**Department of Water Resources Engineering**
**Bangladesh University of Engineering and Technology**

**COURSE OUTLINE**
Course No: PHY 107
Level 1/ Term 1
Credit (Contact) Hours: 3.0

**PART A: General Information**

# Description of Course PHY 107

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| **1** | **Course Title** | : Physical Optics, Waves & Oscillations and Heat & Thermodynamics |
| **2** | **Type of Course** | : Non-departmental course |
| **3** | **Offered to** | : Department of Water Resources Engineering |
| **4** | **Pre-requisite Course(s)** | : N/A |

## PART B: Course Details

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

**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, Interferometers; 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, Polaroid.

**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, Architectural acoustics, Reverberation and Sabine's formula.

**Heat & Thermodynamics**: 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, Review of the 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 physical optics, waves & oscillation, and heat & thermodynamics required for the students of water resources engineering.

Objective 2: To understand the different laws of Physics associated with physical optics, waves & oscillation, and heat & thermodynamics, 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>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) |
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| CO1 | Describe the basic laws of Physics related to physical optics, waves & oscillation, and heat & thermodynamics to express different phenomena in the physical world. | PO(a) | C1 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |

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| CO2 | Explain the fundamental concepts and theories of physical optics, waves & oscillation, and heat & thermodynamics applicable for different physical conditions. | PO(a) | 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(a) | C3, C4 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |

***POs**
PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): Engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): 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) |
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| 1 | • Theories of light, Interference of light, Young's double slit experiment<br>• Introductory discussion of this course; Definition of wave motion and Simple harmonic motion (SHM), differential equation of SHM.<br>• Thermometry, different types of thermometers, platinum resistance thermometer, thermo-electric thermometer | CO1, CO2, CO3 |
| 2 | • Displacements of fringes and its uses, Fresnel bi-prism<br>• Solution of differential equation of SHM, velocity and acceleration of SHM, Significance of angular frequency, and solving mathematical problems.<br>• Kinetic theory of gases: Maxwell distribution of velocities, mean velocity | CO1, CO2, CO3 |
| 3 | • Interference at parallel and wedge-shaped films<br>• Total energy and average energy of SHM, and solving mathematical problems related to energy of SHM<br>• Most probable velocity, root mean square velocity, most probable energy, and average energy | CO1, CO2, CO3 |
| 4 | • Newton's rings, interferometers<br>• Examples of SHM: spring-mass system, effect of spring mass in the oscillation (effective mass), torsional pendulum, and solving mathematical problems<br>• Degrees of freedom, equipartition of energy, ratio of specific heats of monoatomic, diatomic, and triatomic molecules | CO1, CO2, CO3 |
| 5 | • Solving mathematical problems related to interference of light<br>• Combination of simple harmonic motions (in a same line and right angles), Lissajous figures<br>• Class Test (Heat & Thermodynamics) | CO1, CO2, CO3 |
| 6 | • Class Test ( Physical Optics)<br>• Damped harmonic oscillation (over-, under- and critical-damping conditions), quality factor, and logarithmic decrement<br>• Brownian motion, mean free path, solving mathematical problems of previous lectures | CO1, CO2, CO3 |
| 7 | • Diffraction of light, Fresnel and Fraunhofer diffraction, diffraction due to single slit<br>• Forced oscillation, resonance, two-body oscillations and reduced mass | CO1, CO2, CO3 |

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| | • Van der Waals' equation of state, finding critical constants, and Van der Waals' constants | |
| 8 | • Diffraction from a circular aperture, diffraction at double slits<br>• Solving mathematical problems related to damped, forced and two-body oscillations<br>• First law of thermodynamics, applications of first law | CO1, CO2, CO3 |
| 9 | • N-slits-diffraction grating<br>• Class Test ( Waves & Oscillations)<br>• Reversible and irreversible processes, Carnot's cycle, second law of thermodynamics | CO1, CO2, CO3 |
| 10 | • Resolving power of optical instruments<br>• Various types of waves, progressive wave equation and differential equation of a progressive wave, and solving mathematical problems.<br>• Carnot's theorem, entropy, entropy in reversible and irreversible processes | CO1, CO2, CO3 |
| 11 | • Solving mathematical problems related to diffraction of light<br>• Energy, power and intensity of wave motion, stationary wave, analytical treatment of stationary wave, and solving mathematical problems.<br>• Thermodynamic functions and potentials, mathematical problems | CO1, CO2, CO3 |
| 12 | • Polarization of light, production and analysis of polarized light, Brewster's Law, Malus law<br>• Energy of stationary wave, group velocity, phase velocity and relation between group velocity and phase velocity.<br>• Maxwell's thermodynamic relations | CO1, CO2, CO3 |
| 13 | • Polarization by double refraction, retardation plates, Nicol prism, optical activity<br>• Architectural acoustics, reverberation and Sabine's reverberation formula for growth of intensities<br>• Clausius-Clapeyron equation, specific heat for perfect gas and Van der Waals' gas | CO1, CO2, CO3 |
| 14 | • Polarimeters, polaroid, solving mathematical problems related to polarization of light<br>• Sabine's reverberation formula for decay of intensities, equation for reverberation time and solving mathematical problems related to reverberation.<br>• Gibbs phase rule, third law of thermodynamics, and its applications for perfect gas | 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. Fundamentals of Optics; F. A. Jenkins, and H. E. White
3. Vibrations & Waves; A. P. French
4. Waves & Oscillations; N. Subrahmanyum and Brij Lal
5. Heat and Thermodynamics; N. Subrahmanyum and Brij Lal
6. Physics for Engineers - Part-1; 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 | | |