

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.

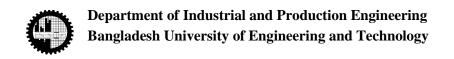
Objective 2: To understand the different laws of physics associated with waves and oscillation, physical optics and wave mechanics, and apply them to solve the real life problems.

#### 3. Knowledge required

Insert previous knowledge requirements: N/A

#### 4. Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and	Delivery Method(s) and	Assessment Tool(s)
	At the end of the course, a student should be able to		Taxonomy level(s)**	Activity(-ies)	
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;



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		oscillation, physical optics and				presentation; assignment
		wave mechanics applicable for				assignment
L		different physical conditions.				
	CO3	Apply the relevant laws of physics	PO 1	C3, C4	e.g., Lectures,	e.g., Written exams;
		to solve various mathematical			Homework	viva voce;
		problems and interpret the result				presentation;
		and its consequences.				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	<ul> <li>Introductory discussion of this course; definition of wave motion and Simple harmonic motion (SHM), differential equation of SHM.</li> <li>Theories of light, Interference of light, Young's double slit experiment</li> <li>Principles of statistical physics, phase space, phase point, cell, macroscopic and microscopic states, ensemble, probabilities</li> </ul>	CO1, CO2
2	<ul> <li>Solution of differential equation of SHM, Velocity and acceleration of SHM, Significance of angular frequency, and solving mathematical problems.</li> <li>Displacements of fringes and its uses, Fresnel bi-prism</li> <li>Classical statistics, quantum statistics, fermions, bosons</li> </ul>	CO1, CO2, CO3
3	<ul> <li>Total energy and average energy of SHM, and solving mathematical problems related to energy of SHM</li> <li>Interference at parallel and wedge-shaped films</li> <li>Statistical equilibrium, Entropy and probability, Maxwell Boltzmann distribution law, partition function, average energy of the particle.</li> </ul>	CO1, CO2, CO3
4	<ul> <li>Examples of SHM: spring-mass system, effect of spring mass in the oscillation (effective mass), torsional pendulum, and solving mathematical problems</li> <li>Newton's rings, Interferometers</li> <li>Bose-Einstein distribution law, Bose-Einstein condensation, experimental proof of Bose-Einstein condensation</li> </ul>	CO1, CO2, CO3
5	<ul> <li>Combination of simple harmonic motions (In a same line and right angles), Lissajous figures.</li> <li>Class Test 1 (Waves and Oscillation)</li> <li>Fermi- Dirac statistics, a few applications of Fermi-Dirac statistics, Fermi surface, behaviour of Fermi function at different temperatures and explain the significance</li> </ul>	CO1, CO2, CO3
6	<ul> <li>Class Test 2 (Physical Optic)</li> <li>Solving mathematical problems related to interference of light</li> <li>Mathematical problems on classical and quantum statistics</li> </ul>	CO1, CO2, CO3

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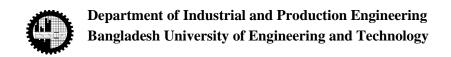
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7	<ul> <li>Damped harmonic oscillation (over-, under- and critical-damping conditions), Quality factor, and Logarithmic decrement.</li> <li>Diffraction of light, Fresnel and Fraunhofer diffraction, Diffraction due to single slit.</li> <li>Failure of classical physics, Fundamental postulates of quantum mechanics, wave function, probability</li> </ul>	CO1, CO2, CO3
8	<ul> <li>Forced oscillation, resonance, two-body oscillations and reduced mass.</li> <li>Diffraction from a circular aperture, Diffraction at double slits.</li> <li>Time dependent Schrodinger equation, normalization of wave function</li> </ul>	CO1, CO2, CO3
9	<ul> <li>Solving mathematical problems related to damped, forced and two-body oscillations</li> <li>N-slits- Diffraction grating.</li> <li>Class test 3 (Wave Mechanics)</li> </ul>	CO1, CO2, CO3
10	<ul> <li>Various types of waves, progressive wave equation and differential equation of a progressive wave.</li> <li>Resolving power of optical instruments.</li> <li>Time dependent Schrodinger equation, Normalization of wave function</li> </ul>	CO1, CO2, CO3
11	<ul> <li>Energy, power and intensity of wave motion.</li> <li>Solving mathematical problems related to diffraction of light</li> <li>Eigen function, eigenvalue, operator, expectation value</li> </ul>	CO1, CO2, CO3
12	<ul> <li>Stationary wave, analytical treatment of stationary wave, energy of stationary wave.</li> <li>Polarization of light, Production and analysis of polarized light, Brewster's Law, Malus law.</li> <li>Solution of Schrodinger equation for one-electron atom</li> </ul>	CO1, CO2, CO3
13	<ul> <li>Group velocity, phase velocity and relation between group velocity and phase velocity.</li> <li>Polarization by double refraction, Retardation plates, Nicol prism, Optical activity.</li> <li>Application of Schrodinger equation for particle in a box</li> </ul>	CO1, CO2, CO3
14	<ul> <li>Mathematical Problems related to waves</li> <li>Polarimeters, Polaroid, solving mathematical problems related to polarization of light.</li> <li>Mathematical problems related to quantum mechanics</li> </ul>	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



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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

Prepared by:					
Name: Course Teacher	Name: Course Teacher	Name: Course Teacher			
Signature:	Signature:	Signature:			
Date of Preparation: 24 August, 2022					
Date of Approval by BUGS: 27 August, 2022					