N–55032

Seat No. _____

M. Sc. (Part - I) Examination

April / May – 2003

Physics : Paper - III

(Solid State Physics, Electronics & Solid State Electronic Devices)

Time : **3** Hours] [Total Marks :

Instructions : (1) All questions carry **equal** marks.

(2) Symbols have their usual meanings. Calculators can be used.

1 (a) Explain the motion of an electrons in one–dimension using band theory and explain the concept of effective mass.

(b) Determine the first three Brillouin zone for a square lattice.

OR

1 (a) Discuss the lattice effect on the cohessive energy.

(b) What are the differences in nearly free electron model and light–binding approximation.

2 (a) Give conceptual exposition of BCS theory.

(b) The critical field at which super conductivity is destroyed at zero kelvin is given by

$$H_c(0^\circ K) \simeq \left(\frac{2n k^2}{\mu_0 \in_F} \right)^{1/2} T_c$$

and H_c is proportion to T_c. The electron concentration 'n' also aooears in above equation and this value differs from one super conductor to another. Why does the linear relationship still hold nontheless ?

OR

2 (a) What are the excitons ? Give their characteristics.

(b) Explain the difference between Schottky defect and Frankel defect. Obtain an expression for number of Schottky defect in a binary ionic crystal.

3 (a) What are the advantages of push–pull connections over single transistor transformer coupled power amplifier ? Draw the circuit of a push–pull class A power amplifier and explain it's working. Derive an expression for the output voltage of this amplifier.

(b) What are the limitations of conventional vacuum tubes when they are used at microwave frequencies ? Describe construction of a two cavity Klystron amplifier. With the Applegate diagram briefly describe the bunching phenomenon in this tube. Why two Cavity Klystron is not used as oscillator ?

OR

3 (a) What are expandable AND–OR Invert Gates ? Draw its schematic diagram and give its logic symbol. What are expanders ? Show how it can be connected with Expandable AND–OR Invert Gate to in increase its width.

(b) For an OPAMP, explain the following parameters :

(a) Input offset voltage

(b) Input offset current

(c) CMRR.

4 (a) Draw the circuit of a phase shift oscillator using BJT and explain its working. Derive expression for frequency of oscillation and obtain condition for sustained oscillations.

(b) Draw the circuit diagram of the source follower and derive expression for its voltage gain, output resistance and input resistance at mid frequency. Show how the input impedance of a source follower can be increased with boot strapped bias circuit.

OR

4 (a) What is Schmitt trigger ? Construct a circuit of a schmitt trigger using transistors and explain the existence of Hysteresis voltage. With the help of proper input waveform show the squaring action of the Schmitt trigger.

(b) Draw a shunt regulator using single transistor and a zener diode, explain its working. Derive expression for stabilization factor and output resistance of this regulator.

5 (a) Obtain expressions for energy state densities in semiconductors and discuss the effect of temperature on Fermi Factor and consequently on energy state densities.

(b) Germanium has a donor type impurity added to the extent of 1 in 10^8 atoms. What effect does this have on the conductivity of the material at 300 K ?

$$n_i = 2.5\times10^{13} \ \text{cm}^{-3} \qquad N_d = 4.42\times10^{14} \ \text{cm}^{-3}$$

$$\mu_n = 3900 \ \text{cm}^2 \ \text{volt}^{-1} \ \text{sec}^{-1}$$

$$\mu_p = 1900 \ \text{cm}^2 \ \text{volt}^{-1} \ \text{sec}^{-1}$$

OR

5 (a) Explain fully why the discrete energy levels for a free single atom does not apply to the same atoms in a crystal ?

Distinguish among conductors, insulators and semiconductors on this basis.

(b) The following data is given for intrinsic germanium at 300 K

$n_i = 2.4 \times 10^{19}\ m^{-3}$ $\quad$ $\mathbf{e = 1.6 \times 10^{-19}}$ coulomb

$\mu_e = 0.39\ m^2\ V^{-1}\ S^{-1}$ $\quad$ $\mu_p = 0.19\ m^2\ V^{-1}\ S^{-1}$

Calculate the conductivity of this specimen.
