Final Assessment Test- Jan/Feb 2023

VIT
Vellore Institute of Technology

Course: BPHY101L - Engineering Physics
Class NBR(s): 5670/5690/5703/5716/5724/5729/5742/ 5750/5885
Slot: C1+TC1
Time: Three Hours
Max. Marks: 1

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS TREATED AS EXAM MALPRA

Answer any TEN Questions
(10 X 10 = 100 Marks)

1. What is standing wave? Derive standing wave equation on a stretched string fixed in both ends and obtain the expression for it's fundamental frequency with a neat diagram. [2+5+3]

2. a) When a plane wave encounters with a fixed end, show that the reflected wave undergoes an 180^0 phase reversal with proper calculation and schematic. [4+1]

   b) A string is attached at one end (x = 0) with a tuning fork; which produce a 1D progressive wave in the string. After some time, the displacement of the particles at x = 5 cm and at x = 10 cm are -0.1 cm and 0.5 cm, respectively. The speed of the wave is 100 m/s. Calculate the frequency of the tuning fork. [5]

3. Write Maxwell's equation in free space and state their physical significances, and show that the oscillating **E** and **B** fields follow the wave equation. [4+3+3]

4. Draw the blackbody spectral emission density with respect to wavelength for three different temperature considering $T_1<T_2<T_3$. State the characteristic features of this spectrum. Further explain what kind of assumption Planck made to derive the radiation formula. [3+3+4]

5. a) Explain the unique properties of an acceptable wave function to represent matter waves. [5]

   b) A 71-pm wavelength incidents X-ray on a calcite target. Find the wavelength of the X-ray scattered at a 30° angle. What is the maximum shift that can be expected in this experiment? [3+2]

6. Obtain the energy eigen function and eigen values for a subatomic particle confined in an infinite potential box $0 \leq x \leq a$. Draw the relevant diagrams of energy level, wavefunction and probability of this particle in a first three permitted energy levels. [6+4]

7. *Explain the phenomena of quantum tunnelling. Further explain in detail the underlying principle of Scanning tunnelling microscope (STM) and its working with appropriate figures.* [3+7]

8. Explain the role of metastable state in three and four level energy systems. Furthermore, write different modes of vibration in CO_2 molecule and with the help of an energy level diagram, explain the working principle of CO_2 laser. [3+2+

9. a) Prove that the ratio between spontaneous emission and stimulated emission is proportional to ν^3: where ν is frequency. Explain its inferences. [5]

   b) Compare the coherence length of conventional and laser radiation sources as follows; [5]

   If the radiation emitted from a low-pressure sodium lamp with a typical linewidth of sodium D lines at λ = 569 nm is $5.1 \times 10^{11} Hz$, and if the laser radiation at λ = 633 nm emitted from a He Ne laser operating in a single mode with linewidth of 1MHz.

10. Considering the meridional rays in optical fiber derive that light gathering capacity depends on the acceptance angle of an optical fiber with a neat diagram. Further describe in short, different factors that contribute to the attenuation of light signal in an optical fiber. [5+5]

11. a) Write down the different kinds of dispersion in an optical fiber. Further, illustrate the way to overcome intermodal dispersion. [5]

    b) A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and cladding refractive index of 1.47. Determine (i) the critical angle at the core cladding interface; (ii) numerical aperture (NA) for the fiber and (iii) acceptance angle in air for the fiber. [5]

12. Considering the energy momentum (or wave vector) (E-K) diagram how can we classify semiconductor materials. Furthermore, with proper schematic discuss the working principle of PIN photodetector. [4+

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