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

Continuous Assessment Test (CAT - II), April 2024

Programme	:	**B.Tech.**	Semester	:	**Winter 2023-2024**
Course Title	:	**Engineering Physics**	Course Code	:	**BPHY101L**
School	:	**School of Advanced Sciences**	Slot	:	**D2+TD2**
Duration	:	**90 mins**	Max. Marks	:	**50**
Class No	:	1914 (Krishnamoorthi C) - CNR 1906 (Balakrishnan S), 1910 (Ankur Rastogi), 1912 (Ummal Momeen), 1916 (Abhinav Anand), 1903 (Vishwa Bandhu Pathak), 1905 (Samuel P) ,1915(Anusha P T), 1913(Laxmi Narayan Tripathi), 1911 (Deepak Bhatt), 1908 (Joseph Nathanaela)			

Part – A (5 x 10 = 50)

Answer ALL Questions

Sl. No	Questions	Max Marks
1	Draw blackbody spectral energy density distributions at three different temperatures, 1000 K, 1500 K, and 5000 K as a function of emission frequencies. Discuss the characteristic features of the spectra. Plot the Rayleigh Jeans model corresponding to spectrum at 1000 K. Does the model fit the whole spectrum? Give reasons.	**10**
2	a) Obtain the time-independent Schrödinger wave equation from the time-dependent Schrödinger wave equation. b) Calculate the de-Broglie wavelength associated with a proton accelerated through a potential difference of 200 kV.	**5** **5**
3	a) Draw the schematics and explain the working of an experiment used to prove the particle nature of an X-Ray photon. b) Normalize the wave function, $\psi(x) = D\, e^{i\,10^5 kx}$ given that interval of x as -L ≤ x ≤ L and $i = \sqrt{-1}$.	**5** **5**
4	Show that the energy of an electron trapped in an infinite potential well is discrete. Obtain the general expression for the energy difference between any two consecutive energy levels. Draw the first three energy levels indicating the difference between them.	**10**
5	a) Given a spherical nanoparticle of radius r, find the expression for surface to volume ratio and draw it as a function of radius r. Discuss the properties of the nanoparticle based on the curve. b) Given the transmission probability of 10^{-5} for an electron, calculate the width of the potential barrier. Given that the electron energy is 1 eV and barrier height is 10 eV.	**5** **5**

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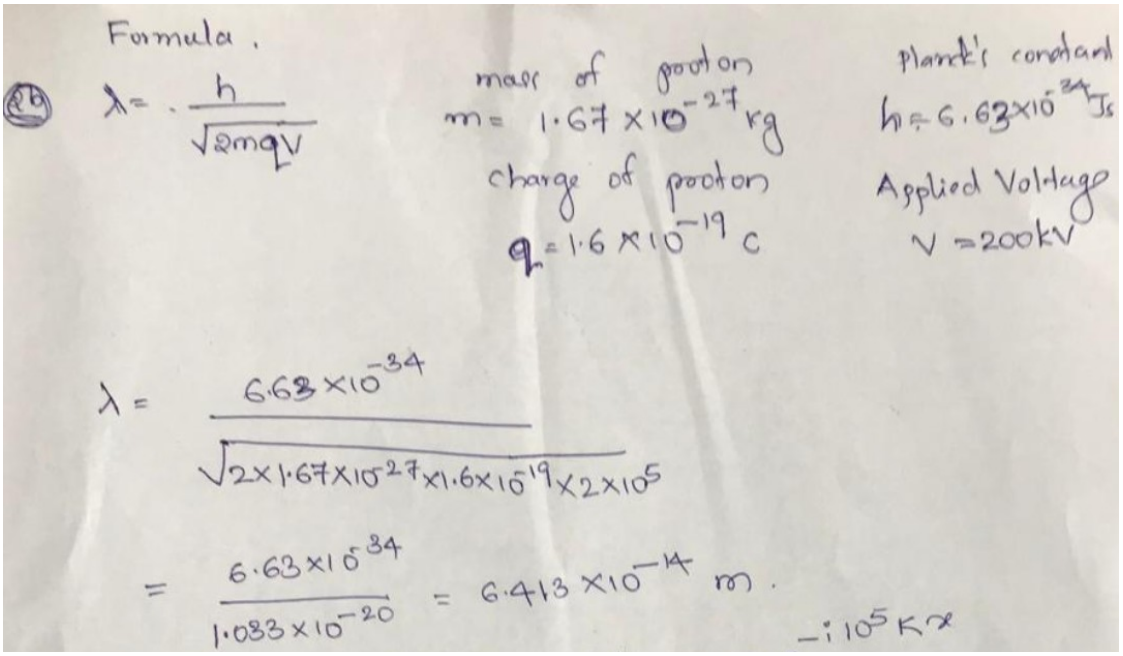
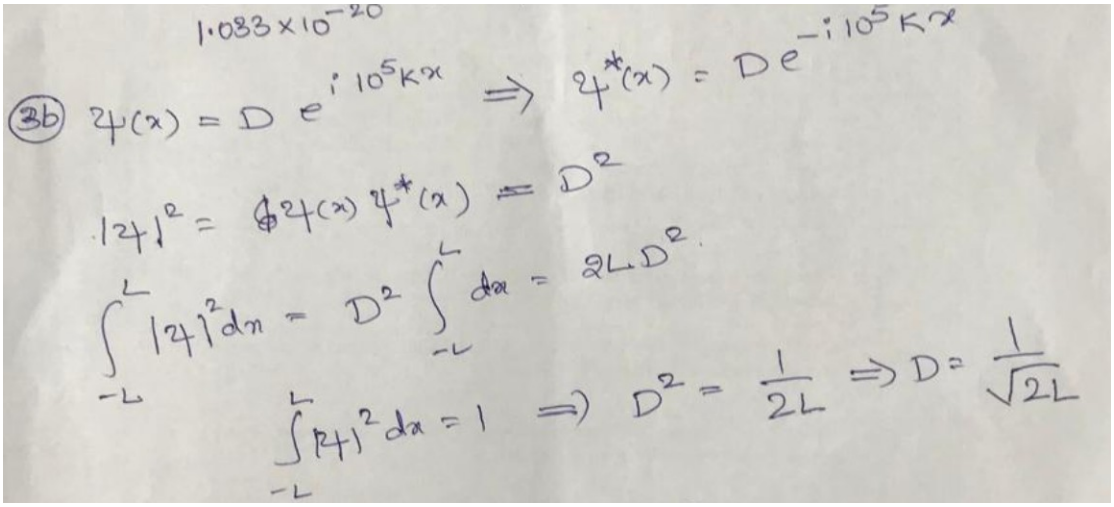
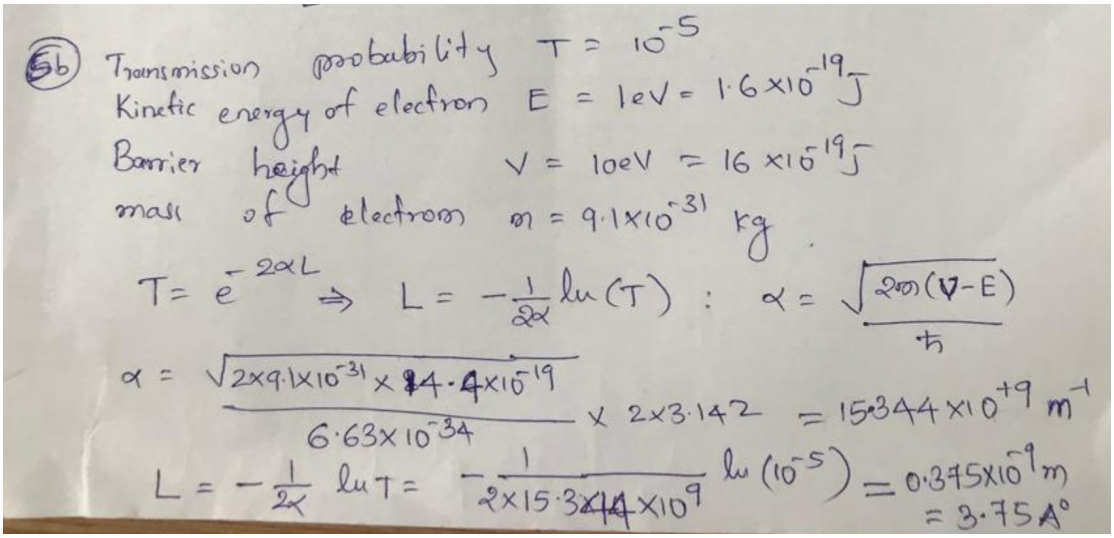
Class No	:	**1914, 1906, 1910, 1912, 1916, 1903, 1905, 1915, 1913, 1911, 1908**			

Answer Key

Sl. No	Questions		Max Marks
1	Blackbody radiation spectrum-drawing Characteristics (Wein's displacement law and Stefan-Boltzmann law) Rayleigh-Jeans law - Drawing Discussion on the failure of Rayleigh-Jeans law	2 marks 4 marks 2 marks 2 marks	**10**
2	(a) Time-independent Schrodinger equation derivation (with all the steps) (b) de Broglie wavelength formula Calculations and results  **de Broglie wavelength=** $6.41 \times 10^{-14} m$	5 marks 1 mark 4 marks	**5** **5**
3	(a) Compton Scattering experiment-diagram Working (with results) (b) Normalization of wavefunction	1 mark 4 marks 5 marks	**5** **5**

	 **After normalization, wavefunction is** $\psi(x)=\frac{1}{\sqrt{2L}}e^{i10^5 k x}$	
4	Potential energy diagram — 1 mark Solution to the time-independent Schrodinger equation — 2.5 marks Apply the two boundary conditions — 2.5 marks Energy-difference between any two consecutive levels — 2 marks Draw the first three energies (indicating the proper energy difference) — 2 marks	**10**
5	(a) Find the surface-to-volume ratio — 2 marks Draw the surface-to-volume ratio as a function of radius — 1 mark Properties of nonmaterial based on the surface-to-volume ratio — 2 marks (b) Formula for the transmission probability — 1 mark Calculations and results — 4 marks  **Width of the potential barrier= 3.75A°**	**5** **5**