

2007

ELECTRONICS**PAPER-I***Full. Marks : 75**Time : 3 hours**The figures in the right-hand margin indicate full marks.**Candidates are required, to give their answers in their own words as far as practicable.**Write the answers questions of each Group in separate books.**Answer Q. No. 1 and any three from the rest in each group.***.. Group - A***(Marks a .40)*1. (a) Find the Laplace transform of 'sin at' . 2

(b) Using Laplace transform, prove that

$$\int_0^{\infty} t e^{-ts} \sin t dt = 0. \quad 4$$

(c) Find the Fourier transform of a Gaussian function

$$(_ e^{-\circ x^2}). \quad 4$$

2. (a) If $f(z) = \frac{z^2 + 5z + 6}{z - 3}$, find the values of $\int_C f(z) dz$;

(i) When C is a circle of radius 4, having its centre at the origin.

(ii) When C is a circle of radius 2 with the origin. at its centre. 5*(Turn Over)*

- (b) Define analytic function. Prove that the function $u = x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$ satisfies Laplace's equation and determine the corresponding analytic function $u + iv$. 1+2+2

3. (a) Solve $\frac{dy}{dx} + 4y = 4e^{-2t}$ with $y(0) = -1$ and

$y'(0)=4$ using **Laplace transform.** 5

- (b) Let $P_n(x)$ denote the Legendre polynomial of degree n , prove that

(i) $P_n(1) = 1$ and (ii) $P_n(-1) = (-1)^n$. 2

- (c) Prove the recurrence formula

$$(2n+1)x P_n(x) = (n+1) P_{n+1}(x) + n P_{n-1}(x)$$

where $P_n(x)$ is the Legendre's polynomial of degree n . 3

4. (a) Derive trapezoidal formula.

- (b) Calculate $\int_0^1 \frac{x}{1+x^2} dx$ taking 6 intervals by using

Simpson's $\frac{1}{3}$ rd rule. 5

5. (a) Explain the regula-falsi method to find the real root of an equation $f(x) = 0$. 5

- (b) Find the root of the equation $x^3 - 8x - 4 = 0$. **5**

6. (a) Establish Newton's forward interpolation formula. 5

- (b) Given the following table

x	0	5	10	15	20
f(x)	1.0	1.6	3.8	8.2	15.4

Find the value of $f(21)$.

Group - B

(Marks : 35)

1. (a) Why a Schottky defect is called a point defect and a dislocation a line defect ?
(b) Define & Explain the term 'exciton'.
(c) What is Josephson effect ?
(d) What is quantum wire?
(e) In an n-type semiconductor will the Fermi level lie at the middle of the band gap ? If not, which way will it move? 1x5
2. Discuss the motion of Carrier in a semiconductor under the action of an external electric field and a magnetic field, applied perpendicular to each other. How can you use this situation to obtain the values of the effective mass and the mobility of the carriers ? 10
- 3.. (a) What do you. meant by crystal Imperfections ?
Mention different types of crystallographic defects. 2+3
(b) Show that the number of Frenkel defects in equilibrium at a given temperature is proportional to $(N N_i)^{1/2}$ where N be the no. of atoms & N_i be the interstitial atoms. 5
4. (a) What is the practical significance of the parameter 'mobility' of the carriers in a semiconductor?
(b) What do you mean by direct and indirect band gap semiconductors ? Explain with relevant band diagrams. Which type of semiconductors you would use for source and detector of light and why? 2+3+3+1+1

- S. (a) What is a Superconductor ? Explain type I & type II superconductor with suitable diagram. 1+3**
- (b) Discuss BCS Theory in connection with Superconductivity. What is Josephson tunneling ? 4+2**
- 6. (a) Define the term polarizability, show that electronic polarizability $\alpha_e = r^3$ where r is the atomic radius. 5**
- (b) For a Ferroelectric crystal show that the static dielectric constant changes with temperature according to the relation**

$$\epsilon_s = \frac{C}{T - T_c} \quad T_c = \text{Curic temperature.}$$