University of Khenchela
Faculty of Sciences and Technology
Department of Computer Science

Academic year 2025-2026
1st year Computer science LMD
Duration: 1h,30

# Final exam of Electricity

**Questions:** **(1.25 pts)**

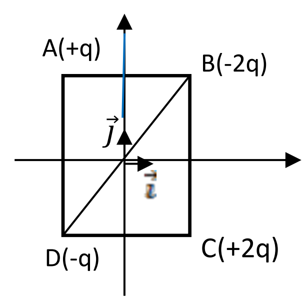
Choose the correct answer:

1- Like charges: a- repel. b- attract each other.

2- Electric force is: a- $F = k\frac{|q_1.q_2|}{r}$ b- $F = k\frac{|q_1.q_2|}{r^2}$ c- $F = k\frac{|q_1.q_2|}{\sqrt{r}}$

3- The electric field is zero: a - inside the conductor. b- outside a charged conductor. c- just outside a charged conductor.

**Exercise 1:** **(7.25pts)**




Four electric point charges $\mathbf{q_A = q}$, $\mathbf{q_B = -2q}$, $\mathbf{q_c = 2q}$ and $\mathbf{q_D = -q}$ are placed at the vertices **A**, B, **C** and **D** of a square with side length **a**.

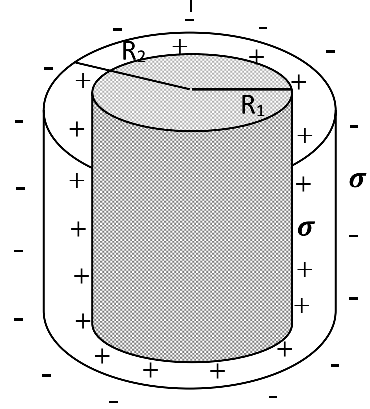
1- Represent and find the electrostatic field at the center **O** of the square.

2- We put a charge **Q = -q** at point **O**, represent and find the electrostatic force exerted on this charge.

3- Determine the electric potential V(O) at point **O**.

4- What is the value of the potential energy at this point $E_P$(O).

**Exercise 2:** **(5.25pts)**

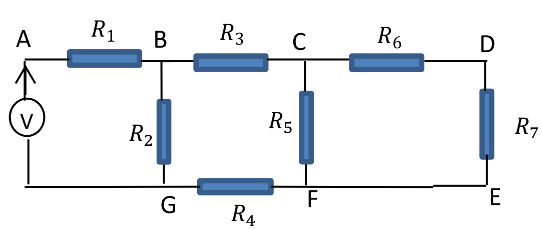



Consider two cylinders in a vacuum with the same axis, with radii R1 and R2 where $R_1 < R_2$, of negligible thickness, and uniformly charged on their surfaces, with charge densities $+\sigma$ and $-\sigma$, respectively.

1- Determine the electric field at all points in space.

2- Calculate the difference in potential $\Delta V$ between the two cylinders.

**Exercise 3:** **(6,25 pts)**




Let the circuit in the following figure

1- Name the circuit elements: number of nodes, number of branches and number of loops.

2- Determine the equivalent circuit resistance and give the simplified circuit.

3- Calculate the current intensity I.

V=20 V, R1= R3= R5= 100 Ω, R2= 200 Ω and R4= R6= R7= 50 Ω.

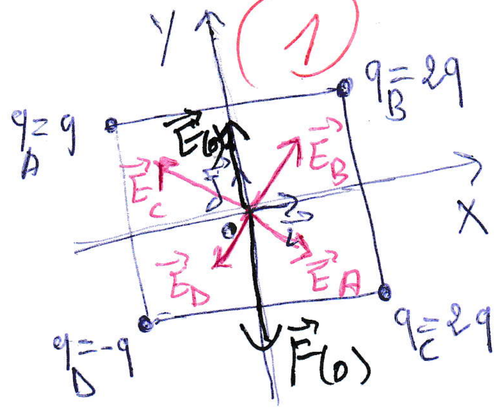
*Good Luck.*

# Model answer for Final Exam 1 - $1^{st}$ C.S Electricity 2025-2026

Questions: (1.5 pts)

1- $\longrightarrow$ a 0.5, 2- $\longrightarrow$ b 0.5, 3- $\longrightarrow$ a. 0.5

## Ex n°1:




### 1- Electric field $\vec{E}$ at center O:

we have: $\vec{E}(O) = \vec{E}_A + \vec{E}_B + \vec{E}_C + \vec{E}_D$ 0.5

By raison of symetry, we have: 0.25

$\vec{E}_A = \vec{E}_D \Rightarrow \vec{E}_A + \vec{E}_D = -2\vec{E}_A \cos\frac{\pi}{4}\vec{j} = \frac{-2kq}{\|\vec{AO}\|^2}\cos\frac{\pi}{4}\vec{j}$ 0.25

In triangle ADC, we have: $a^2 + a^2 = AC^2 \Rightarrow AC = \sqrt{2}\,a$ 0.25

$\Rightarrow \|\vec{AO}\| = \frac{AC}{2} = \frac{\sqrt{2}}{2}a$ 0.25

Hence: $\vec{E}_A + \vec{E}_D = \frac{-2k(q)}{\left(\frac{\sqrt{2}}{2}a\right)^2}\cdot\frac{\sqrt{2}}{2}\vec{j} = \boxed{\frac{-2\sqrt{2}kq}{a^2}\vec{j}}$ 0.25

we have the same: $\vec{E}_C = \vec{E}_B \Rightarrow \vec{E}_C + \vec{E}_B = 2E_C \cos\frac{\pi}{4}\vec{j}$ 0.25

$\Rightarrow \vec{E}_C = \frac{2kq_c}{(\|\vec{CO}\|)^2}\cos\frac{\pi}{4}\vec{j} = \frac{2k(2q)}{\left(\frac{\sqrt{2}}{2}a\right)^2}\cdot\frac{\sqrt{2}}{2}\vec{j} = \frac{4kq\sqrt{2}}{a^2}\vec{j}$ 0.25 0.25

So, $\vec{E}(O) = \frac{-2kq\sqrt{2}}{a^2}\vec{j} + \frac{4kq\sqrt{2}}{a^2}\vec{j} \Rightarrow \boxed{\vec{E}(O) = \frac{2kq\sqrt{2}}{2}\vec{j}}$ 0.25

2/ $\vec{F}(O) = -q\vec{E}(O) = \frac{-kq^2}{a^2}\vec{j}$ 0.5 0.5

3/ $V(O) = V_A + V_B + V_C + V_D = \frac{kq_A}{AO} + \frac{kq_B}{BO} + \frac{kq_C}{CO} + \frac{kq_D}{DO}$ 0.5 0.5

$$V(0)=K\left(\frac{q}{a}+\frac{-2q}{a}+\frac{2q}{a}+\frac{-q}{a}\right)=0 \quad 0{,}5$$

4/ $$E_p(0)=q_0(V(0)-\cancel{V(\infty)}^{0})=-q\times 0=0 \quad 0{,}5 \quad 0{,}5$$

Ex n°2

1/ By consideration of symetry $\vec{E}(r)$ is radial

$$\vec{E}(r)=E(r)\vec{u_r} \quad 0{,}5$$

$$\oiint \vec{E}\cdot d\vec{S}=\frac{\sum Q_{int}}{\varepsilon_0} \Rightarrow E\cdot S_G=\frac{\sum Q_{int}}{\varepsilon_0} \quad 0{,}25$$

we have 3 cases:

⊛ 1st case: $R<R_1$ 0,25

$$Q_{int}=0 \Rightarrow \boxed{E_1(r)=0} \quad 0{,}25$$

0,5

⊛ 2nd case: $R_1<r<R_2$: 0,25

$$Q_{int}=\sigma S=2\pi R_1 h\sigma \quad 0{,}5 \quad , \quad S_G=2\pi R_1 h$$

$$E_2\cdot S_G=\frac{Q_{int}}{\varepsilon_0}\Rightarrow E\cdot 2\pi r h=\frac{2\pi R_1 h\sigma}{\varepsilon_0} \quad 0{,}25 \Rightarrow \boxed{E_2(r)=\frac{\sigma R_1}{\varepsilon_0 r}} \quad 0{,}25$$

⊛ 3rd case: $r>R_2$ 0,25

$$Q_{int}=\sigma 2\pi R_1 h-\sigma 2\pi R_2 h=2\pi\sigma(R_1-R_2) \quad 0{,}5 \quad ; \quad S_G=2\pi r h.$$

$$E_3 S_G=\frac{Q_{int}}{\varepsilon_0}\Rightarrow E_3\cdot 2\pi r h=\frac{2\pi\sigma}{\varepsilon_0}(R_1-R_2) \quad 0{,}5 \Rightarrow \boxed{E_3=\frac{-\sigma}{\varepsilon_0}\left(\frac{R_2-R_1}{r}\right)} \quad 0{,}25$$

2/ $\Delta V=?$

$$\vec{E}=-\vec{grad}\,V=\int_{V(R_1)}^{V(R_2)} dV(r)=-\int^{R_2}\vec{E}\cdot d\vec{r} \quad 0{,}25$$

0,5

$$\Delta V=V(R_2)-V(R_1)=-\int_{R_1}^{R_2}\frac{\sigma R_1}{\varepsilon_0 r}dr=\frac{-\sigma R_1}{\varepsilon_0 r}\ln r\Big|_{R_1}^{R_2} \quad 0{,}5 \Rightarrow \boxed{\Delta V=\frac{\sigma R_1}{\varepsilon_0 r}\ln\frac{R_1}{R_2}}$$

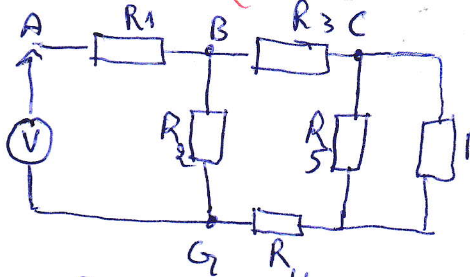
## Ex n°3.

### 1/ The elements of the circuit:

we have:

- 4 nodes: B, C, F and G. (1)
- 6 branches: AB, BC, CDEF, FG, GB and CF. (1,5)
- 3 loops: ABGA, BCFGB and CDEFC. (0,75)

### 2/ The equivalent resistance:

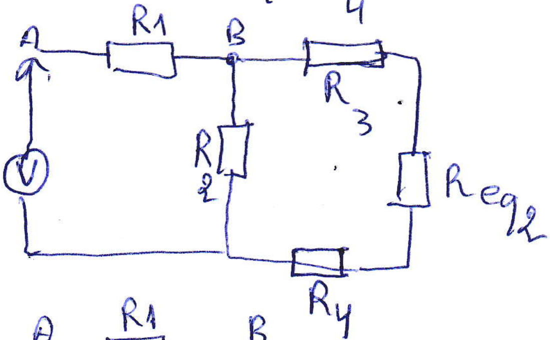


(0,25)

- $R_6$ and $R_7$ in serie $\Rightarrow$

$$\boxed{R_{eq_1} = R_6 + R_7 = 50 + 50 = 100\,\Omega}$$ (0,25)

- $R_{eq_1} // R_5 \Rightarrow$

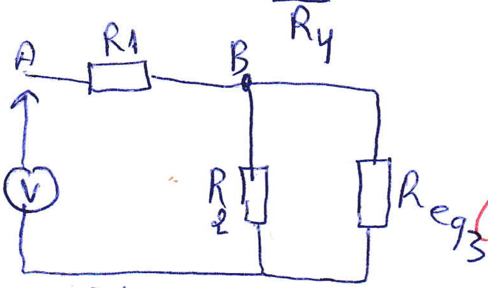


(0,25)

$$\frac{1}{R_{eq_2}} = \left(\frac{1}{R_{eq_1}} + \frac{1}{R_5}\right) = \frac{1}{100} + \frac{1}{100} = \frac{2}{10}$$ (0,5)

$$\Rightarrow \boxed{R_{eq_2} = 50\,\Omega}$$

- $R_{eq_2}$, $R_3$ and $R_4$ in serie $\Rightarrow$

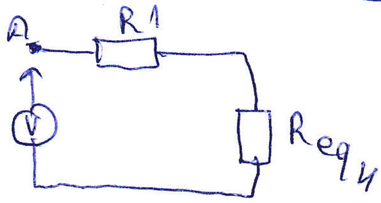


(0,25)

$$R_{eq_3} = R_{eq_2} + R_3 + R_4 = 50 + 50 + 100$$ (0,25)

$$\boxed{R_{eq_3} = 200\,\Omega}$$

- $R_{eq_3} // R_2 \Rightarrow$

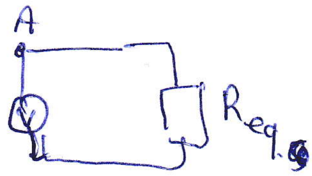


(0,5)

$$\frac{1}{R_{eq_4}} = \left(\frac{1}{R_{eq_3}} + \frac{1}{R_2}\right) = \frac{1}{200} + \frac{1}{200} = \frac{2}{200}$$

$$\Rightarrow \boxed{R_{eq_4} = 100\,\Omega}$$

- $R_{eq_4}$ and $R_1$ in serie $\Rightarrow R_{eq} = R_{eq_4} + R_1 = 100 + 100$



$$\Rightarrow \boxed{R_{eq} = 200\,\Omega}$$ (0,25)

### 3/ The current intensity I:

$$V = R_{eq} I \Rightarrow I = \frac{V}{R_{eq}} = \frac{20}{200} = \boxed{0,1\,A}$$ (0,5)