Total No. of printed pages = 4

PH 181101

Roll No. of candidate | | | | | | | | | | |

25/31 2022

B.Tech. 1st Semester End-Term Examination

PHYSICS–101

New Regulation (w.e.f. 2017-18) &

New Syllabus (Group-B) (w.e.f. 2018-19)

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 of the following MCQs (10 × 1 = 10)

(i) Gradient of a scalar quantity is

(a) Scalar (b) Vector

(c) Zero (d) A negative quantity

(ii) The equation of continuity explains

(a) non-conservative nature of charge

(b) conservation of charge for a static electric field

(c) conservation of charge for a non-static electric field

(d) non destructive nature of charge

(iii) Newton's ring experiment is based on

(a) division of amplitude (b) division of wavefront

(c) combination of (i) and (ii) (d) none of the above

(iv) Optical pumping in a laser is done

(a) to create population inversion

(b) to create an amplified, coherent lasing beam

(c) to create a three level laser beam

(d) none of the above

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(v) Light travelling in a graded index fibre follows a

(a) helical path (b) circular path

(c) zigzag path (d) straight line path

(vi) Phase velocity is

(a) equal to group velocity

(b) greater than group velocity

(c) less than group velocity

(d) equal to particle velocity

(vii) Chromatic aberration in lenses occurs due to the phenomenon of

(a) interference (b) polarization

(c) diffraction (d) dispersion

(viii) The Hamiltonian operator defines the

(a) total energy of the system

(b) potential energy of the system

(c) kinetic energy of the system

(d) electric energy of the system

(ix) In an allowed band, the velocity of electron is zero at

(a) bottom (b) top

(c) bottom and top (d) none of the above

(x) The BCS theory is based on

(a) electron-electron interaction

(b) electron-spin interaction

(c) electron-phonon interaction

(d) electron-lattice interaction

2. (a) What do you mean by divergence of a vector function? Obtain an expression for divergence of a vector in a Cartesian coordinate. (2+2=4)

(b) Why Ampere's circuital law was modified by Maxwell and hence obtain modified Ampere's law. (4)

(c) If $\varphi(x, y, z) = 4x^2y - y^3z^2$, find gradient of φ at point (1, –1, –1). (3)

(d) What are ferromagnetic domains? How are their existence explained? (2+2=4)

3. (a) Explain the formation of fringes in Newton's rings experiment. Describe how this experiment is used to determine the wavelength of incident monochromatic light. (3+4=7)

(b) In a Newton's ring experiment, the diameter of the 5th ring was 0.3cm and the diameter of the 25th ring was 0.8cm. If the radius of curvature of the planoconvex lens is 1m, calculate the wavelength of light used. (3)

(c) Show that chromatic aberration of two thin lenses kept in contact forms an achromatic doublet if they satisfy the condition:

$$\frac{\omega}{f}+\frac{\omega'}{f'}=0.$$ (5)

4. (a) Distinguish between spontaneous and stimulated emission. (2)

(b) Explain briefly the pumping methods used in lasers. (4)

(c) At what temperature the rates of spontaneous and stimulated emission are equal? Given, λ=400nm. (3)

(d) Explain with diagram what are meridional ray and skew ray. (3)

(e) An optical fibre has a core material with refractive index 1.55 and its cladding material has refracting index of 1.5. The light is lunched into it in air. Calculate its numerical aperture and the acceptance angle. (3)

5. (a) State the Heisenberg's uncertainty principle. How does the Heisenberg's uncertainty principle account for the absence of electrons in the nucleus? (2+4=6)

(b) A fast moving neutron is found to have an associated deBroglie's wave length of 2×10^{-12} m. Find the kinetic energy and the group velocity of the deBroglie's waves ignoring the relativistic mass. (Given mass of the neutron=1.675×10^{-27} kg) (3)

(c) Find the eigen values and eigen functions for particle in one-dimensional potential well of infinite height. (6)

6. (a) What is the importance of Kronig-Penny Model in explaining the band theory of solids? Draw energy band diagrams of conductor, semiconductor and insulator. (5)

(b) An n-type semiconductor specimen has a Hall coefficient R_H=3.66 × 10^{-11} m^3/As. The conductivity of the specimen is found to be 112 × 10^{-15} m^3/As. Calculate the charge carrier density n and the electron mobility at room temperature. (3)

(c) Explain the working of a solar cell. (3)

(d) Explain the principle of holography. How are the holograms classified? (2+2=4)

7. (a) Meissner effect is the standard test used to conclusively prove whether a particular material is superconductor or not. Is the statement correct? Explain your answer. (4)

(b) What is the importance of isotope effect in superconductivity? (4)

(c) Explain the distinction between the type-I and type-II superconductors. (4)

(d) Calculate the transition temperature for lead (Pb) if the critical magnetic field is $\frac{1}{20}$ of that of at 0K if $T_c = 4.8K$. (3)