B.Sc. Eng. CSE/1st Sem. Date: 03 April 2026 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination **Winter Semester**: 2024-2025
Course Number: PHY 4141 **Full Marks**: 120
Course Title: Physics I **Time**: 2 Hours

Please answer according to the order of the questions. Answer all (4) questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in brackets.

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1. a) State and explain the Biot-Savart law and Ampere's law. Compare the applicability and limitations of the two laws in calculating magnetic fields for different current configurations. [6] (CO 1) (PO 1)

   b) Define inductance and explain its physical significance in electromagnetic systems. Derive an expression for the inductance of a toroid having a rectangular cross-section. [10] (CO 2) (PO 2)

   c) A long coaxial cable consists of two concentric cylindrical conductors with radii a and b. The inner conductor carries a steady current I, and the outer conductor provides the return path. (i) Calculate the energy stored in the magnetic field for the length L of such a cable. (ii) Determine the inductance of the length L of the coaxial cable? [14] (CO 3) (PO 2.)

2. a) Define and briefly explain the phenomenon of interference of light waves. (i) State the necessary conditions for sustained interference. (ii) Discuss whether interference occurs for sound waves, giving appropriate reasoning. [7] (CO 1) (PO 1)

   b) Explain the formation of Newton's rings with the help of a neat, labeled diagram. (i) Describe the theory underlying the formation of concentric bright and dark rings. (ii) Derive the expression required to determine the radius of curvature of a plano-convex lens using Newton's rings method. [18] (CO 2) (PO 2)

   c) A monochromatic light of wavelength *550 nm* from a narrow source is incident on a double-slit arrangement as in Young's Double slit experiment. If the total separation of *15* consecutive fringes on a screen placed *2.5 m* away is *5 cm*, calculate the slit separation. [5] (CO 3) (PO 2.)

3. a) Define the phenomenon of diffraction of light. Distinguish clearly between Fraunhofer diffraction and Fresnel diffraction in terms of experimental arrangement, wavefront nature, and pattern characteristics.

b) Using wave theory, derive the expression for the intensity distribution due to Fraunhofer diffraction at a single narrow rectangular slit. From the derived expression, show that the intensities of successive maxima are nearly

$$1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2} \cdots\cdots$$

c) Sketch the intensity distribution curve and indicate the positions of minima and maxima.

[5]
(CO 3)
(PO 2)

4. a) Define and explain the following terms related to the photoelectric effect:

(i) Photoelectrons
(ii) Threshold frequency
(iii) Work function
(iv) Stopping potential

[10]
(CO 1)
(PO 1)

b) Starting from quantum theory of radiation proposed by Max Planck, formulate Einstein's photoelectric equation. Show how the value of Planck's constant, h, can be determined experimentally from the slope of the stopping potential versus frequency graph.

[14]
(CO 2)
(PO 2)

c) In a photoelectric experiment using a sodium surface, the following data are obtained:

- Stopping potential = *1.85 V* for wavelength *300 nm*
- Stopping potential = *0.820 V* for wavelength *400 nm*

Using these data, calculate:

(i) The experimental value of Planck's constant.
(ii) The work function of sodium.

[06]
(CO 3)
(PO 2)