KAMARAJ COLLEGE (Autonomous)

Accredited with A+ Grade by NAAC

(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

THOOTHUKUDI – 628 003

(6 Pages) **Reg. No: ……**

Question. Code No : 25O003309 **Course Code : 24PEPH22**

PG Degree - End Semester Examinations, November 2025

Second Semester

M.Sc. PHYSICS

Non Linear Dynamics

(For those who joined in July 2024 onwards)

Time : 3Hours **Maximum : 75 Marks**

PART – A (10 × 1 = 10 Marks)

Answer ALL Questions

Choose the correct answer :

1. Which of the following is a second-order linear ordinary differential equation?

   (a) $y''+(y')^2=0$ (b) $y''+3y'+2y=0$

   (c) $dy/dx=y^2+x$ (d) $y^2+y'=x$

2. Which of the following is a feature of a nonlinear oscillator?

(a) Solution always periodic

(b) Amplitude-dependent frequency

(c) Sinusoidal output for all inputs

(d) Superposition principle is valid

3. Which of the following best describes the nature of solitons?

(a) Stable, self-reinforcing solitary waves that maintain their shape

(b) Random fluctuations in a medium

(c) Unstable wave packets that dissipate over time

(d) Regular waves that lose shape as they propagate

4. Which of the following represents the KdV equation?

(a) $\nabla^2 u=0$ (b) $u_t+6uu_x+u_{xxx}=0$

(c) $u_{xx}= (1/c^2)u_{tt}$ (d) $u_t+6u^2u_x+u_{xxx}=0$

5. The Logistic Map is an example of a

(a) Discrete-time dynamical system

(b) Hamiltonian system

(c) Linear differential equation

(d) Continuous-time system

6. Which route to chaos involves period doubling as a control parameter is varied?

(a) Quasiperiodicity

(b) Homoclinic tangency

(c) Intermittency

(d) Period-doubling cascade

7. _____ is a fractal with non-integer dimension equal to 0.631

(a) Cantor set (b) Julia set

(c) Snow flake (d) None

8. The unit interval of cantor set is

(a) [0,1] (b) [1,0]

(c) [1,1] (d) [1,1.5]

9. Which type of doped glass fibre enables intercontinental communication at speeds of 10 billion bits per second in light amplification?

(a) Silica-doped fibre (b) Erobium-doped fibre

(c) Germanium-doped fibre (d) Zinc-doped fibre

10. What is the purpose of time series analysis in chaos-based computation?

(a) To study the randomness of cryptographic keys

(b) To detect patterns and predict behaviour in chaotic data

(c) To encrypt images using solitons

(d) To amplify noise using stochastic resonance

PART – B (5 X 5 = 25 Marks)

Answer ALL Questions choosing either (a) or (b).
Answer should not exceed 250 words.

11. (a) Discuss the motion of free linear harmonic oscillator.

(OR)

(b) What is equilibrium point? Discuss any two classification of equilibrium points depending upon the nature of eigen values.

12. (a) What are linear waves? Give three examples.

(OR)

(b) Explain Hirota method to MKdV equation and obtain the one and two soliton solutions.

13. (a) What are limit cycles? Classify and explain limit cycle.

(OR)

(b) What is Hopf bifurcation? Explain.

14. (a) List the properties of fractals.

(OR)

(b) Write the applications of fractals.

15. (a) Explain the soliton based computation.

(OR)

(b) Write a note on chaos based communication.

PART – C (5 X 8 = 40 Marks)

Answer ALL Questions choosing either (a) or (b).

Answer should not exceed 600 words.

16. (a) Compare linear and nonlinear system with examples.

(OR)

(b) Discuss damped and driven nonlinear oscillators

i. Oscillations and

ii. Forced oscillations.

17. (a) Derive the Korteweg-de Vries simple nonlinear dispersive wave equation.

(OR)

(b) Derive the nonlinear Schrodinger equation in optical fibres.

18. (a) Explain simple bifurcations

i. Saddle node bifurcation

ii. Transcritical bifurcation.

(OR)

(b) Discuss the strange attractor in the henon map.

19. (a) What is Fractal? Explain the Koch curve fractal with the neat diagram.

(OR)

(b) Explain the construction of Sierpinski triangle and give the properties of Fractals.

20. (a) Explain the following

i. Soliton based communication systems

ii. Chaos based communication

(OR)

(b) What is Cryptography? Explain the elementary chaotic cryptographic system.