Reg. No. : .....

(6 pages)

Code No. : 7858 **Sub. Code : PPHM 14**

M.Sc. (CBCS) DEGREE EXAMINATION, NOVEMBER 2019.

First Semester

Physics – Core

NONLINEAR DYNAMICS

(For those who joined in July 2017 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The condition for under damping is ————.

(a) $2w_0 < \alpha < 0$ (b) $0 < \alpha < -2w_0$

(c) $0 < \alpha < 2w_0$ (d) $-2w_0 < \alpha < 0$

2. The nonlinear differential equation is ————.

(a) $\frac{d^2x}{dt^2} + \frac{dx}{dt} + t^2 = 0$ (b) $\frac{d^2x}{dt^2} + \frac{dx}{dt} + \sin x = 0$

(c) $\frac{dx}{dt} + w_0^2 x = f \cos wt$ (d) None

3. When damping coefficient "b" is ———— stable star.

(a) +1 (b) –1

(c) +2 (d) –2

4. The condition for nondissipative system is ————.

(a) $\nabla.\vec{F} < 0$ (b) $\nabla.\vec{F} > 0$

(c) $\nabla.\vec{F} = 0$ (d) $\nabla \times \vec{F} = 0$

5. If a resistor is characterized by VI curve other than a straight line, it is called a ———— resistor.

(a) Linear (b) Non linear

(c) Sheet (d) None

6. Ad712 is an ———— device.

(a) Analog (b) Digital

(c) Analog and Digital (d) None

7. A ———— spectrum of exponents is needed in multifractal system.

(a) Single (b) Continuous

(c) Discontinuous (d) None

8. The fractal dimension of sierpinski triangle is _____.

(a) 1.285 (b) 1.385

(c) 1.485 (d) 1.585

9. The example for the linear Dispersive wave is _____

(a) Plucking the string of the veena

(b) Earth quakes

(c) Tidal waves

(d) Cyclonic waves

10. Physically the solutions behave like _____ particles exhibiting in general elastic collision property on collisions with other soliton in one spatial dimension.

(a) Stable (b) Unstable

(c) Homogeneous (d) None

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).
Each answer should not exceed 250 words.

11. (a) Write a note on damped oscillators.

Or

(b) Differentiate between linear and nonlinear system.

12. (a) Explain Hopf bifurcation with an example.

Or

(b) Write short note on periodic attractor.

13. (a) Investigate the Dynamics of the RL Diode circuit both experimentally and numerically.

Or

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

14. (a) What is meant by multifractal? Explain how the multifractal is constructed and characterized?

Or

(b) Explain briefly the construction of sierpinski triangle.

15. (a) Obtain the general solution of the wave equation.

$\frac{1}{c^2}\frac{\partial^2 u}{\partial t^2} - \frac{\partial^2 u}{\partial x^2} = 0$ where $c^2 = \frac{k\alpha^2}{m}$ subject to the initial condition $u(x,t) = \eta(x = n\alpha, t)$.

Or

(b) Explain the basic features of John Scott Russel observation on solitary wave.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b)
Each answer should not exceed 600 words.

16. (a) Discuss the effects of nonlinearity by giving any four specific examples.

Or

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

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

17. (a) Explain the occurance of saddle-node bifurcation in the system $\dot{x} = u - x^2$, $\dot{y} = -y$ using linear stability analysis and exact solution.

Or

(b) Explain the occurance of

(i) Pitch force and

(ii) Transcritical bifurcations in the system.

18. (a) Draw the schematic diagram of the simple nonautonomous MLC circuit and carry out the stabilty analysis.

Or

(b) Construct a suitable analog simulation circuit to study the dynamics of duffing oscillator equation.

$$\ddot{x} + \alpha \dot{x} + w_*^2 x + \beta x^3 = f \sin wt \; \alpha > 0 .$$

19. (a) Explain the construction and properties of

(i) Middle third contor set and

(ii) Julia set fractals

Also write the applications of fractals.

Or

(b) Explain the construction and properties of koch curve and Mandelbrot set.

20. (a) Explain the numerical experiments of Zabusky and Kruskal.

Or

(b) Explain in detail how the Korteweg – de vries (kdv) equation gives the relevant explanation for scott Russel Phenomenon.

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