

Time : Three Hours]

[Maximum Marks : 75

Note: There are **three** sections (A, B and C) and candidate has to attempt questions from all sections. Marks are indicated against each section.

Section-A

1. Attempt **all** of the following : 5×3=15

~~(a)~~ Define the frames of reference and differentiate between inertial and non-inertial frames.

~~(b)~~ State the Ohm's law in terms of electrical conductivity.

~~(c)~~ What do you mean by laser ? Define spontaneous and stimulated emission.

~~(d)~~ What is the black body radiation ? State the Wien's Law.

~~(e)~~ Write the expression for the line integral, surface integral, and volume integral.

Section-B

Note: Attempt all questions :

4×5=20

2. (a) Show that $E^2 = P^2 C^2 + m_0^2 C^4$

Or

$m_{rel} \quad m_0^2$

(b) Show that the circle $x^2 + y^2 = a^2$ in frames S appear to be an ellipse in frame S', which is moving with velocity V relative to S.

3. (a) Compute the de-Broglie wavelength of a proton whose kinetic energy is equal to the rest energy of an electron. Mass of proton is 1840 times that of an electron.

Or

(b) Derive the solution of Schrodinger wave equation for one-dimensional particle in a box.

4. (a) Derive the line element, surface element, and volume element expressions in the spherical polar coordinate system.

Or

(b) Show that the vector field $\vec{F}_1 = (x^2 + xy^2)\hat{i} + (y^2 + x^2y)\hat{j}$ is irrotational and the vector field $\vec{F}_1 = (x + 3y)\hat{i} + (y - 3z)\hat{j} + (x - 2z)\hat{k}$ is solenoidal.

5. (a) What are Newton's rings and how is the wavelength determined using Newton's rings?

Or

- (b) What do you mean by a Wedge-shaped film? Discuss the interference due to it and obtain the expression for the fringe width.

Section-C

Note: Answer any two questions:

2×20=40

6. What do you mean by wave function? Derive the time dependent and time-independent Schrodinger wave equation. And also write in three-dimension.

7. Write the Lorentz transformation and inverse Lorentz transformation. By using the Lorentz transformation, derive the expression for length contraction and time dilation. Also show that space-time interval $(x^2 + y^2 + z^2 - c^2t^2)$ is invariant under Lorentz transformation.

8. Discuss the interference and diffraction phenomenon of light. Derive the fringe width expression using Young's double slit experiment. Also discuss the intensity variation in the interference patterns for the constructive and destructive interference.

9. Describe the laws of electromagnetic induction for self and mutual induction. Establish the electromagnetic waves equations in free space and solve them to show that they travel with the speed of light in free space and are transverse in nature.

