M.Sc. 3rd Semester Examination, 2013

PHYSICS

PAPER—PHS-304

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

(*Solid State Special*)

[*Marks* : 40]

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

1. Answer any *five* questions :   5 × 2

   (*a*) Prove that change in thermal entropy per vacancy depends on the frequency of the neighbouring atoms surrounding a vacancy.

   (*b*) The energy band relation in a linear chain with interatomic distance '*a*' is given by

$E(k) = E_0 - T \cos ka$. When the width of the band is increased by 20%, calculate the effective mass of the electron at band top.

(c) Explain what is meant by ultraquantum region when De Haas Van Alphen effect is considered.

(d) For copper $n_0 = 8.5 \times 10^{22}$ cm^{-3}, EF$_0 = 3.2$ ex. Calculate Thomas Fermi Screening length.

(e) Explain what is meant by Polaron and show the relation between Band Effective mass and Polaron mass.

(f) Assuming a simple cubic crystal show that

$$m^* = \frac{\hbar^2}{2\gamma a^2}$$

where γ is the overlapping integral.

(g) Clearly explain what is meant by edge dislocation.

(*Continued*)

(h) Indicate the important characteristics of a Ferroelectric material.

2. Prove that according to Nearly Free Electron approximation the energy discontinuity occurs at Zone Boundary and find also energy at the lower and upper band at this band edge position.   10

3. (a) Derive LST relation assuming interaction between photon and phoonon in an Ionic crystal.   8

   (b) What is soft optical phonon mode.   2

4. (a) Derive the expression of Energy Corresponding to Landau levels.   8

   (b) Explain why low temperature is required for the appearance of Landau Levels.   2

5. (a) Describe in details the characteristics of First order transition in a Ferroelectric solid.   7

(b) Explain ionic polarization in an alternating field and hence find the expression of dielectric constant. 3

6. (a) Explain the diffusion mechanism in an ionic crystal and hence find an expression of diffusion coefficient a temperature T. 6

(b) Explain in details the mechanism of thermo-luminerence in a solid. 4

(*Electronics Special*)

GROUP – A

[*Marks* : 20]

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

1. Answer any *five* bits : 2 × 5

(a) Draw the circuit diagram of a perfect differential amplifier using a single OP-Amp and explain its limitations.

(*Continued*)

(b) Explain one application of Chopper Stabilized Amplifier.

(c) Draw the circuit diagram of a Voltage Controlled Oscillator and write down one of its uses.

(d) Explain how a PLL can be used as FM demodulator ?

(e) How analog multiplier can be realised using Log and Antilog amplifiers ?

(f) Draw the circuit diagram of a peak detector and explain its operations.

(g) Explain how a Band Pass Filter can be realised using a given Low Pass Filter and a High Pass Filter. What is the necessary condition ?

2. (a) Draw and explain the circuit diagram of an antilog amplifier using matched pair of transistors and derive the expression for the output voltage in terms of input voltage and input reference voltage.   5

(b) What do you mean by a series voltage regulator ? Draw the circuit diagram of a series voltage regulator using an OP-Amp as comparator, a power transistor as pass element and a low power transistor as current limiter. Derive the expression for its output voltage. 5

3. (a) Draw the circuit diagram of a 2nd order low pass Butterworth Filter and derive the expression for the normalised gain as a function of frequency. 1 + 4

(b) Explain how a Schmitt Trigger circuit can be converted to generate triangular waves with proper circuit diagram. Derive the expression for the output frequency of oscillation and draw the output waveforms. 1 + 4
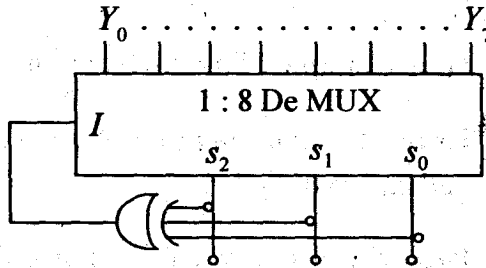
GROUP – B

[*Marks* : 20]
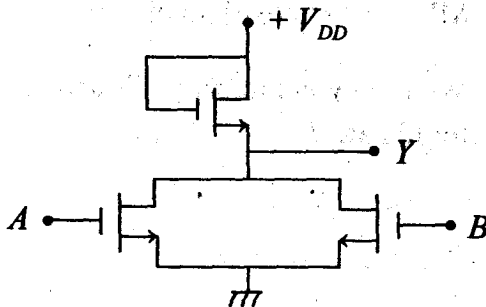
Answer **Q. No. 1** and any **one** from the rest

1. Answer any *five* bits : 5 × 2

(a) What is EEPROM ?

(b) What will be the different outputs for the following circuit ?

(c) Draw the circuit diagram of 8 : 3 encoder.

(d) Explain the operation of CMOS transmission gate.

(e) What is 'wire'd logic ? Give example.

(f) What is the concept of I^2R logic gate ?

(g) Explain the operation of the following circuit :

(Turn Over)

2. (a) Explain the operation of two phase dynamic shift register. 3

   (b) Give example of magnetic memory. 2

   (c) Draw the circuit diagram of a DRAM unit cell and explain briefly. 3

   (d) Draw the circuit to check A whether a two bit signal $A (A_1 A_0)$ is greater than another signal $B (B_1 B_0)$ or not. 2

3. (a) Give example of diode-transistor logic gate. 2

   (b) Explain the operation of TTL two input NOR gate. 3

   (c) Design a 24 : 1 MUX circuit using 8 : 1 MUX IC and explain briefly. 3

   (d) What do you mean by "figure of merit" of a logic gate ? 2