B.Sc. Eng.ME/IPE/1st Sem. **Date: 3 April 2026**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination **Winter Semester**: 2024-2025
Course Number: PHY 4113 **Full Marks**: 120
Course Title: Structure of Matter, Electricity, Magnetism and Modern Physics **Time**: 2 Hours

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

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1. a) State the differences between self and mutual inductance. (6) (CO1,PO1) (WK1, WP1)

b) A current carrying conductor produces magnetic field in the surrounding spaces. Name and describe the law which gives the relation between current and magnitude of the field it produces with necessary figure. (6) (CO1,PO1) (WK1, WP1)

c) Define photoelectric effect. Describe the dependency of the output current of a photoelectric cell on the frequency and intensity of incident light. (6) (CO1,PO1) (WK1, WP1)

2. a) i) Explain how the capacitance of a parallel plate capacitor changes due to insertion of dielectric material between the two plates. Discuss the following cases: (17+3) (CO2,PO2) (WK1, WP2)

a) when time t=0,
b) dielectric constant is equal to unity and
c) the space is completely filled with dielectric material.

b) i) Describe Galilean and inverse Galilean transformation equations. (4+16) (CO2,PO2) (WK1, WP2)

ii) Discuss whether in different frame of references velocity, force, acceleration and Newton's laws are variant or invariant under Galilean transformations.

c) i) For an LR circuit considering the current reaching maximum value i_0, discuss the decay of current from its maximum value and establish a relationship between the value of current i at any time t with i_0 along with graphical representation. (17+3) (CO2,PO2) (WK1, WP2)

ii) Explain the concept of inductive time constant.

3. a) Determine the expression for coefficient of self inductance for a long solenoid. A cylindrical bar magnet is kept along the axis of a circular coil. If the magnet is rotated about its axis, find out whether an electric current is induced in the coil. (5+2) (CO3,PO2) (WK1, WP2)

b) A circular loop of area 5 x 10-2m^2 rotates in a uniform magnetic field of 0.2 T. If the loop rotates about its diameter which is perpendicular to the magnetic field as shown in figure. Find the magnetic flux linked with the loop when its plane is (i) normal to the field (ii) inclined 60° to the field and (iii) parallel to the field. (7) (CO3,PO2) (WK1, WP2)

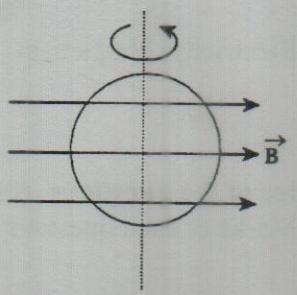


Figure: 1

c) i) In the figure 2 below, each capacitor has 12 μF of capacitance. Calculate the equivalent capacitance of the network and charge on each capacitor. (4+3) (CO3,PO2) (WK1, WP2)

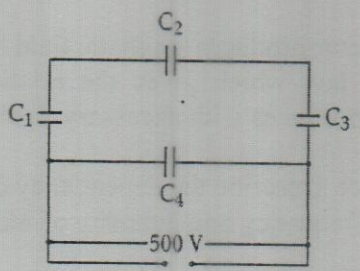


Figure: 2

ii) A coil of effective area 4 m^2 is placed at right angles to a magnetic field of induction 0.05 Wb m^{-2}. If the field is decreased by 20% of its original value in 10 seconds, find the e.m.f. induced in the coil.

4. a) The photoelectric work function of metal is 5 eV. Calculate the threshold frequency for the metal. If a light of wavelength 4000 Å is incident on this metal surface, will photoelectron be ejected? (7) (CO3,PO2) (WK1, WP2)

b) (7) (CO3,PO2) (WK1, WP2)

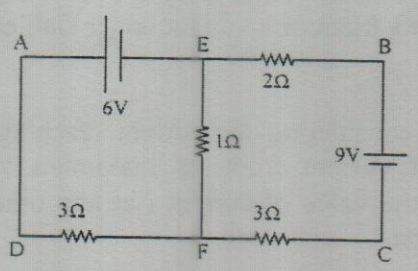


Figure:3

Calculate the current that flows through the 1 Ω resistor in the above circuit in figure 3.

c) For a radioactive disintegration process use the radioactive decay law to demonstrate a relation between the numbers of atoms present at any time t with the number of atoms initially present. Apply this equation to find the half life of the radioactive substance. (4+3) (CO3,PO2) (WK1, WP2)