DBK-003-1015026 Seat No. _____

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

June – 2022

Physics : Paper - 502

(Electrodynamics & Relativity) (New Course)

Faculty Code : 003

Subject Code : 1015026

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

Instructions :

(1) Attempt any **five** questions.

(2) Symbols have their usual meaning.

(3) Figure on **right** hand sides indicates full marks.

1 (A) Do as directed : **4**

(1) The inverse of _____ is called resistivity.

(2) $\nabla \times B = \mu_0 J$ is known as _____ law.

(3) What is Neumann formula?

(4) The equation $\frac{dp_{mech}}{dt} = -\mu_0 \in_0 \frac{d}{dt}\iiint S d\tau + \iint T\, da$ is the statement of conservation of _____ in electrodynamics.

(B) Two metallic objects are embedded in weakly conducting material of conductivity σ. Show that the resistance between them is related to the capacitance of the arrangement by $R = \frac{\in_0}{\sigma C^*}$ **2**

(C) Prove Neumann formula. **3**

(D) Explain energy stored in magnetic field. **5**

2 (A) Do as directed : 4

(1) Far an ideal source of emf the net force on charges is _____.

(2) $\iint Edl = -\iint \frac{\partial B}{\partial t} da$ is Faraday's law in _____.

(3) What Ampere's law in integral form?

(4) The energy per unit time per unit area transported by the fields is called the _____.

(B) A cylindrical resistor of cross sectional area a and Length L is made from material having conductivity σ. If the potential is constant over each end, the potential difference between the ends is V, what current flows? 2

(C) Write Maxwell's equations. 3

(D) Explain Poynting theorem, 5

3 (A) Do as directed. 4

(1) Mechanical wave required _____ to propagate.

(2) Generally sinusoidal wave can be represented as _____.

(3) Relation between wave number k and wavelength λ is _____.

(4) Different frequencies in the visible range correspond to different colours, such waves are called _____.

(B) The intensity of sunlight hitting the earth is about 1300 W/m^2. If sunlight strikes a perfect absorber, what pressure does it exert? 2

(C) Explain boundary conditions. 3

(D) Derive wave equation. 5

4 (A) Do as directed. **4**

(1) What is k in equation, $f(z,t) = A\cos\left[k(z - vt) + \delta\right]$?

(2) In electromagnetic wave, electric field and magnetic field are _____ to the direction of propagation.

(3) What is the formula of Poynting vector?

(4) The average power per unit area transported by an Electromagnetic wave is called _____.

(B) Find the Poynting vector for given electric field **2**

$E = 10\sin(\omega t - kz)\,\hat{y}$ and magnetic field $B = \frac{10k}{\omega}\sin(\omega t - kz)\,\hat{x}$.

(C) Explain polarization. **3**

(D) Explain energy and momentum in electromagnetic waves. **5**

5 (A) Do as directed : **4**

(1) In Maxwell's equations; $\nabla \times E =$ _____.

(2) In equation, $\nabla^2 - \mu_0 \in_0 \varphi \frac{\partial^2}{\partial t^2} = \square^2 . \square^2$ is called _____.

(3) The equations, $V(r,t) = \frac{1}{4\pi \in_0}\int \frac{\rho(r', t_r)}{r} d\tau'$ and

$A(r,t) = \frac{\mu_0}{4\pi}\int \frac{J(r', t_r)}{r} d\tau'$ are called _____.

(4) $B(r, t) = \frac{\mu_0}{4\pi}\int\left[\frac{J(r', t_r)}{r^2} + \frac{J(r', t_r)}{cr}\right] \times \hat{r} d\tau'$ is time dependent generalization of the _____ law.

(B) What are the electric and magnetic fields of the potentials $\varphi = 0$ and $A = k\left(xzi - yzj\right)$? **2**

(C) Explain advance time and give scalar vector potential in form of it. **3**

(D) Explain retarded potential. **5**

6 (A) Do as directed : **4**

(1) $\square^2 - V = \frac{-\rho}{\in_0}$ and $\square^2 A = \mu_0 J$ are four dimensional versions of _____ equation.

(2) $E\left(r,\ t\right) = \frac{1}{4\pi \in_0} \int \left[\frac{\rho\left(r',\ t_r\right)}{r^2}\hat{r} + \frac{\dot{\rho}\left(r',\ t_r\right)}{c\ r}\hat{r} - \frac{\dot{J}\left(r',\ t_r\right)}{c^2 r}\right] \cdot d\tau'$

is the time dependent generalization of _____ law.

(3) The four dimensional Poisson's equations are reduce to $\nabla^2 V = \frac{-\rho}{\in_0}$ and $\nabla^2 A = -\mu_0 J$ in _____ case.

(4) $V\left(r,\ t\right) = \frac{1}{4\pi \in_0} \frac{q\,c}{\left(r\,c - t\,v\right)}$ and $A\left(r,\ t\right) = \frac{\mu_0}{4\pi} \frac{q\,c\,v}{\left(r\,c - t\,v\right)}$ are the _____ potentials for the moving point charge.

(B) Find electric field that would give rise to the potentials; $\varphi = 0$ and $A = \frac{\mu_0 k}{4\,c}\left(ct - |x|\right)^2 \hat{z}$. **2**

(C) Derive Jefimenko equations. **3**

(D) Explain electric and magnetic fields of a moving point charge with constant velocity. **5**

7 (A) Do as directed. 4

(1) Radiation means _____ flow of energy away from the source.

(2) In static limit, i.e. $\omega \to 0$,

$$V(r, \theta, t) = \frac{p_0 \cos\theta}{4\pi \in_0^r}\left[\frac{-\omega}{c}\sin\left\{\omega\left(t-\frac{r}{c}\right)\right\}+\frac{1}{r}\cos\left\{\omega\left(t-\frac{r}{c}\right)\right\}\right]$$

Reduces to V = _____.

(3) White sunlight consists of the entire range of frequencies of _____ light.

(4) For perfect magnetic dipole, the current loop to be very _____.

(B) Draw figures of physical dipole and perfect dipole. 2

(C) How does EM waves produced? 3

(D) Write E and B and find total power radiated by electric dipole. 5

8 (A) Do as directed : 4

(1) To convert physical dipole into perfect dipole separation Distance to be _____.

(2) The effect of a red sunset becomes more pronounced if the Atmosphere contains _____ particles.

(3) When a = 0 in Taylor series, the series is called _____ series.

(4) The formula of power radiated, $P = \frac{\mu_0 q^2 a^2}{6\pi c}$

is known as _____ formula.

(B) Explain static source do not radiate. **2**

(C) Describe blueness of sky and redness of sunset. **3**

(D) Describe the physical basis of the radiation reaction. **5**

9 (A) Do as directed : **4**

(1) Two events that are simultaneous in one inertial system are not _____ in another.

(2) What is formula of Lorentz contraction?

(3) $\overline{x} = x - vt$, $\overline{y} = y$, $\overline{z} = z$ and $\overline{t} = t$ are called _____ transformation.

(4) $\overline{u} = \frac{u - v}{\left(1 - \frac{uv}{c^2}\right)}$ is known as Einstein's _____ rure.

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

(C) Discuss relativity of simultaneity. **3**

(D) Explain the space time diagram. **5**

10 (A) Do as directed : **4**

(1) Dimensions perpendicular to the _____ are not contracted.

(2) $P = \frac{mu}{\sqrt{\left(1 - \frac{u^2}{c^2}\right)}}$ is the relativistic _____ of an object of rest mass m travelling at ordinary velocity u.

(3) In every closed system, the total relativistic _____ and momentum are conserved.

(4) In relativistic dynamics, a charged particle placed in a Uniform electric field have a _____ motion under a constant force.

(B) Invert the following equation to get the formula for u in terms of V. $\left(1-\frac{u^2}{c^2}\right)v^2 = u^2$. **2**

(C) Write Einstein's postulates of special relativity. **3**

(D) Describe the Minkowski force. **5**