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

Continuous Assessment Test (CAT - II), October 2023

Programme	:	**Int. MTech**	Semester	:	**Fall 2023-2024**
Course Title	:	**Engineering Physics**	Course Code	:	**IPHY101L**
School	:	**School of Advanced Sciences**	Slot	:	**E1+TE1**
Duration	:	**90 mins**	Max. Marks	:	**50**
Class No	:	**5832, 5838, 5843, 5898, 5900**			

Part – A (5 x 10 = 50)

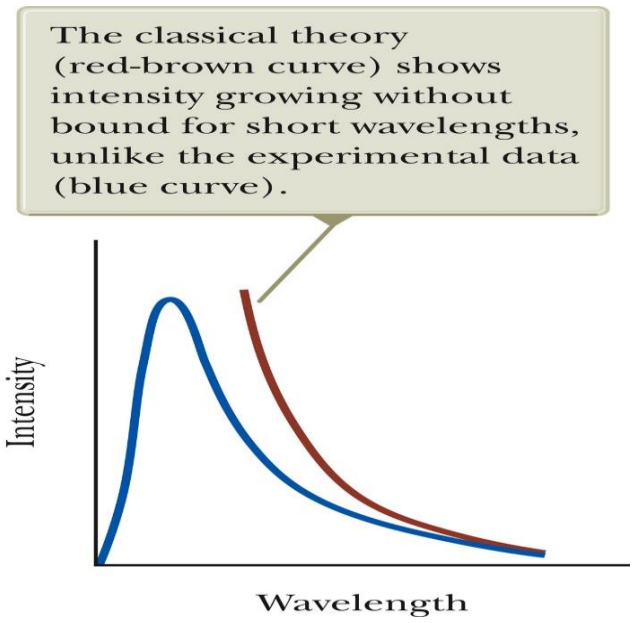
Answer ALL Questions

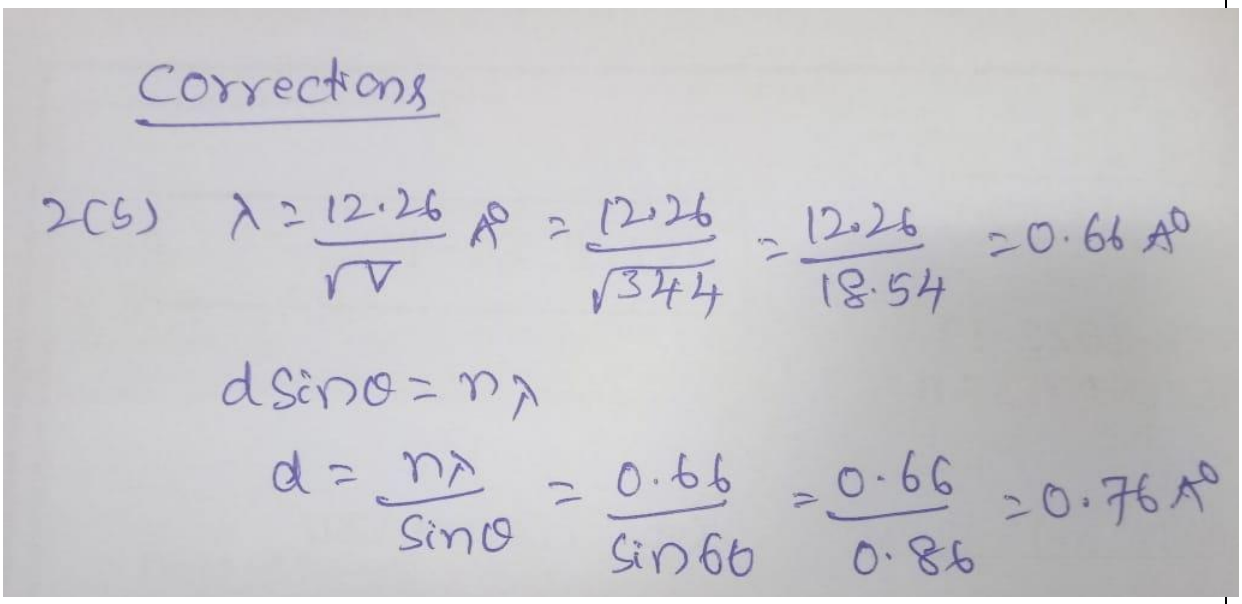
Sl. No	Questions
1	Write the equations to find the energy distribution of a black body radiation using Wein's law, Rayleigh Jean's law and Planck's radiation law. Explain ultraviolet catastrophe with neat diagram.
2	(a) Name the experiments that can prove light (photon) as a particle and electron as a particle. Explain about these experiments in brief. (b) Electrons are accelerated through 344 V and are reflected from crystal. The first reflection maximum occurs when glancing angle is 60^{o}. Determine the spacing of the crystal.
3	(a) Name any five Noble laurates (within the syllabus) who made significant contributions for quantum physics/mechanics. Explain their innovations in brief. (b) An electron with mass 9.11×10^{-31} kg and a bullet of mass 50 gram are moving with same speed (300 m/s), find the uncertainty in finding the position of each?
4	Why the potential energy of an electron is considered as zero (V = 0)? Using Schrodinger time independent wave equations prove that energy of an electron is discrete rather than continuous.
5	(a) Explain briefly about working of scanning tunneling microscope. Mention the merits, demerits and applications of this instrument. (b) Compute the first 3 permitted energy values for an electron in a box of width 4 Å

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

Continuous Assessment Test (CAT - II), October 2023					
Programme	:	B.Tech.	Semester	:	Fall semester 2023-24
Course Title	:	Engineering Physics	Course Code	:	IPHY101L
Class ID	:		Slot	:	E1+TE1
Duration	:	90 min.	Max. Marks	:	50

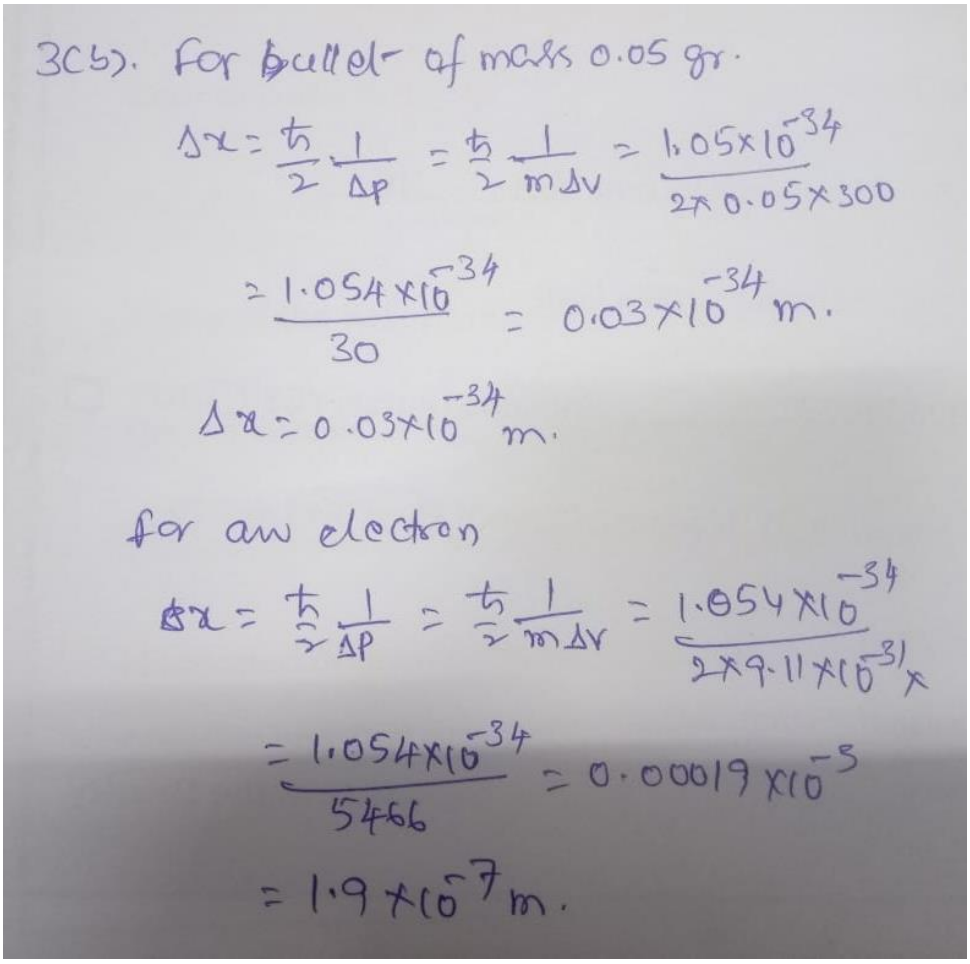
Answer ALL Questions
(5 x 10 = 50)

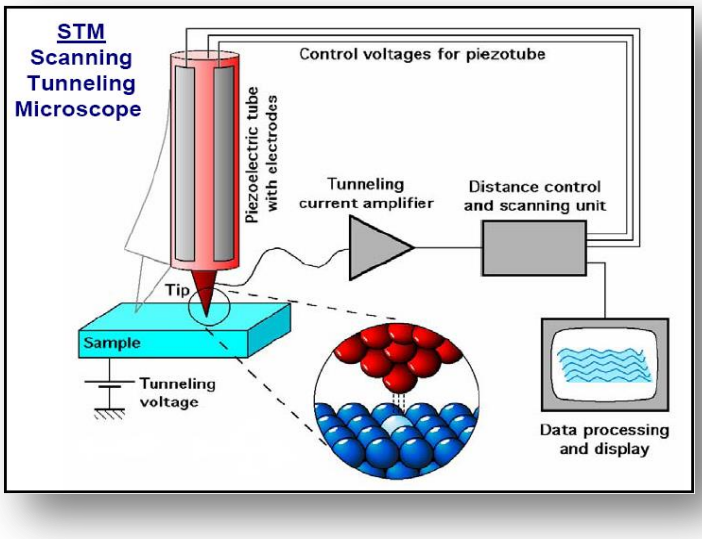
S.No	Question
1	Write the equations to find the energy distribution of a black body radiation using Wein's law, Rayleigh Jean's law and Planck's radiation law. Explain ultraviolet catastrophe. **Wein's Law: $E_\lambda = k\lambda^{-5}e^{-a/\lambda T}d\lambda$,** **Rayleigh and Jeans Law $E_\lambda = B\lambda^{-4}Te^{-a/\lambda T}d\lambda$** $$E_\lambda d\lambda = \frac{8\pi hc\lambda^{-5}}{\left[e^{\left[\frac{hc}{\lambda KT}\right]}-1\right]} \times d\lambda \rightarrow$$ The above equations should be written clearly and expand the terms. And limit of each equation should be mentioned (5 M) Ultraviolet catastrophe with neat diagram (5M) 

2	Name the experiments that can prove light (photon) as a particle and electron as a particle. Explain about these experiments in brief. Electrons are accelerated through 344 V and are reflected from crystal. The first reflection maximum occurs when glancing angle is 60^o. Determine the spacing of the crystal. Compton effect 1M Photoelectric effect 1M A brief description on working of Compton effect (6M) Spacing d = 2.2×10^{-10} m (2 M) 
3	Name any five Noble laurates who made significant contribution for quantum physics/mechanics. Explain their innovations in brief. An electron with mass 9.11×10^{-31} kg and a bullet of mass 50 gram are moving with same speed (300 m/s), find the uncertainty in finding the position of each? Five noble laurates with their innovations 5 M Numerical question 5 M 1. **Max Planck**-1858 – 1947, German physicist, Introduced the concept of "quantum of action", In 1918 he was awarded the Nobel Prize for the discovery of the quantized nature of energy. 2. **Arthur Holly Compton**-1892 – 1962, American physicist, Director of the lab at the University of Chicago, Discovered the Compton Effect, Shared the Nobel Prize in 1927 3. **Louis de Broglie**-1892 – 1987, French physicist, Was awarded the Nobel Prize in 1929 for his prediction of the wave nature of electrons. Louis de Broglie in 1923

proposed that matter particles should exhibit wave properties just as light waves exhibited particle properties. These waves have very small wavelengths in most situations so that their presence was difficult to observe

4. **Werner Heisenberg**, 1901 – 1976, German physicist, Developed matrix mechanics Many contributions include: Uncertainty principle, Prediction of two forms of molecular hydrogen, Theoretical models of the nucleus, Awarded Noble prize in 1932
5. **Erwin Rudolf Josef Alexander Schrödinger**, Nobel Prize in Physics 1933 "for the discovery of new productive forms of atomic theory". He created Schrodinger equation, an important equation that is fundamental to quantum physics



4	Why the potential energy of an electron is considered as zero (V = 0)? Using Schrodinger time dependent and independent wave equations prove that energy of an electron is discrete rather than continuous. As an electron is not influenced by any external forces, the potential energy of an free electron is considered as zero. (2M) Derivation of the expression, $E_n = n^2p^2 \hbar^2 / 2ma^2$ and diagrams that indicate the energy, wave function, and probability density for first three quantum states-8 M
5	Name the electron microscopes that can give two dimensional (2D) images of the nanomaterials. Explain briefly about scanning tunneling microscope that will works on tunnel effect. Mention the merits, demerits and applications of this instrument. Scanning electron microscope Transmission electron microscope  Working of STM in two modes such as constant current mode and constant height mode Any two advantages Advantages of STM 1. No damage to the sample

	2. Spectroscopy of individual atoms 3. Relatively low cost Applications Demerits 1. Sample limited to conductors and semiconductors 2. Limited to biological applications Applications 1) Image the surface structure 2) Estimate the surface roughness 3) 3D image of the surface Numerical question 3 M Formula+Substitution+Answer (E1 = 2.35 eV, E2 = 9.42 eV and E3 = 21.19 eV)