Unit 3 - Week 1

Course outline

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- Week 1
  - Introduction to State Space
  - State Space Representation
  - State Space Representation: Companion Form (Controllable Canonical Form)
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  - State Space Representation: Observable Canonical Form
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Assignment 1

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-08-14, 23:59 IST.

1) By using the state variables, an n^{th} order differential equation can be decomposed into *1 point*

- n number of first order differential equations
- $2n$ number of first order differential equations
- $n/2$ number of first order differential equations
- Unlimited number of first order differential equations

No, the answer is incorrect.
Score: 0

Accepted Answers:
n number of first order differential equations

2) State variable approach of system analysis and design is applicable to *1 point*

- only linear time invariant (LTI) systems
- linear time invariant as well as time varying systems
- linear as well as nonlinear systems
- all systems

No, the answer is incorrect.
Score: 0

Accepted Answers:
all systems

3) Consider the following statements with respect to a system represented by its state space model *1 point*

$\dot{x} = Ax + Bu$
$y = Cx + du$

1. The state vector x of the system is unique.
2. The order of the system is the order of the matrix A.
3. The minimum number of state variables required is equal to the number of independent energy storage elements in the system.

Which of these statements are correct?

- only 2
- 2 and 3
- 1 and 3
- 1, 2 and 3

No, the answer is incorrect.
Score: 0

Accepted Answers:
2 and 3

4) A separately excited dc motor is represented by the differential equation *1 point*

$\ddot{\omega} + \frac{B}{J}\dot{\omega} + \frac{K^2}{JL}\omega = \frac{K}{JL}V_a$

The above equation can be represented in the state space form as

$\begin{bmatrix} \frac{d^2\omega}{dt^2} \\ \frac{d\omega}{dt} \end{bmatrix} = P \begin{bmatrix} \frac{d\omega}{dt} \\ \omega \end{bmatrix} + QV_a$

The P matrix is given by

- $\begin{bmatrix} -\frac{B}{J} & -\frac{K^2}{JL} \\ 1 & 0 \end{bmatrix}$
- $\begin{bmatrix} -\frac{K^2}{JL} & -\frac{B}{J} \\ 0 & 1 \end{bmatrix}$
- $\begin{bmatrix} 0 & 1 \\ -\frac{K^2}{JL} & -\frac{B}{J} \end{bmatrix}$
- $\begin{bmatrix} 1 & 0 \\ -\frac{B}{J} & -\frac{K^2}{JL} \end{bmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\begin{bmatrix} -\frac{B}{J} & -\frac{K^2}{JL} \\ 1 & 0 \end{bmatrix}$

5) Consider the system given by *1 point*

$\frac{Y(s)}{U(s)} = \frac{s+4}{s^2+5s+6}$

The state-space representation of this system in observable canonical form is given as

- $\dot{x} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} 4 & 1 \end{bmatrix} x$
- $\dot{x} = \begin{bmatrix} 0 & 1 \\ -5 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} 1 & 4 \end{bmatrix} x$
- $\dot{x} = \begin{bmatrix} 0 & -6 \\ 1 & -5 \end{bmatrix} x + \begin{bmatrix} 4 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} 0 & 1 \end{bmatrix} x$
- $\dot{x} = \begin{bmatrix} 0 & -5 \\ 1 & -6 \end{bmatrix} x + \begin{bmatrix} 1 \\ 4 \end{bmatrix} u\,;\ y = \begin{bmatrix} 0 & 1 \end{bmatrix} x$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\dot{x} = \begin{bmatrix} 0 & -6 \\ 1 & -5 \end{bmatrix} x + \begin{bmatrix} 4 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} 0 & 1 \end{bmatrix} x$

6) Which of the following statement is false? *1 point*

- The state variable approach is applicable to multi-input multi-output (MIMO) systems
- The input and output equations constitute the state model of the system
- The state and output equations constitute the state model of the system
- The state variable approach is applicable to discrete time systems

No, the answer is incorrect.
Score: 0

Accepted Answers:
The input and output equations constitute the state model of the system

7) Which of the following statement is false regarding the phase variables? *1 point*

- The phase variables, in general, are the physical variables of the system
- The phase variables are not readily available for measurement
- Phase variables are simple to realize mathematically
- Phase variables are not a practical set of state variables from control point of view

No, the answer is incorrect.
Score: 0

Accepted Answers:
The phase variables, in general, are the physical variables of the system

8) Consider the following system *1 point*

$\frac{Y(s)}{U(s)} = \frac{10(s+5)}{s^2(s+3)}$

The state-space representation of this system in controllable canonical form is given by

- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u;\ y = \begin{bmatrix} 50 & 10 & 0 \end{bmatrix} x$
- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u;\ y = \begin{bmatrix} 10 & 50 & 0 \end{bmatrix} x$
- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u;\ y = \begin{bmatrix} 50 & 10 & 0 \end{bmatrix} x$
- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u;\ y = \begin{bmatrix} 10 & 50 & 0 \end{bmatrix} x$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u;\ y = \begin{bmatrix} 50 & 10 & 0 \end{bmatrix} x$

9) Consider the following system *1 point*

$\frac{Y(s)}{U(s)} = \frac{10s^3+15s^2+20s+25}{5s^3+10s^2+15s+20}$

The state-space representation of this system in controllable canonical form is given by

- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -20 & -15 & -10 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} 25 & 20 & 15 \end{bmatrix} x + [10]\, u$
- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -20 & -15 & -10 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} -25 & -20 & -15 \end{bmatrix} x + [10]\, u$
- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -4 & -3 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} 3 & 2 & 1 \end{bmatrix} x + [2]\, u$
- $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -4 & -3 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} -3 & -2 & -1 \end{bmatrix} x + [2]\, u$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -4 & -3 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u\,;\ y = \begin{bmatrix} -3 & -2 & -1 \end{bmatrix} x + [2]\, u$

10) Consider the following system *1 point*

$\frac{Y(s)}{U(s)} = \frac{1}{s^4}$

In the controllable canonical form representation of this system,

- the rank of the system matrix is one
- the rank of the system matrix is two
- the rank of the system matrix is three
- the rank of the system matrix is four

No, the answer is incorrect.
Score: 0

Accepted Answers:
the rank of the system matrix is three