**Department of Biomedical Engineering**
**Bangladesh University of Engineering and Technology**

COURSE OUTLINE
Course No: PHY 167
Level 1/ Term 2
Credit (Contact) Hours: 3.0

### PART A: General Information

## Description of Course PHY 167

| 1 | Course Title | : Electricity and Magnetism, Modern Physics and Mechanics |
| 2 | Type of Course | : Non-departmental course |
| 3 | Offered to | : Department of Biomedical Engineering |
| 4 | Pre-requisite Course(s) | : N/A |

### PART B: Course Details

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

**Electricity and magnetism:** Coulomb's Law, Electric field, Electric flux, Gauss's Law and its application, Electric potential, Electric potential energy, Equipotential surfaces, Capacitors and capacitance, Dielectrics, Charging and discharging of a capacitor, RC and LC circuit, Current and Current density, Ohm's Law, Resistivity and Conductivity, 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.

**Modern Physics**: Galilean relativity and Einstein's special theory of relativity; Lorentz transformation equations, Length contraction, Time dilation and mass-energy relation, Photoelectric effect, Compton effect, de Broglie matter waves and its success in explaining Bohr's theory, Pauli's exclusion principle, X-ray production and application , Laser production and application, Constituent of nucleus, Nuclear binding energy, Different types of radioactivity, Radioactive decay Law, Radiation dose, Nuclear reaction: Nuclear fission, Nuclear fusion, Nuclear power plant.

**Mechanics:** Linear momentum of a system of particles, Conservation of linear momentum, Elastic and inelastic collisions, Angular Kinematics, Torque, Rigid Bodies, Moment of Inertia, Angular momentum of a system of particles, Conservation of angular momentum, Introduction to Fluid Mechanics, pressure, measuring pressure, Pascal's & Einstein's principle of fluid pressure, viscosity, laminar flow, turbulence, equation of continuity, Bernoulli's equation, Introduction to Quantum Mechanics, Wave function, Uncertainty principle, Postulates of Quantum Mechanics, Schrödinger time independent equation, Expectation value, Probability, Particle in a zero potential, Calculation of energy.

**2.** Course Objectives

Objective 1: To develop logical and critical thinking with scientific knowledge of electricity & magnetism, modern physics and mechanics required for the students of biomedical engineering.

Objective 2: To understand the different laws of physics associated with electricity & magnetism, modern physics and mechanics, 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<br><br>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 electricity & magnetism, modern physics and mechanics to express different phenomena in the physical world. | PO 1 | C1 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |
| CO2 | Explain the fundamental concepts and theories of electricity & magnetism, | PO 2 | C2 | e.g., Lectures, Homework | e.g., Written exams; viva voce; |

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| | modern physics and mechanics applicable for different physical conditions. | | | | presentation; assignment |
| CO3 | Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences. | PO 3 | C3, C4 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |

**\*POs**

PO 1: Engineering knowledge; PO 2: Problem analysis; PO 3: Design/development of solutions; PO 4: Investigation; PO 5: Modern tool use; PO 6: Engineer and society; PO 7: Environment and sustainability; PO 8: Ethics; PO 9: Individual work and teamwork; PO 10: Communication; PO 11: Project management and finance; PO 12: 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 | • 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<br>• Frame of reference, Failure of Newtonian mechanics, Galilean transformation, Concept of ether<br>• Linear momentum of a particle, Linear momentum of a system of particles, Conservation of linear momentum, Some applications of the momentum principle | CO1, CO2 |
| 2 | • Flux - Gauss' Law - Application of Gauss' Law: Cylindrical, spherical and planar symmetry<br>• Michelson-Morley experiment, consequence of Michelson-Morley experiment<br>• Angular momentum of a particle, Angular momentum of a system of particles, Kepler's Law of planetary motion | CO1, CO2, CO3 |
| 3 | • Electric potential energy and electric potential, Equipotential surface, Calculating potential from the field<br>• Derivation of Lorentz transformation equations, relativity of length, time and mass<br>• The Law of universal gravitation, The motion of planets and satellites | CO1, CO2, CO3 |
| 4 | • Potential due to a point charge and a group of point charges, Potential due to continuous charge distribution, Conductors in electrostatic equilibrium<br>• Mass-Energy relation, relativistic addition of velocities, relativity of simultaneity<br>• Introductory quantum mechanics Wave function, Schrodinger equation | CO1, CO2, CO3 |
| 5 | • Capacitance - Capacitors in series and in parallel - Energy stored in an electric field - Capacitors with dielectric<br>• Class Test (Modern Physics)<br>• Postulates of quantum mechanics, probability density, normalization of wave function, mathematical problem | CO1, CO2, CO3 |
| 6 | • Class Test ( Electricity and Magnetism)<br>• Theory of light, Planck's quantum theory, photo-electric effect, characteristics (laws) of photoelectric emission<br>• Mathematical Problem on Normalization of wave function | 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 | CO1, CO2, CO3 |

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| | | |
|---|---|---|
| | • Failure of wave theory of light to explain photoelectric effect, Einstein photoelectric equation, determination of Planck's constant, light-matter interaction, applications of photo-electric effect<br>• Expectation values, quantum mechanical operator, mathematical problem | |
| 8 | • Magnetic fields, Hall effect, Biot-savart law, torque on a current loop, magnetic dipole moment<br>• Compton effect, Compton theory, Wave particle duality/de-Broglie hypothesis, Determination of de-Broglie wavelength<br>• Time independent Schrodinger equation, stationary states | CO1, CO2, CO3 |
| 9 | • Magnetic field due to a current, force between two parallel currents, ampere's law, solenoid<br>• Limitation of Rutherford's atom model, postulates of the Bohr atomic model, limitation of Bohr's atom model, de-Broglie atom model<br>• Class Test (Quantum Mechanics) | CO1, CO2, CO3 |
| 10 | • Faraday's law of induction, Lenz's law, induction and energy transfer, induced electric field<br>• Properties of nucleus: static nuclear properties and dynamic properties, mass defect, binding energy, binding energy per nucleon, nuclear force<br>• Properties of stationary states and mathematical problem | CO1, CO2, CO3 |
| 11 | • Inductors and inductance, self-induction, energy stored in a magnetic field, mutual induction, LR circuit<br>• Nuclear chain reactions, Different condition for nuclear chain reactions, Nuclear fission, Nuclear fusion, Little Boy: A gun-type bomb, Fat Man: Implosion-type bomb<br>• Particle in an infinite square well potential: wave function and energy | CO1, CO2, CO3 |
| 12 | • Magnetic properties of matter, types of magnetic materials, application of magnetic materials<br>• Nuclear power reactor, different parts of nuclear fission reactor, types of fission reactor, nuclear fusion reactor, types of fusion reactor<br>• Mathematical problem on infinite square well potential | CO1, CO2, CO3 |
| 13 | • Hysteresis curve; electromagnetic oscillation: L-C oscillations and its analogy to simple harmonic motion.<br>• Difficulties against using nuclear fusion, nuclear models, the liquid drop model, semi-empirical mass formula<br>• Particle in a zero potential: wave function and energy | CO1, CO2, CO3 |
| 14 | • Mathematical problems related to magnetic field and magnetism<br>• The shell model, radioactivity, radioactive transformation, decay law, average life period of a radioelement<br>• Mathematical problems related to zero potential | 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% |

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8.   **Textbook/ Reference**
    1.   Fundamentals of Physics; D. Halliday, R. Resnick, and J. Walker
    2.   Concepts of Modern Physics; A. Beiser
    3.   Modern Physics; Kenneth S. Krane
    4.   Quantum Mechanics; David J. Griffith
    5.   Quantum Physics; R. Eisberg and R. Resnick
    6.   Physics for Engineers -Part-2; Giasuddin Ahmad

| **Prepared by:** | | |
|---|---|---|
| Name: Course Teacher<br>Signature: | Name: Course Teacher<br>Signature: | Name: Course Teacher<br>Signature: |
| Date of Preparation: 03 August, 2022 | | |
| Date of Approval by BUGS: 07 August, 2022 | | |