VIT®

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Continuous Assessment Test (CAT - II), May 2023

Programme	:	**B.Tech**	Semester	:	**Winter 2022-2023**
Course Title	:	**Engineering Physics**	Course Code	:	**BPHY101L**
School	:	**School of Advanced Sciences**	Slot	:	**E2+TE2**
Duration	:	**90 mins**	Max. Marks	:	**50**
Class No	:	**4935, 4939, 4941, 4943, 4945, 4947, 4949**			

Part – A (5x 10 = 50)

Answer ALL Questions

Instructions:

1. ***Draw suitable diagrams wherever needed. They will fetch you more marks.***
2. ***Your answer should be concise and specific to the question.***

Sl. No	Questions	Max Marks
1	What are matter waves? Mention three characteristics of matter waves. Discuss the experiment in detail that proved the existence of matter waves with suitable diagrams. (1+3+6)	10
2	What is an ultraviolet catastrophe? Write expression of Planck's radiation law and the assumptions he made to resolve the ultraviolet catastrophe. Assuming the Sun as a black body, show by drawing how the intensity of black body radiation emitted by the Earth varies with frequency throughout the day considering three cases of temperature in the morning (T_1), evening (T_2) and afternoon (T_3) where $T_1 < T_2 < T_3$. (3+4+3)	10
3	(i) Explain why the wavefunction and its first derivative have to be single-valued and continuous? Why should a quantum mechanical wave function always be normalized? (3+2) (ii) A 45-kW broadcasting antenna emits 4 MHz frequency radio waves. How many photons are being emitted by the antenna per second? Is the quantum nature of electromagnetic radiation important in analyzing the radiation emitted from this antenna? Justify your answer. (3+2)	5 5
4	For a particle trapped in a one-dimensional box (infinite potential well) find the expressions for its energy eigen values and normalized eigen functions. Draw the probability density and evaluate the corresponding energy eigenvalues for first three energy states. (4+3+3)	10
5	(a) Classify nanomaterials based on the confinement direction citing one example of each. Explain how does confinement of the dimensions change the energy levels of the nanomaterials along with suitable diagram? (3+2) (b) Consider a quantum mechanical particle confined in a 1-dimensional space, $0 \leq x \leq a$ having wavefunction $\psi(x,t) = \sin\left(\frac{\pi x}{a}\right) \exp(-i\omega t)$. (i) Find the potential $V(x)$. (3) (ii) Calculate the probability of finding the particle in the interval, $\frac{a}{4} \leq x \leq \frac{3a}{4}$ (2)	5 5