

## B.Tech 1st Semester Exam., 2017

## 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.
- (v) Symbols used (if any) have their usual meaning.

1. Answer any seven questions :  $2 \times 7 = 14$ 

- (a) Write down Maxwell's equations in integral forms.
- (b) Define Gauss' law in dielectrics.
- (c) Write down the expression for the resultant intensity due to double-slit Fraunhofer diffraction.
- (d) What do you mean by stimulated emission of radiation?
- (e) Define Brewster's law.
- (f) What do you mean by circularly polarized light?

- (g) What is the physical significance of wave function?
- (h) Write down Schrödinger's time dependent wave equation in one dimension.
- (i) State fundamental postulates of the special theory of relativity.
- (j) Write down any two properties of carbon nanotubes.

2. (a) What are nanomaterials? List the methods used to prepare nanomaterials. Describe any one method used for the synthesis of nanomaterials. 8

(b) What is Compton effect? Derive an expression for Compton wavelength.  $2+4=6$ 3. What do you mean by population inversion? How is it achieved by optical pumping? Describe the construction and working principle of helium-neon laser.  $2+2+10=14$ 4. Describe Michelson-Morley experiment with the help of neat diagram. Derive an expression for the fringe shift in Michelson-Morley experiment. Discuss its negative result.  $5+5+4=14$

5. Using Maxwell's equations, deduce the equation of continuity. Also prove that electromagnetic waves travel with the speed of light in vacuum. 6+8=14

6. Solve the Schrödinger's wave equation for one-dimensional motion of a particle in a box of length  $L$ . Also show that the normalized wave function for such particle is given by

$$\Psi_n = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L},$$

where  $n = 1, 2, 3, \dots$  10+4=14

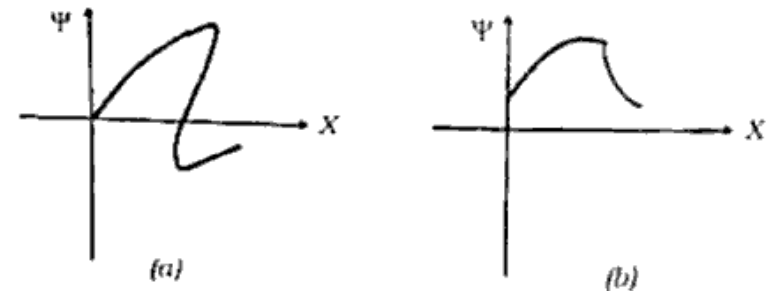
7. Write short notes on the following : 5+5+4=14

- (a) Missing orders in Fraunhofer's double-slit diffraction pattern
- (b) Fraunhofer's diffraction pattern in single-slit (Derivation not required)
- (c) Effect of increasing the slit width and the distance between the double-slit Fraunhofer's diffraction pattern

8. Explain plane of polarization and plane of vibration. Describe how, plane polarized, circularly polarized and elliptically polarized lights are produced and detected. 4+10=14

9. (a) A metre stick makes an angle of  $30^\circ$  with respect to the  $x$ -axis of  $O$ . What must be the value of velocity ( $v$ ) if the metre stick makes an angle of  $45^\circ$  with respect to the  $x$ -axis of  $O$ ? 6

(b) Which of the following cannot have physical significance in the interval shown? Why not? 4



(c) Find the stored energy in a system of four identical charges  $Q = 4 \text{ nC}$ , at the corners of a square 1 m on a side. What is the stored energy in the system when only two charges are in place? 3+1=4

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