RAN-2103000205021001

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B.Sc. (Sem. - V) Examination October - 2025

Physics (Paper - PH-506) Classical Mechanics and Solid State Physics

[Total Marks: 50

સૂચના : / Instructions

(1) ઉપરોક્ત દર્શાવેલ વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fill up strictly the above details on your answer book
(2) Draw neat diagrams wherever necessary.
(3) Symbols used in the paper have their usual meaning.
(4) Figures to the right indicate full marks of the question.
(5) Scientific calculator may be used.

Seat No.:

Student's Signature

Q.1. Answer the following questions in brief: (Attempt any ten) **10**

1. Define Holonomic Constraint
2. Mention kepler's third law.
3. If a generalized co-ordinate of dimension of charge, then what is the unit of Generalized velocities ?
4. A man weight 50 kg. He stands on a weighing scale in a lift which is moving downwards with a uniform acceleration of $1 m/s^2$. What would be the reading on the scale? ($g = 10\ m/s^2$)
5. What is direction of the angular momentum vector in an orbital motion?
6. What is the degree of freedom for system having 12 particle and 4 independent constrains ?
7. What is the level that acts as a reference which separated the vacant and filled states at 0K?
8. Evaluate kinetic energy of a body have an angular momentum 10 Js and moment of inertia 2 kgm^2 .
9. Resistivity of rod is 4×10^{-8} Ωm find its conductivity
10. Define Fermi energy.
11. What are the success of classical free electron theory?
12. Write down the solution of Schrodinger equation according to Bloch.

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 ofthe following: **(3)**

(i) The orbital radius of the moon is 3.84×10^8m and the period of the moon is 27.3 days. The height of the artificial satellite from the centre of earth 8500 km, calculate periodic time of satellite.
(ii) A Force $\vec{F} = 4\hat{i} - 12\hat{j} - 16\hat{k}$ is acting at a point $\vec{r} = a\hat{i} - 6\hat{j} - 8\hat{k}$ then find value of a for which angular momentum conserved.

Q.3. (a) Attempt any one of the following in details: **(7)**

(i) Explain D'alembert's principle.

(ii) 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.

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) Explain by giving examples, the meaning of holonomic and nonholonomic constraints

Q.4. (a) Attempt any one of the following in details: **(7)**

(i) By using Free electron gas model for metal derive equation of resistivity and conductivity equation for metal.

(ii) Explain Hall effect.

Q.4. (b) Attempt any one of the following: **(3)**

(i) The resistivity of copper at room temperature is 1.76×10^{-8} ohm-meter. If the density of mobile electrons is $8.38\times10^{28}m^{-3}$, calculate the relaxation time for free electrons in copper.
(mass of electron 9.1×10^{-31}kg, charge of electron 1.6×10^{-19}C)

(ii) The mobility of holes is 0.035 m^3/Vs. what whould be resistivity of P type silicon if Hall coefficient is 2.25×10^{-5} m^3/C.

Q.5. (a) Attempt any one of the following in details: **(7)**

(i) Describe 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 0.31×10^{-6} Ns and mass of electron 9.1×10^{-31} kg then inside the conductor according to Kronig penny model when (barrier strength)P---->0Find the kinetic energy of free electron.

(ii) Calculate the energy of state for quantum number n=6. lattice spacing 0.234 Å, mass of electron 9.1×10^{-31} kg,h = $6.625\times l0^{-34}$Js

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