## SH-VI/PHSH/DSE-4/23

# B.Sc. 6th Semester (Honours) Examination, 2023 (CBCS) Subject : Physics Course : DSE-4:(9) (OR)

#### Time:

#### Full Marks: 40

 $2 \times 5 = 10$ 

The figures in the margin indicate full marks. Candidates are required to give their answers in their own words as far as applicable.

- 1. Answer any five questions:
  - (a) Define fluid.
  - (b) When sugar or salt is poured from a container it appears to flow? Do you consider these as fluid? Explain your answer from the definition of fluid.
  - (c) Define shear stress.
  - (d) What is fixed point of a dynamical system?
  - (e) What is a dynamical system? Give two examples of dynamical system.
  - (f) What characteristics should a dynamical system possess in order to be modelled using ordinary differential equation (ODE)? How is the ODE formed for such a one dimensional system?
  - (g) Define fractal.
  - (h) What is fractal dimension?
- 2. Answer any two questions:

5×2=10

- (a) (i) What is phase space of a dynamical system? What is phase trajectory? Name one software package used for computing and visualizing trajectories of dynamical system on the computer.
  - (ii) What is a discrete dynamical system? What kind of mathematical equation is used to model a discrete dynamical system?
    (1+1+1)+(1+1)
- (b) (i) State the continuum hypothesis of fluid dynamics. Give two examples where continuum hypothesis is not valid.
  - (ii) Define viscosity of a fluid. What is the physical origin of viscosity? (2+1)+(1+1)
- (c) (i) What is exponential growth model? Why is this model considered unrealistic?

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- (ii) A bacteria colony is growing in a petridish. The bacteria colony is growing according to the formula  $p(t) = 200 e^{t/40}$ , where t is measured in minutes. What will be the population of bacteria in the petridish after 2 hours? How much long will it take for the bacteria population to grow to 80,000?
- (d) What is the predator-prey model? Give a general formulation of this model. Give an example of predator-prey model and explain briefly. (1+2+2)
- 3. Answer any two questions:

10×2=20

(2+1)+2

- (a) (i) What is diffusion limited aggregation (DLA)? Give two examples where DLA model is used for simulation.
  - (ii) What is the fractal dimension of a DLA cluster in two-dimensional medium (in the continuous limit)?
  - (iii) What is logistic map? Write down the logistic map equation explaining each term. Give two examples of use of logistic map. (2+2)+1+(1+2+2)
- (b) (i) Explain the Sinai billiard and mention its significance. State one application of chaotic billiard model.
  - (ii) What is cobweb plot? How to draw a cobweb plot for any recursive formula?

(2+2+1)+(3+2)

- (c) (i) What do you mean by steady and unsteady flow?
  - (ii) What is flow dimensionality?
  - (iii) Define uniform and non-uniform flow.

(2+2)+2+(2+2)

- (d) (i) When is a fixed point (I) stable and (II) unstable?
  - (ii) What is basin of attraction?
  - (iii) Find the fixed points and classify their stability (I)  $\dot{x} = x^2 1$ , (II)  $\dot{x} = \sin x$ .

(1+1)+2+(3+3)