M.Sc. 3rd Semester Examination, 2022

PHYSICS

PAPER – PHS-303A, 303B.1 & 303B.2

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

PHS-303A

[*Marks* : 40]

(*Solid State (Special)*)

A. Answer any *four* questions : 2×4

1. For copper $n_o = 8.5 \times 10^{22}$ cm^{-3}, $E_{Fo} = 3.2$ey. Calculate Thomas Fermi Screening Length.

2. Clearly distinguish luminescent and nonluminescent solid through E Vs q plot.

3. What is V center ?

4. Find the Burger vector corresponding to stable dislocation in BCC and FCC crystal.

5. Show that Madelung constant for NaCl structure is 1.747558.

6. What is meant by ultra quantum region ?

B. Answer any *four* questions : 4×4

7. Draw the first three bands in a simple cubic lattice in [110] on the basis of empty lattice approximation.

8. Show that change of thermal entropy for a perfect crystal is zero.

9. The energy band relation in a linear chain with interatomic distance a is given by $E_k = E_o - T \cos k_a$. When the width of the band is increased by 20%, calculate the change in effective mass.

10. Find the equilibrium concentration of Frenkel defects in an ionic crystal at any temperature.

11. Explain thermoluminescence in a solid and hence find an expression of intensity.

12. Explain what is Mott's Metal to insulator transition.

C. Answer any *two* questions :   8 × 2

13. Explain De Haas Van Alphen effect. How will you determine the area of Fermi surface experimentally ?   5 + 3

14. Find an expression of conductivity(σ) in an ionic crystal. Explain log $\sigma Vs \dfrac{1}{KT}$ curve for such crystal.   6 + 2

15. What is Polariton ? Derive LST relation for an ionic crystal.   2 + 6

16. Derive the energy of electron in a solid according to Tight Binding Approximation. *What is meant by polarization* catastrophe ?
          7 + 1

PHS–303B.1

[*Marks* : 20]

(*Applied Electronics Special* : *Analog Electronics*)

A. Answer any *two* of the following questions : 2 × 2

1. Draw the circuit diagram of a Precision Rectifier and explain its operation.

2. Draw the circuit diagram of a current limited series regulated power supply using OP-Amp as comparator.

3. Draw the circuit diagram of a bridge power amplifier.

4. Write the advantages of SMPS over series regulated power supply.

B. Answer any *two* of the following : 4 × 2

5. Draw the circuit diagram of a logarithmic amplifier using OP-Amps and matched pair of transistors and derive the expression for

its output voltage in terms of input voltage and input reference voltage.

6. Draw the circuit diagram of a square wave generator using modified version of Schmitt Trigger. Also derive the expression for its output amplitude and frequency.

7. Explain the use of PLL as FM modulator with proper block diagram. What is its advantage over standard FM discriminators ?

8. Draw the circuit diagram of a second order high pass Butterworth active filter and derive the expression for its transfer function as a function of frequency.

C. Answer any *one* of the following : 8×1

9. (*i*) Draw the circuit diagram of an instrumentation amplifier using three operational amplifiers which does not load either input terminals and derive the expression for its output voltage in terms of *input voltages.*

(ii) Explain the use of log and antilog amplifier for the realisation of analog multiplier.   5 + 3

10. (i) Draw the circuit diagram of a Voltage Controlled Oscillator (VCO) using operational amplifiers and MOSFETs as active devices and derive the expression for its frequency of oscillation. Also draw the output waveform.

(ii) Explain two uses of Voltage Controller Oscillator.   5 + 3

PHS–303B.2

[*Marks* : 20]

(*Applied Electronics Special : Digital Electronics*)

D. Answer any *two* bits :   2 × 2

11. In a TTL NAND gate the following parameters are given; find out the 'fan out'.

$I_{OH} = 60mA$; $I_{OL} = 50mA$; $I_{IH} = 7mA$; $I_{IL} = 8mA$

12. Write down the difference between LAN and WAN.

13. How do you take out the outputs of 'Sum' and 'Carry' of a full adder using a DeMux IC ?

14. Show the circuit of FPLA to get $Y = \sum\{1, 3, 5\}$.

E. Answer any *two* bits : 4×2

15. Draw the circuit of 3-input CMOS NOR gate and explain the truth table.   4

16. What is the role of MTSO in mobile communication ? What are the basic features of second generation (2G) of cell phone ? $2 + 2$

17. What is DRAM ? Give the structure of DRAM unit cell by MOSFET. $2 + 2$

18. What do you mean by packet switch network in Computer communication ? What do you mean by topology of computer communication ? $2 + 2$

F. Answer any *one* bit :   8 × 1

  19. (*i*) Give the structure and working principle
        of three phase CCD memory unit.

    (*ii*) Explain the operation of CMOS switch.

    (*iii*) Write down the advantage and disadvan-
         tage of ECL gate.   4 + 2 + 2

  20. (*i*) You have to choose 24 different signals,
        one at time, selectively. Design the
        required circuit using 8:1 Mux IC(s).

    (*ii*) Explain the operation of two phase ratio-
         less dynamic shift register.   4 + 4

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