Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech(OLD)/SEM-2/PH-201/2013
2013
ENGINEERING PHYSICS

Time Allotted : 3 Hours   *Full Marks :* 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following
    questions :   10 × 1 = 10

    i)   Newton's ring experiment is based on

          a)   division of amplitude

          b)   division of wave-front

          c)   none of these.

    ii)   de Broglie wavelength of a particle of mass *m* and
          kinetic energy *E* is

          a) $\lambda = \dfrac{h}{2mE}$

          b) $\dfrac{h}{\sqrt{2mE}}$

          c) $\dfrac{\sqrt{2mE}}{h}$

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iii) Mass of a photon of frequencies ν is given by

    a) $\dfrac{h\nu}{c}$

    b) $\dfrac{h\nu}{c^2}$

    c) $\dfrac{h\nu^2}{c}$

iv) The eigenvalue of the eigenfunction e^{ix} for the operator $\dfrac{d^2}{dx^2}$ is

    a)   1

    b)   0

    c) -1.

v) Miller indices of a plane which cut intercepts of 2, 3 and 4 units along the three axes are

    a)   (2, 3, 2)

    b)   (2, 3, 4)

    c)   (6, 4, 3).

vi) In a plane transmission grating, light

    a)   diffracts to produce the resultant pattern

    b)   diffracts and interfares to produce the resultant pattern

    c)   Interfares to produce the resultant pattern.

vii) The atomic radius of a face centred cubic crystal of lattice constant a is

   a) $\dfrac{a}{2}$

   b) $\dfrac{\sqrt{3a}}{4}$

   c) $\dfrac{\sqrt{2a}}{4}$.

viii) An X-ray tube is subjected to a potential difference of 50 kV with the corresponding current of 8 mA through it. The number of electrons striking per second on the garget material is

   a) 5×10^{16}

   b) 6×10^{11}

   c) none of these.

ix) In He-Ne laser, the laser light emits due to the transition from

   a) $3s \rightarrow 2p$

   b) $3s \rightarrow 3p$

   c) $2s \rightarrow 2p$.

x) For an optical fibre, if n_0, n_1 and n_2 are the refractive index of air, core and cladding region respectively, then

   a) $n_0 > n_2 > n_1$

   b) $n_1 > n_2 > n_0$

   c) $n_2 > n_1 > n_0$.

xi) If the speed of an electron increases, the specific charge

   a) increases

   b) decreases

   c) remains constant.

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xii) One milligram of matter converted into energy will give

    a)   90 joule

    b) 9×10^{10} joule

    c)   None of these.

xiii) Relative velocity of two particles moving with velocity (C) of light in opposite direction is

    a) C

    b) $2C$

    c) O.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2.   a)   What is the difference between temporal coherence and spatial coherence ?   2

    b)   If the amplitudes of two coherent light waves are in the ratio 1 : 4, find the ratio of maximum and minimum intensity in the interference pattern.   3

3.   a)   What is Compton effect ? Calculate the Compton wavelength for an electron. $1\frac{1}{2} + 1\frac{1}{2}$

    b)   Why does the unmodified line appear in Compton scattering ?   2

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4. a) Deduce the formulae for interplaner spacing of a simple cubic crystal. 4

   b) Why X-ray diffraction is used for crystal structure analysis ? 1

5. Find the possible arrangements of two particles in three cells for

   (i) Bose-Einstein Statistics

   (ii) Fermi-Dirac Statistics. $2\frac{1}{2} + 2\frac{1}{2}$

6. a) Describe briefly the working principle of laser action. 3

   b) Mention at least three main advantages of optical fibre over wire or cable ? 2

7. a) What are the basic postulates of special theory of relativity ? 2

   b) Show that for V << C, Lorentz transformation reduces to the Galilean transformation. 3

8. a) Discuss the important characteristics of nuclear forces. 2

   b) Why nuclear fission reaction must be done first before nuclear fusion ? 3

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GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

9. a) What is double refracting crystal ? 2

   b) Discuss Nicol prism as polarizer and analyzer. 4

   c) Determine the Brewster's angle for glass of refractive index 1·5 immersed in water of refractive index 1·33. 3

   d) Prove that the intensit of secondary maxima formed for Fraunhofer diffraction at a single slit are of decreasing order. 3

   e) In a plane transmission grating the angle of diffraction for 2nd order maxima for wavelength 5×10^{-5} cm is 30°. Calculate the number of lines in one centimetre of the grating surface. 3

10. a) State and explain de Broglie hypothesis. 2

    b) Prove that the product of phase velocity and group velocity for a de Broglie wave is equal to the square of the velocity of light. 5

    c) Compute the smallest possible uncertainty in the position of an electron moving with velocity 3×10^7 m/s. The rest mass of electron is $9 \cdot 1 \times 10^{-31}$ kg. 3

    d) Derive the Wein's displacement law from Planck's radiation law. 5

11. a) Write down the postulates of Fermi-Dirac statistics. 3

    b) Plot electron distribution function governed by Fermi-Dirac statistics in metal at T = OK and T > OK. Explain their physical significance. $2 + (3 + 3)$

    c) Why Compton effect cannot be observed with visible light but can be observed due to X-rays ? 4

12. a) If an electron is subjected to a potential difference of v volts then prove that the corresponding de-Broglie wavelength. $\lambda = \dfrac{12 \cdot 26}{\sqrt{v}}\overset{\circ}{\text{A}}$. 3

b) On the average, an exited state of a system remains in the state for 10^{-11}s. What is the minimum uncertainty in the energy of an excited state. 3

c) State the position-momentum Heisenberg uncertainty principle. 2

d) What is the value of $\left| \dfrac{\partial}{\partial x}, \dfrac{\partial}{\partial t} \right|$? 3

e) When a particle moves with a velocity much less compared to the velocity of light in free space, then show that the relativistic expression of K.E approaches the classical limit. 4

13. a) What is the difference between unpolarised light and polarized light ? Explain how polarized light can be obtained from unpolarised light. 2 + 2

b) What are plane of vibration and plane of polarization ? 2

c) Discuss the phenomenon of double refraction. Distinguish between O-ray and E-ray. 2 + 4

d) A ray of light is incident at the polarizing angle on the surface of a glass plate having refractive index 1·5. Find the angle of refraction of the ray. 3