the system described by the following state variable model. (8)

$$\dot{X} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U; \quad Y = [0 \quad 1 \quad 0]\, X$$

20 a) The state equation and initial condition vector of a linear time-invariant system are given below. Determine the solution of state equation. (7)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad ; \quad x_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

b) Check the controllability and observability of the following system. (7)

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U; \quad Y = [1 \quad 0]\, X$$

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