National University of Computer and Emerging Sciences (NUCES), Lahore Campus				
	Course:	Applied Physics	Course Code:	NS1001
	Program:	BS(CS), BS(DS) & BS (SE)	Semester:	Fall 2023
	Duration:	60 minutes	Total Marks:	30
	Date:	11-11-2023	Weight:	15%
	Section(s):	All	Page(s):	3
	Exam:	Midterm 2	Section	[redacted]
	Name:	[redacted]	Roll No.	[redacted]
Instructions/Notes:	Write your answer within the space provided only. You can take rough sheet, but do not attach it with the paper. Constants: permittivity of free space: 8.85×10^{-12} $C^2/N.m^2$; Coulomb's constant: 9×10^9 $N.m^2/C^2$			

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Question 1 (a): Determine the magnitude and direction of the electric field at a point in the middle of two-point charges of $4\ \mu C$ and $-3.2\mu C$ separated by 4 cm? Also make a vector diagram. (7 marks)

E

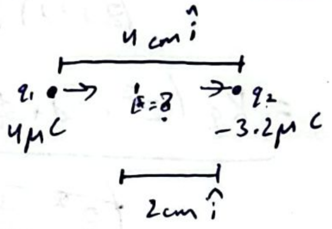
$k = \frac{1}{4\pi\epsilon_0}$

$$E = \frac{kq_1}{r^2} + \frac{kq_2}{r^2}$$

$$E = \frac{k}{r^2}(q_1 + q_2)$$

$$E = \frac{9\times10^9}{(0.02)^2} \times (4 + 3.2)\times10^{-6}$$

$$\boxed{E = 1.62\times10^{8}\hat{i}\ N/C}$$



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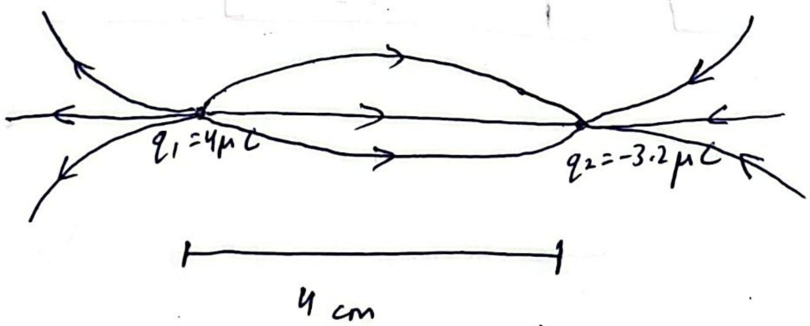

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$\frac{2Kqd}{z^3}$

Question 1 (b): Derive an expression of net electric field due to an electric dipole at point 'P' on the dipole at a distance 'z' from the center of the dipole. Draw the illustration as well. (8 marks)

$$E_{net} = E_1 + E_2$$

$$= \frac{kq}{(z-\frac{1}{2}d)^2} + \frac{kq}{(z+\frac{1}{2}d)^2}$$

$$= \frac{Kq(z+\frac{1}{2}d)^2 + Kq(z-\frac{1}{2}d)^2}{(z-\frac{1}{2}d)^2(z+\frac{1}{2}d)^2}$$

$$= \frac{Kq\left(z^2 + zd + \frac{d^2}{4} + z^2 - zd + \frac{d^2}{4}\right)}{\cancel{\left(z^2 - \frac{d^2}{2}\right)^{2}} \left(z^2 - zd + \frac{d^2}{4}\right)\left(z^2 + zd + \frac{d^2}{4}\right)}$$

$$= \frac{kq\left(2z^2 + \frac{d^2}{2}\right)}{\left(z^4 + z^3 d + \frac{zd^2}{4} - z^3 d - z^2 d^2 - \frac{zd^3}{4} + \frac{z^2 d^2}{4} + \frac{zd^3}{4} + \frac{d^4}{8}\right)}$$

After extensive Algebra:-

$$\boxed{E = \frac{2Kqd}{z^3}} \quad \text{or} \quad \boxed{E = \frac{2qd}{4\pi\varepsilon_0 z^3}} \Rightarrow \boxed{\frac{qd}{2\pi\varepsilon_0 z^3}}$$

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0265

n 2 (a): A (closed) cylindrical Gaussian surface, embedded perpendicularly in the conductor, encloses some of the charge. Electric field lines pierce the external end cap of the cylinder, but not the internal end cap. external end cap has area A and area vector A. Calculate electric field by applying the Gauss's law. (5 marks)

$E_o \phi = q_{enc}$

$E \cos 0 = 1$

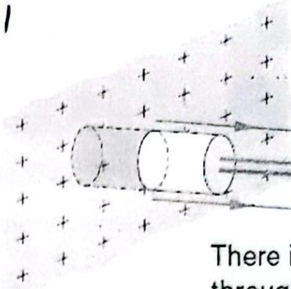
$q = \sigma A$

$E_o \int E.dA = q_{enc}$

$E_o E \int dA = q_{enc}$

$E_o.E.A = \sigma A$

$$\boxed{E = \frac{\sigma}{E_o}}$$



There is flux only through the *external* end face.

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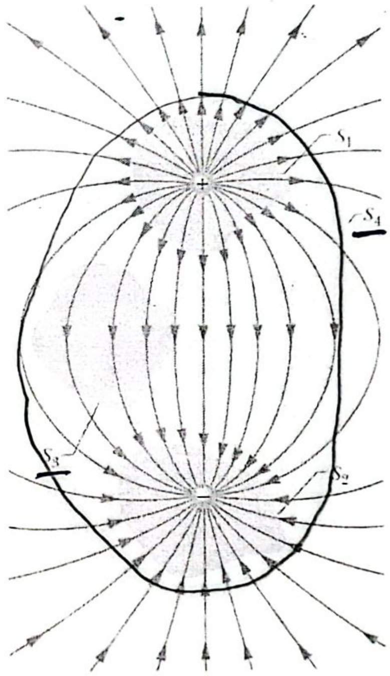
Question 2 (b): What will be the net flux across gaussian surfaces S_3 and S_4 in the figure below? Assume that the charges indicated are of equal magnitude. (5 marks)

In S_3, $\phi = 0$ As all the electric field lines that are entering are also exiting. other than that it is also parallel so the surface hence $E \cos 90 = 0$.

In S_4, $\phi = 0$ as within a surface, $E_{net} = 0$. Therefore there will be no flux ~~outside~~ across the surface S_4.



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Question 2 (c): Determine the electric field on the surface of a sphere of radius 0.333 m, if 1969 nC are contained within. (5 marks)

$E_o.E.4\pi r^2 = q$

$$E = \frac{q}{4\pi E_o r^2} = \frac{1969\times10^{-9}}{4\pi E_o (0.333)^2} = \boxed{1.60\times10^5 \ N/C}$$

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