RAN-2103000205021001

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B.Sc. (Sem. V) Examination October - 2023

Physics : Paper 506

Classical Mechanics and Solid State Physics

[Total Marks: 50

સૂચના : / Instructions

(૧) **નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.**
Fill up strictly the details of ☛ signs on your answer book

Name of the Examination:

☛ **B.Sc. (Sem. V)**

Name of the Subject :

☛ **Physics : Paper 506**
Classical Mechanics and Solid State Physics

Subject Code No.: **2103000205021001**

Seat No.:

Student's Signature

(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.

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

1. A man weight 50 kg he stands on a weighing scale in a lift which is moving downwards with a uniform acceleration of 2 m/s^2 . What would be the reading on the scale? ($g = 10\ m/s^2$)
2. Why 'an apple appears to fall towards the earth and not the earth towards the apple' ?
3. What is direction of the angular momentum vector in an orbital motion?
4. What is Lagrange point, where ISRO's Aditya-Ll will be positioned to study Sun ?
5. What is the degree of freedom for system having 7 particle and 2 independent constrains ?
6. On what factor the magnitude of the central force depends?
7. Mention any one application of hall effect.

8. What are the success of classical free electron theory?
9. Mention the region in k-space for first Brillouin zone.
10. Define Fermi energy.
11. What does a negative Hall coefficient mean?
12. Drawbacks of classical free electron gas theory.

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

(I) What is central force ? Using central force motion to obtain the equation of orbit in the form

$$\theta(r) - \theta_0 = \int_{r_0}^{r} \frac{\left(\frac{L}{r^2}\right)dr}{\left[2\mu\left(E - V - \frac{L^2}{2\mu r^2}\right)\right]^{\frac{1}{2}}}$$

(II) Explain total energy of particle in central force field. Discuss the motion of particle in arbitrary potential field.

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

(I) Discuss the developments of Kepler's law of planetary motion.

(II) Calculate the period of revolution of Jupiter around the Sun.
The ratio of the radius of Jupiter's orbit to that of the Earth's orbit is 5.

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

(I) Obtain the Lagrange equations of motion for a spherical pendulum, a point mass suspended by a rigid weightless rod.

(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) What do you mean by constrained motion ? Explain any two illustration of the constrained motion.

(II) 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.

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) 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.

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

(I) The Hall coefficient of a specimen is 3.66×10^{-4} m^3/s. It's resistivity is 7.67×10^{-3} ohm –m. Find concentration of electrons.

(II) The resistivity of copper at room temperature is $1.7 \times l0^{-8}$ ohm– meter. If the density of mobile electrons is $8.4 \times l0^{28}$ m^{-3}, calculate the relaxation time for free electrons in copper.
(mass of electron $9.1 \times l0^{-31}$ kg, charge of electron $1.6 \times l0^{-19}$ 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) Calculate the energy of state for quantum number n = l.
Lattice spacing 0.285 Å, mass of electron 9.1×10^{-31} kg,
$h = 6.625 \times 10^{-34}$ Js

(II) Electron linear momentum 0.4×10^{-6} Ns and mass of electron 9.1×10^{-31} kg then inside the conductor according to Kronig penny model when (barrier strength) P--->0. Find the kinetic energy of free electron.

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