Department of Biomedical Engineering
Bangladesh University of Engineering and Technology

COURSE OUTLINE
Course No: PHY 123
Level 1/ Term 1
Credit (Contact) Hours: 3.0

PART A: General Information

Description of Course PHY 123

1	**Course Title**	: Waves and Oscillations, Optics and Thermal Physics
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)

Waves and Oscillations: Differential equation of simple harmonic oscillator, Total energy, average energy and combination of simple harmonic oscillations, Spring mass system, Torsional pendulum; Two body oscillation, Reduced mass, Damped oscillation, Forced oscillation, Resonance; Progressive wave, Power and intensity of wave, Stationary wave, Group and phase velocities.

Optics: Defects of images: Spherical aberration, Astigmatism, Coma, Distortion, Curvature, Chromatic aberration. Theories of light; Interference of light: Young's double slit experiment, Displacement of fringes and its uses, Fresnel Bi-prism, Interference in thin films, Newton's rings, Interferometers; Diffraction of light: Fresnel and Fraunhoffer diffraction, Diffraction by single slit, Diffraction from a circular aperture, Resolving power of optical instruments, Diffraction at double slit and N-slits, Diffraction grating; Polarization: Production and analysis of polarized light, Brewster's Law, Malus Law, Polarization by double refraction, Nicol prism, Optical activity, Polarimeters.

Thermal Physics: Principle of temperature measurements: Platinum resistance thermometer, Thermo-electric thermometer, Pyrometer; Kinetic theory of gases, Maxwell's distribution of molecular speeds, Mean free path, Equipartition of energy, Brownian motion, Van der Waal's equation of state, First Law of Thermodynamics and its application, Reversible and irreversible processes, Second Law of thermodynamics, Carnot cycle, Efficiency of heat engines, Carnot's theorem, Entropy and disorder, Thermodynamic functions, Maxwell relations, Clausius-Clapeyron equation, Gibbs phase rule, Third Law of Thermodynamics.

2. Course Objectives

Objective 1: To develop logical and critical thinking with scientific knowledge of waves & oscillation, optics, and thermal physics required for the students of biomedical engineering.

Objective 2: To understand the different laws of physics associated with waves & oscillation, optics, and thermal physics, 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 waves & oscillation, optics, and thermal physics 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 waves & oscillation, optics, and thermal physics applicable for different physical conditions.	PO 1	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 1	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	• Introductory discussion of this course; definition of wave motion and Simple harmonic motion (SHM), differential equation of SHM. • Defects of images: spherical aberration, astigmatism, coma • Principle of temperature measurements: Platinum resistance thermometer.	CO1, CO2
2	• Solution of differential equation of SHM, Velocity and acceleration of SHM, Significance of angular frequency, and solving mathematical problems. • Distortion, Curvature, Chromatic aberration • Thermo-electric thermometer, pyrometer, solving mathematical problems related to thermometers.	CO1, CO2, CO3
3	• Total energy and average energy of SHM, and Solving mathematical problems related to energy of SHM • Solving mathematical problems related to aberration • Kinetic theory of gases, kinetic gas equation, kinetic interpretation of temperature and solving mathematical problems related to kinetic theory of gas.	CO1, CO2, CO3
4	• Examples of SHM: Spring-mass system, Effect of spring mass in the oscillation (effective mass), Torsional pendulum, and Solving mathematical problems • Theories of light, Interference of light, Young's double slit experiment, displacements of fringes and its uses • Maxwell's distribution of molecular speeds, Average speed, root means square speed, most probable speed, solving mathematical problems related to Maxwell's distribution.	CO1, CO2, CO3
5	• Combination of simple harmonic motions (In a same line and right angles), Lissajous figures • Class Test (Optics) • Mean free path, equipartition of energy, Brownian motion, solving mathematical problems related to mean free path	CO1, CO2, CO3
6	• Damped harmonic oscillation (over-, under- and critical-damping conditions), Quality factor, and logarithmic decrement • Fresnel bi-prism, interference in thin films • Class Test (Thermal Physics)	CO1, CO2, CO3
7	• Forced oscillation, Resonance, Two-body oscillations and Reduced mass • Newton's rings, Interferometers • Van der Waal's equation of state, first law of thermodynamics and its application to steady flow systems, solving mathematical problems related to Van der Waal's equation of state	CO1, CO2, CO3

8	• Solving mathematical problems related to damped, forced and two-body oscillations • Solving mathematical problems related to interference of light • Thermodynamic variables, process, equilibrium, Reversible and irreversible processes and examples, Carnot's heat engine	CO1, CO2, CO3
9	• Class Test (Waves & Oscillations) • Diffraction of light, Fresnel and Fraunhofer diffraction, diffraction due to single slit • Carnot's cycles, efficiency of heat engine, PV diagram, calculation of work done and efficiency from PV diagram	CO1, CO2, CO3
10	• Various types of waves, progressive wave equation and differential equation of a progressive wave, and solving mathematical problems • Diffraction from a circular aperture, diffraction at double slits • Carnot's theorem and second law of thermodynamics and their uses in solving thermodynamic problems	CO1, CO2, CO3
11	• Energy, power and intensity of wave motion, stationary wave • n-slits- diffraction grating • General notation of entropy, Clausius inequality, physical significance of entropy, entropy in reversible and irreversible cycles, calculation of work done and efficiency from T-S diagram	CO1, CO2, CO3
12	• Analytical treatment of stationary wave, and solving mathematical problems. • Resolving power of optical instruments, solving mathematical problems related to diffraction of light • Thermodynamic functions- internal energy, enthalpy, Helmholtz free energy and Gibb's free energy, uses of these functions in solving thermodynamic problems	CO1, CO2, CO3
13	• Energy of stationary wave, group velocity, phase velocity • Polarization of light, production and analysis of polarized light, Brewster's Law, Malus law • Maxwell's thermodynamic relations and their uses for solving thermodynamic problem	CO1, CO2, CO3
14	• Relation between group velocity and phase velocity, mathematical problems • Polarization by double refraction, Nicol prism, optical activity, polarimeters, polaroid • Clausius-Clapeyron Equation, Gibbs phase rule, Third Law of Thermodynamics.	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; D. Halliday, R. Resnick, and J. Walker
2. Vibrations & Waves; A. P. French
3. Fundamentals of Optics; F. A. Jenkins, and H. E. White
4. Fundamentals of Thermodynamics; C. Borgnakke and R. E. Sonntag
5. Physics for Engineers - Part-1; Giasuddin Ahmad
6. Waves & Oscillations; N. Subrahmanyum and Brij Lal

Prepared by:		
Name: Course Teacher Signature:	Name: Course Teacher Signature:	Name: Course Teacher Signature:
Date of Preparation: 03 August, 2022		
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