M.Sc. 3rd Semester Examination, 2012

PHYSICS

PAPER – PHS-304

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

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

Illustrate the answers wherever necessary

PAPER – PHS-304

(Special Paper : *Solid State Physics*)

[*Marks* : 40]

Time : 2 hours

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

1. Answer any *five* bits : 2 × 5

(*a*) Explain what is meant by Plasmon.

(*b*) Find the bandwidth in simple cubic crystal along [110] direction according to tight binding approximation.

(*c*) Explain what is meant by F-center.

(*d*) The average energy required to create a Frenkel defect in an ionic crystal, $A^{2+} B^{2-}$, is 1·4 eV. Calculate the ratio of Frenkel defects at 300 K and 600 K in 1 gm of crystal.

(*e*) Calculate the Burger vector in Aluminium crystal. Lattice constant is $a = 4.05$ Å.

(*f*) Explain what is meant by complex dielectric constant.

(*g*) Plot screened and unscreened Coulomb potential of a unit positive change as seen by an electron in a solid.

2. (*a*) Derive the energy of electron in a solid according to T.B.A. 8

(*b*) Explain what is meant by reduced zone scheme. 2

3. (*a*) Derive the expression of Thomas Fermi dielectric function assuming screening behaviour of electron gas in a metal. 8

(*b*) What is Thomas Fermi Screening length ? 2

4. (*a*) Describe in detail the dipole theory of Ferro-electricity. 5

(*b*) Derive an expression of A.C. polarizability assuming frequency dependence of dipolar polarizability in a dielectric. 5

5. (*a*) Derive an expression for conductivity in an ionic crystal. 5

(*b*) Find an expression for dislocation energy of a screw dislocation. 5

6. (*a*) Derive the dispersion relation corresponding to Frenkel exciton. 5

(*b*) Describe in detail de Hass-van Alphen effect. 4

(*c*) What is meant by ultraquantum region. 1

(**Special Paper** : *Applied Electronics*)

PAPER – PHS-304 A

[*Marks* : 20]

Time : 2 hours

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

1. Answer any *five* bits : 2 × 5

(*a*) Explain with circuit diagram, how a bridge amplifier can be used as a transducer.

(*b*) Discuss about the advantages of active filters over passive ones.

(*c*) Draw the circuit diagram of an antilog amplifier using matched pair of transistors and OP-AMP.

(*d*) Design a 2nd order high-pass Butterworth filter with cut-off frequency of 10 kHz.

(*e*) Explain the advantages of switching regulators over series regulators.

(*f*) Draw the circuit diagram of a four quadrant analog multiplier using transistor and OP-AMP. State one of its uses.

(*g*) Why a logarithmic amplifier cannot be used for very low and very high input voltages ?

2. (*a*) What do you mean by an instrumentation amplifier ? Draw the circuit diagram of an instrumentation amplifier using 3-OP-AMPs and derive the expression for the output voltage. 1 + 4

(*b*) Draw the block diagram of a Phase Locked Loop and describe its operation. 1 + 2

(*c*) Explain the use of an Ex-OR gate as a digital phase detector. 2

3. (*a*) Explain the circuit operation of an inverting Schmitt trigger and find out an expression for the hysteresis voltage. 5

(*b*) How the circuit of a Schmitt trigger can be changed to design a voltage controlled oscillator and derive the expression for the output frequency. 5

PAPER – PHS-304 B

[*Marks* : 20]

Time : 2 hours

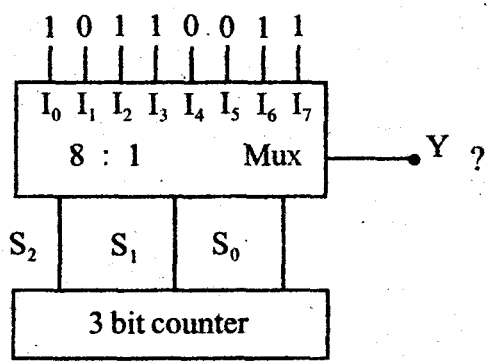
Answer **Q. No. 1** and any **one** from the rest

1. Answer any *five* bits : 2 × 5

(*a*) Why ECL is faster than TTL ?

(*b*) Draw the circuit of 2 input C-MOS NAND gate.

(*c*)



Draw the output waveform.

(*d*) Draw the unit cell of SRAM.

(*e*) State the working principle of optical memory in compact disk.

(*f*) Establish the relation of flip-flop, register and memory cell.

2. (*a*) State briefly the working principle of 3-phase CCD unit. 3

(*b*) What do you mean by "field programmable logic array" ? Give example. 3

(*c*) Show the circuit diagram of "two-phase ratioless dynamic shift" register. 3

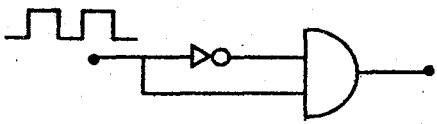
(*d*) (32 K × 16) memory IC has ..... data line and ..... address line. Complete the above sentence. 1

3. (*a*) Solve the following equation by 8 : 1 Multiplexer IC :

$$Y = \sum m(2, 5, 7, 9, 12, 13).$$ 3

(*b*) Design TTL tri-state inverter logic gate and show the three different states. 3

(*c*) What do you mean by propagation delay? Considering propagation delay show the output of the following circuit: 3



(*d*) What is VLSI? 1