Qn. Set Code-1

Semester: 1st
Programme: B.Tech
Branch: Scheme-A

AUTUMN END SEMESTER EXAMINATION-2022

1st Semester B.Tech

PHYSICS

PH10001

(For 2022 Admitted Batch)

Time: 3 Hours

Full Marks: 50

Answer any SIX questions.
Question paper consists of four SECTIONS i.e. A, B, C and D.
Section A is compulsory.
Attempt minimum one question each from Sections B, C, D.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable and all parts of a question should be answered at one place only.

SECTION-A

1. Answer the following questions. [1 × 10]

(a) Write down two examples of forced oscillations.

(b) Find out the velocity of a one-dimensional progressive wave $y(x, t)$ represented by $4\frac{\partial^2 y}{\partial x^2} = \frac{\partial^2 y}{\partial t^2}$, where x and t are in meter and second.

(c) In a Newton's Ring apparatus, if white light is used in place of monochromatic light, what would be the shape of the fringes.

(d) A single slit is illuminated by light composed of two wavelengths λ_1 and λ_2. One observes that the 1st minima obtained due to Fraunhofer diffraction for λ_1 coincides with the second minima of λ_2. Determine the relation between λ_1 and λ_2

(c) If the no of rulings/lines are doubled in a diffraction grating, what would happen to the intensity of the principal maxima?

(f) Write down the Maxwell's equation, which supports the idea of absence of magnetic monopoles.

(g) State the Ampere's circuital law and write down its mathematical form. V : IR , $\oint B \cdot dl = \mu_0 I$

(h) A particle is moving with a velocity of 3500 m/s. What would be the group velocity and phase velocity of the de Broglie waves associated with the particle? $V_g =$

(i) An electron is confined in a 1-D potential box of infinite height. If the length of the box is halved, to what factor the ground state energy of the electron would change. not affected

(j) Write two (specific) applications of laser. Guns,

SECTION-B

2. (a) A narrow slit illuminated by monochromatic light produces Fraunhofer's diffraction. Derive the necessary conditions for central maximum. Also draw the intensity distribution curve with proper labelling. [4]

(b) State the Gauss law in electrostatics and Faraday's law of electromagnetic induction. Also write the corresponding differential form of Maxwell's equations. [4]

3. (a) Write down the expressions for phase velocity (V_p) and group velocity (V_g). Find the relationship between V_p and V_g in a dispersive medium. Show that $V_p.V_g = c^2$, where c is velocity of light. [4]

(b) Explain the terms spontaneous emission, stimulated emission, pumping and population inversion in relation to laser. [4]

(a) for electric field and magnetic field in free space.

(b) Establish the differential equation of two pendulums of mass "m" and length "l" coupled by a spring of spring constant "k". Using the normal coordinates, setup the decoupled equations.

(a) Write down the time independent Schrodinger's equation for a particle confined to a one-dimensional potential box of infinite height and length 'L'. Solve it to obtain the energy eigen values for the system.

(b) Find out the expression for de-Broglie wavelength of a charged particle having charge q accelerated by a potential difference of V. Find the de-Broglie wavelength of an electron accelerated to 1000 volt.

(a) Monochromatic light of wavelength 'λ' falls on a diffraction grating. Considering Fraunhofer's diffraction, write the expression for resultant intensity. From this, derive the condition and intensity of principal maxima.

(b) The first order diffraction line of a plane diffraction grating occurs at an angle of 30° for a wavelength of 6 x 10^{-5}cm. Find the number of lines/rulings per inch in the grating. Also, determine the grating element.

SECTION-D

(a) Explain how the refractive index of an unknown transparent liquid be determined by using Newton's ring experiment.

(b) Derive the expression for acceptance angle for a step index optical fibre.

(a) Use the Heisenberg's uncertainty principle for position momentum to show that the ground state energy of a harmonic oscillator is nonzero.

(b) An electron is confined in the same potential box (given in question 3 (a)) of infinite height and width 1nm. Find the energy difference between the 2nd excited state and ground state. Also, write the normalised eigen function for both ground and 2^{nd} excited state.

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