



**JW-003-1015026**

Seat No. \_\_\_\_\_

**B. Sc. (Sem. V) (CBCS) (W.E.F. 2016) Examination**

**October - 2019**

**Physics : Paper - 502**

*(Electrodynamics & Relativity)*

*(New Course)*

**Faculty Code : 003**

**Subject Code : 1015026**

Time :  $2\frac{1}{2}$  Hours]

[Total Marks : 70

- Instructions :**
- (1) All questions are compulsory.
  - (2) Figures on right hand side indicate marks.
  - (3) Symbols have their usual meanings.

- 1 (a) Write a short answer to the following : 4
- (1) The current density ( $J$ ) is proportional to the force per unit current. Is it true or false ?
  - (2) Eddy Currents are responsible for slowing down the swings of aluminium disc in the field region of magnet. Do you agree with this ?
  - (3) The unit of inductance is \_\_\_\_\_.
  - (4) The poynting vector ( $S$ ) gives the value of energy flux density. Is it true or false ?
- (b) Answer in brief for the following : (any **one**) 2
- (1) A cylindrical resistor of cross sectional area  $A$  and length  $L$  is made from material with conductivity  $\sigma$ . If the potential difference between the two ends is  $V$ , find out the current flowing in the resistor.
  - (2) What is the energy stored in the magnetic field in the solenoid having self-inductance 100 mH. The current flowing in the solenoid is 1 A.
- (c) Answer the following : (any **one**) 3
- (1) Describe Faraday's experiments and explain Faraday's law for electromagnetic induction.
  - (2) Derive the continuity equation.

- (d) Answer in detail : (any **one**) 5
- (1) Explain mutual inductance and derive the Neumann formula for it.
  - (2) Describe - Poynting's theorem.
- 2 (a) Write short answers to the following : 4
- (1) Standing waves do not propagate. Do you agree ?
  - (2) Wave motion is possible in a string only when it is stretched. Is it true or false ?
  - (3) Write a formula relating to wavelength  $\lambda$  and wave number  $k$ .
  - (4) The gamma rays have highest wavelength among the electromagnetic spectrum. Is it true or false ?
- (b) Answer in brief for the following : (any **one**) 2
- (1) Show that the standing wave  $f(z, t) = A \sin(kz) \cos(kvt)$  satisfies the wave equation.
  - (2) The intensity of sunlight hitting the earth is about  $1300 \text{ W/m}^2$ . If sunlight strikes a perfect absorber, what pressure does it exert ?
- (c) Answer the following : (any **one**) 3
- (1) What is wave ? Explain.
  - (2) Obtain the formula for radiation pressure when light falls on the perfect absorber.
- (d) Write in detail : (any **one**) 5
- (1) Discuss boundary conditions for reflection and transmission of waves.
  - (2) Derive the wave equation for  $\mathbf{E}$  and  $\mathbf{B}$  in vacuum.
- 3 (a) Write short answers to the following : 4
- (1) In electrostatics,  $\nabla \times \mathbf{E} = 0$ . Is it true or false ?
  - (2) In magnetostatics,  $\nabla \cdot \mathbf{A} = 0$ . Do you agree ?
  - (3) The direction of a magnetic field of a point charge is always \_\_\_\_\_ to the electric field.
  - (4) In case of a moving point charge, velocity field is responsible for the electromagnetic radiation. Is it true or false ?

- (b) Answer the following : (any **one**) 2
- (1) Calculate only the electric field of a point charge moving with constant velocity.
  - (2) Suppose  $V = 0$  and  $A = A_0 \sin(kx - \omega t)\hat{y}$ , where  $A_0, \omega$  and  $k$  are constants. Find  $\mathbf{E}$  and  $\mathbf{B}$ . Check that they satisfy Maxwell's equations in vacuum. What condition must be imposed on  $\omega$  and  $k$  ?
- (c) Answer the following : (any **one**) 3
- (1) Write equations of  $\mathbf{V}$  and  $\mathbf{A}$  in terms of d'Alembertian operator.
  - (2) Explain : The Coulomb gauge.
- (d) Write in detail : (any **one**) 5
- (1) Explain in detail : Lienard-Wiechert potentials.
  - (2) Derive Jefimenko's equations for  $\mathbf{E}$  and  $\mathbf{B}$ .
- 4 (a) Write short answers to the following : 4
- (1) Only accelerated charge or changing current can produce radiation. Do you agree ?
  - (2) According to Biot-Savart's law, magnetostatic fields decreases according to the term  $1/r^2$ . Is it true or false ?
  - (3) In case of electromagnetic waves , the ratio  $E_0/B_0 = ?$
  - (4) Which one is dominating - magnetic dipole radiation or electric dipole radiation ?
- (b) Answer the following : (any **one**) 2
- (1) Calculate the radiation damping of a charged particle attached to a spring of natural frequency  $\omega_0$  driven at frequency  $\omega$ .
  - (2) Find the radiation resistance of the wire joining the two ends of the dipole. Show that  $R = 790(d/\lambda)^2\Omega$ , where  $\lambda$  is the wavelength of the radiation.

- (c) Answer the following : (any **one**) 3
- (1) Explain the blueness of sky.
  - (2) Discuss radiation reaction and derive Abraham Lorentz formula.
- (d) Write in detail : (any **one**) 5
- (1) Explain magnetic dipole radiation and derive expressions of  $\mathbf{E}$  and  $\mathbf{B}$ .
  - (2) Discuss power radiated by a point charge and obtain Larmor formula.
- 5 (a) Write short answers to the following : 4
- (1) What do you mean by an inertial reference frame ?
  - (2) Write formula for speed of light in terms of permeability and permittivity of vacuum.
  - (3) According to relativity theory a moving clock runs fast. Do you agree ?
  - (4) According to Lorentz contraction, the moving objects are shortened in all dimensions. Is it true or false ?
- (b) Answer the following : (any **one**) 2
- (1) A Muon is traveling through the laboratory at three-fifths the speed of light. How long does it last ? Lifetime of muon is 2 microsecond.
  - (2) How much energy would be released if 1 kg of substance gets fully converted into energy ?
- (c) Answer the following : (any **one**) 3
- (1) Write Einstein's two postulates for relativity.
  - (2) Explain time dilation.
- (d) Write in detail : (any **one**) 5
- (1) Explain : The Lorentz Transformations
  - (2) Discuss : Relativistic energy and momentum.