University of Mumbai
Examination 2021

Examinations Commencing from 1st June, 2021

Program: **Bachelor of Engineering**

Curriculum Scheme: Instrumentation Engineering (Rev. 2016)

Examination: TE Semester VI

Course Code:ISC605 and Course Name: Advanced Control System

Time: 2 hour Max. Marks: 80

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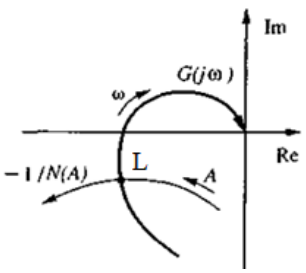
Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	Which of the following is a peculiar feature of a nonlinear system?
Option A:	System is usually represented by transfer function
Option B:	System analysis can be done by root-locus, bode-plot etc.
Option C:	Systems are usually linear time invariant
Option D:	System exhibits limit cycles
2.	When eigen values have opposite signs, singular point is a
Option A:	Node point
Option B:	Focus point
Option C:	Vortex Point
Option D:	Saddle point
3.	Consider a two dimensional linear system dx/dt=Ax, where A is a 2x2 matrix. Which of the following eigen value pair leads to a focus point?
Option A:	2,-2
Option B:	-4,-5
Option C:	-4+2j, -4-2j
Option D:	+4j, -4j
4.	A system with unstable zero is known as
Option A:	minimum phase.
Option B:	non-minimum phase.
Option C:	stable.
Option D:	unstable.
5.	To determine the stability of equilibrium point, candidate Lyapunov function should be differentiable and
Option A:	negative definite.

Option B:	positive definite.
Option C:	negative semidefinite.
Option D:	positive semidefinite.
6.	Stability of limit cycle is determined by using
Option A:	Sylvester's criteria
Option B:	Lyapunovs theorem
Option C:	Perturbation technique
Option D:	Superposition theorem
7.	A first order nonlinear system is described by $\dot{x} + 16x - x^3 = 0$ Determine the equilibrium/equilibira of the system
Option A:	origin
Option B:	0, 4,-4
Option C:	± 8
Option D:	$0, \pm\sqrt{2}$
8.	A perfect control cannot be realized for non-minimum phase system because
Option A:	controller is unstable.
Option B:	controller is non-causal.
Option C:	controller is improper.
Option D:	controller is improper as well as non-causal.
9.	What is delta for the construction of trajectory by delta method for the following system? $\ddot{x} + 0.6\dot{x} + x + x^2 = 0$
Option A:	x^2
Option B:	$0.6\dot{x} + x$
Option C:	$0.6\dot{x} + x^2$
Option D:	$\dot{x}$
10.	The point of intersection of the Nyquist plot and inverse of the describing function represents that
Option A:	System exhibits a limit cycle.
Option B:	System exhibits damped oscillations in response.
Option C:	System exhibits over-damped response.
Option D:	System does not respond to the inputs.
11.	Relative degree of the following system with respect to output *y is* $\dot{x}_1 = {x_1}^2 + x_1 x_2$ $\dot{x}_2 = x_3$ $\dot{x}_3 = \sin(x_1) + 2x_2 + x_3 + \mathrm{e}^{x_1}\mathrm{u}$ $y = x_2$
Option A:	1
Option B:	2
Option C:	3
Option D:	4
12.	Which nonlinearity is called memory type nonlinearity?

Option A:	Saturation
Option B:	Back-lash
Option C:	Relay
Option D:	Dead-Zone
13.	'For a scalar function V to be unique, the curl of its gradient must be zero', this condition is tested for
Option A:	Direct method of Lyapunov
Option B:	Krasovskii's Method
Option C:	Variable gradient Method
Option D:	Popov's method
14.	By adding a pole at the origin of s-plane, the Nyquist plot of a system will rotate by
Option A:	0 deg
Option B:	90 deg
Option C:	180 deg
Option D:	270 deg
15.	Sliding mode control is capable of rejecting
Option A:	Matched uncertainty
Option B:	Unmatched uncertainty
Option C:	Structured uncertainty
Option D:	Unstructured uncertainty
16.	The plot of $G(j\omega)$ plot intersects with $-\frac{1}{N(A,\omega)}$ plot at L (limit cycle)  Using Perturbation technique determine the stability of L
Option A:	Stable
Option B:	Unstable
Option C:	Semi stable
Option D:	Cannot be determined
17.	If ±8 is magnitude of relay output for sinusoidal input of magnitude X then describing function can be given by
Option A:	4/(pi*X)

Option B:	4*8/(pi*X)
Option C:	4*pi/(3*X)
Option D:	4*pi*X
18.	In IMC design, a filter is added
Option A:	to make the IMC controller causal.
Option B:	to make the IMC controller proper.
Option C:	to make the IMC controller stable.
Option D:	to make the IMC controller robust.
19.	If IMC control is to be designed for step input tracking, which one of the following forms of filter for the control design is recommended?
Option A:	$1/(\lambda s+1)^n$
Option B:	$(n\lambda s+1)/(\lambda s+1)^n$
Option C:	$(n\lambda s+1)^n/(\lambda s+1)$
Option D:	Filter is not required
20.	Choose the most appropriate answer for the following: "If a non linear system is globally asymptotically stable, it implies that it has only one equilibrium"
Option A:	false
Option B:	true conditionally
Option C:	true
Option D:	false conditionally

Q2.	**Answer the following**
A	**Solve any Two** **5 marks each**
i.	Write the steps to construct the Lyapunov function using Variable gradient method.
ii.	Linearize the following system at origin using Jacobian linearization, $\ddot{x} - (0.4 - 3x^2)\dot{x} + x + x^2 = 0$
iii.	Derive describing function of Relay with deadzone nonlinearity.
B	**Solve any One** **10 marks each**
i.	Draw phase trajectory of the system using Delta method with initial conditions (1,0). $\ddot{x} + \dot{x} + 6x = 0$
ii.	Design an Internal model controller (IMC) for the following process model

	$gp(s) = \frac{-0.5(-10s+1)e^{-12s}}{(5s+1)(3s+1)}$

Q3.	**Answer the following**
A	**Solve any Two** **5 marks each**
i.	Differentiate linear and nonlinear systems.
ii.	Design an IMC based PID controller for a second order non minimum phase system.
iii.	Discuss advantages and disadvantages of sliding mode control.
B	**Solve any One** **10 marks each**
i.	Investigate stability of the system described by $\dot{x}_1 = x_1\,({x_1}^2 + {x_2}^2 - 2) - 4x_1{x_2}^2$ $\dot{x}_2 = x_2\,({x_1}^2 + {x_2}^2 - 2) + 4x_2{x_1}^2$
ii.	What is Diffeomorphism? Explain in detail method to design controller using feedback linearization.