

Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: EC409

Course Name: CONTROL SYSTEMS

Max. Marks: 100

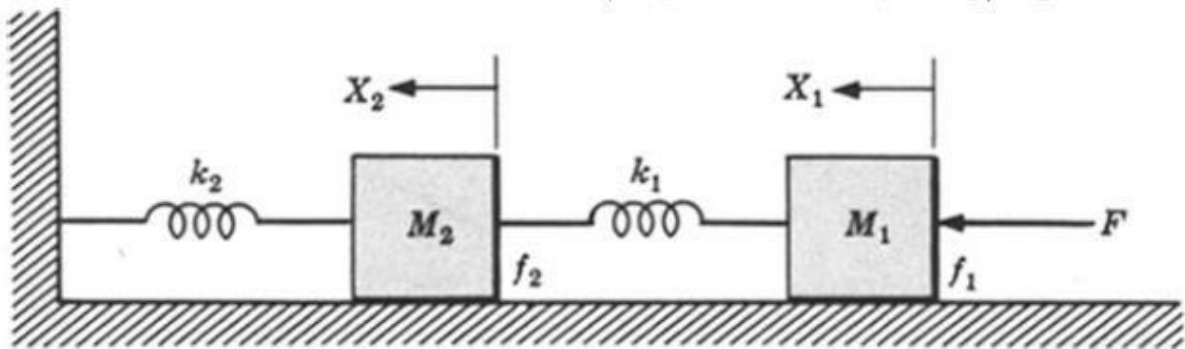
Duration: 3 Hours

PART A

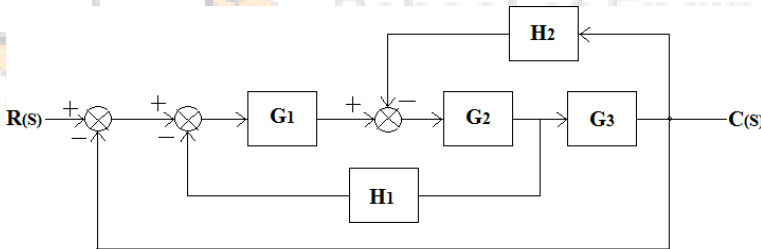
Answer any two full questions, each carries 15 marks.

Marks

- 1 a) Write the differential equations governing the mechanical system. (5)



- b) Obtain the transfer function of the system shown in fig.(3) using block diagram reduction techniques (10)



- 2 a) The forward path transfer function of a unity feedback control system is given by $G(s) = \frac{4}{s(s+5)}$ (5)

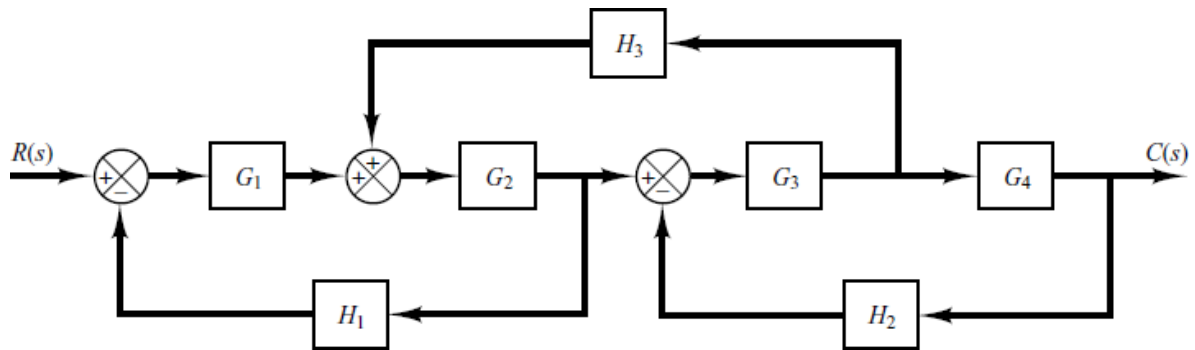
.Obtain the response of the system to unit step input.

- b) A unity feedback control system has an open loop transfer function $G(S) = \frac{10}{s(S+2)}$. Find the (5)

rise time and peak time for a step input of 12 units.

- c) Obtain the time response of a first order system to ramp input and find the steady state error. (5)

- 3 a) Find the transfer function of the given system using block reduction technique. Verify the result using Mason's gain equation (10)



- b) Derive an expression for the maximum percentage overshoot of a second order under damped system. (5)

PART B

Answer any two full questions, each carries 15 marks.

- 4 a) What are frequency domain specifications? Define any three. (5)
 b) A unity feedback control system has an open loop transfer function (10)
 $G(s) = K(s+9) / s(s+3)(s+5)$. Sketch the root locus.
- 5 a) What are Bode plots? What are its advantages. How is stability determined from Bode plots. (5)
 b) Plot the Bode diagram for the following transfer function (10)

$$G(S) = KS^2 / (1+0.2S)(1+0.02S)$$

Determine the value of K for a gain cross over frequency of 20 rad/sec.

- 6 a) Draw the Nyquist plot for the system whose open loop transfer function is (8)

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

. Determine the range of K for which the closed loop system is stable.

- b) The open loop transfer function of certain unity feedback control system is given by (7)

$$G(s) = \frac{K}{s(s+4)(s+80)}$$

. It is desired to have the phase margin to be at least 33° and the velocity error constant $K_v = 30$ per sec. Design a phase lag series compensator.

PART C

Answer any two full questions, each carries 20 marks.

- 7 a) Construct the state model for the system described by (10)

$$\ddot{y} + 7\dot{y} + 5y + 6 \int_0^t y \cdot dt = \dot{u} + 3u + 2 \int_0^t u \cdot dt$$

- b) The transfer function of a control system is given by $\frac{Y(s)}{U(s)} = \frac{s+2}{s^3+9s^2+26s+24}$. Check (10)
for controllability and observability.

- 8 a) Check for stability of the system using Jury's Test (10)

$$Q(z) = z^3 - 1.8z^2 + 1.05z - 0.20 = 0$$

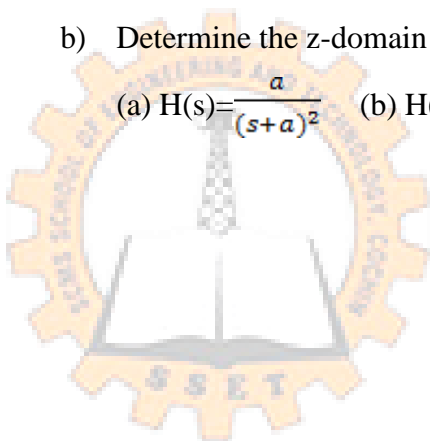
- b) Derive Discrete Time Approximation of a Continuous Time State Space Model for the state equations (10)

- 9 a) Obtain the state model for the given transfer function (10)

$$\frac{Y(s)}{U(s)} = \frac{1}{s^2 + s + 1}$$

- b) Determine the z-domain transfer function for the following s-domain transfer functions (10)

(a) $H(s) = \frac{a}{(s+a)^2}$ (b) $H(s) = \frac{a}{s^2 - a^2}$



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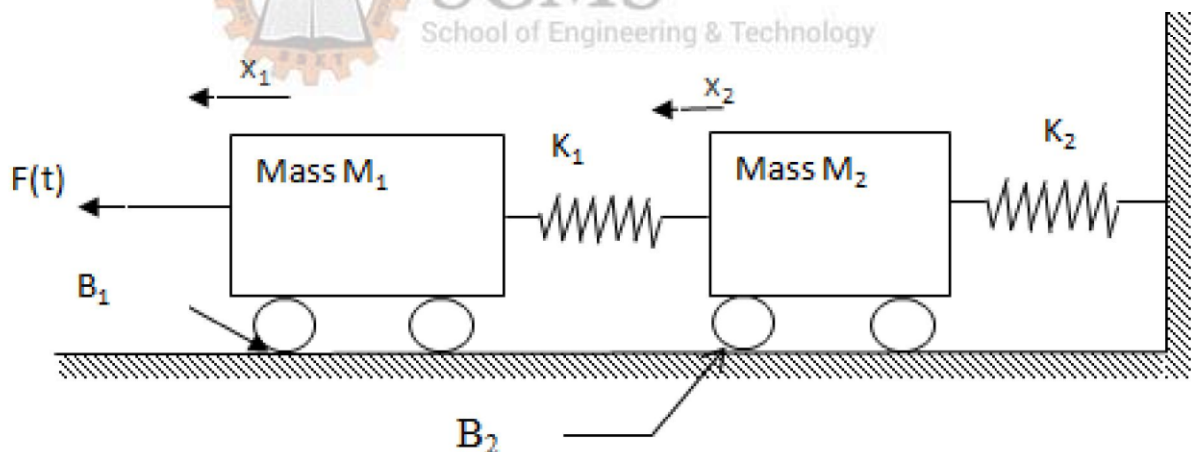
PART A

Answer any two full questions, each carries 15 marks.

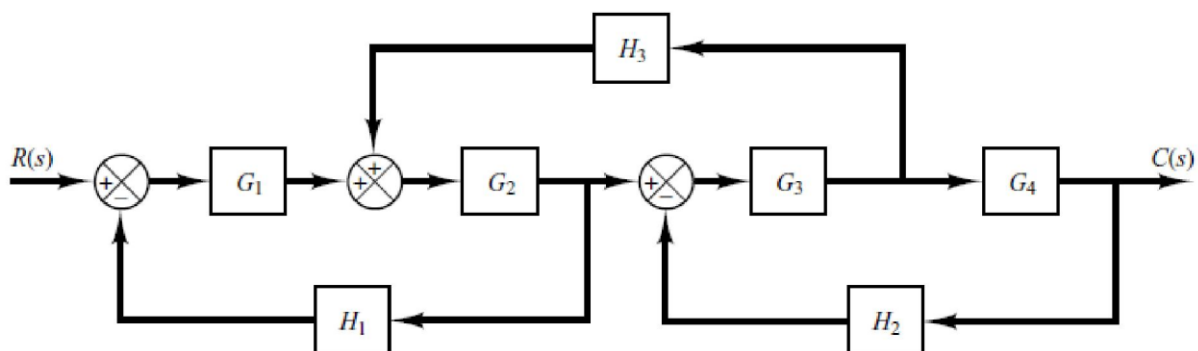
- 1 a) Draw the signal flow graph for the following sets of algebraic equations. (5)

$$x_1 = ax_0 + bx_1 + cx_2, \quad x_2 = dx_1 + ex_3, \quad x_3 = fx_0 + gx_2, \quad x_4 = hx_3$$

- b) Find the transfer function $\frac{x_2(s)}{F(s)}$. Also draw the force voltage analogy of the given system (10)



- 2 a) Explain how the overall transfer function of a system can be found by using Mason's gain formula. (5)
- b) Derive an expression for peak time of a second order system. (5)
- c) Derive an expression for time response of a second order under damped system to step input. (5)
- 3 a) Find the transfer function of the given system using block reduction technique. Verify the result using Mason's gain equation (10)



- b) Determine the step, ramp and parabolic error constants for the unity feedback control system. (5)
- $$G(S) = \frac{10(S+2)}{(S+1)s^2}$$

PART B

Answer any two full questions, each carries 15 marks.

- 4 a) Using Routh Hurwitz criterion, determine the number of roots in the right half of S-plane (5)
- $$S^4 + 2S^3 + 10S^2 + 20S + 5 = 0$$
- b) Sketch the root locus for $G(s)H(s) = \frac{K}{c(c+6)(c^2+4c+13)}$ (10)
- 5 a) Compare PI, PD and PID controllers. (5)
- b) Plot the Bode diagram for the following transfer function and find the Gain margin and Phase margin. (10)

$$G(S) = 10 / S(1+0.4S)(1+0.1S)$$

- 6 a) Draw the Nyquist plot for the system whose open loop transfer function is (8)
- $$G(s)H(s) = \frac{K}{c(c+2)(c+10)}$$
- Determine the range of K for which the closed loop system is stable.
- b) Describe the design procedure of a lead compensator. (7)

PART C

Answer any two full questions, each carries 20 marks.

- 7 a) A dynamic system is represented by the state equation. (5)

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r$$

Check whether the system is completely controllable.

- b) What is transfer matrix of a control system? Derive the equation for transfer matrix. (7)
- c) Obtain the state model for the given transfer function (8)

$$\frac{Y(s)}{U(s)} = \frac{1}{s^2 + s + 1}$$

- 8 a) State initial and final value theorem for Z transform (5)

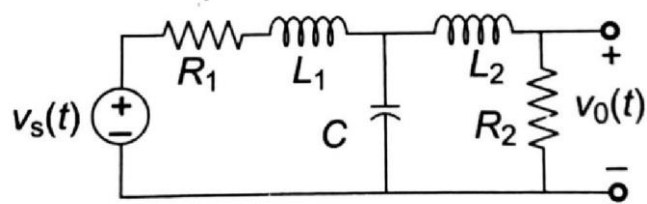
- b) Derive the expression for pulse transfer function of a zero order hold system (7)



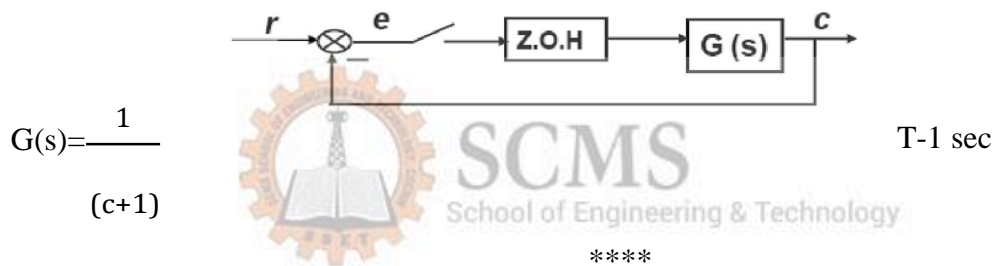
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c) Determine the state transition matrix of $A = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix}$ (8)

9 a) Represent the electrical network shown in fig a in state model in physical variable form (10)



b) For the sampled data control system shown in Fig, find the response to unit step input where (10)



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