RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B. Sc. (General) Degree in Applied Sciences
Third Year - Semester I Examination – June / July 2018

PHY 3209 – SOLID STATE PHYSICS

Time: 2 hours

Answer four (04) questions.
Use of a non – programmable calculator is permitted.

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01. (a) Discuss the different types of chemical bonding. [20 marks]

(b) Explain why graphite is greasy and electrically conducting whereas diamond is hard and electrically insulating. [10 marks]

(c) Distinguish between crystalline materials and amorphous materials. Explain why the single crystalline materials are so precious and rare. [10 marks]

(d) Explain why the ionically bonded ceramics are hard and highly brittle. [10 marks]

02. (a) Explain how the Miller indices of a set of planes and a direction in a crystal are determined. [10 marks]

(b) Calculate the "packing fraction" for simple cubic (sc), body centered cubic (bcc) and face centered cubic (fcc) unit cells. [15 marks]

(c) Explain the concept of planar density in crystals. Show that the planar density in (110) plane in body centered cubic (bcc) lattice is approximately $1.44/a^2$, where a is the length of the edges of the cubic unit cell. [10 marks]

(d) Iron (Fe) has a body centered cubic (bcc) crystal structure. The atomic mass and the density of Fe are 55.84 *g/mol* and 7.86 g/cm^3 respectively. Calculate the length of the edges of the cubic unit cell. [15 marks]

03. (a) Define the terms space lattice, basis and crystal structure and explain the relationship among them. [10 marks]

(b) Discuss the five 2D space lattices (Bravais lattices). [15 marks]

(c) Show that the "Centered square space lattice" (which does not exist in reality) is same as "Square space lattice". [10 marks]

(d) By way of a clear diagram show that the symmetry of the crystal is equal or lower than the symmetry of the space lattice. [15 marks]

04. (a) Describe the rotating crystal method to observe x-ray diffraction of any material. [24 marks]

(b) How can the Laue method be employed to determine the symmetry of a crystal? [16 marks]

(c) With compared to Laue method, what additional information do you get in the rotating crystal method? [10 marks]

05. (a) Using the Krönig-Penny model, show that for $P << 1$, the energy of the lowest energy band is $E = \frac{\hbar^2 P}{ma^2}$. Note: The Kronig-Penney equation is $\frac{P \sin \alpha a}{\alpha a} + \cos \alpha a = \cos ka$, where $\alpha^2 = \frac{2m_e E}{\hbar^2}$, and for $P << 1$, $\tan\left(\frac{\alpha a}{2}\right) = \tan\left(\frac{P}{\alpha a}\right)$. [20 marks]

(b) Explain the concept of forbidden energy bands with the use of Kronig- Penny model [16 marks]

(c) How does the band theory lead to the concept of negative effective mass? [14 marks]

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