INTERNATIONAL CENTRE FOR APPLIED SCIENCES
MAHE, MANIPAL

B.Sc. (Applied Sciences) in Engg.

End – Semester Theory Examinations – Nov./ Dec. 2020

I SEMESTER - PHYSICS-I (IPH 111)

(Branch: Common to all)

Time: 3 Hours **Date: 20 November 2020** **Max. Marks: 100**

- ✓ **Answer any FIVE full questions.**
- ✓ **Missing data, if any, may be suitably assumed**

Useful constants

Planck's constant h = 6.63 x 10^{-34} Js, Velocity of light c = 3x 10^{8} ms^{-1}.
Charge on electron = 1.6x10^{-19} C. Mass of electron = 9.1 x 10^{-31} kg.
Mass of proton = 1.67 x 10^{-27} kg. Boltzmann constant: 1.38 x 10^{-23} J/K
Stefan-Boltzmann Constant: 5.67 x 10^{-8} W/m^2K^4

1. A) What are coherent waves? Explain the mechanism of obtaining the same.

B) Obtain an expression for the radius of m^{th} order bright ring in the case of Newton's rings.

C) In a double-slit experiment, the distance between slits is 5.22mm and the slits are 1.36m from the screen. Two interference patterns can be seen on the screen, one due to light with wavelength 480nm and the other due to light with wavelength 612nm. Find the separation on the screen between the third order interference fringes of the two different patterns.

D) In the Newton's ring experiment the radii of n^{th} and $(n+20)^{th}$ bright rings are measured to be 0.162 cm and 0.368 cm respectively. If the wavelength of the light used is 546 nm, calculate the radius of curvature of the lens.

(6+6+4+4) marks

2. A) What is diffraction of light? Distinguish between Fresnel and Fraunhofer classes of diffraction.

B) Obtain an expression for the intensity of light in double-slit interference using phasor-diagram.

C) A single slit is illuminated by light whose wavelengths are λ_a and λ_b, so chosen that the first diffraction minimum of λ_a component coincides with the second minimum of the λ_b component. i) What is the relationship between the two wavelengths? ii) Do any other minima in the two patterns coincide?

D) In a double slit experiment, the distance of the screen from the slit is 52cm, the wavelength is 480nm, the slit separation is 0.12mm and slit width is 0.025mm. (a) What is spacing between adjacent fringes? (b) What is the distance from the central maximum to the first minimum of the fringe envelope?

(6+6+4+4) marks

3. A) Obtain the locations of single slit diffraction minima and maxima qualitatively.
B) Explain Rayleigh's criterion for resolving images due to a circular aperture.
C) What is polarization of light waves? Give the schematic representation of polarized and un-polarised light? .
D) We wish to use a plate of glass (n=1.50) in air as a polarizer. Find the polarizing angle and the angle of refraction.
E) A diffraction grating has 200 rulings/mm and a principal maximum is noted at 28°. What are the possible wavelengths of incident white light? **(4+4+4+4+4) marks**

4. A) State and explain – i) Stefan's law ii) Wein's law in relation to black body radiation.
B) What is photo-electric effect? What are classical predictions and experimental observations?
C) A blackbody at 7500 K consists of an opening of diameter d = 0.050 mm, looking into an oven. Find the number (n) of photons per second escaping the hole and having wavelengths between 500 nm and 501 nm
D) X- rays having an energy of 300 keV undergo Compton scattering from a target. Find i) The Compton shift at an angle of 37° and ii) the energy of scattered x-ray

(4+6+6+4) marks

5. A) What is Compton effect ? Derive the Compton shift equation.
B) Explain Heisenberg uncertainty principle. Write the equations for uncertainty in (a) position and momentum (b) energy and time.
C) A 0.500 kg baseball is confined between two rigid walls of a stadium that can be modelled as a box of length 100m. Calculate i) the minimum speed of the ball ii) If the ball now moves with a speed of 150m/s determine the quantum number of the state in which the baseball resides.
D) An electron and a bullet (m= 20gm) each have a velocity of 500m/s accurate to within 0.010%. Within what limits could we determine the positions of the objects along the direction of the velocity? **(6+6+4+4) marks**

6. A) Explain – i) Normalisation of wave functions ii) Tunnelling.
B) Solve Schrodinger equation for the wave function of a particle confined in an infinite potential well of one dimension.
C) An electron with energy 5 eV is incident on a barrier with thickness 0.20nm and height 10 eV. What is the probability that the electron (a) will tunnel through the barrier? (b) will be reflected ?
D) A photon with wavelength is absorbed by an electron confined to a box. As a result, the electron moves from state n =1 to n =4. (a) Find the length of the box. (b) What is the wavelength of the photon emitted in the transition of that electron from the state n = 4 to the state n = 2?

(6+6+4+4) marks

7. A) Explain the origin of (i) orbital quantum number (ii) magnetic orbital quantum number and write the relation between them
B) Describe the construction and working of He-Ne laser.
C) Calculate the most probable value and average value of the position for an electron in the ground state of the hydrogen atom.
D) A ruby laser emits light at a wavelength of 694.4 nm. If a laser pulse is emitted for 12.0 ps and the energy release per pulse is 150 mJ, (a) what is the length of the pulse, and (b) how many photons are there in each pulse D.?

(6+6+4+4) marks

8. A) Explain the doped semiconductors

B) Derive the density-of-states function.

C) An H_2-molecule is in its vibrational and rotational ground states. It absorbs a photon of wavelength 2.2112 μm and jumps to the v = 1, J = 1 energy level. It then drops to the v = 0, J = 2 energy level, while emitting a photon of wavelength 2.4054 μm. Calculate (a) the moment of inertia of the H_2-molecule about an axis through its center of mass and perpendicular to the H-H bond (b) the vibrational frequency of the H_2-molecule and (c) the equilibrium separation distance for this molecule.

D) Sodium is a monovalent metal having a density of 971 kg/m^3 and a molar mass of 0.023 kg/mol. Use this information to calculate (a) the density of charge carriers and (b) the Fermi energy.

(4+6+6+ 4) marks