B.Sc. Eng. CSE 1st Semester — 05 December 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION — **WINTER SEMESTER, 2022-2023**

DURATION: 3 HOURS — **FULL MARKS: 150**

Phy 4141: Physics I

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer **all 6 (six)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

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1. a) State the relationship between electric field and electric potential. — 5 (CO1) (PO1)

   b) For an electric dipole, demonstrate that if you double the distance of a point from a dipole center, the electric field at that point drops by a factor of 8. — 15 (CO2) (PO1)

   c) The drum of a photocopying machine has a length of 42 cm and a diameter of 12 cm. The electric field just above the drum's surface is 2.3×10^5 N/C. — 2×2.5 (CO3) (PO1)
      i. What is the total charge on the drum?
      ii. The manufacturer wishes to produce a desktop version of the machine. This requires reducing the drum length to 28 cm and the diameter to 8 cm. The electric field at the drum surface must not change. Compute the charge on this new drum.

2. a) Draw a graph of binding energy per nucleon, E versus atomic mass number, A. Identify the important features of the graph. — 5 (CO1) (PO1)

   b) i. Distinguish between nuclear fission and fusion reactions. — $5 + 7 + 3$ (CO2) (PO1)
      ii. Energy released in the fission of a single Uranium-235 nucleus is 200 MeV. What is the source of such a huge amount of energy? Explain.
      iii. Illustrate how a nuclear fission reaction can be controlled.

   c) Calculate the binding energy per nucleon of ${}^{30}_{15}P$ and ${}^{31}_{15}P$. Which one is more stable and why? (Given: Mass of proton = 1.0078 amu, Mass of neutron = 1.0087 amu, Mass of ${}^{30}_{15}P = 29.978$ amu, and Mass of ${}^{31}_{15}P = 30.974$ amu). — $3 + 2$ (CO3) (PO1)

3. a) Show diagrammatically the behavior of magnetic field lines in the presence of paramagnetic and diamagnetic substances. How does one explain this distinguishing feature? — 5 (CO1) (PO1)

   b) Discuss and compare the properties of diamagnetic, paramagnetic, and ferromagnetic materials. — 15 (CO2) (PO1)

   c) Applying Ampere's circuital law, derive a mathematical expression for the magnetic field due to current carrying wire. — 5 (CO3) (PO1)

4. a) State the Faraday's laws of electromagnetic induction. — 5 (CO1) (PO1)

b) Explain the growth and decay of current in an LR circuit. Discuss the term "inductive time constant" with a graphical representation for both cases. 12+3 (CO2) (PO1)

c) A network of four capacitors, each of 12 μF capacitance is connected with a power supply of 500 V as shown in Figure 1. Determine the equivalent capacitance of the combination and charge on each capacitor. 5 (CO3) (PO1)

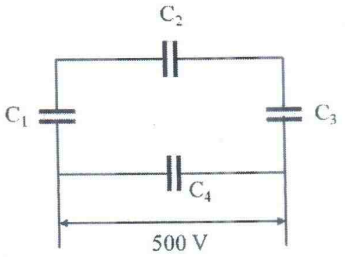

Figure 1: A network of four capacitors for Question 4.c)

5. a) Define diffraction of light. List five differences between Fresnel and Fraunhofer diffraction. 2 + 3 (CO1) (PO1)

b) Discuss the phenomena of diffraction produced by a single slit or aperture of thickness a, where a plane wave is incident on the aperture. Write down the trigonometric equation that gives the distance of the n^{th} dark fringe from the center based on Figure 2. Extend your answer to derive the width of the central bright fringe. 2 + 7 + 6 (CO2) (PO1)

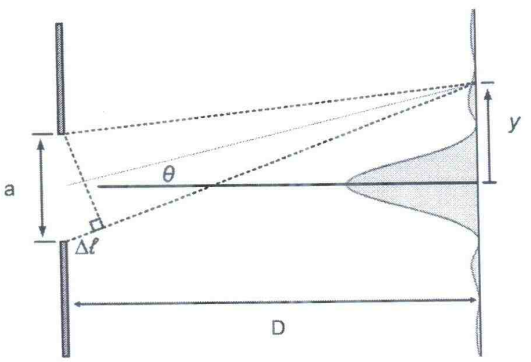

Figure 2: Single slit diffraction for Question 5.b)

c) Unpolarized light in air is reflected from a glass surface in such a way that it is completely polarized. The angle of incidence is 51°. Calculate the refractive index of the glass and the angle of refraction. What will be the speed of light in glass? 5 (CO3) (PO1)

6. a) Describe Newton's corpuscular theory. Why does this theory fail to explain the properties of light? 5 (CO1) (PO1)

b) Discuss Thomas Young's double-slit experiment with geometrical analysis. Summarize the conditions for observing the bright and dark fringes as a result of this experiment. 2 × 7.5 (CO2) (PO1)

c) Interference fringes are observed with a biprism of refracting angle 1° and refractive index 1.8 on a screen 120 cm away from it. The wavelength of light used is 5800 Å. If the distance between the source and the biprism is 20 cm, compute the fringe width. 5 (CO3) (PO1)