Mohamed Boudiaf University - M'sila / Faculty of Technology
Department of Electrical Engineering
2nd Year Academic License **Date:** January 22, 2025
Fundamental Electronics 1 **Duration**: 1h 30

Exam

Exercise 1: (7 pts)

Consider the circuit shown in figure 1 : $R_1 = R_2 = 6\ \Omega$, $R_3 = 4\ \Omega$, $R_4 = 1\ \Omega$, $E = 12V$, $I = 2A$.

- Using the **superposition theorem**, Determine the current I_4 flowing in the resistance R_4.

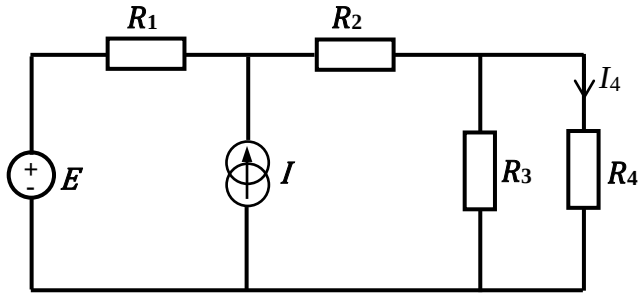


Figure 1

Exercise 2: (6 pts)

Determine the **z-parameters** for the circuit in Figure 2, with: **R = 1Ω, C =1F, L=1H, f = 50 Hz.**

f is the frequency.

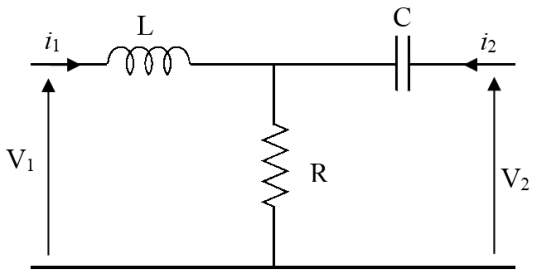


Figure 2

Exercise 3: (7 pts)

Consider the diode circuit shown in Figure 3, D is a silicon diode whose characteristic is linear with $V_0 = 0.7v$ and $r_d = 5\Omega$.

The input voltage is in the form: $V_e(t) = 12\sin(\omega t)$, $R_S = 10\ \Omega$.

1- Give the equivalent electrical diagram of this diode in the forward and reverse directions.
2- Determine the expressions of $i(t)$, $V_D(t)$, and $V_s(t)$.
3- Plot $i(t)$, $V_D(t)$, and $V_s(t)$ on the same graph.

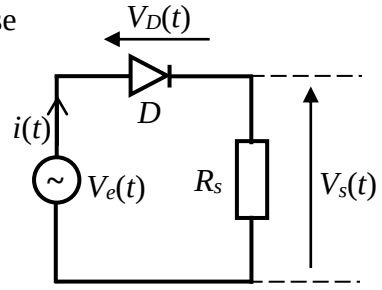


Figure **3**

F. Ouagueni *Good luck*

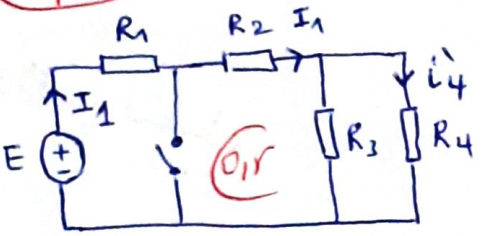
Mohamed Boudiaf University - M'sila / Faculté of Technologie
Department of Electrical Engineering
2nd Year Academic License

22/01/2025

Fundamental Electronics

Exam

Exercise 1 : (7pts)



* $I = 0$ (0,1)

$$I'_4 = \frac{R_3}{R_3+R_4} I_1 \quad (0,1)$$

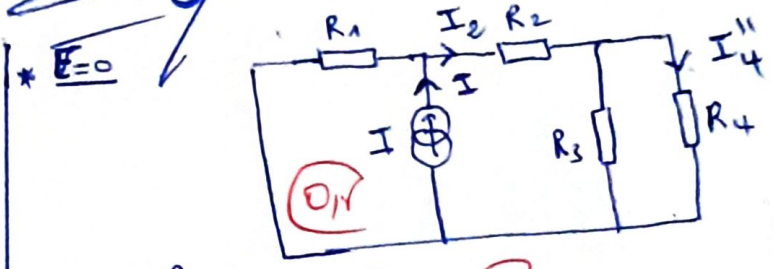
$$I_1 = \frac{E}{Req_1} \; ; \; Req_1 = (R_1+R_2)+(R_3 // R_4) \quad (0,1)$$

$$Req_1 = (6+6)+\left(\frac{4\cdot 1}{4+1}\right) \; ; \; \boxed{Req_1 = 12{,}8\,\Omega} \quad (0,1)$$

$$I_1 = \frac{E}{Req_1} = \frac{12}{12{,}8} \; ; \; \boxed{I_1 = 0{,}93\,A} \quad (0,1)$$

$$I'_4 = \frac{R_3}{R_3+R_4} I_1 = \frac{4}{4+1}\, 0{,}93$$

$$\boxed{I'_4 = 0{,}75\,A} \quad (0,1)$$



* $E = 0$ (0,1)

$$I''_4 = \frac{R_3}{R_3+R_4} \cdot I_2 \quad (0,1)$$

$$I_2 = \frac{R_1}{R_1+Req_2} I \; ; \; Req_2 = R_2+(R_3 // R_4) \quad (0,1)$$

$$Req_2 = 6+\left(\frac{4\cdot 1}{4+1}\right) \; ; \; \boxed{Req_2 = 6{,}8\,\Omega} \quad (0,1)$$

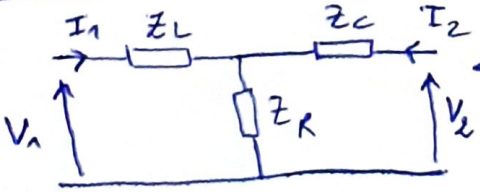
$$I_2 = \frac{R_1}{R_1+Req_2} I = \frac{6}{6+6{,}8}\cdot 2 \; ; \; \boxed{I_2 = 0{,}93A} \quad (0,1)$$

$$I''_4 = \frac{R_3}{R_3+R_4} I_2 = \frac{4}{4+1}\cdot 0{,}93$$

$$\boxed{I''_4 = 0{,}75\,A} \quad (0,1)$$

$$\boxed{I_4 = I'_4 + I''_4 = 0{,}75 + 0{,}75 = 1{,}5\,A} \quad (1)$$

Exercise 2 : (6pts)



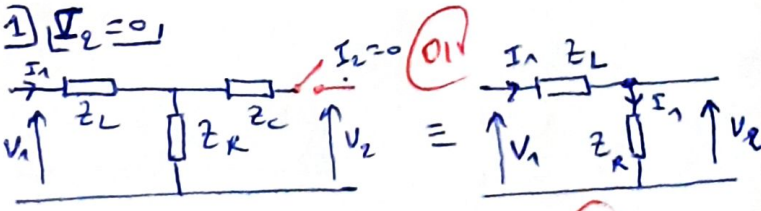
With : $Z_L = jL\omega$, $Z_C = \frac{1}{jC\omega}$, $Z_R = R$

(0,1) $\omega = 2\pi f$; $f = 50\,Hz$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = [Z]\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$\begin{cases} V_1 = Z_{11} I_1 + Z_{12} I_2 \\ V_2 = Z_{21} I_1 + Z_{22} I_2 \end{cases} \quad (0,1)$$

1) $I_2 = 0$



(0,1)

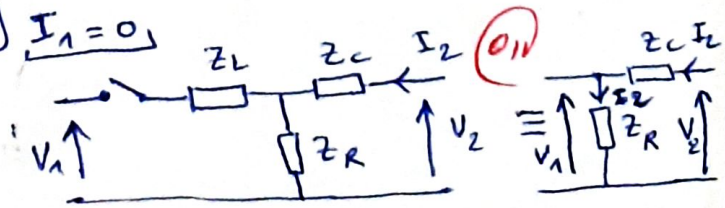
$$Z_{11} = \frac{V_1}{I_1} \; ; \; V_1 = (Z_L+Z_R) I_1 \quad (0,1)$$

$$\Rightarrow \boxed{Z_{11} = Z_L + Z_R = jL\omega + R = (1+j100\pi)\,\Omega} \quad (0,1)$$

$$Z_{21} = \frac{V_2}{I_2} \; ; \; V_2 = Z_R I_1 \quad (0,1)$$

$$\Rightarrow \boxed{Z_{21} = Z_R = R = 1\,\Omega} \quad (0,1)$$

2) $I_1 = 0$



(0,1)

$V_1 = Z_{12} I_2$; $V_1 = Z_R I_2$ (0,1) $\Rightarrow$ $\boxed{Z_{12} = Z_R = R = 1\,\Omega}$ (0,1)

$V_2 = Z_{22} I_2$; $V_2 = (Z_C + Z_R) I_2 \Rightarrow Z_{22} = Z_C + Z_R = \frac{1}{jC\omega} + R$ (0,1)

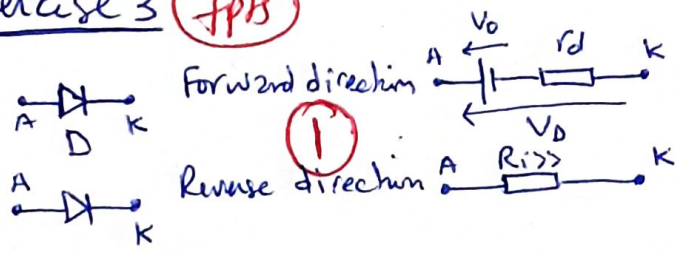
$$\boxed{Z_{22} = \left(1 + j\frac{1}{1\omega_0\pi}\right)\Omega} \quad (0,1)$$

$$[Z] = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 1+j1\omega_0\pi & 1 \\ 1 & 1 - j\frac{1}{1\omega_0\pi} \end{bmatrix}$$

وانتهى فيصل

Exercise 3 (7pts)

1] Forward direction (1)



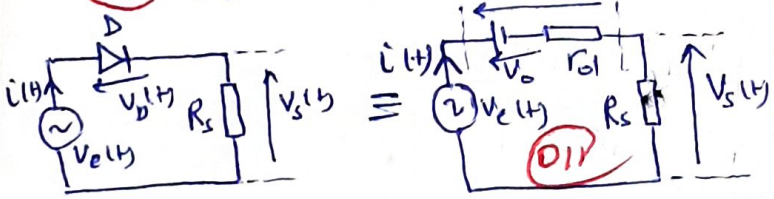
2]

- The diode D is reverse-biased if

$V_e \leq V_0 \Rightarrow i(t) = 0$ (0,1)

- The diode D is forward-biased if

(0,1) $V_e > V_0 \Rightarrow i(t) \neq 0$



Applying the Voltage Kirchhoff's law (VKL)

$V_e(t) = V_0 + (r_d + R_s) i(t)$

$$\boxed{i(t) = \frac{V_e(t) - V_0}{R_s + r_d}} \quad (0,1) \quad \text{①}$$

~~$V_D(t) = V_0 + r_d \cdot i(t)$~~

$$\boxed{V_D(t) = V_e(t) - R_s\, i(t)} \quad \text{②}$$

$$\boxed{V_s(t) = V_e(t) - V_D(t)} \quad \text{③}$$

$$\boxed{V_s(t) = R_s i(t)}$$

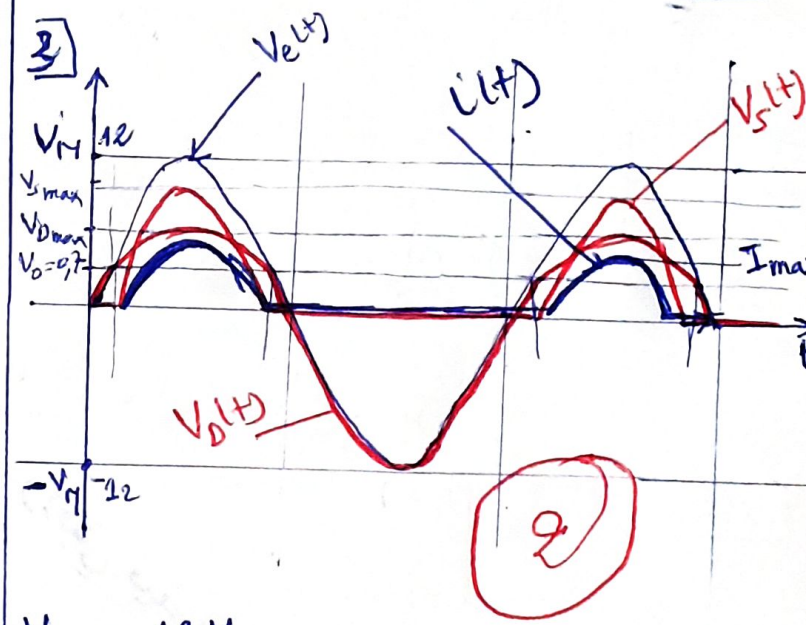
① in ② $\Rightarrow$

$$V_D(t) = \begin{cases} V_e(t) \text{ if } i(t) = 0 \text{ ; D is reverse-biased} \\ \frac{r_d}{r_d + R_s} V_e(t) + \frac{R_s}{r_d + R_s} V_0 \text{ if } i(t) \neq 0 \text{ D is forward-biased} \end{cases} \quad (1)$$

① in ③

$$V_s(t) = \begin{cases} 0 \text{ if } i(t) = 0 \text{ ; D is reverse-biased} \\ R_s \frac{V_e(t) - V_0}{R_s + r_d} \text{ if } i(t) \neq 0 \text{ D is forward biased} \end{cases} \quad (1)$$

3]



$V_M = 12\,V$

$I_{max} = \frac{V_M - V_0}{R_s + r_d} = 0,7\,A$

$V_{s\,max} = R_s \frac{V_M - V_0}{R_s + r_d} = 7,7\,A$

$V_{D\,max} = \frac{r_d}{r_d + R_s} V_M + \frac{R_s}{r_d + R_s} V_0$

$\boxed{V_{D\,max} = 4,46\,V}$