# UG Odd Semester Examination, 2022

## EDUCATION B.Sc. B.Ed

(5th Semester)

Course No.: BSPH-501

**(Electricity, Magnetism and Classical Mechanics)**

*Full Marks: 50*

*Pass Marks: 20*

*Time: 2 hours*

*The figures in the right margin indicate full marks for the question.*
*Answer the following five (5) questions*

1. (a) A sphere of radius R carries a polarization $\vec{p}(r) = 6kr$, where k is a constant and r is the position vector from the centre. Calculate the bound charge densities $\alpha_b$ and $\delta_b$ of the sphere. 3

   (b) Derive the integral form of Gauss's law in dielectric. And find the electric displacement of a long straight wire carrying uniform line charge density $\lambda$ and surrounded by rubber insulation out to a radius 'a'. 4+3=7

Or

2. Derive the relation between peltier coefficient $\Pi$ and thermo emf(E) given by 8+2=10

$$\Pi = T\frac{dE}{dT}$$

Also obtain the relation

$$\sigma_A - \sigma_B = -T \frac{d^2E}{dT^2}$$

where $\sigma_A$ and $\sigma_B$ are Thomson's coefficients of metals A and B respectively.

3. (a) Find the magnetic field at a distance 's' from a straight conductor carrying a current I using Biot-savart law. And deduce the magnetic field due to infinitely long straight wire. 5+2=7

   (b) Show that $\nabla.B = 0$ 3

Or

4. (a) State Ampere's law. Derive the Ampere's law in differential form given by $\nabla xB = \mu_0 J$. 1+4=5

   (b) What are Coulomg and Lorentz gauges? Also obtain the relation $\nabla^2 A = \mu_0 J$ under the Coulomb gauge, where A is magnetic vector potential. 5

5. (a) Derive the differential form of Ampere's law in magnetized material given by 3+2=5

   $\nabla \times H = J_f$

   And deduce its integral form.

   (b) A long copper rod of radius R carries a uniformly distributed free current I. Find H at a point $r < R$ and $r > R$. 4

Or

6. (a) Discuss briefly about ferromagnetism and hysteresis loop. 3+3=6

   (b) State Kirchhoff's laws of electric circuit. Derive the balance condition of Wheatstone bridge. 4

7. (a) Derive Kepler's third law of planetary motion. 5

   (b) Using Lagrangian formulation show that the acceleration of the Atwood's machine system is 5

$$\frac{d^2x}{dt^2} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$$

Or

8. (a) Show that the Lagrangian equation of motion of two-body system under the influence of central force F(r) is 5

$$\mu\frac{d^2r}{dt^2} - \mu r\left(\frac{d\theta}{dt}\right)^2 = F(r)$$

   (b) Derive the differential equation of simple harmonic motion of simple pendulum using Lagrangian formulation. 5

9. (a) Derive Hamilton's equations of motion : 8

$$\dot{q}_k = \frac{\partial H}{\partial P_k},\ \dot{P}_k = -\frac{\partial H}{\partial q_k} \text{ and } \frac{\partial L}{\partial t} = -\frac{\partial H}{\partial t}$$

   (b) For any cyclic coordinate $q_k$, show that the corresponding conjugate momentum $p_k$ is a constant of motion. 2

Or

10. Find the Hamiltonian of a simple pendulum and derive its equation of motion when the amplitude of the pendulum is very small. 2+8=10

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