· 2009

M.Sc.

3rd SEMESTER EXAMINATION

PHYSICS

PAPER—PH-2104

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.

Module–PH-2104A

(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 series voltage regulator using OP–AMP as comparator and a transistor as current limiter.

   (b) Draw the circuit diagram of an instrumentation amplifier using 3 OP-AMPs.

(c) Why a logarithmic amplifier cannot be used at very low and very high input voltages ?

(d) What are the advantages of active filters over passive filters ?

(e) Explain the advantage of bridge amplifiers over single stage amplifiers.

(f) Draw the circuit diagram of a square wave generator and write the expression for frequency of oscillation.

(g) Draw the circuit diagram of an analog multiplier which can multiply both +ve and –ve signals.

2. (a) Explain the operation of a triangular wave generator with proper circuit diagram and derive the expression for the frequency of the output signal.   5

(b) Explain the operation of a Phase Locked Loop with explanation to its different building blocks.   5

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

(b) Draw the circuit diagram of a 2nd order Low pass Butterworth filter and derive the expression for the transfer function as a function of frequency.   1+4

Answer *Q. No. 1* and any *one* from the rest.
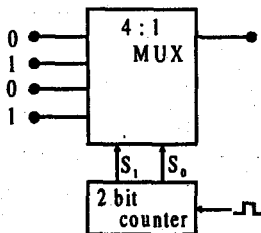
1. Answer any *five* bits :   5×2

   (a) Compare the performance of TTL & CMOS logic gate.

   (b) Give the basic design of a 24 : 1 MUX using 8 : 1 MUX IC.

   (c) "CMOS transmission gate" is an ideal switch ; justify.

   (d) What do you mean by magnetic bubble memory ?

   (e) Using FPLA memory unit solve the following equations :

$$Y_1 = A\ B\ C + \overline{A}\ B\ C$$
$$Y_2 = \overline{A}\ \overline{B} + A\ C + B\ C$$

   (f) Give the basic circuit of 2 : 4 decoder.

   (g)

   Give the nature of output waveform of the above ckt.

2. (a) Explain the working principle of TTL NAND gate with totempole connection.

(b) What do you mean by fan-in and fan-out ?

(c) Give the basic difference between encoder and decoder ?

(d) Draw the circuit diagram of a CMOS NAND gate and explain. 4+2+2+2

3. (a) Show the different section of Dynamic RAM unit cell.

(b) Give example of (i) Optical memory, (ii) Semiconductor memory ; (iii) Magnetic memory & (iv) Sequential memory.

(c) State briefly the working principle of Magneto-Optical Memory.

(d) LIFO and FIFO are the examples of shift register. Give comments in support of this statement. 4+2+2+2

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Module–PH-2104

(Marks : 40)

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

1. Answer any *five* bits : 2×5

  (i) Find the band width for a f.c.c crystal along [1 0 0] according to Tight Binding Approximation. 2

  (ii) The energy of formation of vacancy in copper is 1ev. Estimate the number of vacancy per mole at room temperature. Assume that thermal entropy change is negligible. 2

  (iii) Explain what is meant by Mott's metal & insulator transition. 2

  (iv) What is meant by polarization catastrophe ? 2

  (v) The $E - K$ relation in a particular solid is given by $E = Ak^2 + Bk^3$; where A & B are positive constants. Determine the effective mass of the electron at the band bottom.

  (vi) Find the total polarizability of CO_2, if its susceptibility is 0.985×10^{-3}. Density of carbon dioxide is 1.977 kg/m^3. 2

  (vii) Why electromagnetic wave cannot excite a plasmon ?

                                           2

2. Find the energy spectrum in a solid using nearly free electron approximation & find the energy gap at the zone boundary. 10

(Turn Over)

3. (a) Derive the LST relation assuming photon-phonon interaction in an ionic crystal. 8

(b) What is soft optical phonon & what is its significance? 2

4. (a) Derive an expression of ionic conductivity & show that Einstein relation is valid in this case. 5

(b) Explain with a neat diagram what is meant by Edge dislocation. 3

(c) Why there is break in $\log D$ V $\cdot \frac{1}{T}$ curve for an ionic crystal? 2

5. (a) Describe in details Langwin theory & hence find an expression for dipolar polarizability. 5

(b) Prove that ferroelectric to paraelectric transition in Rochelle salt is second order. 5

6. (a) Describe in details Dehaas Van Alphen effect. What is meant by ultra quantum region? 5+1

(b) What is Frenkel Exciton? Find the dispersion relation for this case. 4

7. (a) Prove that dielectric loss is related to the imaginary part of the dielectric constant. 3

(b) Find an expression for Schotky defect in case of an ionic crystal. 3

(c) Show how polarization direction changes in $BaTiO_3$ when temperature is lowered. 4