2023

(May/June)

PHYSICS

(Honours)

(Solid-State Physics—II, Electronics—II and FORTRAN Programming)

[PHY–06 (T–A)]

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer Question No. **1** and *any* **four** from the rest

1. *(a)* The Fermi energy for lithium is 4·72 eV at absolute zero. Calculate the number of conduction electrons per unit volume in lithium. Given $h = 6 \cdot 63 \times 10^{-34}$ J-s, $m = 9 \cdot 11 \times 10^{-31}$ kg. 3

(b) Calculate the *(i)* operating frequency and *(ii)* feedback fraction for Hartley oscillator, where its tank circuit

contains a capacitor of 20 pF and two inductors of 1000 μH and 100 μH. The mutual inductance between the two inductors is 20 μH. 2+1=3

(c) Evaluate the following arithmetic FORTRAN statement for $I = 5$, $J = 7$ and $K = 10$: 2

$$X = I * I / J - K * 2 / I$$

2. (a) Write Laue's equations representing the conditions of X-ray diffraction by a crystal and hence obtain Bragg's law using Laue equations. 1½+3½=5

(b) Prove that the reciprocal lattice of an FCC lattice is a BCC lattice. 3

(c) What is Madelung constant? Show that Madelung constant for an infinite linear chain of ions of alternating unit charge at an equilibrium separation is 2ln2. 1+3=4

3. (a) What is a phonon? Obtain the dispersion relation for elastic waves in a linear monatomic chain with nearest neighbour interaction. 1+4=5

(b) Discuss in detail Einstein's theory of lattice heat capacity of solid. 6

(c) State Wiedemann-Franz law. 1

4. (a) What is Hall effect? Deduce an expression for Hall coefficient. 1+4=5

(b) Derive an expression for the effective mass of an electron according to the band theory of solids. 4

(c) Distinguish between Type-I and Type-II superconductors with examples. 2+1=3

5. (a) Describe Langevin's theory of para-magnetism. 5

(b) Explain isotope effect in super-conductors. 2

(c) What are field effect transistors (FETs)? Explain the working of a JFET with the help of a diagram. 1+4=5

6. (a) What is an OP-AMP? Discuss the working of an OP-AMP as an integrator with the help of a diagram. 1+3=4

(b) What are meant by CMRR and slew rate of an OP-AMP? 1½+1½=3

(c) Draw the small-signal low-frequency hybrid parameter equivalent circuit of *CE* single-stage amplifier and derive an expression for input impedance and output impedance. 1+2+2=5

7. *(a)* Draw a neat diagram of a two-stage *RC*-coupled transistor amplifier. Show that the voltage gain of an *RC*-coupled transistor amplifier in the mid-frequency range is independent of frequency. 1+5=6

(b) What are multiplexers and demultiplexers? Discuss a 4 : 1 multiplexer with the help of a diagram. 1+1+4=6

8. *(a)* Differentiate between STOP and END statements in FORTRAN programmes. 2

(b) Write the following mathematical expressions as FORTRAN expressions : 2×2=4

(i) $a + \text{sech}^{-1}x$

(ii) $ax^2 + bx + c$

(c) Explain the following FORMAT specifications used in FORTRAN with an example : 2×2=4

(i) E format

(ii) F format

(d) Explain the following non-executable statements : 1×2=2

(i) NAMELIST

(ii) DIMENSION

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