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**PG/IIIS/PHS/303A,303
(B.1&B.2)/24**

M. Sc. 3rd Semester Examination, 2024

PHYSICS

PAPER — PHS-303A & 303(B.1,B.2)

Full Marks : 50

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*

PAPER — PHS-303A

(Advanced Condensed Matter Physics-I)

[Marks : 40]

GROUP—A

A . Answer any *four* questions : 2 × 4

- 1.** Explain what is meant by ultraquantum region assuming De Haas Van Alphen effect in a solid.

(Turn Over)

2. Clearly explain what is meant by Schotky defect ?
3. For copper $n_0 = 8.5 \times 10^{22} \text{ cm}^{-3}$, $E_{F_0} = 3.2 \text{ eV}$. Calculate the Thomas Fermi Screening length.
4. Find the Burger Vector corresponding to stable dislocation in B.C.C and F.C.C crystal.
5. Show that madelung constant for NaCl structure is 1.747558.
6. What is meant by polarization catastrophe ?

GROUP-B

B. Answer any *four* questions : 4 × 4

7. Find the equilibrium concentration of Frenkel defect in an ionic crystal ?

(3)

8. What is meant by thermoluminescence and hence find an expression of intensity of it ?
9. What is meant by plasmon ? Find an expression of plasma Frequency.
10. What is meant by De Haas Van Alphen effect ? How the shape of fermi surface can be determined using this effect ?
11. Clearly explain Raman effect in a solid.
12. Find the expression of elastic energy per unit length of a screw dislocation in a solid.

GROUP – C

C. Answer any *two* questions : 8 × 2

13. What is meant by polariton ? Derive LST relation assuming an ionic crystal. 2 + 6

14. Explain the condition required to generate Landau levels in a solid? Derive the expression of energy corresponding to Landau Level. 2 + 6

15. What is meant by Exciton? Derive the dispersion relation corresponding to Tightly Bound Exciton. 2 + 6

16. Derive the expression of conductivity in an ionic crystal. What is Einstein-relation? 6 + 2

[Internal Assessment – 10 Marks]

PAPER – PHS-303B.1

(Applied Electronics Special: Analog Electronics)

[Marks : 20]

GROUP – A

1 . Attempt any *two* of the following questions : 2 × 2

- (a) List the advantages of a Switch Mode Power Supply (SMPS) compared to a series regulated power supply.
- (b) Sketch the circuit diagram of a current-limited series regulated power supply that uses an operational amplifier as a comparator.
- (c) Sketch the circuit diagram of a bridge audio power amplifier.
- (d) Sketch the circuit diagram of a Precision Rectifier and describe how it works.

GROUP-B

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

- (a) Explain how a Phase-Locked Loop (PLL) functions as an FM modulator, accompanied by a proper block diagram. What are the advantages of using PLL over traditional FM discriminators ?

- (b) Draw the circuit diagram of a second-order high-pass Butterworth active filter and derive the formula for its transfer function in terms of frequency.
- (c) Draw the circuit diagram of a square wave generator using a modified Schmitt Trigger. Also, derive the formula for its output amplitude and frequency.
- (d) Draw the circuit diagram of a logarithmic amplifier utilizing operational amplifiers and a matched pair of transistors and derive the formula for the output voltage in terms of the input voltage and reference voltage.

GROUP – C

Answer any **one** of the following question : 8×1

3. (a) (i) Draw the circuit diagram of an instrumentation amplifier using three operational amplifiers, which does not load

the input terminals and derive the expression for the output voltage in terms of the input voltages.

(ii) Explain how log and antilog amplifiers are used for the realization of an analog multiplier. 5 + 3

(b) (i) Draw the circuit diagram of a Voltage Controlled Oscillator (VCO) using operational amplifiers and MOSFETs as active components and derive the formula for its frequency of oscillation. Also, sketch the output waveform.

(ii) Explain two applications of a Voltage Controlled Oscillator. 5 + 3

PAPER – PHS-303B.2

[Marks : 20]

GROUP – A

Answer any **two** bits :

2 × 2

1. In a logic gate the following parameters are given; find out 'fan out' in low state and Fan out in high state :

$$I_{OH} = 65\text{mA}; I_{OL} = 75\text{mA}; I_{IH} = 9\text{mA}; I_{IL} = 8\text{mA}$$

2. Write down the difference between LAN and WAN.
3. Differentiate 1G and 2G mobile communication technology.
4. What is the advantage of DRAM unit cell over SRAM unit cell ?

GROUP-- B

Answer any **two** bits :

4 × 2

5. Draw the circuit of 3-input CMOS OR gate and explain the truth table.
6. What is the role of MTSO to connect a call from a mobile to a land-phone ? What are the key components of a mobile handset ? 2 + 2

7. Solve the digital equation both by a Mux IC and by a DeMux IC : 2 + 2
 $Y = \Sigma(2,3,5,7)$
8. What is the basic difference between packet switch and message switch network in Computer communication ? 2 + 2

GROUP- C

Answer any *one* bit : 8 × 1

9. (a) How the information is stored in a CCD memory unit ?
- (b) Give the circuit and explain the operation of a Tristate TTL Not Gate.
- (c) What are the merits and demerits of ECL logic family ? 2 + 3 + 2
10. (a) You have to send a signal into 12 different paths selectively. Design the required circuit using 1:8 DeMux IC(s).

(10)

(b) Describe the data transmission through two phase ratio-less dynamic shift register.

(c) Define the term :

(i) Computer topology

(ii) Router

3 + 3 + 2

[Internal Assessment – 10 Marks]
