Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech
BS 1102

Second Semester Regular Examination – 2014

PHYSICS - I

BRANCH(S) : ALL

QUESTION CODE : F 460

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

(a) If two pendulums ,each of mass 0.60 kg and length 1 meter, are connected by a spring of spring constant of 0.3 Nm^{-1}, find the normal mode of frequencies of coupled oscillator.

(b) Write down the differential form of Maxwell's equations in a charge free non conducting medium.

(c) What is double refraction ? Why double refraction cannot occur along the optic axis of a crystal ?

(d) The ratio of intensities of two waves that produce interference pattern is 16:1 . Deduce the ratio of maximum to minimum intensities in fringe system.

(e) How many orders will be visible if the wavelength of the incident radiation is 5000 $\mathring{A}$ and the number of lines on the grating is 2620 in one inch ?

(f) If the angle between a polarizer and analyser is 60^0, what will be the intensity of transmitted light for original intensity of incident light as I_0 ?

(g) Find the value of ∇r^{-n}, where $r = \sqrt{x^2 + y^2 + z^2}$.

(h) Show that the rest mass of a photon is zero.

P.T.O.

(i) What is the magnitude of Poynting vector at the surface of a long cylindrical wire of radius R, length L carrying a current I, when its ends are kept at a potential difference V.

(j) Prove that $\left[\hat{x}, \hat{p}\right] = \frac{ih}{2\pi}$.

2. (a) Starting with the differential equation for a damped harmonic oscillator discuss

(i) under damped

(ii) critically damped

(iii) over damped oscillation

Draw the displacement-time graph for all the cases. 6

(b) Light sources emitting the light of wavelengths $\lambda_1 = 6.0 \times 10^{-7} m$ and $\lambda_2 = 4.8 \times 10^{-7} m$ is used to obtain Newton's rings in reflected light. It is found that the n^{th} dark ring of λ_1 coincides with $(n + 1)^{th}$ dark ring of λ_2. If the radius of curvature of the curved surface of the lens is 0.96 m. Calculate the diameter of $(n+1)^{th}$ dark ring of λ_2. 4

3. (a) What is Quality factor ? Discuss the effect of quality factor on the motion of a under-damped oscillator. 3

(b) What is the physical significance of damping coefficient ? What is its unit ? 2

(c) Explain the formation of interference fringes by means of Fresnel's biprism when a monochromatic source of light is used, and derive the expression for the fringe width. 5

4. (a) What is a zone plate and how is it made ? Explain how a zone plate acts like a convergent lens having multiple foci. Derive an expression for its focal length. 4

(b) What is a Nicol Prism. Describe the construction and use of a Nicol Prism. 3

(c) Using gauss divergence theorem show that volume of a sphere is $4.1888r^3$. 3

5. (a) Explain the Fraunhofer diffraction due to a single slit. Hence find the conditions for principal maxima and minima. 5

(b) State Brewster's law. Hence show that at polarizing angle, the reflected and refracted rays are perpendicular to each other. 3

(c) State Poynting theorem. What are the dimension and unit of Poynting vector? 2

6. (a) If $\mathbf{A} = \hat{i}yz + \hat{j}xz + \hat{k}xy$, then find the value of $\oint_c$ A.dl. Where C is along the perimeter of a rectangular area bounded by $x=0$, $x=a$ and $y=0$, $y=b$. 4

(b) Derive the electromagnetic wave equations for magnetic field in vacuum. 4

(c) Define scalar and vector potentials. 2

7. (a) What are the characteristic features of a wave function? 2

(b) Find the value of A for $\psi = A\cos^2 x$ for $-\frac{\pi}{2} < x < \frac{\pi}{2}$. 3

(c) State Heisenberg's uncertainty principle. Hence show that the ground state energy of a linear harmonic oscillator is $\frac{1}{4\pi} h\omega$. 5

8. (a) For wave function $\psi(x) = \sqrt{\frac{2}{L}} \sin\frac{\pi x}{L}$, $0 < x < L$, find the expectation value of $\hat{p}^2$. 5

(b) The energy of an electron constrained to move in a one dimensional box of length 4 A^0 is 9.664×10^{-17} J. Find out the order of excited state and the momentum of the electron in that state. 5

Given $h = 6.63 \times 10^{-34}$ J sec.