Department of Mechanical Engineering
Bangladesh University of Engineering and Technology

COURSE OUTLINE
Course No: PHY 159
Level 1/ Term 2
Credit (Contact) Hours: 3.0

PART A: General Information

Description of Course PHY 159

1	**Course Title**	: Waves & Oscillation, Geometrical Optics and Wave Mechanics
2	**Type of Course**	: Non-departmental course
3	**Offered to**	: Department of Mechanical Engineering
4	**Pre-requisite Course(s)**	: N/A

PART B: Course Details

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

Waves & Oscillations: Differential equation of a Simple Harmonic Oscillator, Total energy and average energy, Combination of simple harmonic oscillations, Lissajous figures, Spring-mass system, Calculation of time period of torsional pendulum, Damped oscillation, Determination of damping co-efficient, forced oscillation, Resonance, Two-body oscillations, Reduced mass, Differential equation of a progressive wave, Power & intensity of wave motion, Stationary wave, Group velocity and Phase velocity, Architectural Acoustics, Reverberation and Sabine's formula.
Geometrical Optics: Combination of lenses: Equivalent lens and equivalent focal length, Cardinal points of a lens, Power of a lens; Defects of images: Spherical aberration, Astigmatism, Coma, Distortion, Curvature, Chromatic aberration; Optical instruments: Compound microscope, Polarising microscope, Resolving power of a microscope, Camera and photographic techniques.
Waves Mechanics: Principles of statistical physics, probabilities, Classical statistics; Quantum statistics: Bose-Einstein statistics, Fermi-Dirac statistics and their applications; Fundamental postulates of wave mechanics, Time dependent Schrodinger equation, Schrodinger equation for one-electron atom and its solution.

2. Course Objectives

Objective 1: To develop logical and critical thinking with scientific knowledge of waves and oscillation, geometrical optics and wave mechanics required for the students of mechanical engineering.

Objective 2: To understand the different laws of physics associated with waves and oscillation, geometrical optics and wave 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 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 and oscillation, geometrical optics and wave 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 waves and oscillation, geometrical optics and wave mechanics 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. • Geometrical optics- assumptions of geometrical optics, paraxial and small angle approximation, sign convention rules for lenses, • Principles of statistical physics, phase space, phase point, cell, macroscopic and microscopic states, ensemble, probabilities	CO1, CO2
2	• Solution of differential equation of SHM, Velocity and acceleration of SHM, Significance of angular frequency, and solving mathematical problems. • Deviation produced by a lens, Combination of lenses Equivalent lens and equivalent focal length. • Classical statistics, quantum statistics, Fermions, bosons	CO1, CO2, CO3
3	• Total energy and average energy of SHM, and solving mathematical problems related to energy of SHM • Cardinal points of a lens-principal points, focal points and nodal points for equivalents lens and solving mathematical problem related to lens system. • Statistical equilibrium, Entropy and probability, Maxwell Boltzmann distribution law, partition function, average energy of the particle.	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. • Power of a lens, power of equivalent lens and defects of images, common causes of lens defect, monochromatic aberration and it causes, chromatic aberration and its causes. • Bose-Einstein distribution law, Bose-Einstein condensation, experimental proof of Bose-Einstein condensation.	CO1, CO2, CO3
5	• Combination of simple harmonic motions (In a same line and right angles), Lissajous figures. • Class Test 1 (Geometrical Optics) • Fermi- Dirac statistics, a few applications of Fermi-Dirac statistics, Fermi surface, behaviour of Fermi function at different temperatures and explain the significance	CO1, CO2, CO3
6	• Class Test 2 (Waves and Oscillation) • Types of monochromatic aberrations- causes of spherical aberration, methods of reduction of spherical aberrations, solving mathematical problem related to monochromatic aberration. • Mathematics problems on classical and quantum statistics	CO1, CO2, CO3
7	• Damped harmonic oscillation (over-, under- and critical-damping conditions), Quality factor, and Logarithmic decrement.	CO1, CO2, CO3

	• Astigmatism, causes and minimization of astigmatism for a lens, astigmatism in human eye, comatic aberration, causes and minimization of comatic aberration. • Failure of classical physics, Fundamental postulates of quantum mechanics, wave function, probability	
8	• Forced oscillation, resonance, two-body oscillations and reduced mass. • Distortion, cause and elimination of distortion, Curvature, cause and elimination of curvature. • Time dependent Schrodinger equation, normalization of wave function	CO1, CO2, CO3
9	• Solving mathematical problems related to damped, forced and two-body oscillations • Dispersion of light, angular dispersion, dispersive power, chromatic aberration, longitudinal and transverse chromatic aberration, solving mathematical problems related monochromatic aberration. • Class test 3 (Wave Mechanics)	CO1, CO2, CO3
10	• Various types of waves, progressive wave equation and differential equation of a progressive wave, and solving mathematical problems. • Cause of chromatic aberration for the combination of lens, elimination of chromatic aberration for a system of lens. • Time dependent Schrodinger equation, Normalization of wave function	CO1, CO2, CO3
11	• Energy, power and intensity of wave motion, stationary wave, analytical treatment of stationary wave, and solving mathematical problems. • Achromatic doublet, achromatism of a camera lens and telescope objective, mathematical problems related to chromatic aberration • Eigen function, eigenvalue, operator, expectation value	CO1, CO2, CO3
12	• Energy of stationary wave, group velocity, phase velocity and relation between group velocity and phase velocity. • Optical instruments-construction and working principle of simple and compound microscopes, uses of compound microscope. resolving power of a microscope. • Solution of Schrodinger equation for one-electron atom	CO1, CO2, CO3
13	• Architectural acoustics, reverberation and Sabine's reverberation formula for growth of intensities. • Polarising microscope-construction and working principle, orthoscopic and conoscopic mode of polarization, uses of polarization microscope. • Application of Schrodinger equation for particle in a box	CO1, CO2, CO3
14	• Sabine's reverberation formula for decay of intensities, equation for reverberation time and solving mathematical problems related to reverberation. • Camera and photographic techniques. • Mathematical problems related to quantum mechanics	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. Vibrations & Waves; A. P. French
3. Fundamentals of Optics (4th edition); F. A. Jenkins, H. E. White
4. Concepts of Modern Physics; A. Beiser
5. Electronic Properties of Materials; Rolf E Hummel
6. Quantum Physics; R. Eisberg, R. Resnick
7. Physics for Engineers- Part-1; Giasuddin Ahmad
8. Physics for Engineers - Part-2; Giasuddin Ahmad
9. Waves & Oscillations; N. Subrahmanyum and Brij Lal

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