END SEMESTER EXAMINATIONS (DECEMBER 2021/JANUARY 2022) - QUESTION PAPER - PART A

COURSE CODE : ICE 3153
COURSE NAME : Modern Control Theory
SEMESTER : V
DATE OF EXAM : 21/12/2021
DURATION : 45 + 5 minutes

Instructions for Students:
(1) ANSWER ALL THE QUESTIONS.
(2) EACH QUESTION CARRIES 1 MARK.
(3) YOU ARE INSTRUCTED TO INFORM THE INVIGILATOR AFTER SUBMISSION OF THIS FORM IN THE CHAT SECTION.

* Required

* This form will record your name, please fill your name.

1

STUDENT NAME: *

2

REGISTRATION NUMBER: *

3

The system matrix of the given differential equation in controllable canonical form is (1 Point)

$$\dddot{y} + 6\ddot{y} + 3\dot{y} + 5y = \ddot{u} + 2$$

- [0 1 0; 0 0 1; -6 -3 -5]
- [0 1 0; 0 0 1; -5 -3 -6]
- [-7 1 0; -2 0 1; -1 0 0]
- [1 0 0; 0 1 0; -1 -2 -7]

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The system matrix in the diagonal canonical form of the given system is
(1 Point)

$$\frac{Y(s)}{R(s)} = \frac{10}{(s-1)(s}$$

- [-1 0; 0 -2]
- [0 -1; -2 0]
- [0 1; 2 0]
- [1 0; 0 2]

5

The input matrix of the given transfer function in observable canonical form is (1 Point)

$$\frac{Y(s)}{R(s)} = \frac{s^2 + 7s +}{s^3 + 9s^2 + 26}$$

- [2; 7; 1]
- [1 7 2]
- [1; 7; 2]
- [1 7 2]

6

The output matrix of the given transfer function in diagonal canonical form is (1 Point)

$$\frac{Y(s)}{R(s)} = \frac{10}{(s-1)(s}$$

- [-10 10]
- [-10 ; 10]
- [10 ; -10]
- [1 ; 1]

7

The input matrix of the given transfer function in controllable canonical form is (1 Point)

$$\frac{Y(s)}{R(s)} = \frac{s^2 + 7s +}{s^3 + 9s^2 + 26}$$

- [1; 0; 0]
- [1 0 0]
- [0 0 1]
- [0; 0 ; 1]

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The Input matrix in diagonal canonical form of given transfer function is (1 Point)

$$\frac{Y(s)}{R(s)} = \frac{10}{(s-1)(s}$$

- [1 1]
- [0 1]
- [1 ; 1]
- [1; 0]

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Given the system the controllability matrix using Kalman test is (1 Point)

$$\dot{x}(t) = \begin{bmatrix} -1 & 3 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t); y(t)$$

- [0 -2; 1 3]
- [0 3; 1 -2]
- [0 1; 3 -2]
- [1 -2; 0 3]

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The system given is (1 Point)

$$\dot{x}(t) = \begin{bmatrix} -1 & 3 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t); y(t)$$

- Not completely state controllable
- One state is not controllable
- Completely state controllable
- Two states are not controllable

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The dimension of state feedback controller gain matrix for the given system is (1 Point)

$$\dot{x}(t) = \begin{bmatrix} -1 & 3 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t); y(t)$$

- 2X1
- 2X2
- 1X1
- 1X2

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For the given system, the state transition matrix using Silvester's interpolation formula is (1 Point)

$$\dot{x}(t) = \begin{bmatrix} 0 & 2 \\ 0 & -3 \end{bmatrix} x(t) + |$$

- [1 0;-0.67(e^-3t+1) 0]
- [0 e^-3t; 1 -0.67(e^-3t+1]
- [1 -0.67(e^-3t+1); 0 e^-3t]
- [0 1 ; 1 -0.67(e^-3t+1)]

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The given LTI system is (1 Point)

$$\dot{x}(t) = \begin{bmatrix} 0 & 2 \\ 0 & -3 \end{bmatrix} x(t) + |$$

- Unstable
- Stable
- Marginally Stable
- Can not determine

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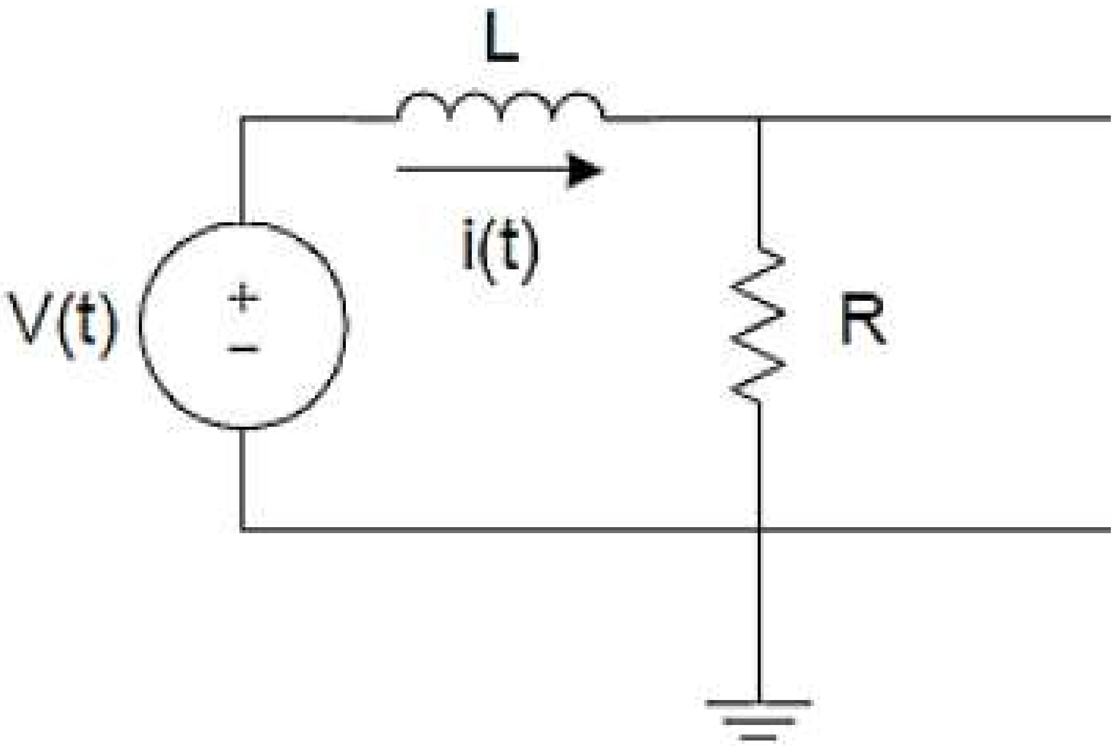
If VR(t) is the output of the of the RL circuit, the state equation of the circuit is (1 Point)



- xdot=VL-(RL)x
- xdot=V/L-(R/L) x
- xdot=Rx
- xdot=Rx+V

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The transfer function of the given state model is (1 Point)

$$\dot{x} = -2x + 1u \, ; y = 2x + 2u$$

- ○ (2s+6)/(s+2)
- ○ (s+2)/(2s+6)
- ○ 1/(s+2)
- ○ 1/(2s+6)

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The direct transmission matrix in the given transfer function is (1 Point)

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

- ○ 0
- ○ 1
- ○ 2
- ○ 3

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Given the system matrix A, the Vandermonde matrix is given as (1 Point)

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

- P=[0 0 1; -1 -2 -3; 1 0 0]
- P=[0 1 0; 0 0 1; -1 -2 -3]
- [1 1 1; -1 -2 -3; 1 4 9]
- [1 1 1; 1 4 9; -1 -2 -3]

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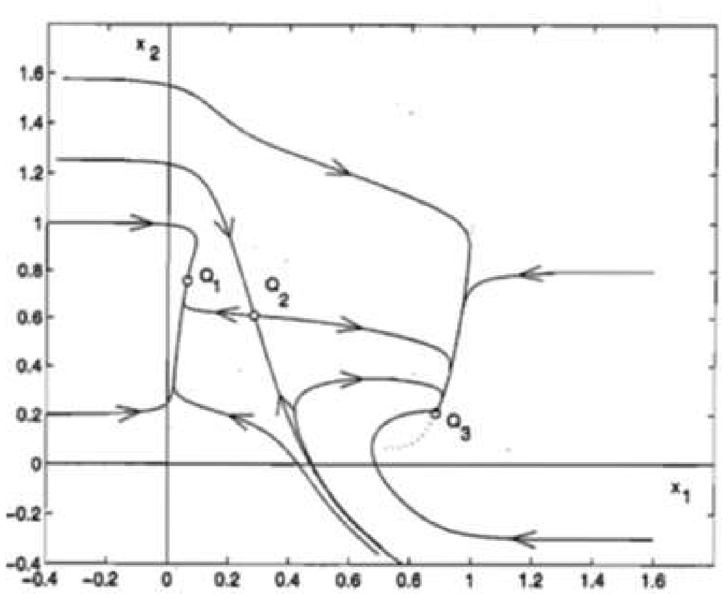
The phase portrait of a tunnel diode is shown in the below figure, where the equilibrium points are marked as Q1, Q2, Q3. The equilibrium point Q2 is a ___________.

(1 Point)



- Stable focus
- Unstable focus
- Saddle point
- Stable Node

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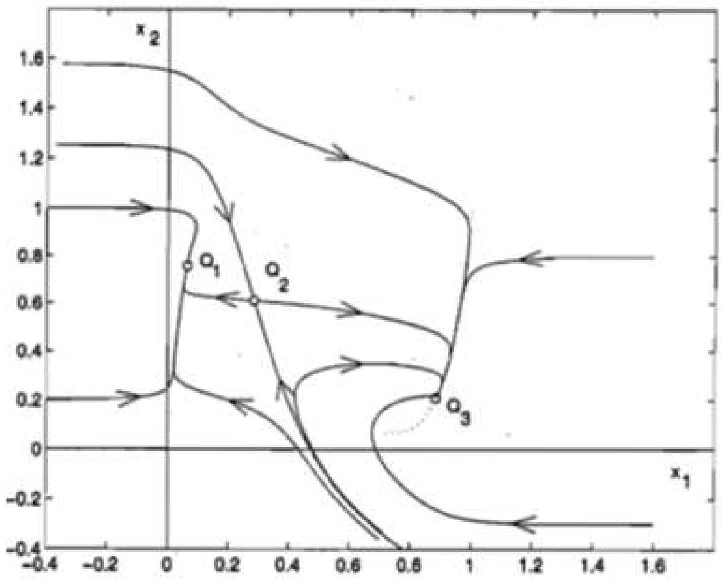
The phase portrait of a tunnel diode is shown in the below figure, where the equilibrium points are marked as Q1, Q2, Q3. The type of the equilibrium point Q3 is __________.

(1 Point)



- Stable focus
- Unstable Node
- Saddle point
- Stable Node

20

For the nonlinear system represented by the state equation given below, the number of equilibrium points are ____.

(1 Point)

$$\dot{x}_1 = x_1 + x_1 x_2, \quad \dot{x}_2 = -x_2 + x_2^2 + x_1 x_2 - x_1^3$$

- 2
- 4
- 3
- None of the above

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For the nonlinear system represented by the state equation given below, the type of the equilibrium point (1, -1) is ______. (1 Point)

$$\dot{x}_1 = x_1 + x_1 x_2, \quad \dot{x}_2 = -x_2 + x_2^2 + x_1 x_2 - x_1^3$$

- Stable focus
- Unstable focus
- Stable node
- Unstable node

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Which of the following is not a properties of nonlinear dynamic systems?
(1 Point)

- Finite escape time
- Commutativity does not apply
- Isolated closed curves
- Unique equilibrium point

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There is _________ exist for the following nonlinear system.

(1 Point)

$$\dot{x}_1 = -x_1 + 2x_1x_2^2 + g(x_2)\ ;\ \dot{x}_2 = x_2 + 2x_1^2x_2 + h($$

- no chaos
- no jump response
- no limit cycle
- no singular point

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A nonlinear system produces an output, **W** as the cube of its input **X**. Assume the input to be a sinusoidal signal and nonlinear output has an odd function characteristic. The term a1 in the output **W** is ________. (1 Point)

- 0
- 3A^3/4
- 3A^2/4
- 1

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A nonlinear system produces an output, **W** as the cube of its input **X**. Assume the input to be a sinusoidal signal and nonlinear output has an odd function characteristic. The term b1 in the output **W** is ________. (1 Point)

- 2
- 3A^3/4
- 3A^2/4
- 3A^2

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A nonlinear system produces an output, **W** as the cube of its input **X**. Assume the input to be a sinusoidal signal and nonlinear output has an odd function characteristic. The describing function for the nonlinear component can be obtained as ________. (1 Point)

- ○ 3A^3/4
- ○ 3A^2/4
- ○ 4A^3/3
- ○ 4A^2/3

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For nonlinearities which are characterized as single valued function, *N* is ______ and therefore the plot of -1/*N* will always lies on the real axis. (1 Point)

- ○ Imaginary
- ○ Real
- ○ Odd
- ○ Symmetric

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Which of the following parameters of the limit cycle cannot be used to discriminate between acceptable and dangerous oscillations? (1 Point)

- Oscillation frequency
- Phase shift in oscillation
- Oscillation magnitude
- Stability

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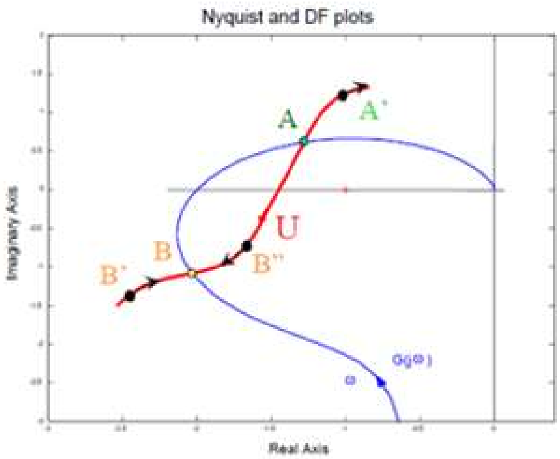
Analyze the given figure and select the TRUE statement for the given scenario.
(1 Point)



- Point B is not a limit cycle
- Point A and B are stable limit cycle
- Point B″ is unstable system
- Point A′ is unstable system

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For the following dynamical system, what is the value of the constant **a** such that the equilibrium point is globally asymptotically stable. (1 Point)

$$\dot{x}_1 = -x_1 + 4x_2 \qquad V = x_1^2 + a x_2^2.$$
$$\dot{x}_2 = -x_1 - x_2^3.$$

- 3
- -5
- 4
- 5

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Which of the following statement is not correct if the linearized system is marginally stable? (1 Point)

- Linearization could not conclude about the stability
- Equilibrium point may be asymptotically stable for the nonlinear system
- All the equilibrium point may be marginally stable for the nonlinear system
- Equilibrium point may be unstable for the nonlinear system

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The sign definiteness of the Lyapunov function given below is __________.
(1 Point)

$$V(x) = x_1^2 + x_2^2 + x_3^3 - x_1x_2 + x_2x_3 - x_1x_3$$

- Negative definite
- Positive definite
- Positive semi definite
- Negative semi definite