MCT END SEMESTER MAKE-UP EXAMINATION (FEBRUARY 2022)

COURSE CODE : MODERN CONTROL THEORY
COURSE NAME : ICE 3153
SEMESTER : V
DATE OF EXAM : 19.02.2022
DURATION : 45 + 3 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.

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STUDENT NAME: *

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REGISTRATION NUMBER: *

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The Characteristic equation of a system is given as below. The system matrix A is (1 Point)

$$s^2 + 6s + 5$$

- A=[1 0 ; 5 6]
- A=[0 1 ; -5 -6]
- A=[0 1; 6 5]
- A=[-5 1; 0 0]

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The transfer function of a system is given as below. The direct transmission matrix D is (1 Point)

$$\frac{1}{s^2 + 6s + 5}$$

- D=1
- D=-5
- D=0
- D=-6

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The system in state space is given as shown below. It is ______ (1 Point)

$$\dot{x} = \begin{bmatrix} 1 & 0 \\ 0 & 0.5 \end{bmatrix} x + \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix} u \; ; \; y = \begin{bmatrix} 1 & 1 \end{bmatrix} x$$

- Not completely state observable
- Some states are not observable
- Completely state observable
- Only one state is observable

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

Given state model, the transfer function of the system is (1 Point)

- Y(s) / U(s) = (2s+6)/(s+2)
- Y(s))/U(s)=(s+2) / (2s+6)
- Y(s) / U(s)= 1 / (2s+6)
- Y(s) / U(s)= (2s+6)

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Below given transformation matrix Identify the Vander Monde matrix (1 Point)

- [0 1 0; 0 0 1; -6 -11 -6]
- [1 0 0; 2 1 0; 4 4 1]
- [1 1 1; 2 3 5; 4 9 5]
- [1 1 1;1 2 1; 2 4 1]

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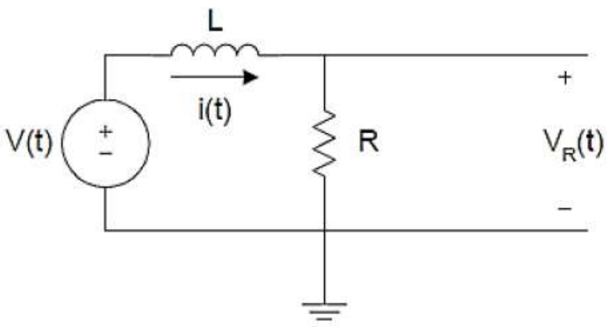
If is the output of the of the RL circuit, the output equation of the circuit is
(1 Point)



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

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The given LTI system is
(1 Point)

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

- Unstable
- Marginally stable
- Stable
- Indeterminate

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Given the system the controllability matrix is

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

(1 Point)

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

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The system given is

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

(1 Point)

- one state is controllable
- not commpletely state controllable
- Completely state controllable
- uncontrollable

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

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

- 2 X 1
- 1 X 2
- 2 X 2
- 2 X 4

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$$\dddot{y} + 6\ddot{y} + 3\dot{y} + 5y = \ddot{u} + 2\dot{u} + 7u$$

The input matrix of the given difference equation in observable canonical form is (1 Point)

- [1;2;7]
- [1 2 7]
- [7;2;1]
- [0;0;1]

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$$\dddot{y} + 6\ddot{y} + 3\dot{y} + 5y = \ddot{u} + 2\dot{u} + 7u$$

Input matrix in controllable canonical form of the given system is (1 Point)

- [1;2;7]
- [1 2 7]
- [0 0 1]
- [0;0;1]

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$$\frac{Y(s)}{R(s)} = \frac{10}{(s-1)(s-2)}$$

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

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

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

$$\frac{Y(s)}{R(s)} = \frac{10}{(s-1)(s-2)}$$

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

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Given the homogenous state equation the solution is _____. (if x(0)=1) (1 Point)

$$\dot{x} = -2x$$

- e^2t
- 0
- e^-2t
- e^t

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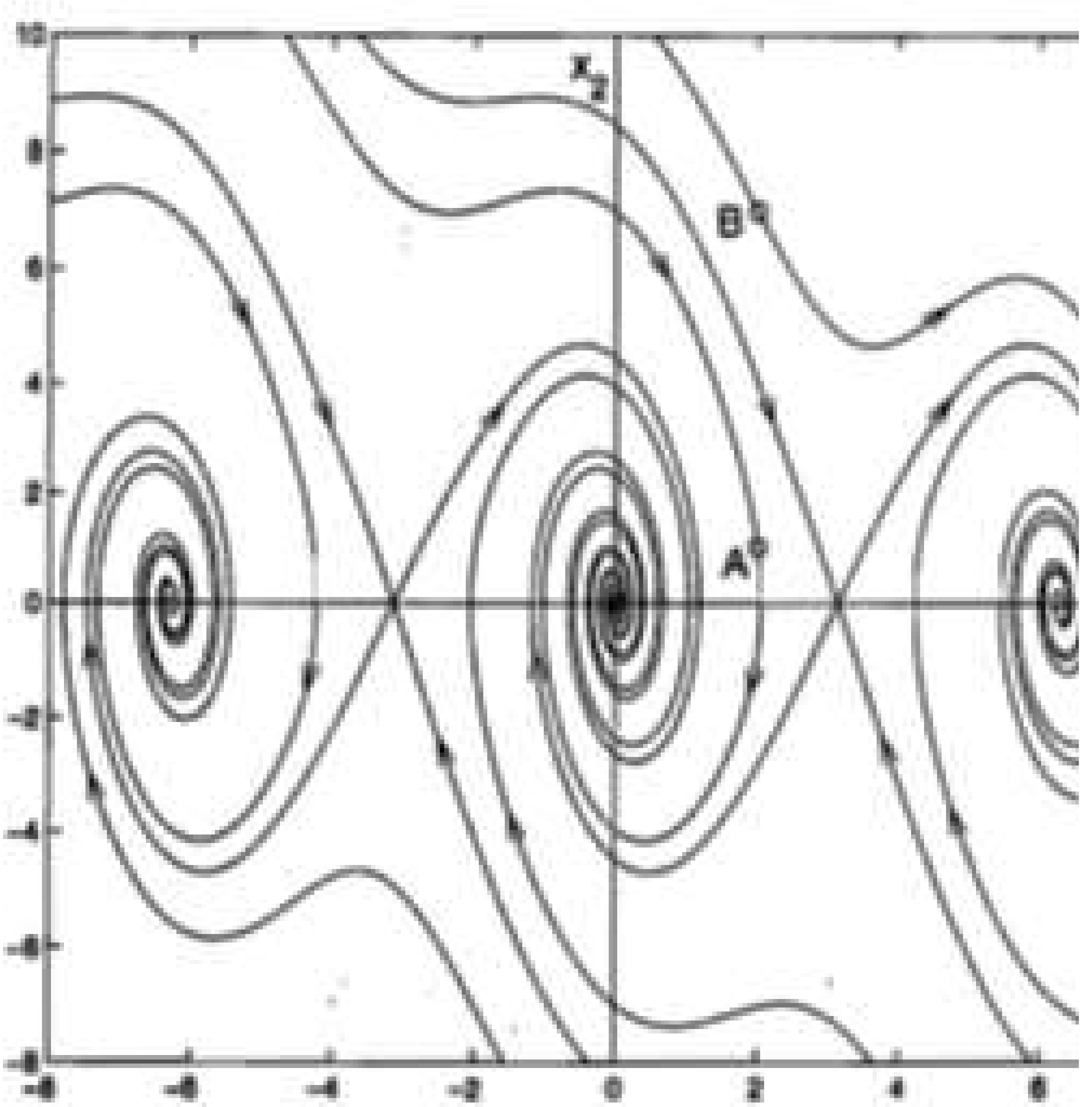
The phase portrait of a pendulum is shown as in the given figure, where the equilibrium point (0,0) is ___________. (1 Point)



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

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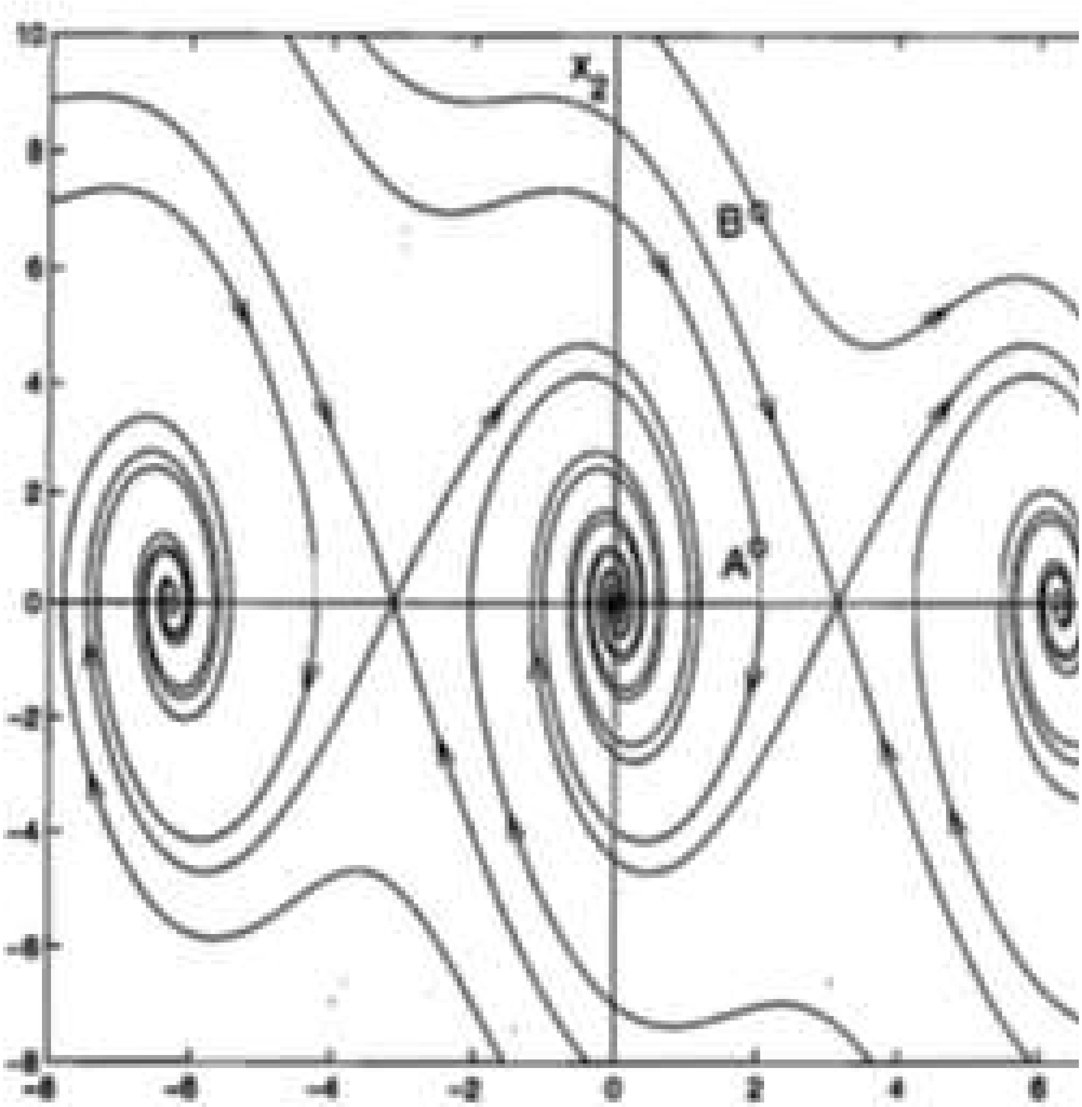
The phase portrait of a pendulum is shown as in the given figure, where the equilibrium points other than (0,0) are ___________. (1 Point)



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

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For the nonlinear system represented by the state equation given below, the number of equilibrium points are ____. (1 Point)

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

- 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 (0, 0) is ______. (1 Point)

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

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

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Which of the following is a unique properties of nonlinear dynamic systems? (1 Point)

- Obeys BIBO stability
- Commutativity applies
- Bifurcations
- Unique equilibrium point

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In a stable control system backlash can cause which of the following? (1 Point)

- Underdamping
- Overdamping
- Poor stability at reduced values of open loop gain
- Low-level oscillations

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Consider the following statements.
1. Nonlinear systems have unique equilibrium point
2. Describing function method is used for the prediction of limit cycles in nonlinear systems.
3. Describing function method is an approximated analysis.

Which of these statements are correct?
(1 Point)

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

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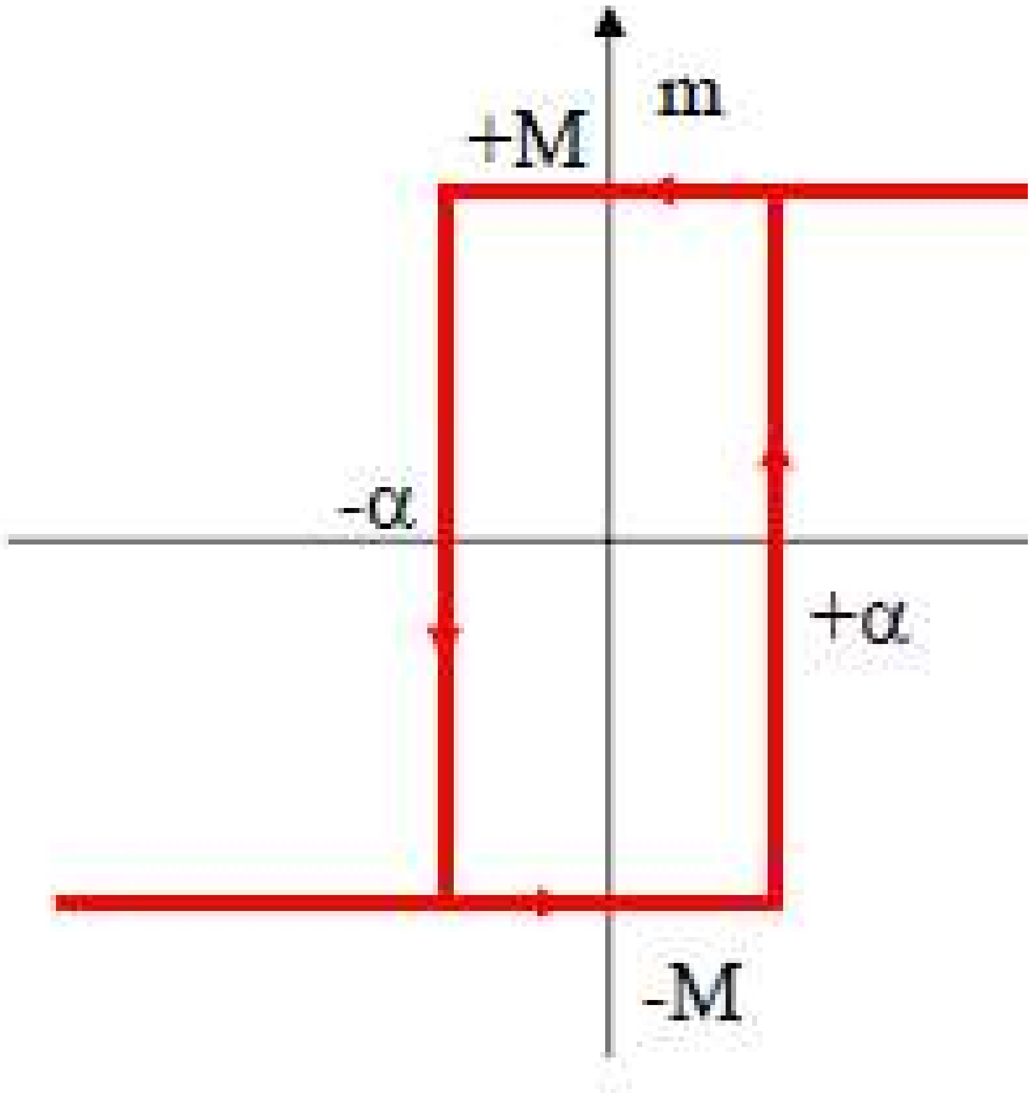
The relationship between input and output for a system is shown below. Identify the correct type of nonlinearity. (1 Point)



- Relay with hysteresis
- Backlash
- Hysteresis
- Relay with saturation

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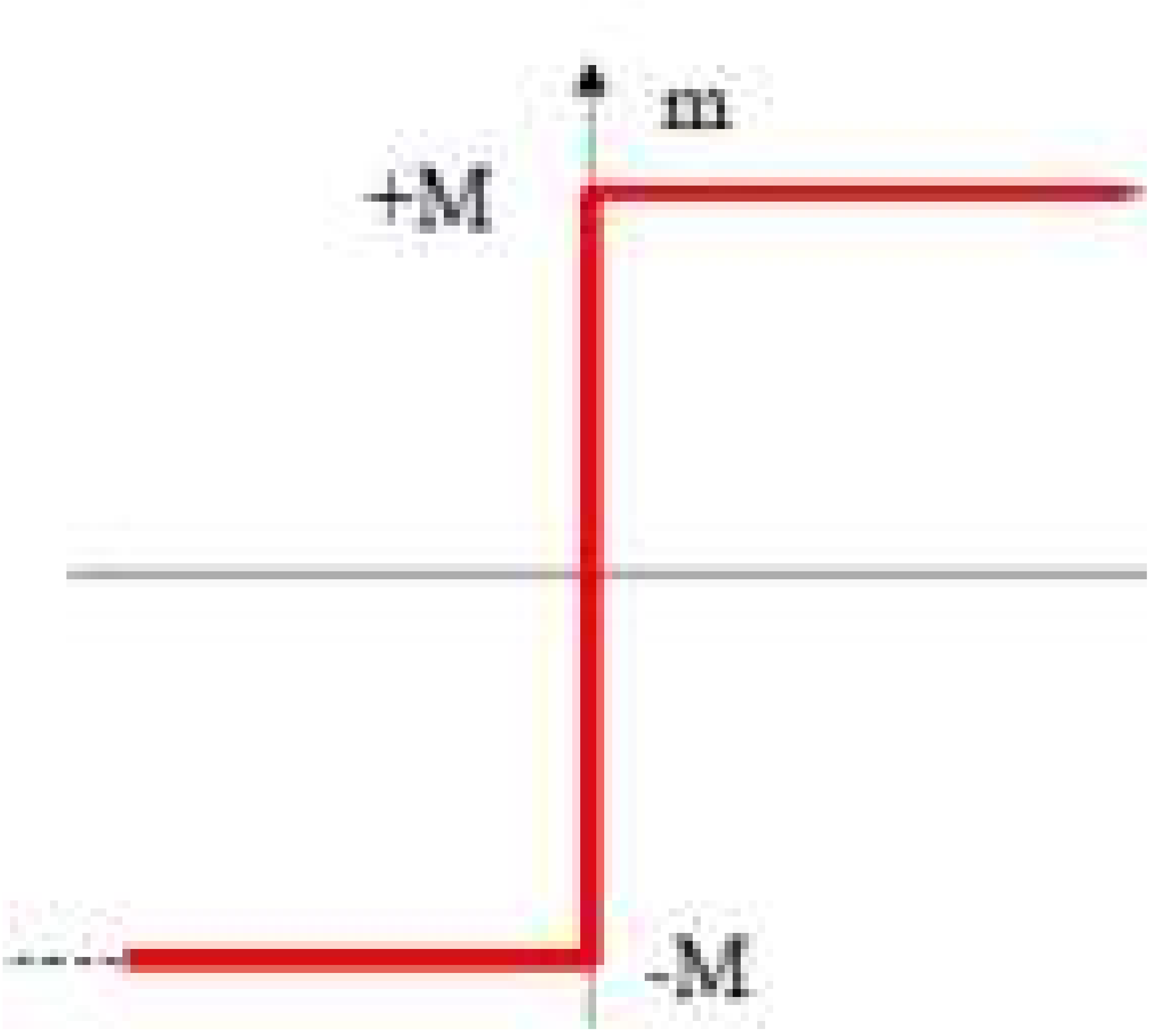
For the nonlinear characteristics shown as in below figure, what is the describing function? (1 Point)



- 2M/Pi
- 4M/Pi
- M/Pi
- 3M/Pi

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Which of the following is not a property of Lyapunov function? (1 Point)

- It is a unique function for a given system
- It is a positive definite, at least in the neighborhood of origin
- It is a scalar function
- Its time derivative is non-positive

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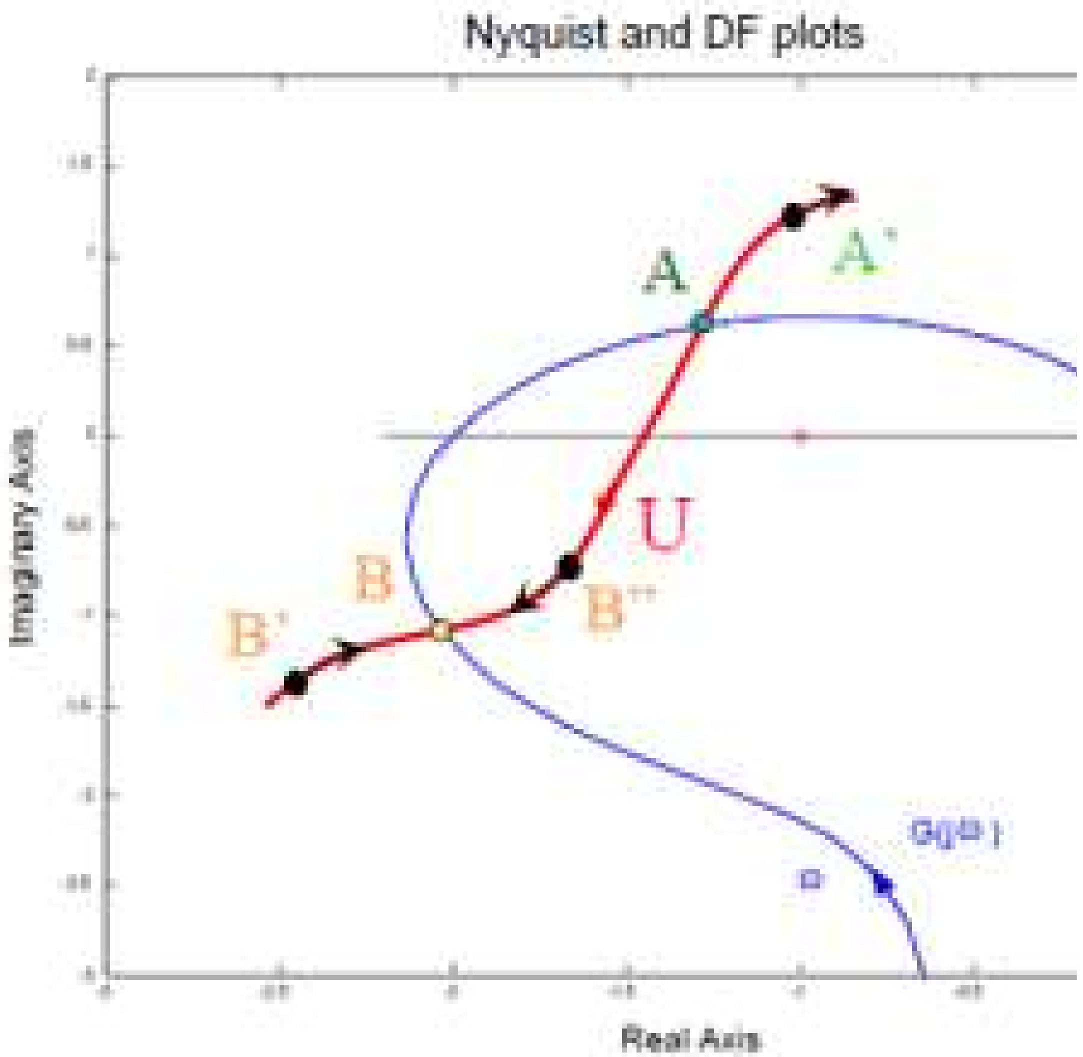
Analyze the given figure and select the FALSE statement for the given scenario. (1 Point)



- Point B is a limit cycle
- Point B′ is stable system
- Point B″ is stable system
- Point A′ is stable system

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Which of the following statement is not completely correct with respect to limit cycle in nonlinear systems? (1 Point)

- Causes instability of the equilibrium point
- Causes wear and failure in mechanical systems
- Causes loss of accuracy in regulation
- Causes the controller design to become complex

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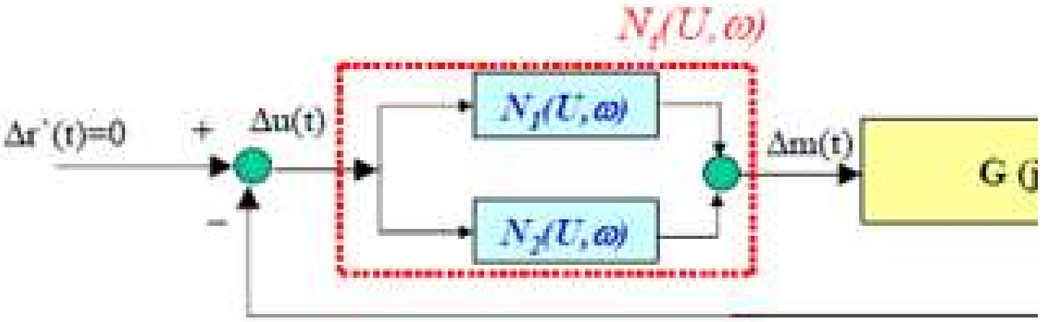
For the closed loop system shown below, the loop has to be rearranged in such a way that Nt=______ in order to perform describing function analysis. (1 Point)



- N1+N2
- N1-N2
- N1*N2
- None of the above

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The points at which derivatives of all the state variables are zero are ______. (1 Point)

- Singular points
- Nonsingular points
- Origin
- Initial condition

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For non-linear systems stability cannot be determined due to: (1 Point)

- Possible existence of multiple equilibrium states
- No correspondence between bounded input and bounded output stability and asymptotic stability
- Output may be bounded for the particular bounded input but may not be bounded for the bounded inputs
- All of the above mentioned