DR-003-2016033 Seat No. _____

B. Sc. (Sem. VI) (CBCS) (W.E.F. 2019) Examination

April - 2022

Physics : P-603

(Electrodynamics & Applied Optics) (New Course)

Faculty Code : 003

Subject Code : 2016033

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

Instructions : (1) Attempt all questions.

(2) Figures on right side indicates marks.

(3) Symbols have their usual meaning.

1 (A) Answer following objective questions : (1 mark of each) **4**

(1) In electrodynamics, curl of E is non-zero. (True/False).

(2) If $\nabla\lambda$ is add to vector potential and $\frac{\partial\lambda}{\partial t}$ is subtract from scalar potential, it will act as a Gauge. (True / False).

(3) In the Lerentz gauge, we take, $\nabla.A = 0$. (Ture/False).

(4) The retarded time is given by $t_r = t + \frac{r}{c}$. (Ture/False).

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

(1) Prove that, Gauss law and Ampere-Maxwell law in terms of potential V and A, can be expressed in simplified form as follows;

$$\square^2 V + \frac{\partial l}{\partial t} = -\frac{1}{\epsilon_0}\rho$$

$$\square^2 A - \nabla L = -\mu_0 J$$

Where,

$$\square^2 = \nabla^2 - \mu_0 \in_0 \frac{\partial^2}{\partial t^2}$$

$$L = \nabla . A + \mu_0 \in_0 \frac{\partial V}{\partial t}$$

(2) Suppose, scalar potential V=0 and vector potential $A = A_0 \sin(kx - \omega t)\hat{y}$. Find the value of electric field (E) and magnetic field (B). Consider B is in x-direction.

(C) Answer any one in detail : **3**

(1) Explain Coulomb Gauge.

(2) Explain Blueness of sky and redness of sunset in terms of power formula of radiation.

(D) Answer any one question : **5**

(1) Explain retarded potential.

(2) Deduce Jefimenko's equation.

2 (A) Answer following questions : (**1** mark of each) **4**

(1) In Lorentz transformation, the resultant velocity of two objects moving in same direction with velocities v_1 and v_2 is $v = v_1 + v_2$ (True/False).

(2) In Lorentz transformation, $t' = \frac{\left(t + \frac{v}{c^2}x\right)}{\sqrt{1 - \frac{v^2}{c^2}}}$ (True/False)

(3) Time dilation is given by, $\Delta t' = \Delta t \sqrt{1 - \frac{v^2}{c^2}}$ (True/False).

(4) If time associated with and objects is remains same as its velocity is increase, it is called proper time. (True/False).

(B) Answer any one out of two questions : **2**

(1) If a spacecraft moving with the velocity 0.6 times the velocity of light. If such ship emits the light in the direction of its motion. Find the resultant velocity of light.

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

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

(1) Deduce addition of velocity formula for inertial reference frames S and S'.

(2) Deduce the formula for variation of mass with velocity.

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

(1) Explain mass-energy equivalence.

(2) Deduce Lorentz's transformation equations.

3 (A) Answer following questions : (1 mark of each) 4

(1) The probability for absorption transition is proportional to the photon density $\rho(f)$. (True/False?)

(2) _____represents the probability of a spontaneous transition from level $2 \rightarrow 1$.

(3) Write the formula for the rate of absorption transition.

(4) Nd-YAG LASER has four-level pumping scheme. (True/False?)

(B) Answer any one : 2

(1) The wavelength of emission is 5000 $\overset{0}{A}$ and the coefficient of spontaneous emission is 10^6 per second. Determine the coefficient of stimulated emission. (Take $\mu = 1$)

(2) The wavelength of emission is 5000 $\overset{0}{A}$ and the coefficient of spontaneous emission is 10^6 per second and coefficient for stimulated emission is 0.7510×10^{10}. Find Planck's constant. (Take $\mu = 1$)

(C) Answer any one question : 3

(1) Explain metastable state.

(2) Explain brightness, monochromaticity and coherent properties of LASER beam.

(D) Answer any one in detail : 5

(1) Explain population inversion.

(2) Deduce relation between Einstein coefficient for spontaneous and stimulated emission.

4 (A) Answer following questions : (1 mark of each) 4

(1) Penetration power of X-ray depends on kinetic energy of cathode ray. (Ture / False ?)

(2) In Coolidge tune the intensity and quality of X-ray can be controlled independently. (Ture / False ?)

(3) Distance of a reciprocal lattice point from the arbitrary origin, is equals to interplanar distance of set of parallel plans. (True / False ?)

(4) For reciprocal lattice vector a^* and direct lattice vector a; $a^* . a =$ _____.

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

(1) If the minimum wavelenght recorded in an X-ray spectrum is 24.7×10^{-12} m, when voltage across tube is given by an amount of 50 kV. Calculate the Planck's constant.

(2) Find out θ for first order x-ray reflection obtained with x-ray having 1 A^0 wavelength and interplanar spacing of 1 A^0 for particular sets of planes.

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

(1) Explain Bragg's law for X-ray diffraction.

(2) Give the important features of continuous X-ray spectrum.

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

(1) Deduce the relation between reciprocal lattice vector and direct lattice vector.

(2) Deduce Bragg's law for the reciprocal lattice.

5 (A) Answer following questions : (1 mark of each) **4**

(1) Core is necessary to prevent leakage of light energy through evanescent waves. (True/false?)

(2) Acceptance angle is given by θ_0 =_____.

(3) Numerical aperture is given by NA= _____.

(4) In Graded index fiber, path length of different modes is compensated by constant velocity of light within the different refractive index. (True/False?)

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

(1) Calculate numerical aperture (N.A.) of an optical fiber with a refractive index of core 1.6 and cladding 1.56.

(2) Find propagation angle of optical fiber having core of refractive index 1.43 and cladding of refractive index 1.40.

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

(1) Explain extrinsic attenuation in optical fiber.

(2) Define numerical aperture and derive its expression.

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

(1) Derive expression of an acceptance angle of the optical fiber.

(2) Explain graded index fiber with its characteristics, advantages and disadvantages.