Total No. of Questions : 4]

SEAT No. :

P8482

[Total No. of Pages : 2

Oct-22/BE/Insem-68

B.E. (Electrical)

ADVANCED CONTROL SYSTEM

(2019 Pattern) (Semester - VII) (403142)

Time : 1 Hour] *[Max. Marks : 30*

Instructions to the candidates :

1) ***Answer any one question from each pair of questions : Q.1 & Q.2 and Q.3 & Q.4.***
2) ***Figures to the right side indicate full marks.***

Q1) a) Draw Electrical network & Derive Transfer function of lag compensation network. **[5]**

b) For a certain system,

$$G(s)=\frac{5}{s(1+0.1s)(1+0.3s)}$$

Design a suitable lag compensator, phase margin = 50°. **[10]**

OR

Q2) a) Design lead compensation for the system having open loop transfer function. **[10]**

$$G(s)H(s)=\frac{25}{s(0.5s+1)(0.016s+1)} \text{ \& PM around } 42^\circ$$

b) Explain steps to be taken to design lead network by bode plot approach. **[5]**

Q3) a) Explain any one peculiar behavior of nonlinear system : **[5]**

i) Jump resonance

ii) Limit cycle

iii) Sub-harmonic oscillation

P.T.O.

b) In unity feedback system an ideal relay with output equal to $\pm$ 1 unit is connected in cascade with **[10]**

$G(s)=\dfrac{20}{s(s+1)(s+3)}$ Determine amplitude and frequency of limit cycle if it Exist by describing function method.

OR

Q4) a) Explain Lyapunov stability analysis and its stability conditions. **[7]**

b) Explain common type of Nonlinearities with diagrams. **[8]**

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Total No. of Questions : 4]

SEAT No. :

P5214

[Total No. of Pages : 2

[6188]-167

B.E. (Electrical Engineering) (Insem)

ADVANCED CONTROL SYSTEM

(2019 Pattern) (Semester - VII) (403142)

Time : 1 Hour] *[Max. Marks : 30*

Instructions to the candidates:

1) ***Solve Q.1 or Q.2 ; Q.3 or Q.4.***
2) ***Figures to the right indicate full marks.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Assume suitable additional data, if necessary.***
5) ***Use of non-programmable calculator is allowed.***

Q1) a) Draw the circuit diagram and hence derive the transfer function for a phase lag network, and state its importance. **[7]**

b) The open loop Transfer function of a unity feedback control system is given by G(s) = K / S(1 + 0.2S). Design a suitable lead compensator such that the given system has static velocity error constant 10 and Phase margine 50°. **[8]**

OR

Q2) a) Draw the circuit diagram and hence derive the transfer function for a phase lead network and also state its importance. **[7]**

b) Design a lag compensator network for G(s) = K / S(S + 2), with velocity error constant >= 10 and Phase margin greater than 60°. **[8]**

Q3) a) Explain the following with respect to non-linear system. **[7]**

Support the answers with figures.

i) Limit Cycle

ii) Sub harmonic oscillations.

P.T.O.

b) In a unity feedback control system an ideal relay is connected in series with linear element having transfer function $G(s) = 6 / S(S + 2)(S + 3)$. The output of the relay is ± 2 units. Check for the existence of limit cycle and if it exists determine the amplitude and frequency. **[8]**

OR

Q4) a) Derive the mathematical expression for the describing function of an ideal relay. Support the answer with a figure. **[7]**

b) Explain any four common non linearities with their characteristics. **[8]**

Total No. of Questions : 4]

SEAT No. :

PC208

[Total No. of Pages : 2

[6361]-68
B.E. (Electrical) (Insem)
ADVANCED CONTROL SYSTEM
(2019 Pattern) (Semester - VII) (403142)

Time : 1 Hour] ***[Max. Marks : 30***

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4.***
2) ***Figures to the right indicates full marks.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Assume suitable data, if necessary.***

Q1) a) Define a lag compensator. Explain lag compensator with the electrical circuit and derive transfer function. Draw Pole zero plot. **[5]**

b) The open loop transfer function of an uncompensated system is $G(S)=\frac{k}{s^2(0.2s+1)}$. Design a suitable lead compensator such that the system will have k_a = 10 and Phase Margin $\geq$ 35 degrees. Draw a bode plot of the uncompensated system and write the overall transfer function of the compensated system. (No need to draw a bode plot of the compensated system). **[10]**

OR

Q2) a) Explain the approach to the control system design using a compensator. **[5]**

b) A unity feedback system has an open loop transfer function, $G(s)=\frac{k}{s(s+1)}$. Design a lag compensator such that the system will have k_v = 10 and Phase margin at least 45 degrees. Draw a bode plot of the uncompensated system and write the overall transfer function of the compensated system. (No need to draw a bode plot of the compensated system). **[10]**

P.T.O.

Q3) a) List out the common nonlinearities and explain any two. **[8]**

b) Explain limit cycles. Define stable limit cycles and unstable limit cycles. **[7]**

OR

Q4) a) Define stability, asymptotic stability, asymptotic stability at large, and in stability in the sense of Lyapunov with graphical interpretation. **[8]**

b) The open loop transfer function of a certain unity feedback control system is given by, $G(s) = \dfrac{5}{(s+1)(0.1s+1)^2}$. An ideal relay having output ± 1 is used to improve the system performance. Determine amplitude, frequency and time period of limit cycle, if it exists. **[7]**

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Total No. of Questions : 8]

SEAT No. :

P568

[Total No. of Pages : 2

[6004]-504

B.E. (Electrical)

ADVANCED CONTROL SYSTEM

(2019 Pattern) (Semester - VII) (403142)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) *Attempt Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6 and Q.7 or Q.8.*

2) *Figures to the right indicate full marks.*

Q1) a) $\frac{Y(s)}{U(s)} = \frac{S+1}{S^2 + 1.3S + 0.4}$ Given system represent in **[10]**

i) Controllable canonical form.

ii) Observable canonical form.

b) For a given system $A = \begin{bmatrix} 0 & 1 \\ -3 & 4 \end{bmatrix}$, $x(0) = [1 \;\; 0]^T$.

Obtain STM & find its solution. **[8]**

OR

Q2) a) Explain and derive the Cayley Hamilton theorem of STM. **[8]**

b) Derive the transfer function from the state variable model and Evaluate the transfer function $\frac{Y(s)}{U(s)}$ from the state variable model of a discrete time system with usual notation. **[10]**

$$X = \begin{bmatrix} 1.8 & 1 \\ 0 & 2.5 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0.5 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

P.T.O.

Q3) a) Given $X = \begin{bmatrix} 0.1 & 0.1 & 0 \\ 0.3 & -0.1 & -0.2 \\ 0 & 0 & -0.3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u$ & $Y = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} x$.

Determine controllability & Observability of the system. **[8]**

b) Derive and explain Ackermann's formula for Pole placement design. **[9]**

OR

Q4) a) What is principle of duality? Explain the effect of pole-zero cancellation on controllability & Observability. **[8]**

b) For a given system $A = \begin{bmatrix} 0 & 15 \\ 1 & 0 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 0 & 2 \end{bmatrix}$.

Determine observing gain matrix Ke such that $S_1, S_2 = -2 \pm j3$ are eigen values of observer gain matrix. **[9]**

Q5) a) Explain in detail basic building blocks of discrete time control system. **[8]**

b) Explain the sampling & reconstruction process, State the sampling theorem and Give its importance. **[9]**

OR

Q6) a) Show how mapping of left half of S-plane is done into the Z plane with stable and unstable Region. **[8]**

b) Determine stability of system using Jury's Test whose characteristic polynomial is $2z^4 + 8z^3 + 12z^2 + 5z + 1 = 0$. **[9]**

Q7) a) Define adaptive control. Explain the need of adaptive control. What is adaption mechanism? **[6]**

b) Explain Gain scheduling adaptive control strategy with proper block diagram. **[6]**

c) Draw block diagram of Model Reference Adaptive Control scheme and explain it. **[6]**

OR

Q8) a) Describe a self-tuning regulator with suitable block-diagram. **[6]**

b) List out the properties of sliding mode control. **[6]**

c) Explain the terms, variable structure control, sliding mode control, sliding phase, reaching phase and chattering with suitable diagram. **[6]**

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Total No. of Questions : 8]

SEAT No. :

PB-2267

[Total No. of Pages : 2

[6263]-105

B.E.(Electrical Engineering)

ADVANCED CONTROL SYSTEM

(2019 Pattern) (Semester - VII) (403142)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Solve Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.***
2) ***Figures to teh right side indicate full marks.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Assume suitable data if necessary.***
5) ***Use of non-programmable calculator is allowed.***

Q1) a) State and prove the properties of state transition matrix (STM). **[4]**

b) Define state, state vector, state equation and output Equation. Draw state diagram. **[6]**

c) For a given system **[8]**

$$A=\begin{pmatrix} 0 & 1 \\ -2 & -3 \end{pmatrix} \quad x(0)=\begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

OR

Q2) a) Write down the steps to be followed for computing state transition matrix using Caley Hamilton theorem. **[4]**

b) Evaluate the transfer function Y(s)/U(s) from the state variable model of a system with usual notation. **[6]**

$$x=\begin{pmatrix} -2 & -3 \\ 4 & 2 \end{pmatrix}x+\begin{pmatrix} 3 \\ 5 \end{pmatrix}u, \quad y=\begin{pmatrix} 1 & 1 \end{pmatrix}x$$

c) Obtain diagonal canonical state model of state Space representation of the system. Also draw state model diagram. **[8]**

$$\frac{C(s)}{R(s)}=\frac{s+5}{s^3+6s^2+11s+6}$$

P.T.O

Q3) a) What is principle of Duality? Explain effect of pole-zero cancellation on Controllability and Observability. **[7]**

b) Given **[10]**

$$x = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{pmatrix} x + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} u$$

$$y = \begin{pmatrix} 1 & 3 & 2 \end{pmatrix} x$$

Determine Controllability& Observability of the system.

OR

Q4) a) Derive and explain Ackermann's formula for pole placement design. **[7]**

b) For a given system **[10]**

$$A = \begin{pmatrix} 0 & 1 \\ 0 & -2 \end{pmatrix} \quad B = \begin{pmatrix} 0 \\ 4 \end{pmatrix} \quad C = \begin{pmatrix} 1 & 0 \end{pmatrix}$$

Determine the observer gain matrix K_e such that the observer poles are placed at S_1, $S_2 = -8, -8$.

Q5) a) Explain mapping between s-plane and z-plane with proper diagrams. **[8]**

b) Determine stability of system using Jury's test whose characteristic polynomial is $P(z) = Z^3 + 2.1Z^2 + 1.44Z + 0.32 = 0$. **[10]**

OR

Q6) a) Explain the sampling and reconstruction process. Also state the sampling theorem and give its importance. **[8]**

b) Explain in detail the basic building blocks of discrete time control System with appropriate diagram. **[10]**

Q7) a) What is adaptive control? **[3]**

b) List the salient properties of sliding mode control. **[6]**

c) What is reaching law? Why is it required? Derive expressions of control for constant rate reaching law, constant plus proportional rate reaching law and power rate reaching law. **[8]**

OR

Q8) a) Explain the terms sliding phase and reaching phase in the context of sliding mode control. **[3]**

b) Explain the gain scheduling adaptive scheme with a block diagram. **[6]**

c) Draw block diagram of Model Reference Adaptive Control scheme and explain it. **[8]**

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Total No. of Questions : 8]

SEAT No. :

PA-924

[Total No. of Pages : 3

[5927]-356
B.E. (Electrical)
ADVANCED CONTROL SYSTEM
(2019 Pattern) (Semester - VII) (403142)

Time : 2½ Hours] *[Max. Marks : 70*

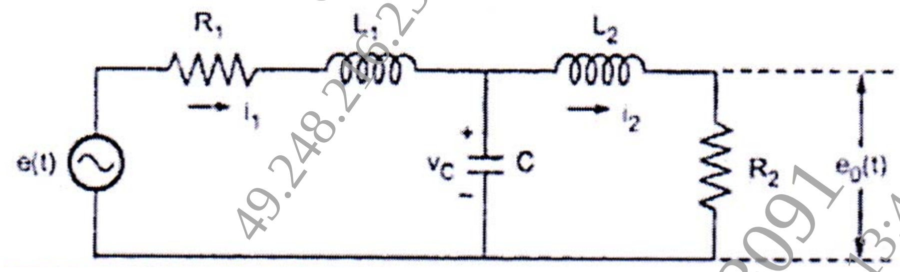
Instructions to the candidates:

1) ***Solve Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.***
2) ***Figures to the right indicate full marks.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Use of algorithmic tables slide rule, and electronic pocket calculator is allowed.***
5) ***Assume suitable data if necessary.***

Q1) a) Derive the formula to get transfer function from the state model. **[6]**

b) Determine state transition matrix for the system give below by using Lapalce transformation technique $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ **[6]**

c) Write a set of state equations for the circuit given below. **[6]**



OR

Q2) a) Obtain the state model of the following differential equation (phase variable representation) $4\dddot{y} + 3\ddot{y} + \dot{y} + 2y = 5u$ **[6]**

b) What is state transition matrix? List the properties of sate transition matrix. **[6]**

c) Define state, state variable, state vector, state equation and output equation. Draw state diagram. **[6]**

P.T.O.

Q3) a) Check the observability of the state model given below usingKalman's Test **[6]**

$$X = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -9 & -11 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$Y = \begin{bmatrix} -10 & -10 & 5 \end{bmatrix} x$$

b) Explain the effect of pole zero cancellation. **[6]**

c) Explain full order observer with proper block diagram. **[6]**

OR

Q4) a) What is controllability? How to investigate controllability of a system using Gilbert's test for **[6]**

i) Distinct eigenvalues and

ii) Repeated eigenvalues

b) Determine state feedback gain matrix for the system given below to place the closed loop poles at $s_1 = -1.8 + j2.4$ and $s_2 = -1.8 - j2.4$ by matrix transformation technique. **[6]**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 20.6 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

c) Explain the principle of duality. **[6]**

Q5) a) State and explain Shannon's Sampling theorem. How to select the sampling period? **[6]**

b) Explain mapping between s-plane and z-plane. **[6]**

c) Determine the stability of sampled data control system using Jury's stability analysis having following polynomial $z^3 + 2.1\, z^2 + 1.44z + 0.32 = 0$. **[5]**

OR

Q6) a) Explain the concept of Zero Order Hold and First Order Hold operations. Derive the transfer function of ZOH. **[6]**

b) Draw block diagram of the digital control system. State function of each block. **[6]**

c) Determine the stability by using Bilinear transformation for sampled data control system having polynomial **[5]**

$z^3 - 4z^2 + 5z - 2 = 0$

Q7) a) Define adaptive control. Explain the need of adaptive control. What is adaption mechanism? **[6]**

b) If the system is given by $\dot{x} = Ax + Bu$ and sliding surface is given by $s = Sx$, prove that the closed loop system obtained by applying the equivalent control is $\dot{x} = \left(I_n - B(SB)^{-1}S\right)Ax$. **[6]**

c) State and explain the linear quadratic regulator problem. **[5]**

OR

Q8) a) Draw block diagram of Model Reference Adaptive Control scheme and explain it. **[6]**

b) What is reaching law? Why is it required? Write expressions of constant rate reaching law, constant plus proportional rate reaching law and power rate reaching law. **[6]**

c) What is optimal control? Write down the steps in linear quadratic regulator problem. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P-7861

[Total No. of Pages : 3

[6181]-126A
B.E. (Electrical)
ADVANCED CONTROL SYSTEM
(2019 Pattern) (Semester-VII) (403142)

Time : 2½ Hours] ***[Max. Marks : 70***

Instructions to the candidates :

1) ***Solve Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of algorithm tables slide rule and electronic pocket calculator is allowed.***
5) ***Assume suitable data, if necessary.***

Q1) a) Determine State Transition matrix using Caley Hamilton method having **[6]**

$$A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}.$$

b) Define i) State ii) State Variables iii) State Space representation. **[6]**

c) Consider the state model with A as **[6]**

$$\begin{bmatrix} 0 & 2 & 0 \\ 4 & 0 & 1 \\ -48 & -34 & -9 \end{bmatrix}$$

Obtain Eigen values, Eigen vectors and Model matrix for matrix A.

OR

Q2) a) Determine transfer function Y(s)/U(s) for the state model given below **[6]**

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

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

With D=0.

b) Check controllability and Observability of the system given below. **[6]**

$$A = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, C = \begin{bmatrix} 1 & -1 \end{bmatrix}, D = [0]$$

P.T.O.

c) Obtain the state space representation for the transfer function given below

$$\frac{Y(s)}{U(s)} = \frac{2}{s^3 + 2s^2 + 3s + 4}.$$ **[6]**

Q3) a) Explain the effect of Pole zero cancellation on the controllability and observability of the system. **[6]**

b) Determine the state feedback gain matrix k to place the closed loop poles at $s = -2 \pm j2\sqrt{3}$, using transformation matrix method. **[6]**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 4 \end{bmatrix} u$$

c) Explain full order Observer with proper block diagram. **[6]**

OR

Q4) a) Construct the State model using phase variables if the system is described by the differential equation. **[6]**

$$\dddot{y} + 6\ddot{y} + 11\dot{y} + 10y = 3u$$

b) The system is described by $\dot{x} = Ax$, $Y = Cx$, where **[6]**

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

It is desired to place the poles at $s = -1 \pm j2$, $s=10$. Determine state feedback gain matrix 'k' using Ackerman's formula.

c) Explain concept of effect of pole zero cancellation. **[6]**

Q5) a) State and explain Shannon's Sampling theorem. Also discuss aliasing effect. **[6]**

b) Explain mapping between s-plane and z-plane. **[6]**

c) Determine the stability of sampled data control system using Jury's stability analysis having following polynomial **[5]**

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

OR

Q6) a) Explain in detail ZOH and FOH operation. Derive the transfer function of ZOH. **[6]**

b) Explain basic block diagram of the digital control system. **[6]**

c) Determine the stability by using Bilinear transformation for sampled data control system having polynomial $z^3 - 0.2z^2 - 0.25z + 0.05 = 0$. **[5]**

Q7) a) What is reaching law? Why is it required? Write expressions of constant rate reaching law, constant plus proportional rate reaching law and power rate reaching law. **[6]**

b) State and explain the linear quadratic regulator problem. **[6]**

c) Describe a self-tuning regulator with suitable block-diagram. **[5]**

OR

Q8) a) Derive the expression of equivalent control in sliding mode control. **[6]**

b) Describe a self-tuning regulator with suitable block-diagram. **[6]**

c) List out the properties of sliding mode control. **[5]**