

Time : 3 Hours

Max. Marks : 60

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note: Attempt five questions in all, selecting one question from each from section A, B, C and D, Section E is compulsory.

SECTION A

1. (a). What is length contraction and time dilation in special theory of relativity? Deduce an expression for both, in regard to the interval between two events measured from two different frames of reference. (7)
- (b). Calculate the rest mass, relativistic mass and momentum of a photon of energy 5eV. (3)
2. ~~(a)~~ Explain the terms spontaneous emission and stimulated emission with schematic diagram. (3)
- ~~(b)~~ Explain the construction and working of a Helium-Neon laser with energy level diagram. (4)
- (c). A He-Ne laser is emitting a laser beam with an average power of 4.5 mW. Find the number of photons emitted per second by the laser. The wavelength of the emitted radiation is 6328 Å. (3)

SECTION B

3. Discuss the theory of forced oscillations and obtain an expression for amplitude resonance. (10)

4. (a) Explain how transmission of light takes place in optical fibers. (5)
- (b). The angle of acceptance of an optical fiber is 30° when kept in air. Find the angle of acceptance when it is in medium of refractive index 1.33. (5)

SECTION C

5. (a). Derive the time-independent Schrodinger wave equation. (5)
- (b). An electron has a speed of 600 m/s with an accuracy of 0.005%. Calculate the certainty with which we can locate the position of the electron. (3)
- (c). Prove the non-existence of electrons inside the nucleus. <https://www.hptuonline.com> (2)
6. ~~(a)~~ Write a short note on continuous and characteristics X-rays. (5)
- (b). Discuss Bremsstrahlung effect in details. (5)

SECTION D

7. By using Maxwell's equations develop wave equation for electric and magnetic fields in free space. (10)
8. ~~(a)~~ Explain Meissner effect. (3)
- (b). Explain general properties of superconductors. Give two applications. (3)
- (c). Write a short note on Isotope effect and high temperature superconductor. (4)

SECTION E

9. (a). What is Galilean transformation? Derive Galilean transformation equations. (5)
- (b). The Ruby laser has two states at 300K and 500K. If it emits light of wavelength 7000\AA , then calculate the relative population (Given, $k = 8.6 \times 10^{-5} \text{ eV/K}$). (5)
- (c). The core of an optical fibre is fabricated from a material such that relative core-cladding index difference is 0.01. The refractive index of cladding is 1.3. Keeping the material of the core same, the cladding material is replaced by another medium, such that core-cladding index difference is now 0.02. Calculate the ratio of light gathering ability of the optical fibre for the two cases with refractive index of outer medium to be 1. (5)
- (d). Establish time dependent Schrodinger wave equation and further deduce time independent equation from it. (5)

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