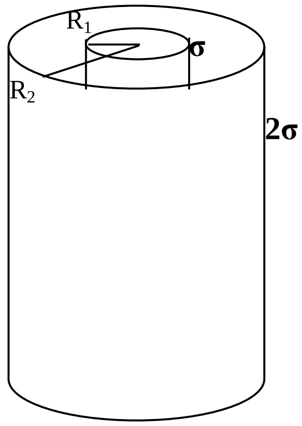
University of Tlemcen
Faculty of Science
Duration: 30mn

Academic Year 2023/2024
1st Year LMD-M and MI

First name:
Last name:

Face-To-Face Test

Consider two infinitely long coaxial cylinders of radius R_1 and R_2 such that $R_1<R_2$. The first of radius R_1, charged with surface **density +σ**; and the second of radius R_2, charged with surface **density +2σ.**



1- Calculate the electrostatic field **outside the system**.
2- Deduce the electrostatic potential **outside the system**.
3- Tracer l'allure de E(r).

Correction of test:

1- The field : Consider a cylinder of radius r and height h as a Gauss surface.

$$\text{Gauss's theorem : } \varphi = \iint \overrightarrow{E}.\overrightarrow{ds} = \frac{\sum Q_{int}}{\varepsilon_0}$$

$$\varphi = \iint \overrightarrow{E}.\overrightarrow{ds} = 2\iint \overrightarrow{E}.\overrightarrow{ds_{base}} + \iint \overrightarrow{E}.\overrightarrow{ds_{lat}}$$

$\overrightarrow{E} \therefore \overrightarrow{ds_{lat}}$ et $\overrightarrow{E} \perp \overrightarrow{ds_{base}} \Rightarrow \iint \overrightarrow{E}.\overrightarrow{ds_{lat}} = 0$

so : $\varphi = \iint \overrightarrow{E}.\overrightarrow{ds_{lat}} = \overrightarrow{E}.\int \overrightarrow{ds_{lat}} = E.S_{lat} = E2\pi rh$

For : $r \geq R_2$

$$Q_{int} = Q_1 + Q_2$$

$Q_1 = \sigma 2\pi R_1 h$ and $Q_2 = 2\sigma 2\pi R_2 h$ donc $\boldsymbol{Q_{int}} = \sigma 2\pi h(R_1 + 2R_2)$

$$E_3 2\pi rh = \frac{\sigma 2\pi h(R_1 + 2.R_2)}{\varepsilon_0} \Rightarrow \boldsymbol{E_3} = \frac{\boldsymbol{\sigma(R_1+2.R_2)}}{\boldsymbol{\varepsilon_0}}\frac{\boldsymbol{1}}{\boldsymbol{r}}$$

2- The potentiel

$\overrightarrow{E} = -\overrightarrow{grad}\,V$

$E = E(r) \Rightarrow E = -\frac{dV}{dr} \Rightarrow V = -\int E.dr$

$$V_3 = -\int E_3.dr = -\frac{\boldsymbol{\sigma(R_1 + 2.R_2)}}{\boldsymbol{\varepsilon_0}}\int \frac{\boldsymbol{1}}{\boldsymbol{r}}.dr = -\frac{\boldsymbol{\sigma(R_1 + 2.R_2)}}{\boldsymbol{\varepsilon_0}}\boldsymbol{lnr} + \boldsymbol{C_3}$$