

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -2 EXAMINATION-2022

Ph.D.-I Semester (PMS)

COURSE CODE (CREDITS): 22PIWPH131 (3)

MAX. MARKS: 25

COURSE NAME: Theoretical Physics

COURSE INSTRUCTORS: Santu Baidya

MAX. TIME: 1 Hour 30 Min

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*Note: All questions are compulsory. Marks are indicated against each question in square brackets.*

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Q1. What is a Bravais lattice and what is a primitive unit cell? Give justification if graphene a Bravais lattice or not? Explain how a graphene can be a Bravais lattice with picture of the lattice.

[3]

Q2. How to define Wigner-Seitz cell for a given lattice? Show Wigner-Seitz cell for a 2D square lattice with diagram and explain. Calculate the angle between the [110] direction and the [111] direction for a monoclinic lattice with  $a = 0.3 \text{ nm}$ ,  $b = 0.4 \text{ nm}$ ,  $c = 0.5 \text{ nm}$ , and  $\beta = 107^\circ$

[3]

Q3. What is a Brillouin Zone of a crystal? How to get first Brillouin Zone for a 2D square lattice. The lattice parameters of a simple hexagonal crystal are  $a=b=3 \text{ \AA}$ ,  $c=4 \text{ \AA}$ ,  $\alpha=\beta=90^\circ$ ,  $\gamma=120^\circ$ . From this information determine the primitive lattice vectors. What is the length of the translation vector with  $h=4$ ,  $k=3$ , and  $l=1$ ?

[5]

Q4. Write down the relation between direct lattice vectors  $\{a_i\}$  and reciprocal lattice vectors  $\{b_i\}$ . What is the relation between the volume of unit cell of direct and reciprocal lattice vector?

[4]

Q5. What is Thomas-Fermi model? Write down the kinetic energy for the Thomas-Fermi model. Explain the advantage of Thomas-Fermi model.

[5]

Q6. Define space-group and point group symmetry. How many space-groups are there for three-dimensional solids and how many crystal systems exist? Explain the point group symmetries for the symbol  $Fd-3m$  of a space-group.

[5]