NATIONAL INSTITUTE OF TECHNOLOGY, PATNA

MID SEMESTER EXAMINATION- October 2023

Program: BT-MT (DD) **Semester: 3** **Department: Physics**
Course Code: PH38103 **Course Name: Materials Science**
Full Marks: 30 **Duration of Examination: 2 hours**

Attempt all questions. Please assume missing data suitably, if any.

Q.1. (a) The net potential energy between two adjacent ions, E_N, is 10

$$E_N = (-A/r) + (B/r^n)$$

Calculate the bonding energy E_o in terms of the parameters A, B, and n. $\frac{dF}{dt} =$

(b) What do you mean by **packing fraction**? Find the value of packing fraction for simple cubic, body centre cubic and face centre cubic structure.

(c) Discuss the importance of miller indices. In a triclinic crystal, a lattice plane makes intercepts at a length a, $2b$ and $-3c/2$. Find the Miller indices of the plane

Q.2. (a) Derive Bragg's equation of diffraction. Calculate the glancing angle on the cube face (100) of a rock salt crystal (lattice parameter $a = 2.184$ Å) corresponding to second order reflection of X-ray of wavelength 0.710 Å. 10

(b) A monochromatic beam of X-ray of wavelength 1.24 Å is reflected by FCC crystal of KCl. Determine the inter planer distances for (100), (110) and (111) planes. [Given density of KCl = 1980 kg/m^3 and molecular weight (M) = 74.5].

(c) Differentiate Schottky and Frenkel defects of given materials.

Q.3. (a) What is dislocation? Explain edge and screw dislocations with the help of Burger vector. 10

(b) If the average energy required creating a vacancy in a metal is 1eV. Calculate the ratio of vacancies in the metal at 1000 and 500K.

(c) Discuss the Matthissen's rule in detail. Describe the behaviour of carrier concentration with temperature for extrinsic semiconductor by taking suitable example.

Si — Si Cu Ni → 0.12 0.52 52%

NATIONAL INSTITUTE OF TECHNOLOGY PATNA

Department of Mathematics

Mid-Semester Examination - October 2023

Course: Complex Variables and PDEs | Code: MA38101/OE38101

Time: 2 hour | Maximum Marks: $5 \times 6 = 30$

Answer all questions

1. Prove that a necessary and sufficient condition that $w = f(z) = u(x, y) + iv(x, y)$ be analytic in a region R is that the Cauchy–Riemann equations $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$, $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$ are satisfied in R where it is supposed that these partial derivatives are continuous in R.

2. Determine and classify all the singularities of the following functions (a) $f(z) = \sec(1/z)$, and (b) $f(z) = e^{-1/z}\sin(1/z)$.

3. (a) Show that
$$\oint_C \frac{e^{zt}}{z^2+1}dz = \sin t$$
if $t \geq 0$ and C is the circle $|z| = 3$.

   (b) If $a > e$, prove that the equation $az^n = e^z$ has n roots inside $|z| = 1$.

4. (a) Expand $f(z) = e^{z/(z-2)}$ in a Laurent series about $z = 2$.

   (b) Find the residue of $f(z) = \frac{\cot z \coth z}{z^3}$ at $z = 0$.

5. Evaluate $\oint_C \frac{2z^2+5}{(z+2)^3(z^2+4)z^2}dz$ where C is the circle $|z - 2i| = 6$.

6. Show that $\int_0^\infty \frac{\cos mx}{x^2+1}dx = \frac{\pi}{2}e^{-m}$, $m > 0$.

***********All the Best************