THIRD SEMESTER FYUGP EXAMINATION, NOVEMBER 2025

Discipline Specific Core (DSC) Course - Minor

PHY3MN202 : Solid State Physics and Spectroscopy

(Credits: 4)

Time: 2 Hours   Maximum Marks: 70

Section A

Answer the following questions. Each carries 3 marks (Ceiling: 24 marks)

1.	Obtain the expression for the zero-point energy of a particle confined in a one-dimensional box.	BL1	CO1
2.	Explain the probability interpretation of a wave function.	BL2	CO1
3.	The lowest energy of a particle in an infinite one dimensional well is 4.4 eV. If the width of the well is doubled, what is its lowest energy?	BL3	CO1
4.	Differentiate between Fermi velocity and drift velocity.	BL1	
5.	Explain why a material with a completely filled band cannot conduct electricity.	BL2	CO3
6.	Why are crystalline solids anisotropic in nature?	BL2	CO2
7.	What is induced absorption?	BL1	CO4
8.	Discuss the applications of fluorescence.	BL2	CO5
9.	Mention the factors that affects the vibrational frequency.	BL1	CO5
10.	State the selection rule for the rotational Raman spectra of linear molecules.	BL2	CO5

Section B

Answer the following questions. Each carries 6 marks (Ceiling: 36 Marks)

11.	Find the kinetic energy eigen value for the wave function $\Psi(x) = A \sin(n\pi x/L), n = 1, 2, 3, \ldots$	BL3	CO1
12.	Set up time-dependent Schrodinger equation for one-dimensional motion using the wavefunction $\Psi(x,t) = A e^{\frac{-i}{\hbar}(Et - P_x x)}$.	BL3	CO1

(PTO)

13.	The van der Waals force of attraction explains the attraction between a polar molecule and molecules that lack a permanent dipole moment. The electric field of the polar molecule, denoted by E, causes a separation of charge in the other molecule, with the induced dipole moment, p, in the same direction as that of the polar molecule, resulting in an attractive force. Derive an expression for the attractive potential energy of the induced dipole in the electric field E.	BL2 CO2
14.	The wavelength of mercury green light is 546.1 nm. Calculate (i) the frequency in Hz, and (ii) the wave number in cm^{-1} and m^{-1}.	BL3 CO4
15.	The carbon monoxide (CO) molecule has a bond length R of 0.113 nm and the masses of the ^{12}C and ^{16}O atoms are respectively 1.99×10^{-26} kg and 2.66×10^{-26} kg. Find (a) the energy and (b) the angular velocity of the CO molecule when it is in its lowest rotational state.	BL3 CO5
16.	Show that the first two terms in the series for the Madelung constant of NaCl are $\alpha = 6 - \frac{12}{\sqrt{2}}$.	BL2 CO2
17.	Define expectation value. Discuss the physical meaning of expectation value with suitable examples.	BL2 CO1
18.	Compare the different mechanisms of spectral line broadening: natural, Doppler, collision, and saturation.	BL2 CO4

Section C

Answer any one question. Each carries 10 marks (1 x 10 = 10 Marks)

19.	Derive the time-independent Schrodinger equation from the time-dependent form using separation of variables. Also outline the general procedure for solving a system using time-independent Schrodinger equation.	BL2 CO1
20.	Explain the principle of LASER action and describe the working of a laser system with suitable diagrams.	BL2 CO4

CO : Course Outcome

BL : Bloom's Taxonomy Levels (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)