Code : 221201

B.Tech 2nd Semester Exam., 2016

PHYSICS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. 1 is compulsory.

1. Answer any *seven* subquestions of the following : 2×7=14

   (a) If $\vec{F} = \hat{i}ax^2 + \hat{j}\cos by - \hat{k}2z$, evaluate $\vec{\nabla} \cdot \vec{F}$, a and b are constants.

   (b) State Gauss divergence theorem.

   (c) Calculate the speed and angular momentum of the electron in the ground state of hydrogen atom.

   (d) What is the maximum possible value of Compton shift by electrons? In which direction does it occur?

   (e) How does the resolving power of a single slit depend on *(i)* slit width and *(ii)* wavelength?

   (f) How can you distinguish between circularly polarized light and unpolarized light?

   (g) A particle of rest mass m_0 moves with speed $c/\sqrt{2}$. Calculate its mass and momentum.

   (h) Classify the different types of lasers based on their active medium.

   (i) Define spatial coherence.

   (j) Mention the various structures of carbon nanotubes.

2. *(a)* Explain blackbody radiation curves and Planck's quantum hypothesis. 3½+3½=7

   (b) Derive Planck's radiation formula for a blackbody and discuss special cases. 7

3. *(a)* Derive Einstein's mass-energy relation. Show that massless particle must travel at the speed of light.

   (b) Find the momentum and velocity of an electron having a kinetic energy 8 MeV. The rest energy of the electron is 0·551 MeV. 14

4. (a) When do you say that two functions are orthonormal functions? What is Hermitian operator? Show that eigenvalues of Hermitian operator are real. 4+2+4=10

(b) Prove that the operator $-i\hbar\frac{d}{dx}$ is Hermitian. 4

5. Set up the Schrödinger equation for a particle confined in a box of length L and hence find its wave functions and energy eigenvalues. 14

6. What is stimulated emission of radiation? Explain the working of a He-Ne laser. Discuss the role of 'optical resonators' in a laser system. 14

7. (a) Derive Faraday's law of electromagnetic induction. 4

(b) Using Maxwell's equations, derive the equations for plane e.m. waves in a dielectric medium and calculate its velocity of propagation. 10

8. (a) Describe how you measure the spatial coherence using Young's interferometer. 7

(b) Obtain an expression for the resultant intensity in a single-slit Fraunhofer diffraction process. 7

9. Write notes on any *two* of the following : 7×2=14

(a) Double refraction

(b) Davisson-Germer experiment

(c) Electrodeposition

(d) Displacement current

* * *