Control System – II Question Bank

Section A

Q. 1) Answer the following (Short answer questions **2 Marks**)

a) Explain the concept of State.

b) Define following terms (i) State (ii) State Vectors (iii) State Space (iv) State variable.

c) What are advantages and limitations of state variable approach?

d) Write the state model of nth order system?

e) Write the properties of state transition matrix.

f) Define following terms (i) Eigen values (ii) Eigen vectors(iii) State of a System

g) What is meant by diagonalization?

h) Write the solution of homogeneous state equations?

i) Explain advantages of state variable method over conventional one.

j) What is pole placement by state feed back?

k) What is state observer?

l) What is the need for state observer?

m) What is canonical form of state model?

n) The state model of a linear time invariant system is given by

$X(t) = A X(t) + B U(t)$

$Y(t) = C X(t) + D U(t)$

Write the expression for transfer function of the system.

o) What are the merits and demerits of sampled data control systems?

p) Explain the concept of sampling process.

q) _____ Linearization could be applied to any nonlinear system by dividing the whole region of operation into small pieces.

r) Explain state transition matrix?

s) Explain the concept of sampling process.

t) What is pulse transfer function?

u) What are the merits and demerits of sampled data control systems?

v) Write the state model of n^{th} order system

w) What is canonical form of state model?

x) What are the advantages and disadvantages of state space analysis?

y) What is the need for state observer?

z) What are the methods available for the stability analysis of sampled data control systems?

aa) In nonlinear friction, one is _____ friction which is a constant retarding force and the other is the _____ which is the force required to initiate motion.

Q. 2) Find the state transition matrix $\emptyset\ (\boldsymbol{t})$ for a system whose state matrix is given

$A = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix}$

using 1) Cayley Hamilton method

2) Laplace Transform method.

Q. 3) **A)** Find the state transition matrix $\emptyset\ (\boldsymbol{t})$ for a system whose state matrix is given

$A = \begin{bmatrix} -2 & -1 \\ 3 & -1 \end{bmatrix}$ using Cayley Hamilton method.

B) A linear time invariant system is characterized by the homogeneous state equation: $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$

Compute the solution of homogeneous equation, assume the initial state vector:

$x_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

Q. 4) **A)** Find the Eigen value, Eigen vector and Model matrix for the matrix

$A = \begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$ (Use Generalised Eigen Vector Method)

B) Explain advantages of state variable method over conventional one.

Q. 5) **A)** Consider the matrix $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix}$

(i) Find the Eigen values and Eigen vectors of A

(ii) Write the Model matrix M.

B) For a given matrix

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

Determine: a) Characteristic Equation b) Eigen value c) Eigen Vector?

Q. 6) **A)** Find the Eigen value, Eigen vector and Model matrix M for the matrix

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix}$$

B) When the generalized eigen vectors are used? Explain with the help of example.

Q. 7) **A)** Obtain the time time response of the following system:

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

Where u (t) is unit step occurring at t = 0 and $X^T(0) = [1 \;\; 0]$

B) Using Laplace transform method, find $\boldsymbol{e^{At}}$ for $A = \begin{bmatrix} 0 & -3 \\ 1 & -4 \end{bmatrix}$

Q. 8) **A)** Enumerate basic elements of a digital control system and show the block diagram representation of such a system. Also discuss briefly about functioning these elements

B) Define stability of a digital control system and discuss how Jury-stability criterion is applied for stability investigation for such systems.

Q. 9) **A)** What are necessary and sufficient conditions for pole placement?

B) Write short notes on observer based controller.

Q. 10) Find state transition matrix using

1) Laplace Transform method
2) Power Series method

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

Q. 11) Obtain the Eigen values, Eigen Vectors and Model Matrix for

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix}$$

And prove that $\boldsymbol{M^{-1}AM} = \wedge = Diagonal\ matrix$.

Q. 12) Find state transition matrix using

Describe Krasovskkis method and variable gradient method of constructing Lyapunov function.

Q. 13) A) What are the necessary and sufficient conditions for arbitrary pole placement

B) Define stability of a digital control system and discuss how Jury-stability criterion is applied for stability investigation for such systems.

Q. 14) Find the state transition matrix using:

1) Laplace Transform method
2) Cayley Hamilton method

For the system described by,

$$A = \begin{bmatrix} 0 & 1 \\ 4 & -4 \end{bmatrix} X(0)$$

Q. 15) A) Obtain Eigen value, Eigen vector and Model matrix for the matrix

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$$

B) Reduce the given state model in to canonical form by diagonalising matrix A

$$\dot{X}(t) = \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$

$$Y(t) = [1 \quad 0 \quad 0]\, X(t)$$

Q. 16) A) Write the Ackerman's formula to find the state observer gain matrix G.

B) What is the need for state observer?

Q. 17) A) Using Cayley Hamilton method, find $\boldsymbol{e^{At}}$ for $A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$

B) Using Laplace Transform method, find $\boldsymbol{e^{At}}$ for $A = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix}$

Q. 18) Write short note on

a) Necessary and sufficient conditions for arbitrary pole placement
b) State Regulator Design
c) State transition matrix.
d) Diagolization
e) Pulse transfer function
f) Need of Digital Control system.
g) Power Series method
h) Bilinear transformation
i) Digital Control system

Section B

Q. 1) Answer the following (Short answer questions **2 Marks**)

a) Write any two Properties of nonlinear systems. ?
b) Define Learning. What are the different types of Learning?
c) Develop simple ANNs to implement the two input AND and OR operation.
d) What are linear and nonlinear systems? Give examples.
e) List out the differences between artificial neural network and biological network.
f) Write De Morgan's law with the help of Venn diagram.
g) What are limit cycles?
h) Explain properties of fuzzy sets with example
i) Enlist different activation function used in Artificial Neural Network (ANN).
j) What is phase plane?
k) What are the methods available for the analysis of nonlinear system?
l) Define Lyapunov stability
m) Differentiate classical and fuzzy set
n) What is a fuzzy relation?
a) Differentiate fuzzification and defuzzification?
b) List out the differences between artificial neural network and biological network.
c) What are merits and demerits of Back Propagation Algorithm?
d) What are linear and nonlinear systems? Give examples.
e) What is saturation?
f) What is jump resonance?
g) List the Fuzzy set operations?
h) Define fuzzification.
i) What are the basic building blocks of artificial neural network?
j) What is meant by feedback networks?
k) Define Learning.
l) What are merits and demerits of Back Propagation Algorithm?
m) What are the four main steps in back propagation algorithm?

n) Define supervised training.

o) What are the basic building blocks of artificial neural network?

p) What is meant by feedback networks?

q) List the properties of crisp sets?

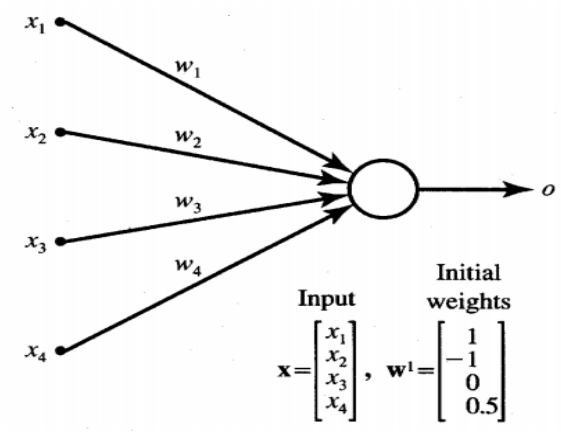
r) List the defuzzification methods.

s) What is meant by universe of discourse?

Q. 2) **A)** Explain saturation and backlash non linearity with necessary diagram.

B) Explain Lyapunov's Direct method

Q. 3) Update the weights of neural network shown in figure using Hebbian learning rule, with the initial weight vector $\mathbf{W_1} = \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0.5 \end{bmatrix}$ needs to be trained using the set of three input vectors as below $\mathbf{X_1} = \begin{bmatrix} 1 \\ -2 \\ 1.5 \\ 0 \end{bmatrix}$; $\mathbf{X_2} = \begin{bmatrix} 1 \\ -0.5 \\ -2 \\ -1.5 \end{bmatrix}$; $\mathbf{X_3} = \begin{bmatrix} 0 \\ 1 \\ -1 \\ 1.5 \end{bmatrix}$ for an arbitrary choice of learning constant c = 1; use bipolar binary activation function.



Q. 4) **A)** Explain in detail common physical nonlinearities.

B) State Lyapunov's stability theorem

Q. 5) **A)** Explain Biological Neuron Model and compare it with Artificial Neural Network

B) Explain Supervised and Unsupervised Learning.

Q. 6) **A)** What are Lyapunov's functions? State their significance.

B) Explain dead zone and relay non linearity with necessary diagram.

Q. 7) **A)** List out the differences between Artificial Neural Network and Biological Network.

B) Using Perceptron learning rule updates the weights for $\mathbf{W_1} = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ and the input vectors as below $\mathbf{X_1} = \begin{bmatrix} 2 \\ 1 \\ -1 \end{bmatrix}$; $\mathbf{X_2} = \begin{bmatrix} 0 \\ -1 \\ -1 \end{bmatrix}$

Use C=1, $d_1 = -1$, $d_2 = 1$ and f (net)= sgn(net)

Q. 8) **A)** For given fuzzy set

$$\tilde{A} = \left\{\left(\frac{0.2}{P_1}\right) + \left(\frac{0.6}{P_2}\right) + \left(\frac{0.5}{P_3}\right) + \left(\frac{0.9}{P_4}\right)\right\} \quad \text{and} \quad \tilde{B} = \left\{\left(\frac{0.4}{g_1}\right) + \left(\frac{0.7}{g_2}\right) + \left(\frac{0.8}{g_3}\right)\right\}$$

Find $\tilde{C} = \tilde{A}$ X $\tilde{B}$ using max-min composition.

B) Draw and explain Fuzzy Logic Controller.

Q. 9) **A)** For fuzzy set

$\tilde{A}$ = {0.6, 0.3, 0.9, 1, 1} and

$\tilde{B}$ = {0.8, 0.4, 0.9, 0.7, 1}

Perform following operations on these fuzzy sets.

1) Union
2) Intersection
3) Complement
4) Demorgan's operation

B) Explain Fuzzy Logic Controller.

Q. 10) **A)** For given fuzzy set

$$\tilde{A} = \left\{\left(\frac{1}{2}\right) + \left(\frac{0.5}{3}\right) + \left(\frac{0.3}{4}\right) + \left(\frac{0.2}{5}\right)\right\} \text{ and } \quad \tilde{B} = \left\{\left(\frac{0.5}{2}\right) + \left(\frac{0.7}{3}\right) + \left(\frac{0.2}{4}\right) + \left(\frac{0.4}{5}\right)\right\}$$

Calculate the several operation of the fuzzy set.

B) Explain min-max method of implication with a suitable example.

Q. 11) **A)** What is learning rule? Explain Hebbian Learning and competitive learning.

B) Explain Biological Neuron model.

Q. 12) Update the weights of neural network using Perceptron learning rule, with the initial weight vector $\mathbf{W_1} = \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0.5 \end{bmatrix}$ needs to be trained using the set of three input

vectors as below $\mathbf{X_1} = \begin{bmatrix} 1 \\ -2 \\ 0 \\ -1 \end{bmatrix}$; $\mathbf{X_2} = \begin{bmatrix} 0 \\ 1.5 \\ -0.5 \\ -1 \end{bmatrix}$; $\mathbf{X_3} = \begin{bmatrix} -1 \\ 1 \\ 0.5 \\ -1 \end{bmatrix}$ for an arbitrary choice of learning constant $\boldsymbol{c}$ = 0.1; $\mathbf{d_1}$ = -1, $\mathbf{d_2}$ = -1, $\mathbf{d_3}$ = 1 and using **f(net) = sgn(net)**.

Q. 13) $\tilde{B} = \left\{\left(\frac{0.5}{60}\right) + \left(\frac{0.7}{40}\right) + \left(\frac{1.0}{20}\right)\right\}$ $\tilde{T} = \left\{\left(\frac{0.9}{10}\right) + \left(\frac{0.7}{8}\right) + \left(\frac{0.5}{6}\right)\right\}$

$\tilde{U} = \left\{\left(\frac{1}{0.9}\right) + \left(\frac{0.8}{0.8}\right) + \left(\frac{0.6}{0.7}\right) + \left(\frac{0.4}{0.6}\right)\right\}$

Find i) $\check{R} = \check{B}\ X\ \check{T}$

ii) $\check{S} = \check{T}\ X\ \check{U}$

iii) $\check{W} = \check{R} \circ \check{S}$

Q. 14) A) A = [0.6, 0.3, 0.9, 1, 1] and B = [0.8, 0.4, 0.9, 0.7, 1]

Perform Union, Intersection, Complement and Demorgan's operation on these fuzzy sets.

B) Explain the types of different membership functions.

Q. 15) Using Perceptron learning rule updates the weights for

$\mathbf{W_1} = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ and the input vectors as below $\mathbf{X_1} = \begin{bmatrix} 2 \\ 1 \\ -1 \end{bmatrix}$; $\mathbf{X_2} = \begin{bmatrix} 0 \\ -1 \\ -1 \end{bmatrix}$

Use C=1, $d_1 = -1$, $d_2 = 1$ and f (net)= sgn(net)

Q. 16) A) Draw and explain error back propagation algorithm.

B) Distinguish between Supervised and Unsupervised Learning.

Q. 17) A) Explain in detail application of fuzzy logic to control speed of DC/AC motor.

B) Explain the applications of fuzzy logic to PID controller

Q. 18) Write short notes on

a) Jump resonance.

b) Biological Neuron Model.

c) Different types of membership function.

d) Multivariable Nonlinearity.

e) Lyapunov function.

f) Different types of learning rules.

g) Fuzzy set operations.

h) Different types of activation function.