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RO-003-1015026

Seat No. _____

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

February - 2019

Physics - P-502

(Electrodynamics & Relativity)

(New Course)

Faculty Code : 003

Subject Code : 1015026

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

Instructions : (1) Attempt all questions.
(2) Figure on right indicates marks.
(3) Symbols have their usual meanings.

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

(1) The flux rule for motional emf ε = _____ .

(2) Ampere's law in integral form $\oint$ B.dI = _____.

(3) A changing electric field induces magnetic field. (True or False)

(4) In electrostatics and Magnetostatics the Newton's third law holds, but in electrodynamics it does not. (True or False)

(b) Answer any **one** out of two : **2**

(1) If a self inductance of a solenoid is 100 mH, radius is 2 cm.

(i) Find out the number of turns per cm of the length of the solenoid, when there is a rod of iron inserted as a core material having value of permeability of 2.5×10^{-2} H/m.

(ii) What is the energy stored in the magnetic field in the above case the current flowing the solenoid is *1A*.

(2) Find the self-inductance of a toroidal coil with rectangular cross section cinner radius, a outer radius b, height h1 which carries a total of N turns.

(c) Answer any **one** out of two : **3**

(1) Derive continuity equation.

(2) A short solenoid having length l and radius a, with n_1 turns per unit length lies on the axis of very long solenoid having radius b, n_2 turns per unit length. Current I flows in the short solenoid. What is the flux through the long solenoid ?

(d) Answer any **one** out of two : **5**

(1) Explain inductance in detail,

(2) Derive Poynting's Theorem.

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

(1) Define : Transverse wave

(2) The waves are travelling in the Z-direction and have no x or y dependence is called plane wave. (True or False)

(3) What is angular frequency ?

(4) Write classical wave equation.

(b) Answer any **one** out of two : **2**

(1) The intensity of sunlight hitting the earth is about 1300 W/m^2. If sunlight strikes a perfect absorber, what pressure does it exert ? How about a perfect reflector ? What fraction of atmospheric pressure does this amount to ? (the atmospheric pressure is 1.03×10^5 N/m^2)

(2) Use equation $A_3 = A_1 + A_2$ or

$A_3 e^{i\delta_3} = A_1 e^{i\delta_1} + A_2 e^{i\delta_2}$ to determine A_3 and δ_3

in terms of A_1, A_2, δ_1 and δ_2.

(c) Answer any **one** out of two : **3**

(1) Explain monochromatic plane waves.

(2) Show that the standing wave $f(z,t) = A \sin(k_z) \cos(kut)$ satisfies the wave equation and express it as the sum of a wave travelling to the left and a wave travelling to the right.

(d) Answer any **one** out of two : **5**

(1) Discuss wave equation.

(2) Explain Boundary condition (Reflection and transmission) for electromagnetic waves.

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

(1) $\nabla \times B$ = _____

(2) The advance time $t_a \cong$ _____

(3) In the column gauge $\nabla \cdot A =$ _____

(4) $\square^2 A =$ _____

(b) Answer any **one** out of two : **2**

(1) Show that the differential equations for V and A can be written in the more symmetrical form.

$$\left.\begin{aligned} \Box^2 V + \frac{\partial L}{\partial t} &= -\frac{1}{\epsilon_0} p \\ \Box^2 A - \nabla L &= -\mu_0 J \end{aligned}\right\}$$

where

$$\Box^2 \cong \nabla^2 - \mu_0 \epsilon_0 \frac{\partial^2}{\partial t^2} \text{ and } L \cong \nabla \cdot A + \mu_0 \epsilon_0 \frac{\partial v}{\partial t}$$

(2) Find the potentials of a point charge moving with constant velocity.

(c) Answer any **one** out of two : **3**

(1) Explain Retarded potentials.

(2) An infinite straight wire carries the current

$$I(t) = \begin{cases} 0 & \text{for } t \le 0 \\ I_0 & \text{for } t > 0 \end{cases}$$

That is, a constant current I_0 is turned on abruptly at $t = 0$. Find the resulting electric field and magnetic field.

(d) Answer any **one** out of two : **5**

(1) Write note on Lienard – Wiechert potentials.

(2) Write note on the fields of a moving point charge.

4 (a) Answer the following questions : 4

(1) E & B are in phase, mutually perpendicular and transverse the ratio of their amplitude

$\frac{Eo}{Bo}$ = _____

(2) The total power radiated over a sphere is independent of the _____ of the sphere.

(3) In a case of a point charge, no power is radiated in the forward or backward direction.
(True or False)

(4) For a non-relativistic particle $(V \ll C)$ the total power radiated is given by the _____ formula.

(b) Answer any **one** out of two : 2

(1) Calculate the radiation damping of a charged particle attached to a spring of natural frequency Wo, driven at frequency w.

(2) Derive the formula for total power in the case of an oscillating electric dipole given by

$p(t) = p_0 \cos(wt)$

$\ddot{p}(t) = -w^2 p_0 \cos(wt)$

(c) Answer any **one** out of two : 3

(1) Explain blueness of sky and redness of sunset.

(2) Suppose V and a are instantaneously collineal (at time t_r) as, for example in straight line motion. Find the angular distribution of the radiation and the total power emitted.

(d) Answer any **one** out of two : **5**

(1) Write note on – Radiation from an arbitrary source.

(2) Write note on – The total power radiated by point charge.

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

(1) The laws of mechanics are certainly the same in accelerating reference frames.
(True or False)

(2) Equation $U_{AC} = U_{AB} + U_{BC}$ is called as Einstein's velocity addition rule.
(True or False.)

(3) The trajectory of a particle on a Minkowski diagram is called _____.

(4) The locus of all points accessible to you is called _____.

(b) Answer any **one** out of two : **2**

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

(2) How much energy would be released if 1 kg of substance gets fully converted into energy.

(c) Answer any **one** out of two : **3**

(1) Explain Lorentz contraction.

(2) A train is moving with the speed of 60 km/hr and a man starts moving the speed of 5 km/hr inside the train. What is the percent error introduced when you use Galileo's rule instead of Einstein's velocity addition rule ?

(d) Answer any **one** out of two : **5**

(1) Write note on – Space-time diagram.

(2) Write note on – Relativistic Energy and Momentum