2023/TDC(CBCS)/ODD/SEM/
PHSDSE-501T (A/B)/158

TDC (CBCS) Odd Semester Exam., 2023

PHYSICS

(5th Semester)

Course No. : PHSDSE-501T

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

Candidates have to answer *either* from Option—A *or* Option—B

OPTION—A

Course No. : PHSDSE-501T (A)

(Classical Dynamics)

SECTION—A

Answer *twenty* questions, selecting any *four* from each Unit : 1×20=20

Unit—I

1. What do you mean by degrees of freedom?

2. Specify whether the constraint is holonomic or non-holonomic :
"Motion of a body on an inclined plane under gravity."

3. Can the centre of mass coincide with centre of gravity?

4. How much is the degrees of freedom for N particles in free space?

5. Define central force.

Unit—II

6. Define generalized coordinates.

7. What is the importance of principle of virtual work?

8. Write down Lagrange's equation for conservative system.

9. Name the constraints which are independent of time.

10. What are the advantages of Lagrangian?

Unit—III

11. When does Hamiltonian equal total energy of a system?

12. Define conjugate momentum.

13. Why is the Hamiltonian formulation preferred over the Lagrangian formulation?

14. What is Hamiltonian function?

15. State the law of conservation of energy.

Unit—IV

16. Define normal modes of vibration.

17. Give an example of stable equilibrium.

18. Why should the amplitude of oscillation be small?

19. What do you mean by small oscillations?

20. What is the amplitude of oscillation in SHM?

Unit—V

21. Explain the importance of Reynold's number.

22. Is the continuity equation based on the conservation of energy?

23. What is the conservation of mass in fluid dynamics?

24. Write down Poiseuille's equation for a flow of a liquid through a pipe.

25. What is the effect of temperature on viscosity?

SECTION—B

Answer *five* questions, selecting *one* from each Unit : 2×5=10

Unit—I

26. Show that the centre of mass of a body is a fixed point whatever be the coordinate system used.

27. Define holonomic and non-holonomic constraints with example.

Unit—II

28. Prove that if Lagrangian of a conservative system does not contain time explicitly, then total energy is conserved.

29. Obtain Lagrange's equation of motion for a freely falling body.

Unit—III

30. If the Hamiltonian H is independent of time t explicitly, prove that it is constant and equal to the total energy of the system.

31. Obtain the Hamiltonian for one-dimensional harmonic oscillator.

Unit—IV

32. Define static and dynamic equilibrium.

33. Calculate potential energy about a point of stable equilibrium.

Unit—V

34. Write down the properties of pressure in a liquid.

35. Define coefficient of viscosity in terms of velocity gradient. Also define fluidity of a fluid.

SECTION—C

Answer *five* questions, selecting *one* from each Unit : 8×5=40

Unit—I

36. Show that the motion of two bodies under a central force can be reduced to a single body motion. Give one example of its application. Define reduced mass. 5+1+2=8

37. Define centre of mass. Show that the centre of mass of two-particle system divides the line joining the two particles in the inverse ratio of their masses. Also show that the linear momentum of the centre of mass is equal to the total momentum of the two-particle system. 1+5+2=8

Unit—II

38. What are meant by virtual displacement and virtual work? Starting with the principle of virtual work, obtain d'Alembert's principle. 3+5=8

39. State and explain Hamilton's principle of least action. Obtain the Lagrange's equation for a simple harmonic oscillator. 5+3=8

Unit—III

40. Derive Hamilton's canonical equations of motion. Obtain Hamilton's equation of motion for a particle in a central force field. 4+4=8

41. Give the physical significance of Hamiltonian. Prove that $\frac{dH}{dt}=\frac{\partial H}{\partial t}$, where H is the Hamiltonian function. Given the Lagrangian

$$L=\frac{1}{2}m(\dot{r}^2+r^2\dot{\theta}^2)-V(r)$$

Find the Hamiltonian and hence the equations of motion. 2+2+4=8

Unit—IV

42. *(a)* What do you mean by normal frequency and vibrational modes? 3

(b) Explain the stability of a simple pendulum and show that it can oscillate about the position of its stable equilibrium. 5

43. *(a)* Calculate the normal frequencies and normal coordinates for the Lagrangian given by

$$L=\frac{1}{2}(\dot{x}^2+\dot{y}^2)-\frac{1}{2}(\omega_1 x^2+\omega_2 y^2)-\alpha xy$$ 5

(b) A particle moves in a potential energy given by $V(x) = bx^2 + \frac{a}{x^2}$; $a, b > 0$. Find its frequency of oscillation. 3

Unit—V

44. Define pressure in a fluid. Show that the pressure at a depth h in a fluid is equal to the pressure outside the fluid plus the fluid pressure. Deduce equation of continuity. 1+3+4=8

45. What do you mean by streamline and turbulent motion of a fluid? Define Reynold's number. How does it vary with variation of critical velocity of a liquid? A flat plate of area 100 cm^2 is separated from a large plate by a layer of glycerin 1 mm thick. If the coefficient of viscosity of glycerin is 2 SI units, what force is required to keep the plate moving with a velocity of 1 cm per second? 4+4=8

OPTION—B

Course No. : PHSDSE-501T (B)

(Biological Physics)

SECTION—A

Answer *twenty* questions, selecting any *four* from each Unit : 1×20=20

Unit—I

1. What is the boundary between the internal and external environment of cells?

2. Which system freely allows exchange of energy and matter with its environment?

3. Define the term 'self-replication'.

4. What are the two distinct types of cell?

5. What are metabolites?

Unit—II

6. What are proteins made of?

7. What are the functions of genetic circuits?

8. What are transcription and translation?

9. Where are genes located in a cell?

10. What are the different types of signalling?

Unit—III

11. Why are humans called complex organisms?

12. What is the meaning of cellular dynamics?

13. What are stem cells?

14. What are the three different types of neural network?

15. What is associative memory model?

Unit—IV

16. Where is memory stored in the brain?

17. What is the mechanism of evolution?

18. What is mutation?

19. Give an example of a self-sustaining ecosystem.

20. What are genotype and phenotype?

Unit—V

21. Is earth a self-sustaining ecosystem?

22. Define spatial scale.

23. Why is molecular interaction important?

24. What is cellular differentiation?

25. Which is the largest part of the brain?

SECTION—B

Answer *five* questions, selecting *one* from each Unit : 2×5=10

Unit—I

26. What are sexual and asexual reproductions?

27. What are the internal and external environments of a cell?

Unit—II

28. What are the energy requirements of a bacterial cell?

29. What is the random walk theory in biology?

Unit—III

30. What are the regulatory networks in cells?

31. Define system biology. Cite an example.

Unit—IV

32. What are the three types of neurons?

33. What is an attractor neural network?

Unit—V

34. What is the role of variation in evolution?

35. What are the two requirements for an ecosystem to be self-sustaining?

SECTION—C

Answer *five* questions, selecting *one* from each Unit : 8×5=40

Unit—I

36. *(a)* Explain the transfer and transformation of energy as it flows through an ecosystem. 4

(b) How does self-replication allow for natural selection of certain molecules? Mention two examples which can self-replicate. 4

37. What is allometric scaling law? What is the hypothesis of allometric scaling? Why is allometry important? Is human growth allometric? 2½+2½+2+1=8

Unit—II

38. *(a)* What are nucleic acids? What is the basic structure of a nucleic acid? 2+2=4

(b) What are the roles of nucleic acids and proteins? 2+2=4

39. *(a)* Describe the various steps involved in the process of translation. 4

(b) What are the different types of random walk models? Give the formula for a random walk. Give two advantages of random walk. 2+1+1=4

Unit—III

40. What is regulatory network in biology? Describe the structure of a regulatory network. Mention two applications of gene regulatory network. 2+4+2=8

41. *(a)* Explain briefly cellular dynamics. 4

(b) Why is origin of life important? What are the various theories of the origin of life? 2+2=4

Unit—IV

42. *(a)* Discuss the various factors affecting cell differentiation. 4

(b) What is the purpose of cell differentiation? Give an example. 3+1=4

43. *(a)* Explain the structure of human brain in detail. 4

(b) Explain the neural network dynamics in human brain. 4

Unit—V

44. Describe briefly the mechanisms of evolution. Mention the seven stages in human evolution. 5½+2½=8

45. *(a)* Explain the terms 'breed' and 'variety'. 2+2=4

(b) What are the structural properties of genotype–phenotype maps? What is genotype to phenotype example? 3+1=4

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