Department of Industrial and Production Engineering
Bangladesh University of Engineering and Technology

COURSE OUTLINE
Course No: PHY 163
Level 1/ Term 2
Credit (Contact) Hours: 3.0

PART A: General Information

Description of Course PHY 163

1	**Course Title**	: Waves & Oscillation, Physical Optics and Wave Mechanics
2	**Type of Course**	: Non-departmental course
3	**Offered to**	: Department of Industrial and Production 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 and intensity of wave motion, Stationary wave, Group velocity and phase velocity.

Physical Optics: Theories of light; Interference of light, Young's double slit experiment, Displacement of fringes and its uses, Fresnel Bi-prism, Interference at wedge shaped films, Newton's rings, Interferometer; Diffraction of light; Fresnel and Fraunhofer 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, Retardation plates, Nicol prism, Optical activity, Polarimeters, Polartoid.

Wave 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, physical optics and wave mechanics required for the students of industrial and production engineering.

Objective 2: To understand the different laws of physics associated with waves and oscillation, physical 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, physical 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	PO 1	C2	e.g., Lectures, Homework	e.g., Written exams; viva voce;

	oscillation, physical optics and wave 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 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. • Theories of light, Interference of light, Young's double slit experiment • 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. • Displacements of fringes and its uses, Fresnel bi-prism • 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 • Interference at parallel and wedge-shaped films • 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 • Newton's rings, Interferometers • 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 (Waves and Oscillation) • 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 (Physical Optic) • Solving mathematical problems related to interference of light • Mathematical problems on classical and quantum statistics	CO1, CO2, CO3

7	• Damped harmonic oscillation (over-, under- and critical-damping conditions), Quality factor, and Logarithmic decrement. • Diffraction of light, Fresnel and Fraunhofer diffraction, Diffraction due to single slit. • Failure of classical physics, Fundamental postulates of quantum mechanics, wave function, probability	CO1, CO2, CO3
8	• Forced oscillation, resonance, two-body oscillations and reduced mass. • Diffraction from a circular aperture, Diffraction at double slits. • Time dependent Schrodinger equation, normalization of wave function	CO1, CO2, CO3
9	• Solving mathematical problems related to damped, forced and two-body oscillations • N-slits- Diffraction grating. • Class test 3 (Wave Mechanics)	CO1, CO2, CO3
10	• Various types of waves, progressive wave equation and differential equation of a progressive wave. • Resolving power of optical instruments. • Time dependent Schrodinger equation, Normalization of wave function	CO1, CO2, CO3
11	• Energy, power and intensity of wave motion. • Solving mathematical problems related to diffraction of light • Eigen function, eigenvalue, operator, expectation value	CO1, CO2, CO3
12	• Stationary wave, analytical treatment of stationary wave, energy of stationary wave. • Polarization of light, Production and analysis of polarized light, Brewster's Law, Malus law. • Solution of Schrodinger equation for one-electron atom	CO1, CO2, CO3
13	• Group velocity, phase velocity and relation between group velocity and phase velocity. • Polarization by double refraction, Retardation plates, Nicol prism, Optical activity. • Application of Schrodinger equation for particle in a box	CO1, CO2, CO3
14	• Mathematical Problems related to waves • Polarimeters, Polaroid, solving mathematical problems related to polarization of light. • 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; D. Halliday, R. Resnick, and J. Walker
2. Vibrations & Waves; A. P. French
3. Fundamentals of Optics; F. A. Jenkins, H. E. White
4. Concepts of Modern Physics; A. Beiser
5. Quantum Physics; R. Eisberg, R. Resnick
6. Physics for Engineers- Part-1 & Part 2; Giasuddin Ahmad

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<tr><td colspan="3">Prepared by:</td></tr>
<tr><td>Name: Course Teacher
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<tr><td colspan="3">Date of Preparation: 24 August, 2022</td></tr>
<tr><td colspan="3">Date of Approval by BUGS: 27 August, 2022</td></tr>
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