M.Sc. 3rd Semester Examination, 2019

PHYSICS

PAPER –PHS-303

Full Marks : 40

Time : 2 hours

Answer **all** questions

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

PHS-303 A

(*Solid State Physics*-I)

1. Answer any *four* bits : 2×4

   (*a*) Why lattice defects are inevitable in Solid ?

(*b*) Explain how dislocation promotes slip in crystal ?

(*c*) What is polarisation catastrophe ?

(*d*) Explain what is meant by Ultraquantum region ?

(*e*) What is meant by effective mass and what negative effective mass correspons to ?

(*f*) Explain what is meant by polaron.

(*g*) What is F-center ? How it is formed ?

(*h*) Show that effective number of electron is minimum where band is half filled ?

2. Answer any *four* bits : 4 × 4

(*a*) The conduction band structure and valence band structure of a solid is given by $E_{cb} = E_1 - E_2$ corka and $E_{vb} = E_2 - E_2 \sin^{-2} \frac{ka}{2}$. Find nature of the band gap, band gap value, band width of conduction band and valence band.

(*b*) Find an expression of Frenkel defect in an ionic crystal.

(*c*) Find an expression of plasma oscillation frequency assuming electromagnetic wave falling in a metal.

(*d*) Show how polarization direction changes in $BaTiO_3$ crystal as use lower the temperature and find an expression of $\frac{\Delta a}{a}$, where a is lattice constant ?

(*e*) Explain what is meant by luminescence ? Clearly distinguish luminescent and non-luminescent solid.

(*f*) Clearly explain ionic polarisation and hence find an expression of dielectric constant when an A. C. field in applied.

(*g*) Show that ideal critical shear stress in a solid is of the order of $\frac{1}{6}$th of the shear modulus.

(*h*) What is Mott Metal-Insulator transition ? What is meant by soft optical phonon mode ?

3. Answer any *two* bits : 8×2

(*a*) Find an expression of conductivity in an ionic crystal and hence find the Einstein relation ?

(*b*) Explain what is meant by electrostatic screening and hence find an expression of Thomas Fermi Screening length for a metal.

(*c*) Show in details the characteristics of transition assuming a Ferroelectric solid $BaTiO_3$.

(*d*) Explain what is meant by De haas Van Alphen Effect and find an expression of period of oscillation of mean energy of electrons near the fermi surface.

PHS-303 B.1

(*Applied Analogy Electronics*-I)

1. Answer any *two* of the following : 2 × 2

(*a*) Draw the circuit diagram of a crystal oscillator and explain its advantage over a simple LC tuned oscillator.

(*b*) Write the advantages of SMPS over series regulated power supply.

(*c*) Why a log amplifier using matched pair of transistors is unsuitable for use with very high and very low input voltages ?

(*d*) Explain how an analog multiplier can be designed using log and antilog amplifiers.

2. Attempt any *two* of the following : 4 × 2

(*a*) What is the advantage of using chopper stabilized amplifier over a simple op-amp amplifier ? Explain the operation of a chopper stabilized amplifier.

(*b*) Draw the circuit diagram of a regulated power supply using op-amp as comparator, a power trasistor as pass element and a transistor as current limiter. Explain its operation and derive the expression for its output voltage.

(*c*) Draw the circuit diagram of a peak detector using op-amp and explain its operation.

(*d*) Draw the circuit diagram of a Schmitt Trigger using op-amp and explain its operation with derivation of the expression for hysteresis voltage.

3. Attempt any *one* of the following : 8 × 1

(*a*) (*i*) Draw the circuit diagram of a voltage controlled oscillator using modified version of Schmitt Trigger and derive the expression for its output frequency in terms of the input voltage. 1 + 4

(*ii*) Draw the block diagram of a phase Locked Loop and explain how it can be used to recover the modulating signal from FM modulated signal ? 3

(*b*) (*i*) Draw the circuit diagram of a 2nd order low pass Butterworth Active Filter and derive the expression for its transfer function. Find out the condition for which it will behave as a 2nd order Butterworth Filter. 1 + 3 + 1

(*ii*) Draw the circuit diagram of a bridge power amplifier using audio IC chips LM380 and explain how it can deliver 4 times the output power compared to a single power amplifier IC. 3

PHS-303 B.2

(*Applied Digital Electronics*-I)

Answer **Q. No. 4 & 5** and any **one** from the rest

4. Answer any *two* questions : 2 × 2

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

(*b*) Give the circuit of 2 bit CMOS OR gate.

(*c*) Give the circuit to solve the following digital equation by 8 : 1 Mux IC

$$Y = \sum_{m} (0, 3, 7)$$

(*d*) Compare the 'fan out' and 'noise immunity' of TTL and ECL gates.

5. Answer any *two* questions : 4 × 2

(*a*) What is MTSO in mobile communication ? What do you mean by topology in computer communication ?

(*b*) Design a ROM unit by FPLA circuit which can convert 3 bit binary number into 3 bit grey code number.

(*c*) Explain the operation of 2 input ECL OR/ NOR gate and discuss the merits and demerits of this gate.

(*d*) Design the following circuit with DTL gates

$$Y = \overline{(A\,B\,C)}$$

What is the limitation of this circuit ?

(*Continued*)

6. (*a*) Give the circuit of two phase ratio-less dynamic shift register.

(*b*) Explain the charge transfer in three phase CCD.

(*c*) Differentiate SRAM and DRAM. 3 + 3 + 2

7. (*a*) Give the basic idea of mobile communication with a schematic diagram.

(*b*) Give the circuit of 3-bit AND gate designed with NMOS technology.

(*c*) Give the block diagram of 1 : 24 De Mux IC designed by cascading three 1 : 8 De Mux ICs. 3 + 3 + 2