Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: EC409

Course Name: CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

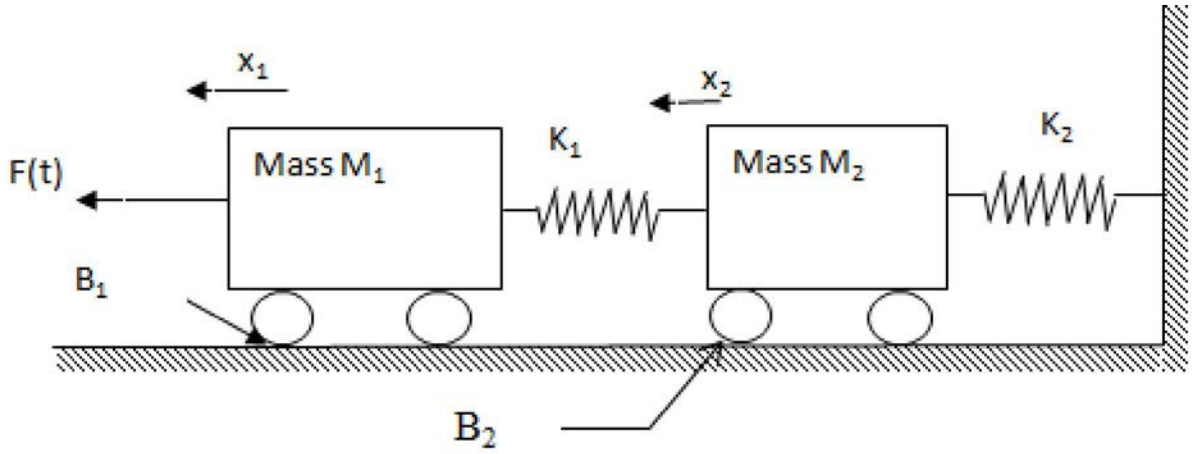
PART A

Answer any two full questions, each carries 15 marks. Marks

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

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

b) Find the transfer function $\frac{X2(S)}{F(S)}$.Also draw the force voltage analogy of the given system (10)

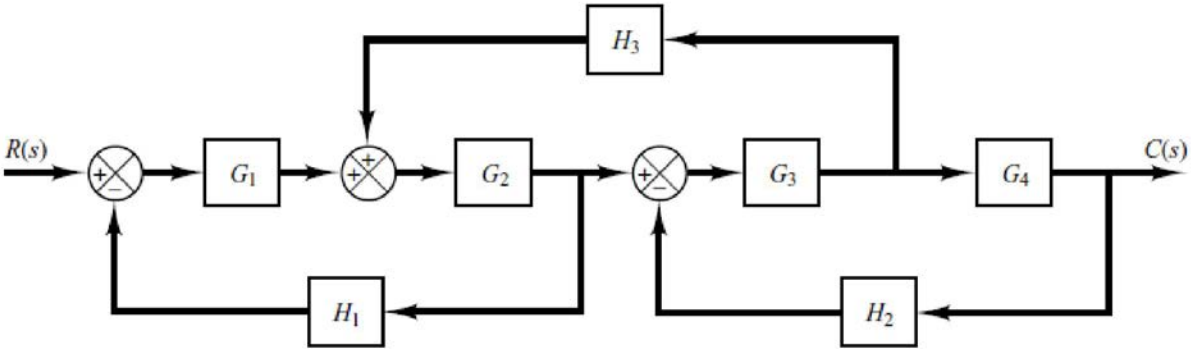


2 a) Explain how the overall transfer function of a system can be found by using Mason's gain formula. (5)

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 $G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$ (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)
$G(s)H(s) = \frac{K}{s(s+2)(s+10)}$. 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 s represented by the state equation. (5)

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

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)

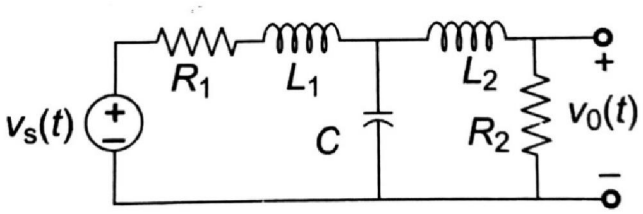
$$\frac{Y(s)}{U(s)} = \frac{1}{s^2+s+1}$$

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

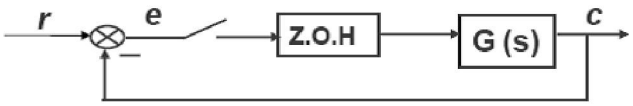
b) Derive the expression for pulse transfer function of a zero order hold system (7)

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 if Fig, find the response to unit step input where (10)



$G(s)=\frac{1}{(s+1)}$ T-1 sec

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: EC409

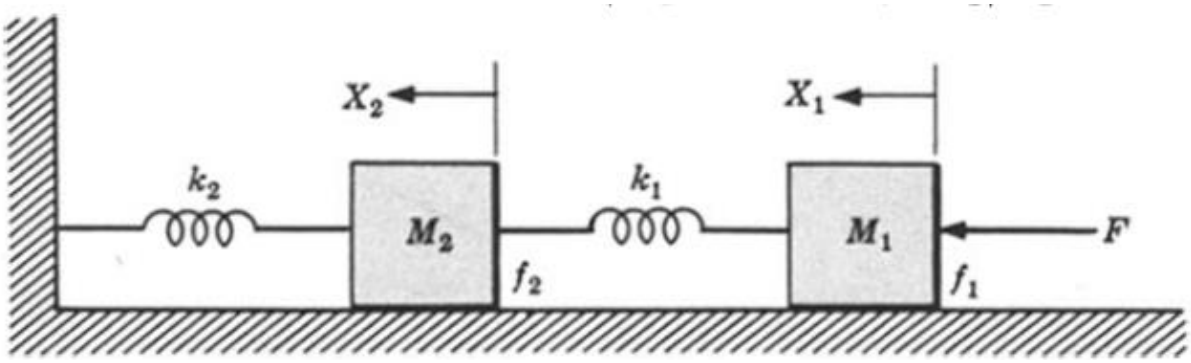
Course Name: CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

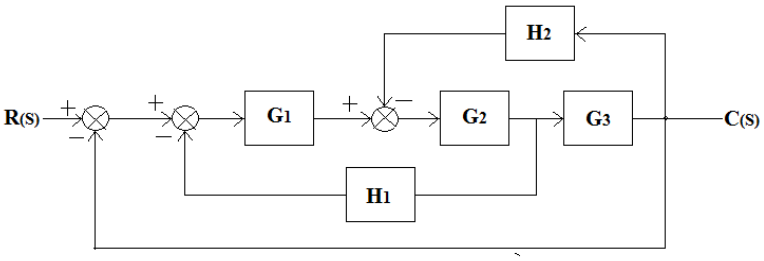
PART A

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)



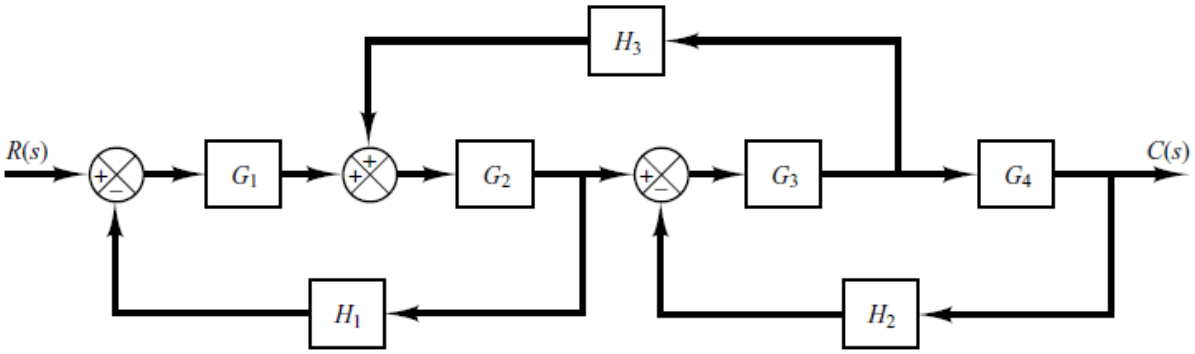
2 a) The forward path transfer function of a unity feedback control system is given by $(s) = \frac{4}{s(s+5)}$ (5)

.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 rise time and peak time for a step input of 12 units. (5)

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)

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

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 for controllability and observability. (10)

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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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: EC409

Course Name: CONTROL SYSTEMS

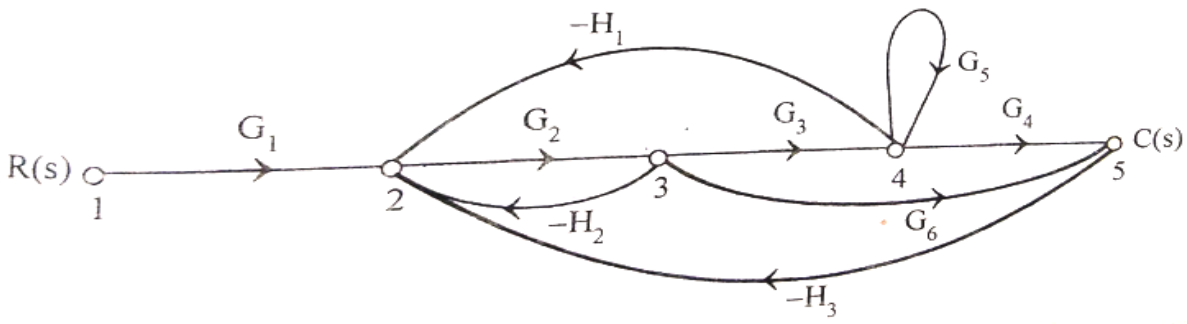
Max. Marks: 100 Duration: 3 Hours

Note: Provide normal and semi log graph sheet

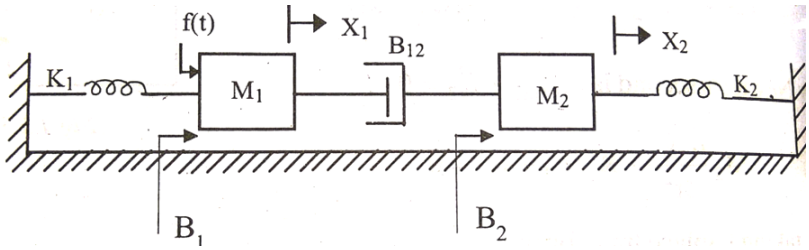
PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Find the overall gain C(s)/R(s) for the signal flow graph shown using Mason's gain equation. (8)



b) Determine the transfer function $X_1(s)/ F(s)$ for the system shown below. (7)



2 a) The open loop transfer function of a servo system with unity feedback is (7)

$G(s) = \frac{10}{s(0.1s+1)}$. Evaluate the static error constants of the system. Obtain the steady state error of the system when subjected to an input given by

$r(t)= a_0 +a_1t+a_2t^2/2$.

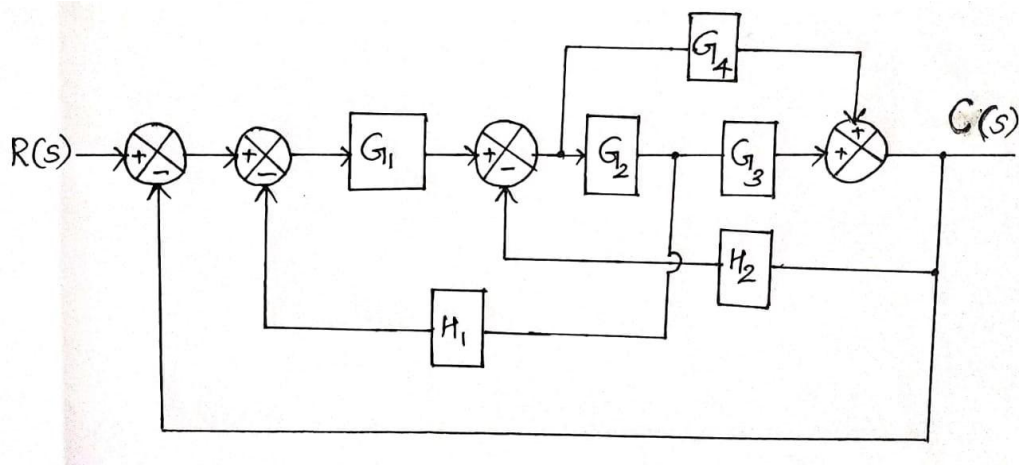
b) Derive an expression for time response of second order under damped system to step input. (8)

3 a) The unity feedback system is characterised by an open loop transfer function G(s) = (7)

$\frac{K}{s(s+10)}$.Determine the gain K so that the system will have a damping ratio of 0.5 for this

value of K. Determine the settling time, peak overshoot, rise time and peak time for a unit step input.

b) Obtain the closed loop transfer function C(s)/R(s) of the system using block reduction technique. (8)



PART B

Answer any two full questions, each carries 15 marks.

4 a) Sketch the root locus for the unity feedback system whose open loop transfer function is (9)

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

b) The characteristic polynomial of a system is $s^7+9s^6+24s^5+24s^4+24s^3+24s^2+23s+15=0$. (6)

Determine the location of roots on s-plane and hence comment on the stability of the system using Routh-Hurwitz criterion.

5 a) Sketch the Bode diagram for the following transfer function. (10)

G(s)= $\frac{75(1+0.2s)}{s(s^2+16s+100)}$.Determine gain margin and phase margin.

b) State and explain Nyquist stability criteria (5)

6 a) Explain frequency domain specifications (6)

b) Describe the design procedure for a lag compensator. (9)

PART C

Answer any two full questions, each carries 20 marks.

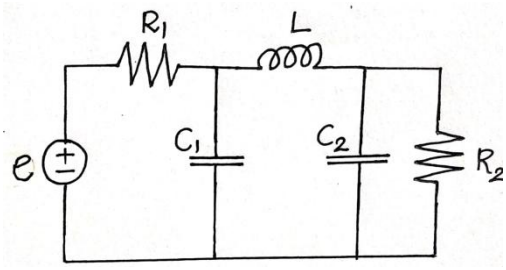
7 a) Determine the controllability and observability of the given system. (5)

$$\begin{bmatrix}\dot{x}\\ \dot{y}\end{bmatrix} = \begin{bmatrix}-0.5 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}x\\ y\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u(t)$$

$$y(t) = \begin{bmatrix}0 & 1\end{bmatrix}\begin{bmatrix}x\\ y\end{bmatrix}$$

b) A system is described by the transfer function $\frac{Y(s)}{U(s)} = \frac{10(s+4)}{s(s+2)(s+3)}$.Find the state and output equations of the system. (10)

c) Obtain the state space representation of the electrical system. (5)



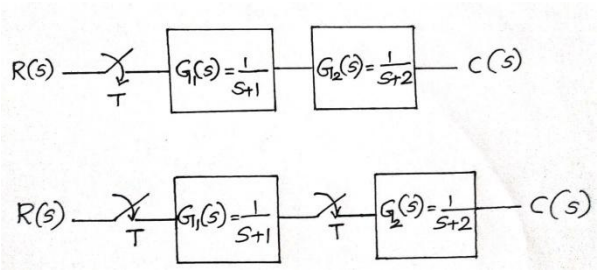
8 a) The input-output relation of a sampled control system is described by the equation (5)
c(k+2) +3c(k+1)+4c(k) = r(k+1)-r(k).Determine the z transfer function.

b) Determine the stability of a sampled data control system having the following characteristic polynomial (10)
z^4-1.7z^3+1.04z^2-0.268z+0.024=0

c) Derive the transfer function of a zero order hold circuit. (5)

9 a) List out the properties of state transition matrix. Obtain the state transition matrix of (10)
$A=\begin{bmatrix} 2 & 0 \\ -1 & 2 \end{bmatrix}$

b) Determine the pulse transfer function for the system represented by the block diagram. (10)



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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh semester B.Tech examinations (S), September 2020

Course Code: EC409

Course Name: CONTROL SYSTEMS

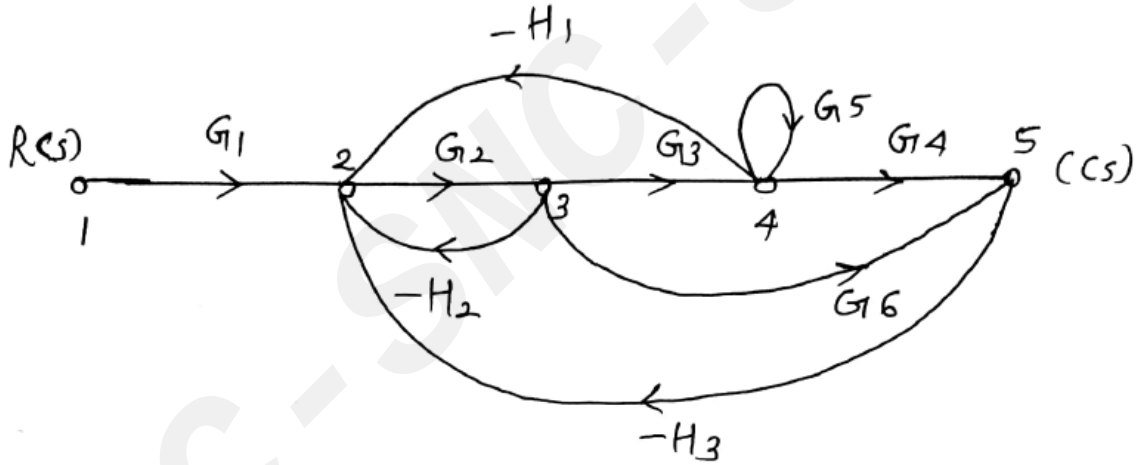
Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Compare open loop and closed loop system with suitable examples. (5)

b) Find the transfer function using Mason's gain equation (10)

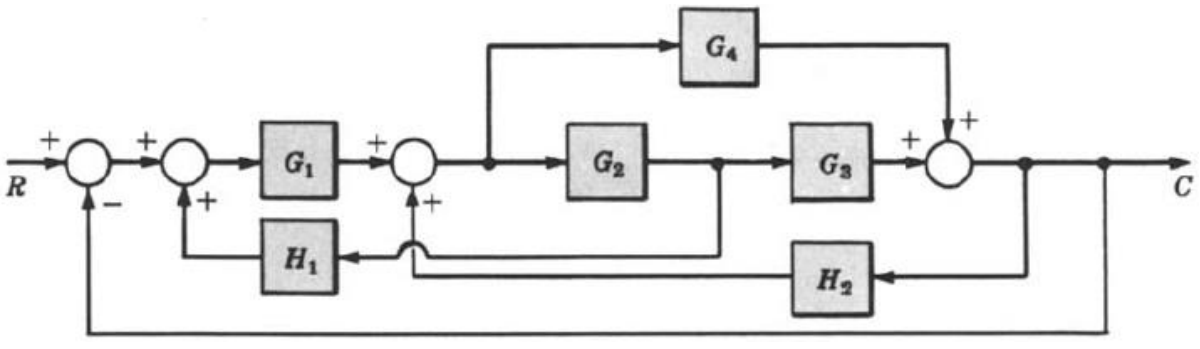


2 a) Determine the rise time, peak time, settling time and peak overshoot of a second order control system subjected to a unit step input. The damping ratio = 0.5 and undamped natural frequency $w_n = 6\ rad/sec.$ (5)

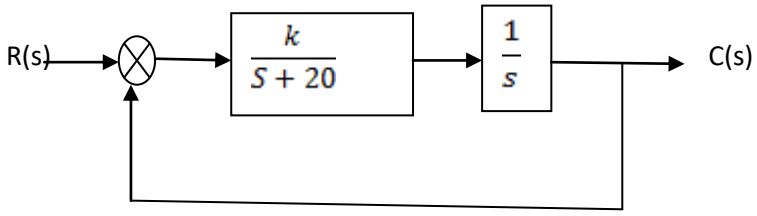
b) Derive an expression for rise time of a second order system. (5)

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 (10)



b) The block diagram of a unity feedback (negative) system is shown in figure. Determine the steady state error for unit ramp input when K=400. Also determine the value of K for which the steady state error to unit ramp will be 0.02 (5)



PART B

Answer any two full questions, each carries 15 marks.

4 a) Comment on the stability of the system whose characteristic equation is given by $s^5+2s^4+3s^3+6s^2+2s+1=0$. (5)

b) A unity feedback control system has an open loop transfer function G(s)=K(s+9)/ s(s+3)(s+5).Sketch the root locus. (10)

5 a) Compare PI,PD and PID controllers. (5)

b) Sketch the bode plot for the following transfer function and determine phase margin and gain margin. G(s) = $\frac{75(1+0.2s)}{s(s^2+16s+100)}$. (10)

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

b) Describe the design procedure of a lag compensator. (7)

PART C

Answer any two full questions, each carries 20 marks.

7 a) A linear system representation in state space is given as (5)

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

$$y = [2 \quad 2 \quad 2]$$

Apply Kalman's test to find whether the system is completely observable.

b) A system is represented by the differential equation y''+3y'+2y = r''+2r'+2r.Obtain a state model in controllable canonical form. Draw the state diagram. (7)

c) Obtain the state model for the given transfer function (8)

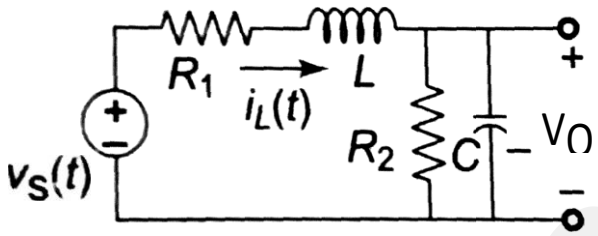
$$\frac{Y(s)}{U(s)} = \frac{1}{s^2 + s + 1}$$

8 a) Explain the procedure of jury test. (5)

b) The input-output relation of a sampled data system is described by the equation $c(k+2)+3c(k+1)+4c(k)=r(k+1)-r(k)$. Determine the z-transfer function. (7)

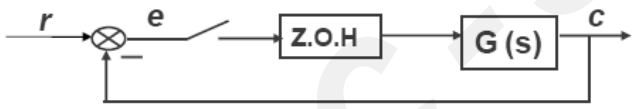
c) Determine the state transition matrix of A=$\begin{bmatrix}0 & 1\\ 0 & -2\end{bmatrix}$ (8)

9 a) An electrical network is shown in fig. a Select asset of proper state variables and write down a state equation, in physical-variable form, to represent the system (10)



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

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



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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 2020

Course Code: EC409

Course Name: CONTROL SYSTEMS

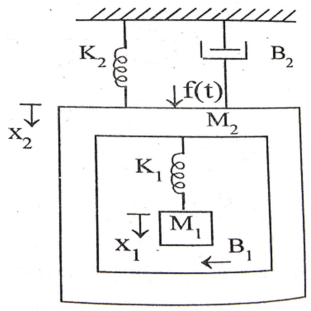
Max. Marks: 100 Duration: 3 Hours

(Note: Provide normal and semilog graph sheet.)

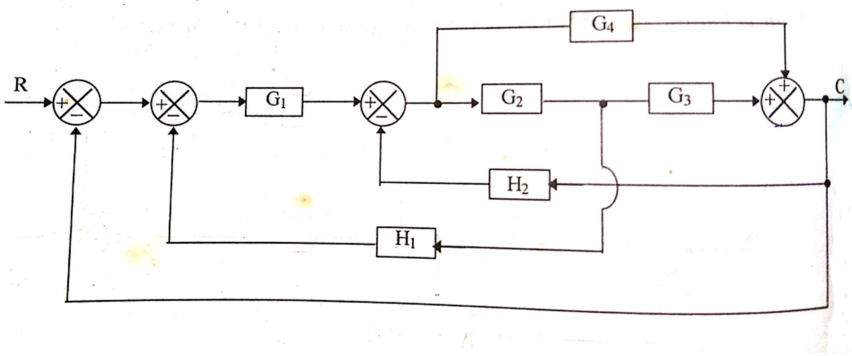
PART A

Answer any two full questions, each carries 15 marks. Marks

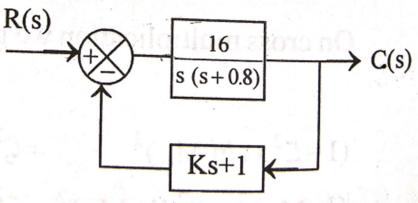
1 a) Determine the transfer function $X_1(s)/F(s)$ for the system shown below. (8)



b) Obtain the closed loop transfer function C(s)/R(s) of the system by block reduction method (7)



2 a) A positional control system with velocity feedback is shown. What is the response c(t) to unit step input? Given that $\varepsilon_s = 0.5$. Calculate rise time, peak time and settling time. (8)



b) The open loop transfer function of a unity feedback system is given as (3)

$$G(S) = \frac{10}{S(S+2)(S+5)}$$

Find the steady state error, if the input to the system is a unit ramp signal.

c) Derive dynamic error coefficients. (4)

3 a) Derive an expression for time response of second order critically damped system to step input. (7)

b) Construct the signal flow graph for the following set of linear algebraic equation and find the overall transfer function using Masons gain formula. (8)

$x_2 = x_1 - 3x_3 - 5x_4$, $x_3 = 2x_2$, $x_4 = 5x_3 + 3x_2$, $x_5 = x_4$.

PART B

Answer any two full questions, each carries 15 marks.

4 a) Sketch the root locus for the unity feedback system whose open loop transfer function is (9)

$G(s)H(S) = \frac{K(s+5)}{s(s^2+4s+11)}$.

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

$G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+2)}$. By applying Routh criterion, discuss the stability of the closed loop system as a function of K. Determine the value of K which will cause sustained oscillations in the closed loop system. What are the corresponding oscillating frequencies?

5 a) Sketch the Bode diagram for the following transfer function and obtain gain and phase cross over frequencies. (10)

$G(s) = \frac{K(s+20)}{(s+1)(s+2)(s+10)}$

b) Use Nyquist criterion to determine whether the closed loop system having the following open loop transfer function is stable or not. If not how many closed loop poles lie in the right half of s-plane $G(S)H(S) = \frac{1}{s(s+2)(s+3)}$ (5)

6 a) Write short notes on PID controllers. (6)

b) Explain the effect of adding poles and zeros on the location of root locus with diagram. (9)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Find the time response of the system given below. (7)

$\dot{X} = AX$

$A = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix}$; $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$; $y = [1 \quad -1] \begin{bmatrix} x1 \\ x2 \end{bmatrix}$

b) A system is represented by the state model. (8)

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \\ \dot{x}_3(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U, \quad y = [0 \quad 2 \quad 0] \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix}$$

Determine whether the system is completely controllable and observable.

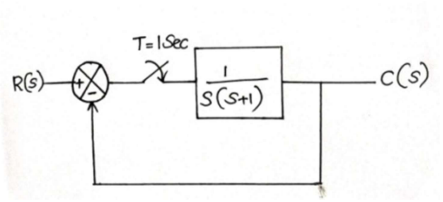
c) Compute the state transition matrix when $A = \begin{bmatrix} -1 & 1 \\ 0 & 2 \end{bmatrix}$ (5)

8 a) Determine the stability of a sampled data control system using Jury's stability test having the following characteristic polynomial (10)

$2z^4+8z^3+12z^2+5z+1=0$

b) Explain sampled data control system. (5)

c) Find the pulse transfer function for the error sampled system given. (5)



9 a) Obtain the state space representation of the transfer function (10)

$$\frac{C(s)}{R(s)} = \frac{K}{(s+1)(s+2)(s^2+1)}$$

b) Find the z-domain transfer function of a system with s-domain transfer function (5)

$$H(s) = \frac{3}{(s+3)^2}$$

c) Write short notes on Sample and hold circuit. (5)

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