

2017

M.Sc. 3rd Semester Examination

PHYSICS

PAPER—PHS-303

Full Marks. : 40

Time : 2 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

(Solid State Special)

Answer Q. No. 1 and any *three* from the rest.

1. Answer any *five* bits : 2×5

- (a) The average energy required to create a Frenkel defect in an ionic crystal, $A^{2+}B^{2-}$, is 1.4ev. Calculate the ratio of Frenkel defects at 300k and 600k in 1 gm of crystal ?
- (b) Explain how will you determine experimentally the area of Fermi surface using the principle of Dehass Van Alphen effect ?

(Turn Over)

- (c) What is F centre and explain its origin ?
- (d) Sodium metal with a BCC structure consists of Na with radius 1.85\AA . Calculate its electrical resistivity at 0°C if the classical value of mean free time is 3×10^{-14} second ?
- (e) Explain what is meant by polarization catastrophe.
- (f) Find the bandwidth for a simple cubic crystal along $[110]$ direction according to Tight Binding Approximation.
- (g) What is Plasmon ?
2. (a) Find the expression of conductivity in an ionic crystal. Why there is a break in the $\log \sigma V_s \frac{1}{T}$ curve, where σ is conductivity and T is temperature.
- (b) Prove that critical shear stress is of the order of $\frac{1}{6}$ of the shear modulus for a solid according to Fresnel estimate.
- 6+1+3
3. (a) Derive Thomas Fermi Dielectric function assuming electrostatic screening in a solid. Define screening length.
- (b) Explain how polaron originates in an ionic crystal ?
- 7+1+2

4. (a) Derive Boltzmann Transport equation. What is meant by relaxation time and hence find an expression of change in the distribution function (f) under first order.
- (b) Explain why high magnetic field and low temperature is required to observe Landau levels in a solid ?
- 6+2+2
5. (a) Show in details the characteristics of ferro electric transition in BaTiO_3 crystals.
- (b) Show how polarizability varies for a dipolar solid with frequency of the applied field. Explain the variation.
- (c) What is meant by dielectric loss ?
- 7+2+1
6. (a) Estimate and plot the first four bands of a simple cubic crystal along $[110]$ direction according to empty lattice approximation.
- (b) Explain the origin of energy gap in solid on the basis of nearly free electron model.
- 5+5
7. (a) Derive the energy dispersion relation for Frenkel exciton in solid.
- (b) Show on the basis of Kramer's Krorig relation how the real part and imaginary part of a complex function can be correlated ?
- 5+5

Use separate Answer-scripts for Group-A & Group-B

(Applied Electronics Special)

Group-A

{ Marks : 20 }

Answer Q. No. 1 and any one from the rest.

1. Answer any *five* questions : 2×5
- (a) Why a logarithmic amplifier using matched pair of transistors is unsuitable for use with very high and very low input voltages ?
 - (b) Write the advantages of SMPS over series regulated power supply.
 - (c) How the circuit of a precision rectifier be changed to get a peak detector ?
 - (d) Draw the block diagram of a phase locked loop (PLL) and qualitatively explain its operation.
 - (e) Draw the circuit diagram of a voltage controlled oscillator (VCO) and write down the expression for the frequency of oscillation of this oscillator.
 - (f) Explain the advantages of a bridge amplifier over a single stage amplifier operating with the same power supply voltage.
 - (g) Explain a chopper Stabilized Amplifier.

2. (a) Draw the circuit diagram of an antilog amplifier using matched pair of transistors and operational amplifiers and derive the expression for its output voltage in terms of its input voltage. 1+4
- (b) Draw the circuit diagram of a 2nd order low pass Butterworth Filter and derive the expression for its transfer function. Find the condition for which it will behave as a 2nd order Butterworth filter. 1+3+1
3. (a) Write the uses of a Schmitt Trigger. Draw the circuit diagram of a Schmitt Trigger using OP-Amp and explain its operation with the necessary derivation. What is hysteresis voltage? 5
- (b) Draw the circuit diagram of a square wave generator using OP-Amps. Derive the expression for the frequency and amplitude of the output waveforms. Is it possible to convert it into a pulse generator and if possible, how? 5

Group-B

[Marks : 20]

Answer Q. No. 1 and any one from the rest.

1. Answer any *five* questions : 5×2
- (a) Compare ECL and TTL in terms of their working principle.

- (b) What is wire'd logic ? Give example.
- (c) Show the memory circuit of EX-NOR gate by FPLA.
- (d) Design 2 : 4 decoder circuit.
- (e) What is topology in computer communication system ? Give example.
- (f) Design CMOS transmission gate with control.
- (g) Find out the fanout of a digital gate whose specification is as follows :

$$I_{OL} = 0.1 \text{ mA} ; \quad I_{OH} = 0.5 \text{ mA} ;$$

$$I_{IL} = 20 \mu\text{A} ; \quad I_{IH} = 60 \mu\text{A} ;$$

2. (a) Design 3 input NOR gate by CMOS and explain briefly.
- (b) What is the advantage of I²L logic gate ? What is 'figure of merit' in digital gate ?
- (c) What is cell structure in mobile communication ? Give the block diagram of the components of mobile communication system. 3+3+4
3. (a) Give the unit cell structure of DRAM.
- (b) Explain the charge propagation in 3 phase CCD.
- (c) Solve the following equation by 8 : 1 MUX IC.

$$Y = \sum_m (0, 2, 6) \quad \text{3+4+3}$$