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B Sc Eng.IPE/1st Sem.

Date:22 December 2023
01:30 pm - 4:30 pm [Afternoon]

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Course Number: PHY 4113
Course Title: Structure of Matter, Electricity, Magnetism and Modern Physics
Semester: Final Examination

Winter Semester: 2022-2023
Full Marks: 150
Time: 3 Hours

Answer all the **6 (Six)** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in the brackets.

1.a) State the differences between Schottky and Frenkel defects. (5) (CO1) (PO1)

b) Explain the following terms with appropriate figures: (15) (CO2) (PO2)
i. Interstitial point defects
ii. Substitutional point defects
iii. Screw dislocations

c) A parallel plate capacitor is made up of two plates, each having an area of 8.0×10^{-4} m^2 and separated by 5 mm. Half of the space between the plates is filled with glass and the other with mica. Calculate the capacitance of the capacitor. (Dielectric constant of glass is 7.0×10^{-11} and of mica is 4.8×10^{-11} $C^2/N.m^2$). (05) (CO3) (PO2)

2. a) Identify the reasons for the formation of energy bands in solids. (5) (CO1) (PO1)

b) Explain the terms valance, conduction, and forbidden band. From the concept of forbidden band, classify materials as conductors, semiconductors, and insulators. (5+10) (CO2) (PO2)

c) Compute the number of conduction electrons in a cube of magnesium of volume $2.00\times 10^{-6}m^3$ considering the magnesium atoms are bivalent. (05) (CO3) (PO2)

3. a) State the differences between self and mutual inductance. (5) (CO1) (PO1)

b) Explain Ohm's law using the concept of the electron gas model. How can you find the expression for resistance of a conductor? (15) (CO2) (PO2)

c) (05) (CO3) (PO2)

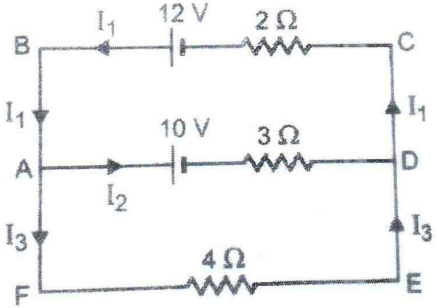

Figure 1: A network of two capacitors

Calculate I_1, I_2, and I_3 in the above network as shown in Fig.1 applying Kirchoff's law.

4. a) Draw the M-H hysteresis curve for ferromagnetic materials and level the following terms: (5) (CO1) (PO1)

i. Saturation magnetization
ii. Remanence
iii. Coercive field

b) Demonstrate that the force experienced by a current-carrying wire in a uniform magnetic field $\vec{B}$ can be denoted as, $\vec{F} = i(\vec{l} \times \vec{B})$. When will be this force maximum? (13+2) (CO2) (PO2)

c) A straight wire of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid-air by a uniform horizontal magnetic field B. What is the magnitude of the magnetic field? (05) (CO3) (PO2)

5. a) State the postulates of Bohr's model of an atom. What are the limitations of this model? (5) (CO1) (PO1)

b) Explain Compton scattering phenomena. From the concept of Compton scattering estimate the change in the wavelength of a photon scattered by an electron at rest. (15) (CO2) (PO2)

c) The photoelectric threshold of copper is 3200 Angstrom. If ultra-violet light of wavelength 2500 Angstrom falls on it, find (i) the maximum kinetic energy of the photo-electrons ejected, (ii) the maximum velocity of the photo-electrons and (iii) the value of the work function. (05) (CO3) (PO2)

6. a) List five differences between nuclear fission and fusion reaction. (5) (CO1) (PO1)

b) Illustrate the law of radioactive decay which gives the quantitative relationship between the original number of nuclei present (N_0) at time zero and a number N at a later time t (sec). Extend your answer to find out the half-life of the nuclei. (10+5) (CO2) (PO2)

c) The half-life of radium is 1620 years. In how many years will one gram of pure element lose one centigram and be reduced to one centigram? (05) (CO3) (PO2)