**Bago University**
**Department of Physics**
**First Semester Examination, March 2019**

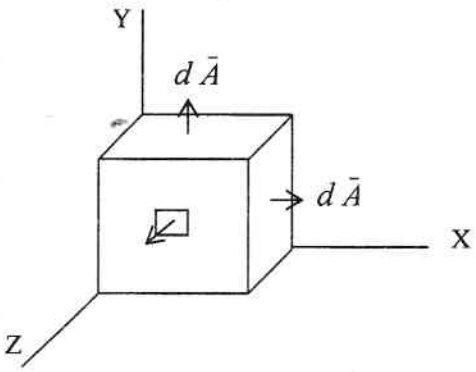
**Second Year (BSc)**
**(Physics Specialization)**

**Phys 2103**
**Electric & Magnetic Fields**
**Time Allowed: (3) Hours**

**Answer any Six questions.**

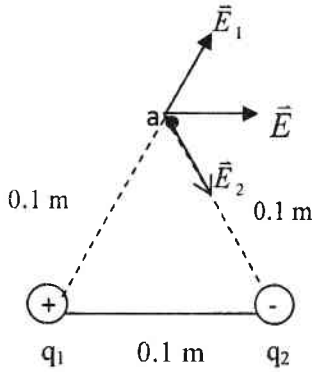
1 (a) State Gauss' law. Derive the electric field due to a long uniformly charged wire.

(b) A uniform electric field $\vec{E}$ exists in the $+x$ direction. Find the net electric flux $\emptyset_E$ through the surface of a cube, edge length $l$, that is oriented with its edges along the coordinates axes as shown in figure.




2 (a) Define electric field. Express the SI unit of electric field. How can the electric field be represented? How does the electric field and the force act for negative charge? Write down the resultant electric field with vector form.

(b) Point charges $q_1$ and $q_2$ of $+10\times10^{-9}$ C and $-10\times10^{-9}$ C respectively are placed 0.1m apart in figure. Compute the electric field due to these charges at 'a'.




3 (a) Derive the energy density of the electric field.

(b) In a rectangular coordinate system, two positive point charges of $10^{-8}$ C each are fixed at the points $x = +0.1$m, $y = 0$ and $x = -0.1$m, $y = 0$. Find the magnitude and direction of the electric field at the following points: (i) the origin and (ii) $x = 0.2$m, $y = 0$.

4 (a) Define Homogeneity, Linearity and Isotropy. Write down the SI units of permittivity and polarization.

(b) A flat slab of sulfur ($\varepsilon_r = 4$) is placed normal to a uniform field. If the polarization-surface charge density $\rho_{sp}$ on the slab surfaces is 0.5 $Cm^{-2}$, what are (i) polarization in the slab, (ii) flux density in the slab, (iii) flux density outside the slab (in air), (iv) field intensity in the slab and (v) field intensity outside the slab (in air)?

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5 (a) Derive the relation between the electric susceptibility and relative permittivity of the dielectric and also calculate the value of electric susceptibility for vacuum.

(b) A horizontal parallel-plate capacitor has a 10 mm plate separation and a 100 V potential difference. There is a dielectric of permittivity ε and thickness 5mm on the lower plate. The space above air-filled, find E, D, and P in the air space and in the dielectric. ($\varepsilon = 3\varepsilon_0$)

6 (a) Explain the state of polarization in a dielectric. Define dielectric strength and give three examples of material with their respective dielectric strength.

(b) A parallel-plate air capacitor is charged to 1,000 V, the potential source disconnected, and the plates separated to twice their original spacing. (i) What is the energy stored in the two cases? (ii) Account for the difference in energies.

7 (a) Derive the general continuity relation between current density J and the charge density $\rho_v$.

(b) A certain electrical conductor has a square cross section, 2mm on a side, and is 12m long. The resistance between its ends is 0.072 Ω. (i) What is the resistivity of the material? (ii) If the electric field magnitude in the conductor is $0.12 Vm^{-1}$, what is the total current? (iii) If the material has $8.0 \times 10^{28}$ free electrons per cubic meter, find the average drift velocity under condition of part (ii).

8 (a) Derive Ohm's law at a point and relates the current of a point to the total field at the point and the continuity $\sigma$ of the material.

(b) A copper wire has a square cross section, 2mm on a side. It is 4m long and carries a current of 10A. The density of free electrons is $8 \times 10^{28}\ Cm^{-3}$. What is the current density in the wire? What is the electric field? How much time is required for an electron to travel the length of the wire?