(7 pages) **Reg. No. :** .....

Code No. : 6386 **Sub. Code : ZPHM 14**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

First Semester

Physics – Core

NONLINEAR DYNAMCIS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Linear superposition principle fails completely in ——— system.

   (a) Linear

   (b) Nonlinear

   (c) Linear and nonlinear

   (d) None

2. The condition for underdamping is ———

   (a) $2\omega_0 < \alpha < 0$ (b) $0 < \alpha < -2\omega_0$

   (c) $0 < \alpha < 2\omega_0$ (d) $-2\omega_0 < \alpha < 0$

3. When real parts of both eigen values are zero then the equilibrium point is ———

   (a) stable (b) unstable

   (c) neutral (d) none

4. Saddle equilibrium point is ———

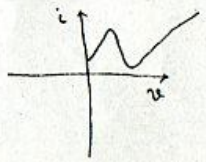
   (a) stable

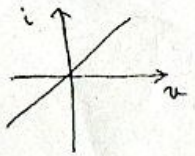
   (b) neutrally stable

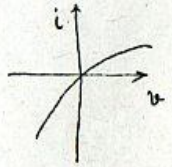
   (c) elliptic equilibrium

   (d) unstable

5. The $v-i$ characteristic curve of a nonlinear resistor is ———

   (a) 

   (b) 

   (c) 

   (d) None

6. AD 712 is an ——— device.

(a) Analog

(b) Digital

(c) Analog and digital

(d) None

7. The fractal dimension of sierpinski triangle is ———

(a) 1.385 (b) 1.485

(c) 1.585 (d) 1.685

8. Generally, chaotic attractors are ———

(a) homogeneous (b) inhomogeneous

(c) linear (d) nonlinear

9. ——— is an example for nonlinear Dispersive system.

(a) Plucking the string on veena

(b) Solitary waves on shallow surfaces

(c) Earth quakes

(d) None

10. Korteveg-de-vires equation is a simple ——— equation.

(a) linear

(b) homogeneous

(c) inhomogeneous

(d) nonlinear

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) For the following systems write the form of forces and the corresponding equation of motion. Identify which of them are linear and which of them are nonlinear.

(i) Anharmonic oscillator

(ii) Damped Harmonic oscillator.

Or

(b) Discuss the motion of the damped linear oscillator.

12. (a) Discuss the occurrence of transcritical bifurcation in the system $\dot{x} = -\mu x + x^2$, $\dot{y} = -y$.

Or

(b) What are limit cycles? Classify and explain limit cycles.

13. (a) Draw the circuit diagram of Bipolar Junction Transitor Colpitt's oxillator and its equivalent circuit. Also set the three autonomous differential equation.

Or

(b) Write the state equation for linear resonant RLC circuit and construct the exact solutions of the system.

14. (a) Explain briefly the construction of sierpinski triangle.

Or

(b) Explain the construction and properties of Koch curve.

15. (a) Write down the properties of solitions.

Or

(b) Obtain the general solution of the wave equation $\frac{1}{e^2}\frac{\partial^2 u}{\partial t^2} - \frac{\partial^2 u}{\partial x^2} = 0$ where $c^2 = \frac{k\alpha^2}{m}$ subject to the initial condition $u(x,t) = \eta(x = n_a t)$.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Distinguish and explain linear system and nonlinear system with specific examples.

Or

(b) Obtain the frequency response relations and draw the primary resonance curves for

$$\ddot{x} + \alpha\dot{x} + w_0^2 x + \beta x^3 = f \sin wt$$

17. (a) Outline the fixed point stability analysis of the damped oscillator $\ddot{x} + 2b\dot{x} + w_0^2 x = 0$ where $2b$ is the damping coefficient.

Or

(b) Describe Pitchfork Bifurcation and also explain super critical and subcritical bifurcation diagrams.

18. (a) Discuss the nonautonomus MLC circuit with neat schematic diagram and carry out the stability analysis.

Or

(b) Draw and study the dynamics of the nonlinear circuit having Chua's diode.

19. (a) Explain the construction and properties of :

(i) Julia set and Madelbrot set fractals.

(ii) Also write the applications of Fractals.

Or

(b) What is meant by Multifractals? Explain how multifractal is constructed and characterized.

20. (a) Starting from Kdv equation, explain the solitary and enoidal waves.

Or

(b) Explain the numerical experiment of zobusky and krushal.
