📘 ADVANCED ENGINEERING PHYSICS – FULL NOTES

(R25 – JNTUH)

🔹 UNIT – I : CRYSTALLOGRAPHY & MATERIALS CHARACTERIZATION

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1. Crystal Structure (10 Marks)

Introduction

A crystal is a solid material in which atoms are arranged in a regular and repeating three-dimensional pattern. This regularity gives materials their mechanical, electrical, and thermal properties.

Crystal Lattice

A lattice is a regular 3D arrangement of points where each point has an identical environment.

Basis

A basis is a group of atoms attached to every lattice point.

👉 **Crystal Structure = Lattice + Basis**

Unit Cell

The smallest repeating unit that forms the entire crystal.

Types:

- Simple Cubic (SC)
- Body Centered Cubic (BCC)
- Face Centered Cubic (FCC)

Structure	Atoms/unit cell	Packing factor
SC	1	0.52
BCC	2	0.68
FCC	4	0.74

Diagram (Text)

SC → atoms at corners

BCC → corners + center

FCC → corners + face centers

Conclusion

Crystal structure helps in understanding material strength, conductivity, and optical behavior.

Keywords

Unit cell, lattice, packing factor, crystal structure.

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2. Miller Indices (10 Marks)

Definition

Miller indices (h k l) represent the orientation of crystal planes.

Steps

1. Find intercepts
2. Take reciprocals
3. Remove fractions

Example

Intercepts: (2, ∞, 1)
Miller indices: (1 0 2)

Interplanar Spacing

[
d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}
]

Conclusion

Miller indices help in crystal orientation and X-ray diffraction analysis.

Keywords

Miller indices, lattice planes, diffraction.

🔹 UNIT – II : QUANTUM MECHANICS

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1. de-Broglie Hypothesis (10 Marks)

Introduction

Louis de-Broglie proposed that matter shows wave nature.

Formula

$$
\lambda = \frac{h}{mv}
$$

Importance

- Explains wave-particle duality
- Verified by Davisson–Germer experiment

Conclusion

Matter waves form the foundation of quantum mechanics.

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2. Heisenberg Uncertainty Principle

$$
\Delta x \cdot \Delta p \ge \frac{h}{4\pi}
$$

Meaning

Exact position and momentum cannot be measured simultaneously.

Conclusion

Explains quantum uncertainty.

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3. Schrödinger Wave Equation

$$
-\frac{h^2}{8\pi^2 m} \frac{d^2\psi}{dx^2} + V\psi = E\psi
$$

Meaning

Describes quantum behavior of particles.

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4. Particle in a One-Dimensional Box

$$
E_n = \frac{n^2 h^2}{8mL^2}
$$

Features

- Energy is quantized
- Zero-point energy exists

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5. Energy Bands

Types

- Valence band
- Conduction band
- Forbidden energy gap

Conclusion

Explains conductivity of solids.

🔹 **UNIT – III : QUANTUM COMPUTING**

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1. Qubit

A qubit can exist in superposition:

$$
|\psi\rangle = \alpha|0\rangle + \beta|1\rangle
$$

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2. Superposition & Entanglement

- Superposition → multiple states
- Entanglement → correlated qubits

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3. Quantum Gates

- Hadamard

- Pauli-X
- CNOT

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4. Quantum Algorithms

- Shor's algorithm
- Grover's algorithm

Conclusion

Quantum computing provides faster computation than classical systems.

🔹 UNIT – IV : MAGNETIC & DIELECTRIC MATERIALS

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1. Magnetic Materials

Types:

- Diamagnetic
- Paramagnetic
- Ferromagnetic

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2. Hysteresis

Lag between magnetization and field.

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3. Dielectrics

Store electrical energy.

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4. Ferroelectric, Piezoelectric, Pyroelectric Materials

Used in sensors, actuators, memory devices.

Conclusion

These materials are essential for modern electronics.

🔹 UNIT – V : LASERS & OPTICAL FIBERS

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1. LASER Principle

LASER = Light Amplification by Stimulated Emission of Radiation.

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2. Types of Lasers

- Ruby
- He-Ne
- CO_2
- Semiconductor

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3. Optical Fiber

Uses **Total Internal Reflection**.

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4. Types of Fibers

- Single-mode
- Multimode

Conclusion

Lasers and optical fibers are essential in communication and medical fields.
