B.Sc. Eng.CEE/2nd Sem.

Date: 16 May, 2024

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination
Course Number: PHY 4253
Course Title: Physics II

Summer Semester: 2022 - 2023
Full Marks: 150
Time: 3.0 Hours

There are **8 (Eight)** questions. Answer any 6 **(Six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Any other statements, if necessary.

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1. (a) Define dielectrics and dielectric constant? (05) (CO1) (PO1)

   (b) (i) Discuss Gauss's law for dielectrics and formulate the law for a dielectric placed in a parallel plate capacitor. (15) (CO2) (PO2)
   (ii) A conducting sphere of radius R in a vacuum carries a charge q, estimate the total electrostatic energy stored in the surrounding space.

   (c) A parallel plate capacitor has a plate area 100 cm^2 and separation 1.0 cm. A potential difference of 100 V is applied to the plate with no dielectric present. Calculate the electric field strength in the gap. (05) (CO3) (PO2)

2. (a) Define magnetic field and its unit. (05) (CO1) (PO1)

   (b) (i) Describe the magnetic field due to the current in a wire, and estimate torque on a current loop placed in a magnetic field. (15) (CO2) (PO2)
   (ii) What is Hall potential? Derive an expression of magnetic potential energy in terms of magnetic dipole moment and magnetic field.

   (c) A circular coil of 100 turns has an effective radius 5.0 cm and carries a current 0.10 A. Determine the required work to turn it in an external magnetic field 1.5 W/m^2 from a position in which θ equals 0° to one in which θ equals 180°? (05) (CO3) (PO2)

3. (a) State Faraday's law of magnetic induction. Write down Lenz's law. (05) (CO1) (PO1)

   (b) (i) A rectangular loop of wire of width l is placed in a uniform magnetic field B, which points at right angles to the plane of the loop. The loop is pulled to the right at a speed v. The resistance of the loop is R. Estimate the rate of Joule heating in the loop. (15) (CO2) (PO2)
   (ii) Find the expression for inductance of a toroid of rectangular cross-

section. Also find the expression of energy stored in the toroid.

(c) A long solenoid has 200 turns/cm and carries a current of 1.5 A; its diameter is 30 cm. At its center we place a 100-turn, close-packed coil of diameter 2.0 cm. This coil is arranged so that B at the center of the solenoid is parallel to its axis. The current in the solenoid is reduced to zero and then raised to 1.5 A in the other direction at a steady rate over a period of 0.050 s. Determine the induced emf appears in the coil while the current is being changed? (05) (CO3) (PO2)

4. (a) Describe the differences between an inertial and a non-inertial frames with examples. (05) (CO1) (PO1)

(b) Describe the postulates of special relativity and using these obtain a set of transformation equations between two inertial frames of which one is fixed and another one is moving with a constant speed v. (15) (CO2) (PO2)

(c) A spaceship, 200 m long as seen on board, moves by the Earth at 0.970c. Calculate its length as measured by an Earth-bound observer? (05) (CO3) (PO2)

5. (a) State what is quantization of light. How does it differ from the classical concept? (05) (CO1) (PO1)

(b) Describe the Planck's radiation formula of a black body. Discuss why the Wien's displacement law and Rayleigh-Jeans law could not explain the full spectrum of black body radiation. (15) (CO2) (PO2)

(c) Calculate the speed of electromagnetic wave by considering the permittivity and permeability in free space. (05) (CO3) (PO2)

6. (a) Define the work function of a metal. How can it be obtained graphically? (05) (CO1) (PO1)

(b) Describe the phenomena of (i) photocurrent versus plate potential by varying photon intensity and (ii) photocurrent versus plate potential by varying photon frequency. (15) (CO2) (PO2)

(c) The work function of a surface is 5.6 eV. When the surface is illuminated by a light of wavelength 180 nm, the maximum kinetic energy of the photoelectron is 1.8 eV. Determine the value of Planck's constant from these data. Also calculate the stopping potential. (05) (CO3) (PO2)

7. (a) Define Compton wavelength and describe its characteristics for electron. (05) (CO1) (PO1)

(b) In a Compton effect experiment, a photon undergoes scattering by an electron while the latter remains stationary. Describe the experiment and find an expression for the frequency shift of the photon. (15) (CO2) (PO2)

(c) An X-ray photon of wavelength 0.16 nm collides with an electron at rest and the scattered photon moves off at an angle of 80° from the direction of the incident photon. Determine the wavelength of the scattered photon, and hence the Compton shift in wavelength. (05) (CO3) (PO2)

8. (a) Define Miller indices of a plane. (05) (CO1) (PO1)

(b) Describe the relation between interplanar spacing and Miller indices. Hence, obtain this relation for the cubic and orthorhombic structures. (15) (CO2) (PO2)

(c) Determine the Miller Indices of a plane which is parallel to x-axis and cuts intercepts of 2 and 1/2, respectively along y and z axes. (05) (CO3) (PO2)