Department of Chemical Engineering
Bangladesh University of Engineering and Technology

COURSE OUTLINE
Course No: PHY 171
Level 1/ Term 2
Credit (Contact) Hours: 3.0

PART A: General Information

Description of Course PHY 171

1	**Course Title**	: Structure of Matter, Electricity & Magnetism and Nanophysics
2	**Type of Course**	: Non-departmental course
3	**Offered to**	: Department of Chemical Engineering
4	**Pre-requisite Course(s)**	: N/A

PART B: Course Details

1. Course Content (As approved by the Academic Council)

Structure of Matter: Crystalline and non-crystalline solids, Single crystal and polycrystal solids, Unit cell, Crystal systems, Coordination number, Crystal planes and directions, NaCl and CsCl structure, Packing factor, Miller indices, Relation between interplanar spacing and Miller indices, Bragg's Law, Methods of determination of interplanar spacing from diffraction patterns; Defects in solids: Point defects, Line defects; Bonds in solids, Interatomic distances, Calculation of cohesive and bonding energy; Introduction to band theory: Distinction between metal, semiconductor and insulator.

Electricity and Magnetism: Coulomb's Law, Electric field (E), Gauss's Law and its application, Electric potential (V), Capacitors and capacitance, Capacitors with dielectrics, Dielectrics an atomic view, Charging and discharging of a capacitor, Ohm's Law, Kirchoff's Law; Magnetic field: Magnetic induction, Magnetic force on a current carrying conductor, Torque on a current carrying loop, Hall effect, Faradays Law of electromagnetic induction, Lenz's Law, Self-induction, Mutual induction; Magnetic properties of matter; Hysteresis curve; Electromagnetic oscillation: L-C oscillations and its analogy to simple harmonic motion.

Nanophysics: Postulates of Quantum Mechanics, Schrödinger equation, Uncertainty principle, Expectation value, Particle in a zero potential, Calculation of energy. Concepts of nanomaterials, Synthesis and characterization of nanomaterials, Applications of nanostructured materials, Production, characterization and applications of thin film, Defects in thin films, Electron transport and optical properties of thin films.

2. Course Objectives

Objective 1: To develop logical and critical thinking with scientific knowledge of structure of matter, electricity & magnetism, and nanophysics required for the students of chemical engineering.

Objective 2: To understand the different laws of physics associated with structure of matter, electricity & magnetism and nanophysics, and apply them to solve the real life problems.

3. Knowledge required

Insert previous knowledge requirements: N/A

4. Course Outcomes

CO No.	CO Statement At the end of the course, a student should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Describe the basic laws of physics related to structure of matter, electricity & magnetism, and nanophysics to express different phenomena in the physical world.	PO(a)	C1	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO2	Explain the fundamental concepts and theories of structure of matter, electricity & magnetism, and nanophysics applicable for different physical conditions.	PO(a)	C2	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment

CO3	Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences.	PO(a)	C3, C4	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment

***POs**
PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): Engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
****Domains**
C-Cognitive : C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective : A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

5. Lecture Plan

wk	Lecture Topics	Corresponding CO(s)
1	• Crystalline and non-crystalline solids, single crystal and polycrystalline solids, unit cell, crystal systems • Electric charge, Coulomb's Law, electric field, electric field lines, electric field due to a point charge, electric dipole, line of charge and charged disk, movement of charge in an electric field • Postulates of quantum mechanics	CO1, CO2
2	• Co-ordinations number, density and packing factor • Flux - Gauss' law - application of Gauss' law: cylindrical, spherical and planar symmetry • Wave function and Schrödinger equation, uncertainty principle	CO1, CO2, CO3
3	• Crystal planes and directions, Miller indices. • Electric potential energy and electric potential, equipotential surface, calculating potential from the field • Quantum mechanical operator, expectation value and mathematical Problems	CO1, CO2, CO3
4	• Relation between interplanar spacing and Miller indices, mathematical problems related to crystal directions • Potential due to a point charge and a group of point charges, potential due to continuous charge distribution, conductors in electrostatic equilibrium • Particle in a zero potential, calculation of energy	CO1, CO2, CO3
5	• Class test (Structure of matter) • Capacitance - capacitors in series and in parallel - energy stored in an electric field - capacitors with dielectric • Concepts of nanomaterials	CO1, CO2, CO3
6	• Crystal structures: NaCl, CsCl, etc • Class Test (Electricity and Magnetism) • Synthesis of nanomaterials	CO1, CO2, CO3
7	• Electric current, resistance and Ohm's law - resistors in series and parallel - power in electric circuits - Kirchhoff's laws and solving circuits - RC circuits • Bragg's Law, Methods of determination of interplanar spacing from diffraction patterns, mathematical problems related to crystal structure analysis • Characterization of nanomaterials	CO1, CO2, CO3
8	• Bonds in solids, interatomic distances	CO1, CO2, CO3

	• Magnetic fields, Hall effect, Biot-savart law, torque on a current loop, magnetic dipole moment • Applications of nanostructured materials	
9	• Calculation of cohesive and bonding energy; mathematical problems related to bonds in solids. • Magnetic field due to a current, force between two parallel currents, Ampere's law, solenoid • Class Test (Nanophysics)	CO1, CO2, CO3
10	• Introduction to band theory • Faraday's law of induction, Lenz's law, induction and energy transfer, induced electric field • Production of thin film	CO1, CO2, CO3
11	• Distinction between metal, semiconductor, and insulator • Inductors and inductance, self-induction, energy stored in a magnetic field, mutual induction, LR circuit • Characterization of thin film	CO1, CO2, CO3
12	• Defects in solids, point defects • Magnetic properties of matter, types of magnetic materials, application of magnetic materials • Applications of thin film	CO1, CO2, CO3
13	• Line defects, plane defects • Hysteresis curve; Electromagnetic oscillation: L-C oscillations and its analogy to simple harmonic motion. • Defects in thin films	CO1, CO2, CO3
14	• Volume defects, consequences of defects and discussion based on application point of view. • Mathematical problems related to magnetic field and magnetism • Electron transport and optical properties of thin films	CO1, CO2, CO3

6. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

7. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

8. Textbook/ Reference

1. Fundamentals of Physics (10th Edition), D. Halliday, R. Resnick, and J. Walker
2. Quantum Mechanics (2nd Edition), David J. Griffith
3. Nanoscience, Hans-Eckhardt Schaefer
4. The Materials Science of Thin Film; Milton Ohring
5. Solid State Physics (2nd Edition); M. A. Wahab
6. Physics for Engineers - Part-2; Giasuddin Ahmad

Prepared by:		
Name: Course Teacher Signature:	Name: Course Teacher Signature:	Name: Course Teacher Signature:
Date of Preparation: 29 May, 2022		
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