VIT UNIVERSITY
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VELLORE ■ CHENNAI
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Term End Examination - November 2014

Course : PHY101 - Modern Physics **Slot : A2+TA2**

Class NBR : 2746 / 2748 / 2750 / 2754/ 2758 / 6252

Time : Three Hours **Max.Marks:100**

General instructions:

Physical constants: $(m_e = 9.109 \times 10^{-31} kg;\ h = 6.626 \times 10^{-34} Js;\ c = 3 \times 10^8 ms^{-1};$
$k = 1.3807 \times 10^{-23} J/K;\ m_p = 1.6 \times 10^{-27} kg)$

PART – A (8 X 5 = 40 Marks)
Answer any <u>EIGHT</u> Questions

1. Prove that the velocity of matter waves travel faster than the velocity of light. **[5]**

2. a) What do you mean by orthogonal and normalized wave function? **[2+3]**
   b) A bullet of mass 25 g is travelling with a speed of 400 m/s. The speed is measured accurately up to 0.02 %. Calculate the certainty with which the position of the bullet can be located.

3. With a neat sketch explain the principle and working of STM. **[5]**

4. Write short notes on quantum well and quantum dots. **[5]**

5. Can we use LASER as headlight in our car? Justify your answer. **[2+3]**
   State the important characteristic of LASER and briefly explain.

6. Can you have laser action with two level energy system? Mention the difficulties. State any two differences between three level laser and four level laser. **[3+2]**

7. What do you mean by laser modes? Mention the types of modes. Define uniphase mode. **[3+2]**

8. Starting with the Maxwell's equation arrive at the wave equations for the electric field, **E**, in free space and by comparing the same with the general wave equation, prove that the velocity of light, c, is nearly equal to $3x10^8$ m/s. **[5]**

9. State any five differences between multimode and single mode fibers. **[5]**

10. What are the necessities of cladding for an optical fibre? What can fibre optics do for us in the future? **[3+2]**

PART – B (6 X 10 = 60 Marks)

Answer any SIX Questions

11. Derive an expression for the change in wavelength of a photon when it is scattered by an electron. Discuss the results when the angle of scattering is 0°, 90° and 180°. **[7+3]**

12. Explain the de-Brolgie's hypothesis. Describe, with neat sketches, how Davisson-Germer experiment helped to prove the wave nature of electron. **[4+6]**

13. Obtain the expression for the energy as well as Eigen function relating to a particle that is confined in a one-dimensional box of finite width. Sketch the wave function (ψ) and probability density ($|\psi|^2$) for each level, starting from n=1 to n=5. **[8+2]**

14. Explain the three fundamental processes in laser and derive expressions for Einstein's coefficients. **[3+7]**

15. a) Derive the condition for threshold gain coefficient. **[5+5]**
    b) Draw the energy level diagram of He-Ne laser and mention the different transition occurs in it.

16. Derive the expression for the electric field and magnetic field components for TE wave in a rectangular wave guide. **[10]**

17. a) What is dispersion? Calculate the pulse spreading due to intermodal dispersion in the case of step index fiber. **[6+4]**
    b) An optical fiber is of diameter 100 micro meter. If the core refractive index is 1.5. Find the axial distance travelled by a ray incident at 30 degree between two successive internal reflections.

18. a) Explain about a P-I-N photodiode with a suitable diagram. **[4+3+3]**
    b) Derive the expression for responsivity and quantum efficiency of PIN photodiode.
    c) A PIN photodiode has a quantum efficiency of 0.7 at a wavelength of 0.85 micrometer. Calculate its responsivity.

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