Seat No. _____

HAK-003-1015026

B. Sc. (Sem. V) (CBCS) Examination

May - 2023

Physics - 502

(Old Course)

Faculty Code : 003
Subject Code : 1015026

Time : $2\frac{1}{2}$ Hours / Total Marks : **70**

Instructions : (1) All questions are compulsory.
(2) Symbols have their usual meanings.
(3) Figures to the right indicate marks

1 (a) Answer the following objective questions: **4**

(1) Ohm's law in vector form is given by $\vec{J} = \sigma \vec{E}$.
True or false?

(2) Write Ampere's circuital law in differential form.

(3) Write Poynting's vector in differential form.

(4) Write the equation of continuity.

(b) Answer any one question: **2**

(1) Show that the function $f = A\sin\left[b\left(z - vt\right)\right]$ satisfies the wave equation.

(2) Find the self inductance of a toroidal coil of inner radius a and outer radius b, having height h and number of turns N.

(c) Answer any one question: **3**

(1) Derive the expression for motional emf.

(2) Derive Neumann's formula.

(d) Answer any one in detail: **5**

(1) State and explain Poynting's theorem.

(2) Write Maxwell's equations. Explain Maxwell's modification of Ampere's law.

2 (a) Answer the following objective questions: **4**

(1) $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ True or false

(2) $\frac{E_0}{B_0} =$ .....

(3) Write the one dimensional wave equation.

(4) Write Maxwell's first equation (Gauss theorem) in free space (vacuum).

(b) Answer any one question : **2**

(1) The intensity of sunlight falling on the earth's surface is $1300 W/m^2$. Find the pressure exerted by the sunlight if the earth is considered as

(a) a perfect absorber.

(b) a perfect reflector.

(2) For a given electric field $\vec{E} = 10\sin(\omega t - kz)\hat{y}$, find $\vec{B}$ and the Poynting vector $\vec{S}$.

(c) Answer any one question : **3**

(1) Explain polarization of electromagnetic waves.

(2) Starting with Maxwell's equation derive the wave equation for electromagnetic waves in vacuum.

(d) Answer any one in detail : **5**

(1) Obtain the equation for energy and momentum in electromagnetic waves.

(2) Explain the boundary conditions for reflection and transmission and obtain the equation for their amplitudes.

3 (a) Answer the following objective questions : **4**

(1) Define vector potential.

(2) Define scalar potential.

(3) What is *d'* Alembertian operator?

(4) Define retarded time.

(b) Answer any one question : **2**

(1) Find the fields corresponding to

$$\vec{A}(\vec{r}, t) = -\frac{1}{4\mu\varepsilon_0}\frac{qt}{r^2}\hat{r}, \phi = 0.$$

(2) Use the gauge function $\lambda = -\frac{1}{4\pi\varepsilon_0}\frac{qt}{r}$ to find new potentials.

(c) Answer any one question : **3**

(1) Explain retarded potential.

(2) Explain Jefimenko's equations.

(d) Answer any one in detail : **5**

(1) Explain gauge transformation.

(2) Explain Lienard-Wiechert potential.

4 (a) Answer the following objective questions: **4**

(1) What is Poynting vector?

(2) Write Abraham Lorentz formula.

(3) If curl of E is zero then E can be defined as .....

(4) What is radiation?

(b) Answer any one question : **2**

(1) $V(\vec{r}, \theta, t) = \frac{p_0 \omega \cos\theta}{4\pi r \varepsilon_0 c} \sin\omega\left(t - \frac{r}{c}\right)$ Express this in co-ordinate free from by writing $p.\cos\theta = p_0 \cdot \hat{r}$.

(2) $\vec{E} = -\frac{\mu_0 p_0 \omega^2}{4\pi r c^2 \varepsilon_0}\left(\frac{\sin\theta}{r}\right)\cos\omega\left(t - \frac{r}{c}\right)\hat{\theta}$ Express this in co-ordinate free from by writing $p.\cos\theta = p_0 \cdot \hat{r}$.

(c) Answer any one question : **3**

(1) Explain Coulomb's gauge.

(2) Write the equation for electric dipole radiation with $d << r$ and $d << \lambda$.

(d) Answer any one in detail : **5**

(1) Explain radiation from an arbitrary source.

(2) Explain power radiated by a point charge.

5 (a) Answer the following objective questions : **4**

(1) What is world line?

(2) State Einstein's postulates.

(3) What are covariant and contravariant terms?

(4) Define inertial frame of reference.

(b) Answer any one question : **2**

(1) Synchronized clocks are stationed at regular intervals, a million km apart, along a straight line. When the clock next to you read 12 noon. What time do you see on the 90^{th} clock down line?

(2) A muon is travelling through the laboratory at three-fifths the speed of light. How long does it last?

(c) Answer any one question : **3**

(1) Explain Lorentz transformation in terms of relativity.

(2) Explain proper time and proper velocity.

(d) Answer any one in detail : **5**

(1) Explain the geometry of relativity in detail.

(2) Explain the structure of space time.
