ECOLE NATIONALE SUPERIEURE DES TRAVAUX PUBLICS (ENSTP)
YAOUNDE

End of Course Re-sit Examinations 2020/2021

Subject: ELE303 - Fundamentals of Electrical Engineering Time Allowed: **3 hours**

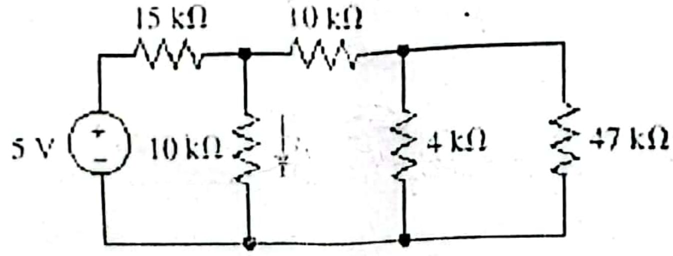
Lecturer: Dr. Engr. MBINKAR Edwin

Answer all (4) four questions. You are reminded of the necessity for orderly presentation of your answers. Documents are NOT allowed. Start answering each question on a new page.

Note: All questions carry equal marks ELE303

Question 1

For the circuit below, determine i_x, and compute the power dissipated by (or absorbed by) the 15-kΩ resistor.



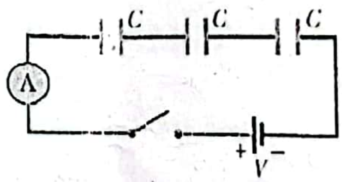
Question 2

(a) The figure below shows an open switch, a battery of potential difference V, a current-measuring meter A, and three identical uncharged capacitors of capacitance C. When the switch is closed and the circuit reaches equilibrium, what are:

(i) the potential difference across each capacitor and

(ii) the charge on the left-hand plate of each capacitor?

Give your answers in terms of C and V.



(b) Most homes use solid copper wire having a diameter of 1.63 mm to provide electrical distribution to outlets and light sockets. Determine the resistance of 75 meters of a solid copper wire having the above diameter. Take the resistivity of copper to be 1.723 x 10-8 Ωm.

Question 3

Draw the schematic diagram of a single-phase, full-wave bridge rectifier showing the input and output waveforms.

Question 4

There are four possible connection configurations a 3 phase transformer banks – the Y – Y, Y - Δ, Δ - Δ and Δ - Y configurations. Draw the wiring of each of these configurations indicating the in each case, the relationship between the primary voltage and the secondary voltage.

ECOLE NATIONALE SUPERIEURE DES TRAVAUX PUBLICS (ENSTP)

YAOUNDE

End of Course Examinations

Subject: ELE303 - Fundamentals of Electrical Engineering **Time Allowed: 2 hours**

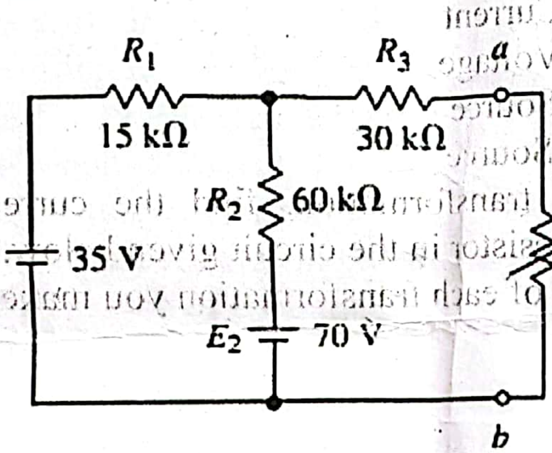
Lecturer: Dr. Engr. MBINKAR Edwin

Answer all 3 questions. You are reminded of the necessity for orderly presentation of your answers. Documents are NOT allowed. Start answering each question on a new page.

Note: All questions carry equal marks

Question 1

Consider the circuit below:



(a) Find the Norton equivalent external to R_L in the circuit (looking between the points a and b).

(b) Solve for the current I_L when $R_L = 0$, 10 kΩ, 50 kΩ, and 100 kΩ

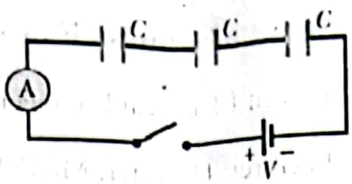
(c) What is the value of R_L for which maximum power is delivered to it from the circuit?

Question 2

(a) The figure below shows an open switch, a battery of potential difference V, a current- measuring meter A, and three identical uncharged capacitors of capacitance C. When the switch is closed and the circuit reaches equilibrium, what are?

(i) the potential difference across each capacitor and

(ii) the charge on the left-hand plate of each capacitor? Give your answers in terms of C and V.



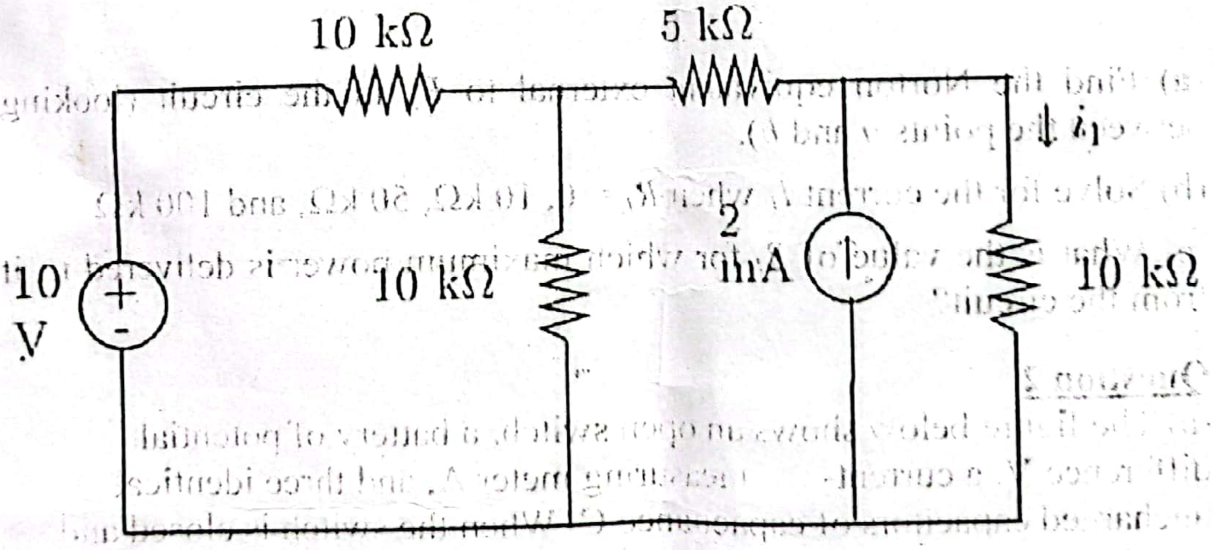
(b) Most homes use solid copper wire having a diameter of 1.63 mm to provide electrical distribution to outlets and light sockets. Determine the resistance of 75 meters of a solid copper wire having the above diameter. Take the resistivity of copper to be 1.723 x 10-8 Ωm.

Question 3

(a)Explain the following:

i) Short Circuit Current
ii) Open Circuit Voltage
iii) Ideal Current Source
iv) Ideal Voltage Source

(b) Using source transformation, find the current i_1 flowing through the 10 kΩ resistor in the circuit given below. Remember to draw a small sketch of each transformation you make.



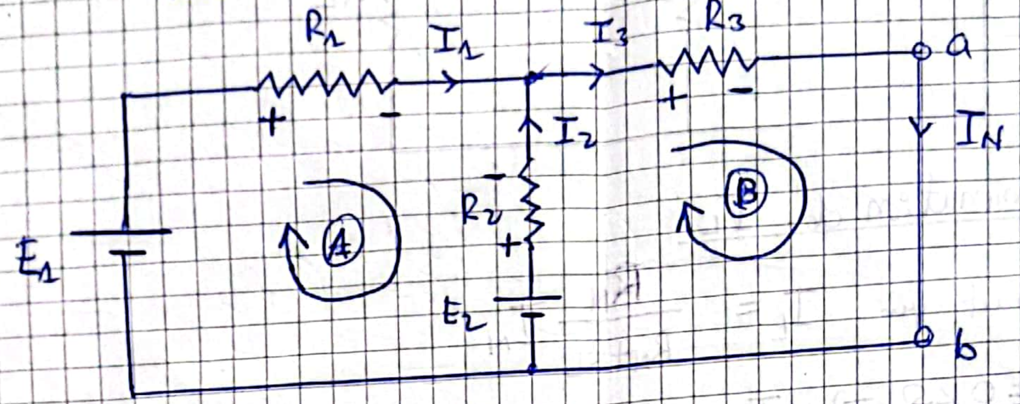
CORRECTION SN DE ELE303 2021

Question 1

a) Déterminons le circuit équivalent de Norton

Données : $R_1 = 15k\Omega$ $R_3 = 30k\Omega$ $E_1 = 35V$

$R_2 = 60k\Omega$ $R_L = 0 \rightarrow 100k\Omega$ $E_2 = 70V$



KCL : $I_3 = I_1 + I_2$ (1)

KVL
maille (A) $-E_1 - R_1 I_1 + R_2 I_2 + E_2 = 0 \Rightarrow -35 - 15 I_1 + 60 I_2 + 70 = 0$

maille (B) $-E_2 - R_2 I_2 - R_3 I_3 = 0 \Rightarrow -70 - 60 I_2 - 30 I_3 = 0$

$$\Rightarrow \begin{cases} -15 I_1 + 60 I_2 = -35 \\ 60 I_2 + 30 I_3 = -70 \end{cases} \Rightarrow \begin{cases} -3 I_1 + 12 I_2 = -7 & (2) \\ 6 I_2 + 3 I_3 = -7 & (3) \end{cases}$$

De (1), (2) et (3) on obtient :

$$\begin{cases} I_3 = I_1 + I_2 \\ -3 I_1 + 12 I_2 = -7 \\ 6 I_2 + 3 I_3 = -7 \end{cases} \Rightarrow \begin{cases} I_3 = I_1 + I_2 \\ -3 I_1 + 12 I_2 = -7 \\ 6 I_2 + 3(I_1 + I_2) = -7 \end{cases}$$

$$\Rightarrow \begin{cases} I_3 = I_1 + I_2 \\ -3 I_1 + 12 I_2 = -7 \\ 3 I_1 + 9 I_2 = -7 \end{cases} \Rightarrow 21 I_2 = -14 \Rightarrow I_2 = -\frac{2}{3}$$

$3 I_1 + 9 I_2 = -7 \Rightarrow I_1 = \frac{1}{3}(-7 - 9 I_2) = -\frac{1}{3}$

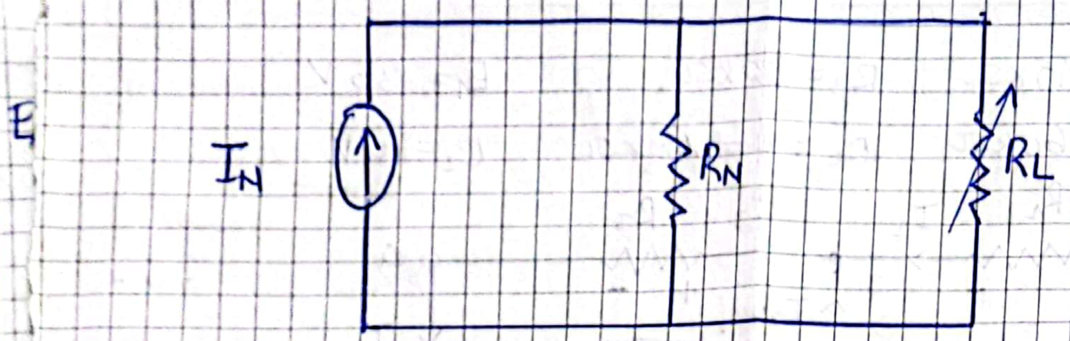
$I_3 = -\frac{1}{3} - \frac{2}{3} = -1$

Ainsi $I_1 = \frac{1}{3} mA$, $I_2 = \frac{2}{3} mA$ et $I_3 = 1 mA$

De cela on trouve $I_N = I_3 \Rightarrow$ $\boxed{I_N = 1 \, mA}$

$$R_N = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}} + R_3 = \frac{R_1 R_2}{R_1+R_2} + R_3 = \frac{15\times 60}{15+60} + 30 = 42\ k\Omega$$

$$\boxed{R_N = 42\ k\Omega}$$



b) Détermination de I_L

On sait que $I_L = \frac{R_N}{R_N+R_L} I_N$

Pour $R_L = 0\ k\Omega \Rightarrow I_L = 1\ mA$

Pour $R_L = 10\ k\Omega \Rightarrow I_L = \frac{42}{42+10} \times 1 = 0{,}81\ mA$

Pour $R_L = 50\ k\Omega \Rightarrow I_L = \frac{42}{42+50} \times 1 = 0{,}457\ mA$

Pour $R_L = 100\ k\Omega \Rightarrow I_L = \frac{42}{42+100} \times 1 = 0{,}3\ mA.$

c) Valeur de R_L pour lequel on a une puissance maximale

On sait que $P = R_L . I_L^2 = R_L \left(\frac{R_N}{R_N+R_L} I_N \right)^2 = R_N^2 I_N^2 . \frac{R_L}{(R_N+R_L)^2}$

$P = P_{MAX} \Rightarrow \frac{dP}{dR_L} = 0.$

$$\frac{dP}{dR_L} = \frac{d\left(R_N^2 I_N^2 . \frac{R_L}{(R_N+R_L)^2}\right)}{dR_N} = R_N^2 I_N^2 . \frac{(R_N+R_L)^2 - 2R_L(R_N+R_L)}{(R_N+R_L)^4}$$

$$= R_N^2 I_N^2 . \frac{R_N+R_L-2R_L}{(R_N+R_L)^3} =$$

$$\frac{dP}{dR_L} = R_N^2 I_N^2 . \frac{R_N - R_L}{(R_N+R_L)^3} . \quad \frac{dP}{dR_L} = 0 \Rightarrow R_N - R_L = 0$$

soit $R_N = R_L \Rightarrow \boxed{R_L = 42\ k\Omega}$

Question 3

a) Expliquons les termes suivants :

i) **Courant de court-circuit**

Le courant de court-circuit (ou intensité de court-circuit) noté I_{cc} d'un dipôle est le courant qui le traverserait si ses bornes étaient reliées par un conducteur parfait de résistance nulle.

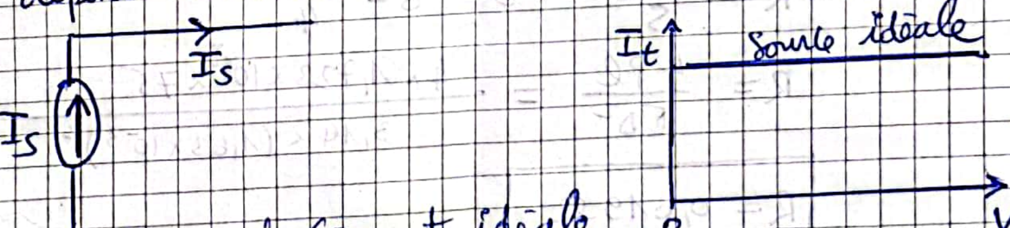
Pour le cas d'un dipôle linéaire, le courant de court-circuit permet de déterminer le courant de Norton utile pour établir le modèle équivalent de Norton d'un dipôle actif linéaire

ii) **Tension en circuit ouvert**

La tension de circuit ouvert, notée U_{co} également dite tension en circuit ouvert, est la tension électrique entre les bornes d'un appareil déconnecté de tout circuit.

iii) **Source idéale de courant**

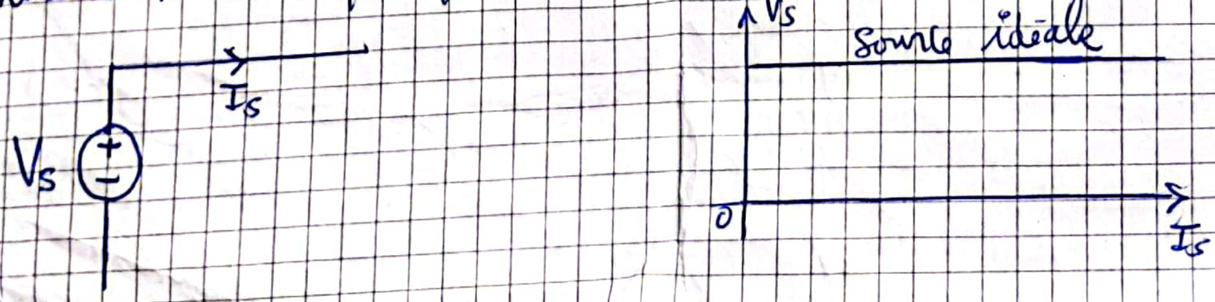
Une source de courant idéale fournit un courant constant indépendamment de la tension apparaissant à ses bornes. La tension dépend de la résistance de charge R ($V = RI$).



Source de courant idéale.

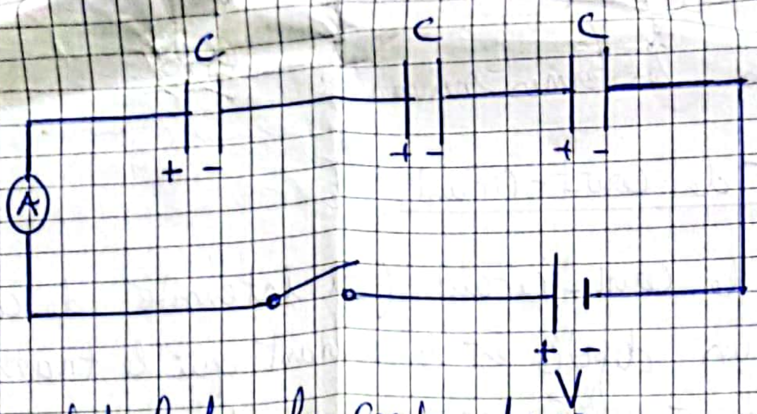
iv) **Source de tension idéale**

Une source de tension idéale fournit une tension V_o constante entre les bornes, quel que soit le courant I débité.



1) Question 2

a)



i) Différence de potentiel dans les condensateurs

Montage en série $\Rightarrow$ $C_{eq} = \dfrac{1}{\frac{1}{C}+\frac{1}{C}+\frac{1}{C}} = \dfrac{C}{3}$

Or $q = C_{eq} \cdot V = C_i V_i \Rightarrow V_i = \dfrac{C_{eq} V}{C_i} = \dfrac{\frac{C}{3} V}{C} = \dfrac{V}{3}$

$$\boxed{V_i = \frac{V}{3}}$$

ii) Charge du côté gauche du condensateur.

La charge du côté gauche du condensateur est positive

$$\boxed{q_{gauch} = C_i V_i = \frac{CV}{3}}$$

b) Résistance R

Données : $D = 1{,}63$ mm, $l = 75$ m, $\rho = 1{,}723 \times 10^{-8}$ Ωm.

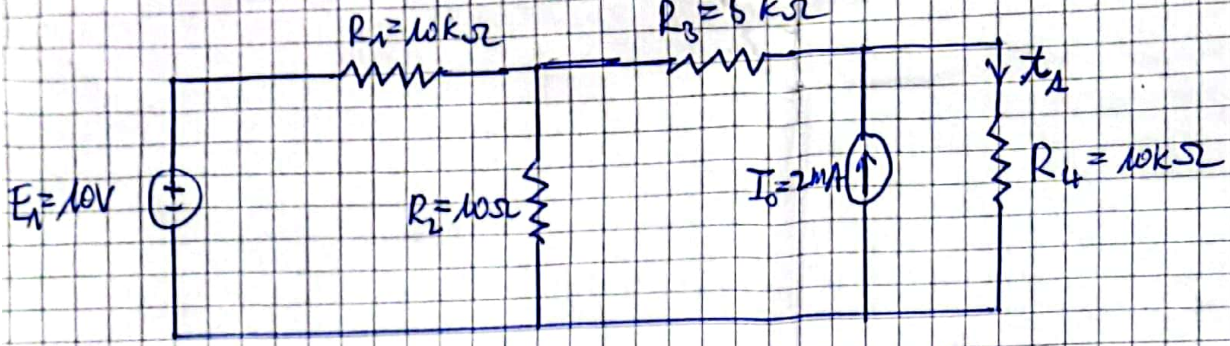
On sait que $R = \dfrac{\rho l}{S}$ or $S = \dfrac{\pi D^2}{4}$

$R = \dfrac{4 \rho l}{\pi D^2} = \dfrac{4 \times 1{,}723 \times 10^{-8} \times 75}{3{,}14 \times (1{,}63 \times 10^{-3})^2}$

$$\boxed{R = 0{,}619\ \Omega}$$

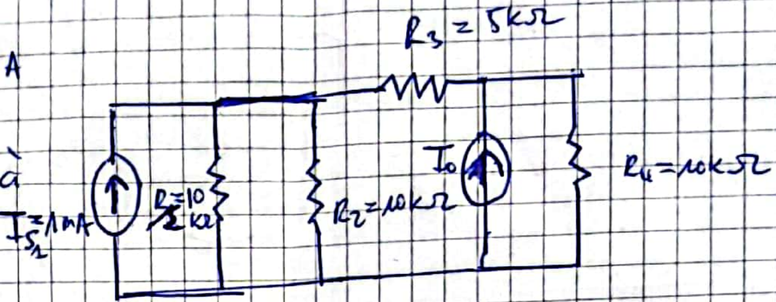
Scanné avec CamScanner

b) En utilisant les transformation de sources, déterminons le courant i_1 traversant le résistor de résistance 10kΩ



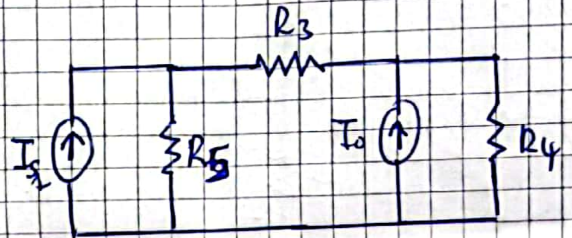
$I_{s_1} = \frac{E_1}{R_1} = \frac{10V}{10k\Omega} = 1mA$

Le circuit est équivalent à



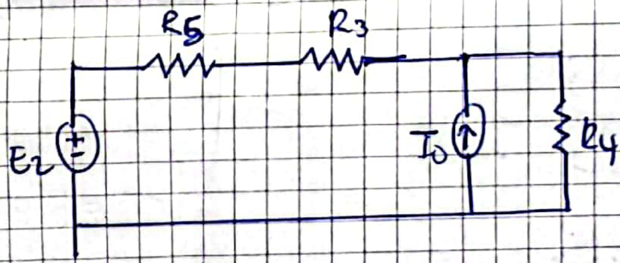
$R_5 = \frac{1}{\frac{1}{10}+\frac{1}{10}} = 5k\Omega$

Le circuit est équivalent à



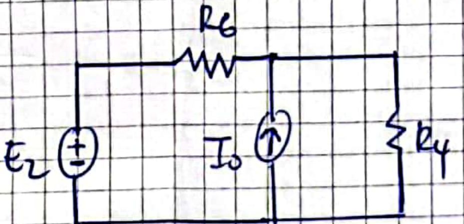
$E_2 = I_{s_1} R_5 = 5V$

Le circuit est équivalent à



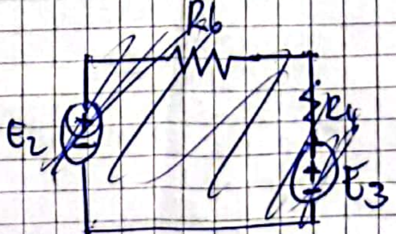
$R_6 = R_5 + R_3 = 10\Omega$

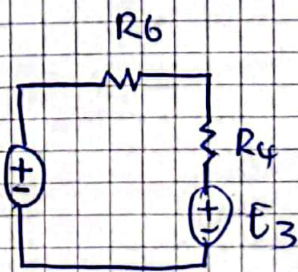
Le circuit équivalent à



$E_3 = I_0 R_4 = 20V$

Le circuit equivalent à





KVL : $i_1 = \frac{E_2+E_3}{R_6+R_4} = \frac{20+5}{10+10} = \frac{25}{20} = 1,25\ mA$

$\boxed{i_1 = 1{,}25\ mA}$