

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING
ECE110 – Electrical Fundamentals

Midterm May 30, 2024

DURATION: 80 Minutes

Calculator Type: 2 (non-programmable calculators)

Examiner: Hamid S. Timorabadi

FAMILY NAME: _____

GIVEN NAME: _____

STUDENT NUMBER: _____

$$K = 1/(4\pi\epsilon_0) = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ F}\cdot\text{m}^{-1}$$

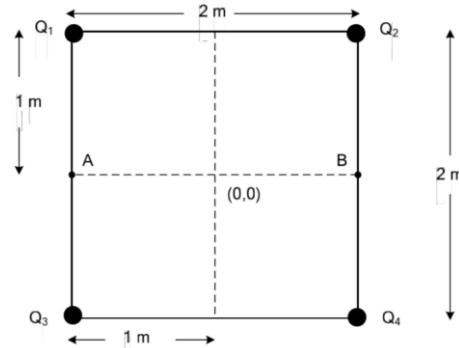
MARKS

Q1	/7
Q2	/10
Q3	/6
Q4	/7
Total	/30

Question 1 [7 Marks]

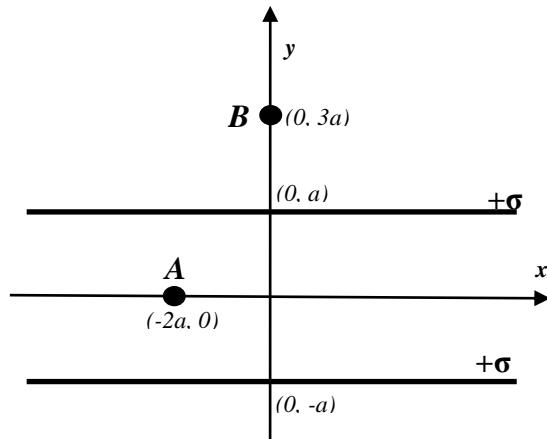
Four charges are located at the corners of a square of side $a=2\text{ m}$ as shown in the Figure below. If $Q_1 = Q_2 = Q_3 = 10\text{ }\mu\text{C}$ and $Q_4 = -10\text{ }\mu\text{C}$.

- Find the magnitude of the electric field at the center of the square, at point $(0, 0)$. Clearly show the direction of the electric field on the diagram.
- If a test charge $Q=2\text{ }\mu\text{C}$ is placed at the square center, point $(0, 0)$, find the magnitude of the electric force on this test charge due the other four charges.



Question 2 [10 Marks]

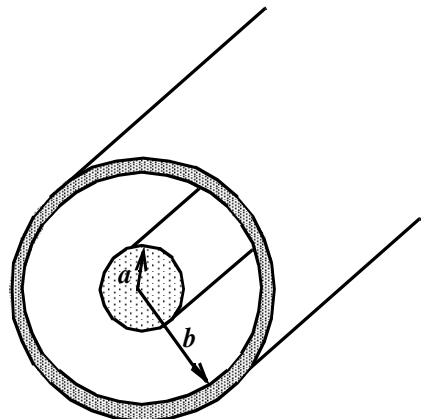
Two infinite parallel plates with a surface charge density of $\sigma \text{ C/m}^2$ are shown in the following Figure. Determine the electric potential between points A and B (V_{AB}) in terms of distance a and charge density σ .



Question 3: [6 Marks]

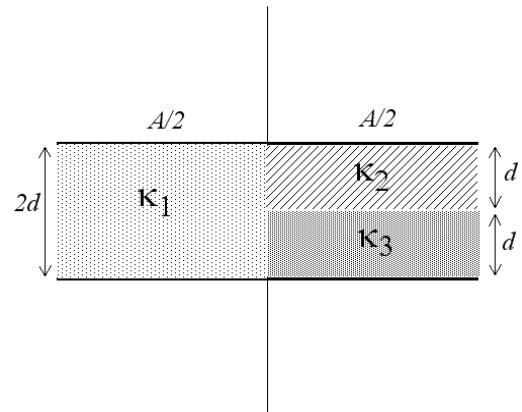
A cylindrical capacitor consisting of two coaxial cylinders of radius a and b ($b > a$) and length (L) where $L \gg b$ is shown in the Figure below. The inner shell has a total charge of $+Q$ and the outer shell has a total charge of $-Q$. Fringing may be neglected.

Develop a relationship for capacitance of this device in terms of a , b , and L .



Question 3 [7 Marks]

A parallel-plate capacitor of plate area $A=10.5 \text{ cm}^2$, plate separation $2d=7.12 \text{ mm}$, and dielectric constants of $\kappa_1=21$, $\kappa_2=42$, and $\kappa_3=58$ is shown in the following Figure. Determine the capacitance.



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Student Number: