Enrollment No._____

NAVRACHANA UNIVERSITY

School: School of Science
Program/s: B.Sc. (Chemistry)
Year: 2nd **Semester:** 3rd
Examination: End Semester Examination
Examination year: December 2022

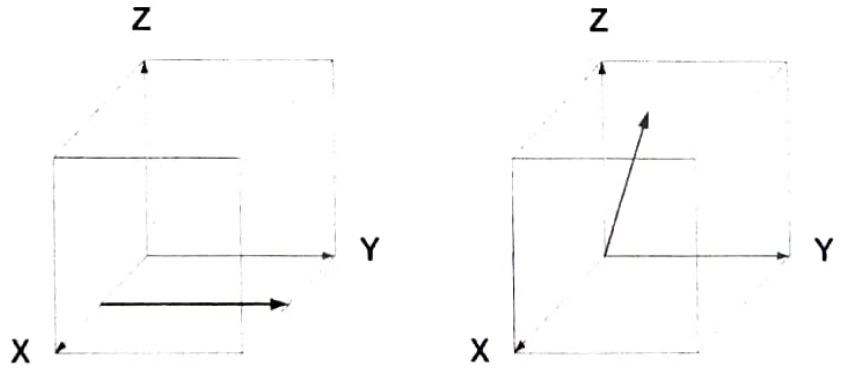
Course Code: PH204 **Course Name:** Quantum Mechanics and Solid State Physics
Date: 07/12/2022
Time: 11.30 am to 01:30 pm

Total Marks: 40
Total Pages: 3

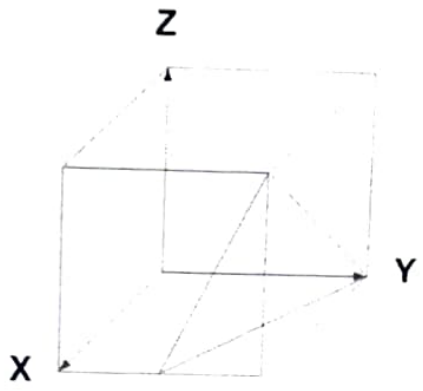
Instructions:

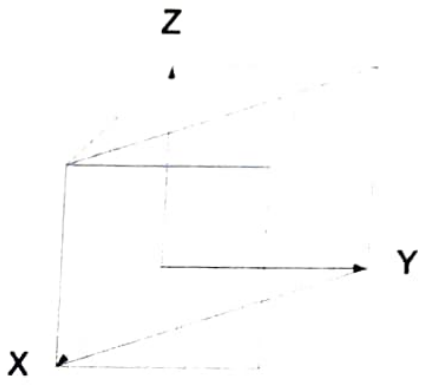
- *Write each answer on a new page.*
- *Use of a scientific calculator is permitted.*
- *Write answers to the questions in sequence.*
- ** COs=Course Outcome mapping. # BTL=Bloom's Taxonomy Level mapping*

Q. No.	Details	Marks	COs*	BTL#
Q.1	**Answer <u>Any Six</u> of the following questions in brief.** (a) With the help of neat diagram, describe all the unit cells in orthorhombic and hexagonal Bravais lattices. Write down the corresponding lattice parameters for each Bravais lattice. (b) Show that the 5-fold rotational symmetry is not possible for a crystal. (c) Momentum operator, $\hat{P}$ acts on a wave function $\Psi(x,t) = 2x^4 e^{-i\omega t}$. What is the outcome of $\hat{P}\Psi$? (d) Define normalization condition for a wave function $\Psi(x)$ and explain its physical interpretation. (e) Show that the commutator of $\hat{x}$ and $\hat{p}$ is equal to $i\hbar$. (f) Explain the meaning of degenerate eigen functions. With the help of neat diagrams explain the degeneracy in d-orbitals. (g) What is the difference between ABABAB and ABCABC type of packing? (h) What are acoustic and optical phonons?	12	CO1 CO2 CO3 CO4	BT1 BT2 BT3 BT4 BT5
Q.2	Consider a quantum particle trapped inside a one dimensional potential well of width L. Using time independent Schroedinger equation, derive expression for allowed normalized wave functions and corresponding energy eigenvalues. Also plot wave functions as well as probability densities for ground and first excited state.	5	CO1 CO2 CO3	BT2 BT3 BT4 BT5 BT6

	Time independent Schroedinger equation can be written as: $-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2}+V(x)\psi(x)=E\psi(x)$			
Q.3	In hexagonal close packed structure show that c/a is 1.633 and hence calculate packing factor for hexagonal close packed structure. **OR** A light beam of wavelength λ=4000 Å falls on a metallic surface used in an experiment to study the photoelectric effect. If the stopping voltage is 1.5 V, calculate i the work function of the surface. ii the maximum wavelength of light that will cause the photoelectric emission.	**3**	CO1 CO2 CO3 CO4	BT1 BT2 BT3 BT4 BT5
Q.4	**Write short notes on <u>Any Four</u> of the following topics.** (a) Van der Waals Bond and Hydrogen Bond (b) Frank Hertz Experiment (c) Lattice vibrations and phonons in one dimensional infinite monoatomic lattice (d) Direct and Indirect bandgap semiconductors (e) Hall Effect	**16**	CO1, CO4 CO5 CO6	BT1 BT2 BT3 BT4 BT5
Q.5	(a) Determine Miller indices for the following directions inside a cubic unit cell.  	**4**	CO4	BT1 BT2 BT3 BT4 BT5

(b) Determine Miller indices for the following planes inside a cubic unit cell.





**********End of Question Paper**********