

2103000205021001
EXAMINATION FEBRUARY -MARCH 2024
BACHELOR OF SCIENCE (FIFTH SEMESTER)
PHYSICS-VI (PH-506-CLASSICAL MECHANICS AND SOLID
STATE PHYSICS) - LEVEL 2

[Time: As Per Schedule]

[Max. Marks: 50]

Instructions:

1. Fill up strictly the following details on your answer book

- a. Name of the Examination: **BACHELOR OF SCIENCE (FIFTH SEMESTER)**
 - b. Name of the Subject: **PHYSICS-VI (PH-506-CLASSICAL MECHANICS AND SOLID STATE PHYSICS)-LEVEL-2**
 - c. Subject Code No: **2103000205021001**
2. Sketch neat and labelled diagram wherever necessary.
 3. Figures to the right indicate full marks of the question.
 4. All questions are compulsory.
 5. Symbols used in the paper have their usual meaning.
 6. Scientific calculator may be used.

Seat No:

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Student's Signature

Q.1 Answer the following questions in brief: (Attempt any ten)

10

1. What is Lagrange point, where ISRO's Aditya-L1 will be positioned to study Sun?
2. If the gravitational force acts on all bodies in proportion to their masses, why does not a heavy body falls faster than light body?
3. What is the degree of freedom for system having 7 particle and 2 independent constrains?
4. Evaluate kinetic energy of a body have an angular momentum 100 Js and moment of inertia 5 kgm².
5. What is central force?
6. Define holonomic Constraints.
7. Drawbacks of classical free electron gas theory.
8. According to Kronig penny model electron at the middle of two lattice point behaves as (Free electron/bound electron)
9. Mention any one application of hall effect.
10. State Bloch theorem.
11. Define density of states.

12. What is constrained motion?

Q.2 [A] Attempt any one of the following in details: 7

- (i) Explain total energy of particle in central force field. Discuss the motion of particle in arbitrary potential field.
- (ii) What is central force? Using central force motion obtain conservation of angular momentum and prove the second law of Kepler's.

Q.2 [B] Attempt any one of the following 3

- (i) The maximum and minimum distances of a comet from the sun are 2×10^{10} m and 1.6×10^{12} m. If its velocity when nearest to the sun is 3×10^4 m/s, what will be comet velocity in m/s when it is farthest.
- (ii) A Force $\vec{F} = \alpha \hat{i} + 4\hat{j} + 5\hat{k}$ N is acting at a point $\vec{r} = 2\hat{i} + 8\hat{j} + 10\hat{k}$ m then find value of α for which angular momentum conserved.

Q.3 [A] Attempt any one of the following in details: 7

- (i) The simplest version of the Atwood machine consist of two masses, m_1 and m_2 , suspended on either side of a mass less, frictionless pulley of radius R, by a mass less rope of length l. By using Langrangian equation derive the acceleration of mass m_1 .
- (ii) Explain D'ealembert's principle. Derive Langrange 's equation of motion from D'ealembert's principle.

Q.3 [B] Attempt any one of the following: 3

- (i) Consider a motion of particle in three dimension under the force F, Obtain the Langrangian equations and show that they are equivalent to Newton's equations.
- (ii) Define holonomic constraint and explain the impact of such constrains on the number of degrees of freedom of a system.

Q.4 [A] Attempt any one of the following in details: 7

- (i) Set up Schrödinger equation for an electron moving in one dimensional potential and solve it to obtain E_n . Find the value of normalization constant and sketch the wave function.
- (ii) State the Hall effect. Derive the Hall coefficient with neat diagram.

Q.4 [B] Attempt any one of the following: 3

- (i) Give a concise explanation of reason that the observed electron contribution to the heat capacity of a metal is only a small fraction of that expected classically.
- (ii) A electron relaxation time of metal A is 2.7×10^{-4} s and that of B is 1.35×10^{-4} s. Find the ratio of resistivity of B to resistivity of A.

Q.5 [A] Attempt any one of the following in details: 7

- (i) Schematically explain the basic assumptions of Kronig-Penney model. Describe how the characteristics equation from the boundary condition of Schrödinger equation to solve the Kronig- Penney model. Discuss the conclusion of Kronig-Penney model.
- (ii) Describe nearly free electron model. Using nearly free electron model schematically shows how the energy dispersion relation give rise to band gap.

Q.5 [B] Attempt any one of the following: 3

- (i) Electron linear momentum 0.48×10^{-6} Ns and mass of electron 9.1×10^{-31} kg then inside the conductor according to Kronig penny model when (barrier strength) $P \rightarrow 0$ Find the kinetic energy of free electron.
- (ii) Calculate the energy of state for quantum number $n=1$. lattice spacing 0.285 \AA , mass of electron 9.1×10^{-31} kg, $h = 6.625 \times 10^{-34}$ Js
