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

**Code No. : 5858** **Sub. Code : PPHM14**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2020.

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 overdamping oscillation is _____

(a) $\alpha < 2w_0$ (b) $\alpha = 2w_0$

(c) $\alpha > 2w_0$ (d) None

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

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

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

(c) $\frac{d^2x}{dt^2} + \frac{dx}{dt} + e^{-t} = 0$

(d) $\frac{dx}{dt} + w_0^2 x = f\cos wt$

3. The condition for stability is ————————

(a) $\frac{|\delta_{n+2}|}{|\delta_n|} < 1$ (b) $\frac{|\delta_{n+2}|}{|\delta_n|} > 1$

(c) $\frac{|\delta_{n+1}|}{|\delta_n|} > 1$ (d) $\left|\frac{\delta_{n+1}}{\delta_n}\right| < 1$

4. When the damping coefficient "*b*" is ———————— unstable state.

(a) +1 (b) –1

(c) +2 (d) –2

5. A sudden qualitative change in dynamics of a system is called ————————

(a) Unification (b) Integration

(c) Fusing (d) Bifurcation

6. Chua's is a simple ———— resistor with piece-wise linear characteristics.

(a) Linear (b) Nonlinear

(c) Shunt (d) None

7. Snowflak mathematical constructions exhibiting ————

(a) Self disimilar

(b) Self similar

(c) Self similar and self disimilar

(d) None

8. Contour set is a fractal with non integer dimension equal to

(a) 0.431 (b) 0.531

(c) 0.631 (d) 0.731

9. The example for the linear dispersive system ————

(a) Solitary waves on shallow water interfaces

(b) Tsunami waves

(c) Earthquakes

(d) Plucking the string on Veena

10. The Korteweg-de Vries equation is a simple ———— dispersive system.

(a) Linear (b) Non linear

(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) Differentiate between linear and non linear systems.

Or

(b) Discuss the motion of a tree linear harmonic oscillator.

12. (a) Study the occurrence of Transcritical bifurcation.

Or

(b) Explain limiting cycle of motion.

13. (a) Write down the important features associated with Chua's circuit.

Or

(b) Draw the circuit diagram of BJT Colpitt's oscillator and its equivalent circuit. Also set the three autonomous differential equations.

14. (a) Explain the construction and properties of middle third contor set.

Or

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

15. (a) (i) Explain :

(1) Solitary wave and

(2) Solition

(ii) State any two applications of soliton.

Or

(b) Explain the basic features of John Scott Russels observation of 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) Obtain the frequency response relations and draw the primary resonance curves for

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

Or

(b) Analyse the dynamics of damped and driven non linear oscillator.

17. (a) Describe Pitchfork bifurcation and also explain super critical and subcritical bifurcation diagrams.

Or

(b) Explain the period doubling phenomenon to Chao's.

18. (a) Construct the suitable analog simulators circuit to study the dynamics of the Duffing oscillator.

$$\ddot{x} + \alpha \dot{x} + w_0^2 \, x + \beta x^3 = f \sin wt \;\; \alpha > 0 \, .$$

Or

(b) Study the Chaotic dynamics of simple non autonomous MLC circuit with schematic diagram.

19. (a) Explain the construction of Sierpinski triangle and give the properties of fractals.

Or

(b) Explain the construction and properties of :

(i) Julia set and

(ii) Mandelbret set fractals. Also write the applications of fractals.

20. (a) Starting from Korteweg-de Vries (KDV) equation, explain the solitary and enoidal waves.

Or

(b) Explain the numerical experiment of Zabusky and Krushal.

———————