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PH 181101

18/2/23

Roll No. of candidate

2023

B.Tech. 1st Semester End-Term Examination

PHYSICS – 101

(Group B) (w.e.f 2018–19)

(New Regulation and New Syllabus)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No. 1 and any *four* from the rest.

1. Write the correct answer from MCQ $(10 \times 1 = 10)$

(i) The equation of continuity represents the conservation of

(a) Energy

(b) Charge

(c) Momentum

(d) None of these

(ii) The boundary wall between domains is known as

(a) Potential wall

(b) Bloch wall

(c) Magnetic wall

(d) None of these

(iii) In Newton's ring arrangement with air film in reflected light the diameter of n^{th}

(a) $\sqrt{\mu}$ times

(b) $1/\sqrt{\mu}$ times

(c) $1/\mu$ times

(d) μ times

(iv) An achromatic combination is to be made using a convex and a concave lens. The two lenses should have

(a) Their powers equal

(b) Their refractive indices equal

(c) Their dispersive powers equal

(d) The product of their powers and dispersive powers equal

(v) In He-Ne laser the ratio of the He to Ne is

(a) 10 : 1

(b) 1 : 10

(c) 100 : 1

(d) None of these

(vi) In optical fibre, the refractive index of cladding is

(a) less than that of the core

(b) more than that of the core

(c) equal to that of the core

(d) may be less than or more than that of the core

(vii) In fibre optics, an optical fibre with a core of constant refractive index and cladding of constant but relatively less refractive index is known as

(a) graded-index fibre

(b) step-index fibre

(c) both (a) and (b)

(d) None of these

(viii) Which of the following couples represent the canonically conjugate quantities?

(a) Energy and mass

(b) Momentum and energy

(c) Time and length

(d) Energy and time

(ix) Which one of the following is correct for Kronig-Penny model

(a) real model

(b) approximate model

(c) virtual model

(d) none of these

(x) At critical temperature, the critical magnetic field becomes

(a) zero

(b) infinity

(c) half its value at 0k

(d) None of these

2. (a) If $\varphi[x, y, z] = 3x^2y - yz^2$ find gradient of φ at point (1, 2, –1). (3)

(b) State Ampere's law and obtain its differential form. (1 + 3 =4)

(c) What do you mean by displacement current? How does it differ from conduction current? (1 + 2 = 3)

(d) What is hysteresis curve? Prove that the energy dissipated per cycle per c.c. magnetization is equal to the area of B-H curve. (2 + 3 = 5)

3. (a) Explain axial chromatic aberration in a lens. Show that it is equal to the mean focal length of the lens system times the dispersive power of the material of the lens. (2 + 3 = 5)

(b) Describe the formation of Newton's rings in reflected monochromatic light. Show that the diameters of dark rings are proportional to the square roots of natural numbers. What will happen to Newton's rings-

(i) if the glass plate is replaced by a plane mirror and

(ii) white light is used instead of monochromatic light? (2 + 3 +2 = 7)

(c) In Newton's ring arrangement a source is emitting two wavelengths $\lambda_1 = 6.0 \times 10^{-7}$ m and $\lambda_2 = 5.9 \times 10^{-7}$ m. It is found that n^{th} darkring due to one wavelength coincides with $(n + 1)^{th}$ dark ring due to the other. Find the diameter of the n^{th} dark ring if radius of curvature of the lens is 0.9 m. (3)

4. (a) What are Einstein's coefficients? Obtain a relation between the probabilities for spontaneous and stimulated emissions. (3 + 5 = 8)

(b) What is meant by population inversion and how is it achieved in practice. (3)

(c) Calculate the population ratio of two states in He-Ne laser that produces light of wavelength 6000A° at 300 K. (4)

5. (a) How does light propagate along a fibre? Define acceptance angle and acceptance cone. (2 + 2 = 4)

(b) Calculate the numerical aperture, the acceptance angle of a fibre having the core refractive index of 1.49 and cladding refractive index of 1.44. (3)

(c) Draw the block diagram of an optical fibre communication system and explain the functions of each block. (6)

(d) Distinguish between holography and conventional photography. (2)

6. (a) An electron has speed of 6.6×10^4 m/s with an accuracy of 0.01%. Calculate the uncertainty in position of an electron. (Given $m_e = 9.1 \times 10^{-31}$ kg and Planck's constant h = 6.6 10^{-34} Js). (4)

(b) Explain the physical significance of ψ. Derive the one dimensional time-dependent Schrödinger wave equation for non relativistic free particle. (2 + 5 = 7)

(c) An electron is bound in one-dimensional potential box which has a width 2.5×10^{-10}m. Assuming the height of the box to be infinite, calculate the lowest two permitted energy values of the electron. (4)

7. (a) Discuss the origin of bands in solids. (3)

(b) Sketch the structure and symbol of a solar cell. Discuss its working and applications. (2 + 2 + 1 = 5)

(c) Explain the difference between type-I and type-II superconductors using Meissner effect. (4)

(d) The super conducting behaviour of a specimen is destroyed at field values of 1.0×10^5 A/m and 2.0×10^5 A/m at 10K and 12K respectively. Calculate the critical temperature of the specimen. (3)