

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2015-2016

FULL MARKS:150

Phy 4141: Physics

Programmable calculators are not allowed. Do not write anything on the question paper.
 There are **8 (eight)** questions. Answer any **6 (six)** of them.
 Figures in the right margin indicate marks.

- 1) Discuss charge and matter in electrostatics. With the help of a suitable example, show that the electric charge is quantized. 8
- 2) Discuss Millikan Oil drop experiment. With the help of an electric circuit, show how a falling charged oil drop is balanced by an opposing electric field. 10
- 3) Protons in the cosmic rays strike the earth's upper atmosphere at a rate, averaged over the earth's surface, of $0.15 \text{ protons/cm}^2\text{-sec}$. What total current does the earth receive from beyond its atmosphere in the form of incident cosmic ray protons? (Earth's radius = 6.4×10^6 meters). 7
- 4) Define Electric field. Define electric field E . Show with the help of a neat diagram, the charge distribution in a neutral atom. What happens when the atom is placed in an electric field? 7
- 5) Figure 1 shows an electron of mass m and charge e projected with speed v_0 at right angles to a uniform electric field E . The electron is deflected upward as shown in the figure and strikes at point P after it exits from the electric field. Derive an equation of motion for the electron. 10

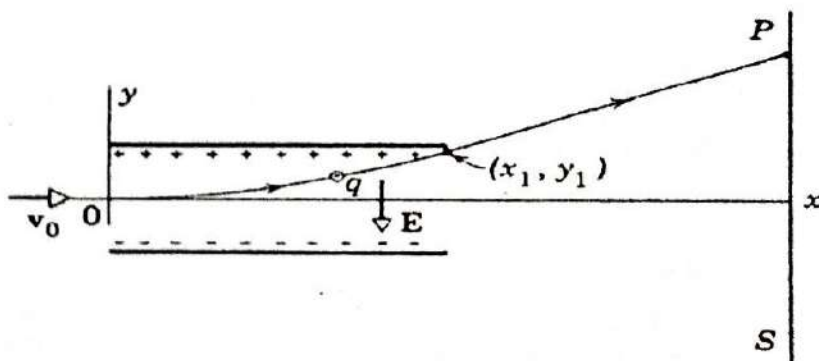


Figure 1: Figure for question no 2 (b)

- 6) The electric field between the plates of a cathode-ray oscilloscope is $1.2 \times 10^4 \text{ nt/coul}$. What deflection will an electron experience if it enters at right angles to the field with a kinetic energy of 2000 eV ($1 \text{ eV} = 1.60 \times 10^{-19} \text{ joule}$)? The deflecting assembly is 1.5 cm long.
 (Ref: Figure 1 (b) to solve this problem) 8
- 7) Discuss Capacitance and Dielectrics. What are free charge and induced surface charge? A dielectric medium e.g., a sheet of Teflon of dielectric constant $k=2.1$ is inserted between the plates of a parallel-plate capacitor which is connected across a potential V . Discuss how the electric field, electric potential and the charges are affected due to the presence of the dielectric medium. 8

- b) Figure 2 shows an assembly of two capacitors. Capacitor C_1 is charged to a potential difference V_0 . This charging battery is then removed and the capacitor is connected to an uncharged capacitor C_2 . Derive an expression for i. The final potential difference across the combination ii. Stored energy before and after the switch is thrown.

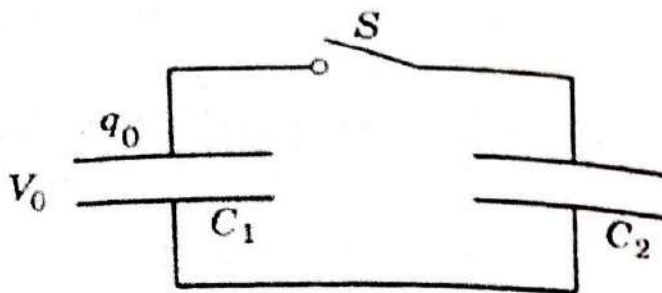


Figure 2: Figure for question no.3 (b)

- c) Two capacitors $C_1 = 2.0 \mu\text{F}$ and $C_2 = 4.0 \mu\text{F}$ are connected in parallel across a 300-volt potential difference. Calculate the total stored energy in the system.
4. a) Discuss electrical resistivity from an atomic point of view. Distinguish Ohmic and non-Ohmic conductor, a superconductor from a normal conductor. What are type 1 and type 2 superconductors?
- b) Discuss drift speed and drift velocity of electrons in a metallic conductor. Define current density. Write down the macroscopic and microscopic forms of Ohms law. Derive an expression relating the current density j and the drift velocity v_d .
- c) A rectangular carbon block has dimensions $1.0 \text{ cm} \times 1.0 \text{ cm} \times 50 \text{ cm}$. What is the resistance measured Between i. the two square ends? ii. Between two opposing rectangular faces? (Resistivity of Carbon at 20°C is $3.5 \times 10^{-4} \text{ ohm-m}$)
5. a) Discuss photocurrent, stopping potential, threshold frequency, and the work function. Discuss how these parameters depend on the frequency and intensity of light falling on a metal.
- b) Draw a clear circuit diagram to determine the threshold frequency of a photo-cathode. Draw a graph showing the stopping potential against frequency of light. From the graph, determine the threshold frequency and the work function.
- c) Ultraviolet light of wavelength 350 nm and intensity 1.00 W/m^2 is directed at a potassium surface.
- Find the maximum kinetic energy of the photoelectrons.
 - If 0.50 percent of the incident photons produce photoelectrons, how many are emitted per second if the potassium surface has an area of 1.00 cm^2 .
6. a) Discuss inertial and non-inertial frames of reference with a suitable example for each. Define time dilation and length contraction citing the example of muon (μ -meson) decay.
- b) Discuss the principle of equivalence in Einsteins general theory of relativity. Discuss the effect of gravity on light. Discuss how the gravity is regarded as the "warping of space and time".
- c) Discuss the precession of the perihelion of the planet Mercury's orbit and the "gravitational lensing" as an effect of the presence of a quasar, which is the nucleus of a young galaxy and is brighter than a billion star.

- a) Classify different types of magnetic materials. Classify the following elements in terms of their magnetic properties (Cr, Mn, Fe, Co, Ni, Cu, Nd, Sm, Tb). What are soft and hard magnetic materials? Draw the hysteresis loops of a soft and a hard magnetic material and explain why are they named so? 7
- b) Discuss Hall effect. What is Lorentz force? Define Hall field and Hall Voltage. Draw a neat circuit diagram to explain Hall effect. Discuss why it is important to measure Hall effect on a semi-conducting material. 10
- c) A copper strip 2.0 cm wide and 1.0 mm thick is placed in a magnetic field with field intensity $B = 1.5 \text{ webers/m}^2$. If a current of 200 amp is set up in the strip, what Hall potential difference appears across the strip? (Cu has $8.4 \times 10^{22} / \text{cm}^3$ conduction electrons) 8
- a) Discuss the phenomenon of reflection, refraction, diffraction, and polarization of light. 7
- b) What are O-ray and E-ray? Describe the construction of a Nicole's prism. 10
- c) Discuss the mechanism of polarization of light by reflection and refraction. Describe how a beam of unpolarized light can be polarized using polarizing material "Polaroid". What happens to these two rays when an unpolarized light is passed through a Nicole's prism? 8
- d) Two polarizing sheets have their polarizing directions parallel so that the intensity I_m of the transmitted light is a maximum. Through what angle must either sheet be turned if the intensity is to drop by one-half?