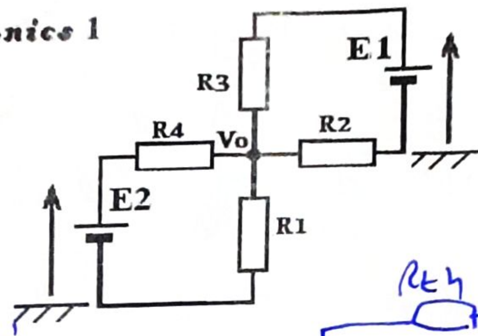
الاسم: ....
اللقب: ....
الشعبة: .... الفوج: ....

A

Exam (1h:30min)

Fundamental Electronics 1



5pts. Exercise 1: Lets consider the opposite circuit :

Select one method to **determinate** the output voltage ?
Choose from : (**Superposition**, **Thevenin**, or **Milman**)

MILMAN

$$V_0 = \frac{E_2 \cdot \frac{1}{R_4} + E_1 \cdot \frac{1}{R_3}}{\frac{1}{R_4} + \frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{R_2}} \quad 2$$

$$V_0 = \frac{R_1 R_2 (R_3 E_2 + R_4 E_1)}{R_1 R_2 R_3 + R_2 R_3 R_4 + R_1 R_2 R_4 + R_1 R_3 R_4} \quad 3$$

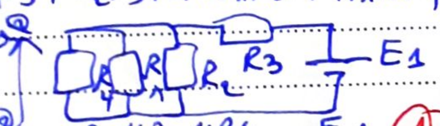
Superposition

$E_1 = 0$

Voltage divider $\Rightarrow V_0^{(1)} = \frac{R_1 // R_2 // R_3}{R_1 // R_2 // R_3 + R_4} E_2$ 1

$\Rightarrow V_0^{(1)} = \frac{R_1 R_2 R_3 E_2}{R_1 R_2 R_3 + R_2 R_3 R_4 + R_1 R_2 R_4 + R_1 R_3 R_4}$ 1

$E_2 = 0$

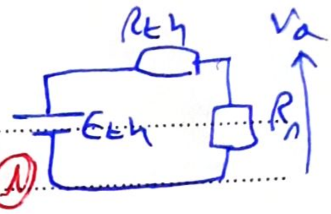


Voltage divider $V_0^{(2)} = \frac{R_1 // R_2 // R_4}{R_1 // R_2 // R_4 + R_3} E_1$ 1

$\Rightarrow V_0^{(2)} = \frac{R_1 R_2 R_4 E_1}{R_1 R_2 R_3 + R_2 R_3 R_4 + R_1 R_2 R_4 + R_1 R_3 R_4}$ 1

So $V_0 = V_0^{(1)} + V_0^{(2)} = \frac{R_1 R_2 (R_3 E_2 + R_4 E_1)}{R_1 R_2 R_3 + R_2 R_3 R_4 + R_1 R_2 R_4 + R_1 R_3 R_4}$ 1

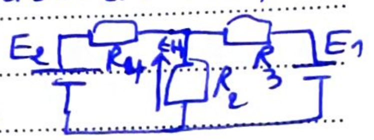
Thevenin



V.D $\Rightarrow V_0 = \frac{R_1 \, E_{th}}{R_1 + R_{th}}$ (a) 1

$R_{th} = R_2 // R_3 // R_4 = \frac{R_2 R_3 R_4}{R_2 R_3 + R_2 R_4 + R_3 R_4}$ 1,5 (b)

MILMAN



$\Rightarrow E_{th} = \frac{\frac{E_2}{R_4} + \frac{E_1}{R_3}}{\frac{1}{R_4} + \frac{1}{R_2} + \frac{1}{R_3}}$

$\Rightarrow E_{th} = \frac{R_2 (R_3 E_2 + R_4 E_1)}{R_2 R_3 + R_3 R_4 + R_2 R_4}$ (c) 1,5

(b) and (c) in (a) $\Rightarrow$

$V_0 = \frac{R_1 R_2 (R_3 E_2 + R_4 E_1)}{R_1 R_2 R_3 + R_2 R_3 R_4 + R_1 R_2 R_4 + R_1 R_3 R_4}$ 1

5pts. Exercise 2:

Lets consider the opposite quadrupole circuit :

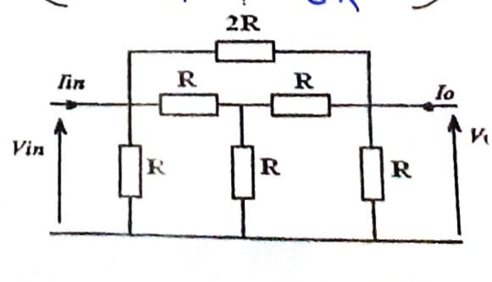
1/ **Determinate** the admittance matrix **[Y]** using **parallel** association?

$$[Y] = [Y1] + [Y2] = \begin{pmatrix} \frac{1}{R} + \frac{1}{2R} = \frac{3}{2R} & -\frac{1}{2R} \\ -\frac{1}{2R} & \frac{3}{2R} \end{pmatrix} + \begin{pmatrix} \frac{2R}{3R^2} = \frac{2}{3R} & -\frac{R}{3R^2} = -\frac{1}{3R} \\ -\frac{1}{3R} & \frac{2}{3R} \end{pmatrix} = \begin{pmatrix} \frac{3}{2R} + \frac{2}{3R} = \frac{13}{6R} & -\frac{1}{2R} - \frac{1}{3R} = \frac{-5}{6R} \\ -\frac{5}{6R} & \frac{13}{6R} \end{pmatrix}$$

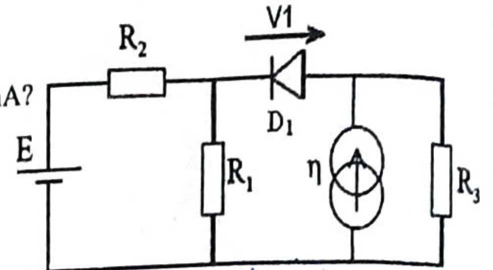
1 1,5 0,5

2/ **Determinate** its hybrid matrix ? [H]=

$$[H] = \begin{pmatrix} \frac{1}{Y_{11}} = \frac{6R}{13} & \frac{-Y_{12}}{Y_{11}} = \frac{5}{13} \\ \frac{Y_{21}}{Y_{11}} = -\frac{5}{13} & \frac{\Delta Y}{Y_{11}} = \frac{24}{13R} \end{pmatrix} \quad 2$$



5pts. Exercise 3: Lets consider the opposite circuit with **ideal** diode:

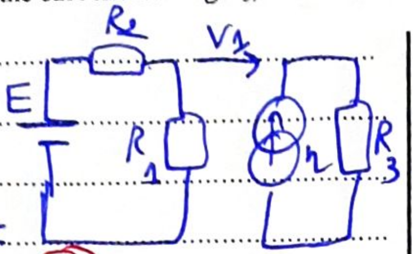


1/ Remove the diode, then **determinate** the dropping voltage **V1**?

2/ **Determinate** the **current** flowing R_3, for $R_1=R_2=R_3=500\Omega$, $E=10v$, $\eta=20mA$?

3/ **Determinate** the **current** flowing R_3, if we reverse the diode?

1/

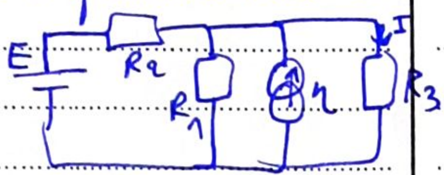


$V_1 = R_3\eta - \frac{R_1}{R_1+R_2}E$ 1

2/ for $R_1=R_2=R_3=R$ we have

$V_1 = R\eta - \frac{E}{2} = +5v > 0$ 1

$\Rightarrow$ the diode is forward $\Rightarrow$ Short circuit



MILMAN

$I = \frac{V_L}{R_3} = \frac{\frac{E}{R_2}+\eta}{R_3\left(\frac{1}{R_2}+\frac{1}{R_1}+\frac{1}{R_3}\right)}$

$\Rightarrow I = \frac{R_1(E+R_2\eta)}{R_1R_3+R_2R_3+R_1R_2}$ 1

$I = \frac{20}{3}\ mA = 6{,}66\ mA$

3/ if we reverse the diode $\Rightarrow$

$V_1 = -5v < 0 \Rightarrow$ D is reverse

$\Rightarrow$ open circuit 1 1

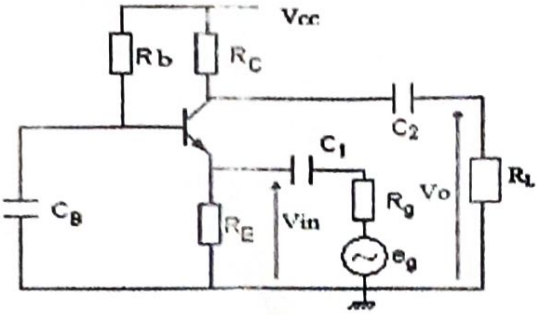
$\Rightarrow$ the current flowing R_3 is $\eta = 20mA$

الاسم: ....

اللقب: ....

الشعبة: .... الفوج: ....

A

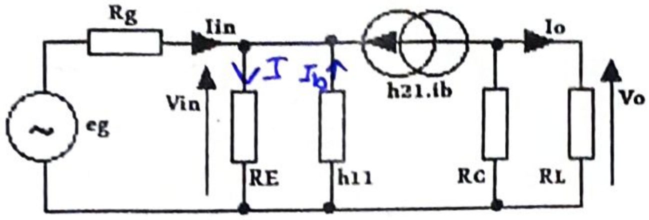


5pts. Exercise 4: Lets consider the opposite amplifier circuit:

1/ **Determinate** the base resistor R_b to have the operating point **Q** at the midpoint (middle) of the static charge.

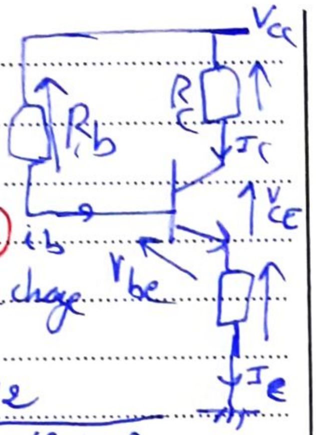
Considering the equivalent AC circuit below:

2/ **Find** the voltage gain G_v and the input impedance Z_{in}?



Given: $R_g=100\Omega$, $R_E=1k\Omega$, $R_C=R_L=10k\Omega$., $h11=5\ k\Omega$, $h21=\beta=100$, $h_{22}=0$, $Vbe=0{,}6$ v, $Vcc=10v$.

the charge loop



$V_{CE} = V_{cc} - \left(R_C + \frac{(\beta+1)}{\beta} R_E\right) I_C$ 0,5

Q in the middle of static charge

⇕

$V_{CE0} = \frac{V_{cc}}{2} \Rightarrow I_{C0} = \frac{V_{cc}/2}{R_C + \frac{(\beta+1)}{\beta} R_E}$

calculating: $I_{C0} = 0{,}454$ mA

then $I_{b0} = \frac{I_{C0}}{\beta} = 4{,}54\ \mu A$ 0,5

the attack loop

$\Rightarrow I_b = \frac{V_{cc} - V_{be}}{R_b + (\beta+1) R_E}$ 0,5

the we have

$R_b = \frac{V_{cc} - V_{be} - (\beta+1) R_E I_{b0}}{I_{b0}}$

0,5

calculating: $R_b = 1{,}97\ M\Omega$

We have $G_v = \frac{V_o}{V_{in}}$

$V_{in} = -h_{11} I_b$ — (a) 0,5

$V_o = -\beta (R_C // R_L) I_b = -\beta \frac{R_C R_L}{R_C + R_L} I_b$ — (b) 0,5

$\frac{b}{a} \Rightarrow G_v = \beta \frac{R_C // R_L}{h_{11}} = \beta \frac{R_C R_L}{h_{11}(R_C + R_L)}$ 0,5

calculating: $G_v = 100$ 0,5

$Z_{in} = \frac{V_{in}}{I_{in}}$

0,5

$\frac{1}{Z_{in}} = \frac{1}{R_E} + \left(\frac{\beta+1}{h_{11}}\right) \Rightarrow Z_{in} = R_E // \frac{h_{11}}{\beta+1}$

calculating: $Z_{in} = 47{,}17\ \Omega$ 0,5

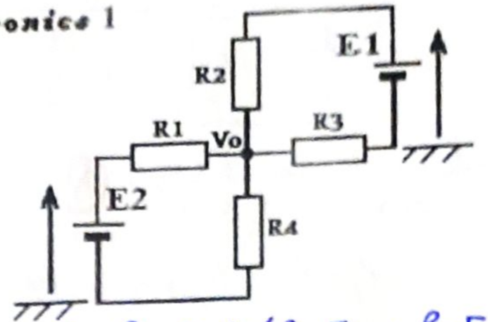
الاسم:
اللقب:
الشعبة: الفوج:

B

Exam (1h:30min)

Fundamental Electronics 1

5pts. Exercise 1: Lets consider the opposite circuit :



Select one method to determinate the output voltage ?
Choose from : (Superposition, Thevenin, or Milman)

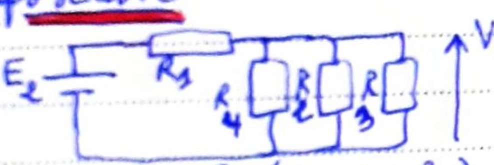
MILMAN:

$$V_o = \frac{E_2 \times \frac{1}{R_1} + E_1 \times \frac{1}{R_2}}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}} \quad 2$$

$$V_o = \frac{R_3R_4(R_2E_2 + R_1E_1)}{R_2R_3R_4 + R_1R_3R_4 + R_1R_2R_4 + R_1R_2R_3} \quad 3$$

Superposition

$E_1 = 0$



1

Voltage divider $\Rightarrow V_o^{①} = \frac{(R_2 // R_3 // R_4)}{(R_2//R_3//R_4) + R_1} E_2$

$$\Rightarrow V_o^{①} = \frac{R_2R_3R_4E_2}{R_2R_3R_4 + R_1R_3R_4 + R_1R_2R_4 + R_1R_2R_3} \quad 1$$

$E_2 = 0$

Voltage divider $\Rightarrow V_o^{②} = \frac{(R_1//R_4//R_3)}{(R_1//R_4//R_3) + R_2} E_1$ 1

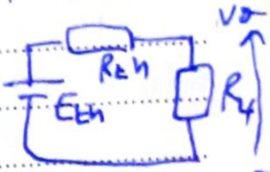
$$\Rightarrow V_o^{②} = \frac{R_3R_4R_1}{R_2R_3R_4 + R_1R_3R_4 + R_1R_2R_4 + R_1R_2R_3} E_1 \quad 1$$

$$\text{So } V_o = V_o^{①} + V_o^{②} = \frac{R_3R_4(R_2E_2 + R_1E_1)}{R_2R_3R_4 + R_1R_3R_4 + R_1R_2R_4 + R_1R_2R_3} \quad 1$$

Thevenin

1

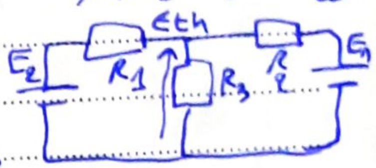
$$\text{V.D.} \Rightarrow V_o = \frac{R_4 \, E_{th}}{R_{th} + R_4} \quad (a)$$



1,5

$$R_{th} = R_1 // R_2 // R_3 = R_1R_2R_3 / R_1R_2 + R_1R_3 + R_2R_3 \quad (b)$$

MILMAN $\Rightarrow$



$$E_{th} = \frac{\frac{E_2}{R_1} + \frac{E_1}{R_2}}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

1,5

$$\Rightarrow E_{th} = \frac{R_3(R_2E_2 + R_1E_1)}{R_1R_2 + R_1R_3 + R_2R_3} \quad (c)$$

(b) and (c) into (a) $\Rightarrow$ 1

$$V_o = \frac{R_3R_4(R_2E_2 + R_1E_1)}{R_2R_3R_4 + R_1R_3R_4 + R_1R_2R_4 + R_1R_2R_3}$$

5pts. Exercise 2:

Lets consider the opposite quadrupole circuit :

Lets consider the opposite admittance matrix [Y] using parallel association?

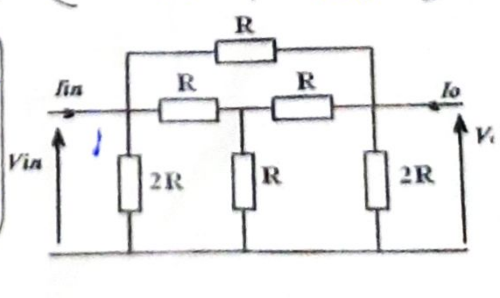
1/ Determinate the admittance matrix [Y] using parallel association?

1 1,5 0,5

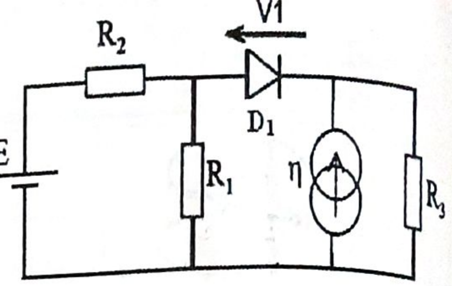
$$[Y] = [Y1] + [Y2] = \begin{pmatrix} \frac{1}{2R}+\frac{1}{R} = \frac{3}{2R} & -\frac{1}{R} \\ -\frac{1}{R} & \frac{3}{2R} \end{pmatrix} + \begin{pmatrix} \frac{2R}{3R^2} = \frac{2}{3R} & -\frac{R}{3R^2} = -\frac{1}{3R} \\ -\frac{1}{3R} & \frac{2}{3R} \end{pmatrix} = \begin{pmatrix} \frac{3}{2R}+\frac{2}{3R} = \frac{13}{6R} & -\frac{1}{R}-\frac{1}{3R} = -\frac{4}{3R} \\ -\frac{4}{3R} & \frac{13}{6R} \end{pmatrix}$$

2/ Determinate its hybrid matrix ? [H]= 2

$$\begin{pmatrix} \frac{1}{Y_{11}} = \frac{6R}{13} & -\frac{Y_{12}}{Y_{11}} = \frac{8}{13} \\ \frac{Y_{21}}{Y_{11}} = \frac{-8}{13} & \frac{\Delta Y}{Y_{11}} = \frac{35}{26R} \end{pmatrix}$$



5 pts. **Exercise 3:** Lets consider the opposite circuit with **ideal** diode:

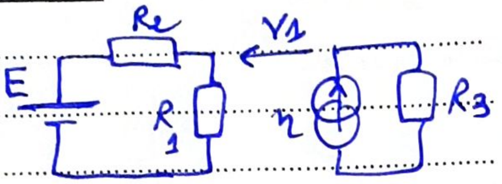


1/ Remove the diode, then **determinate** the dropping voltage **V1**?

2/ **Determinate** the current flowing R_3, for $R_1=R_2=R_3=500\Omega$, E=10v, η=20mA?

3/ **Determinate** the current flowing R_3, if we reverse the diode?

1/



$$V_1 = \frac{R_1}{R_1+R_2}E - R_3\eta \quad 1$$

2/ for $R_1=R_2=R_3=R$ we have

$$V_1 = \frac{E}{2} - R\eta = -5v < 0 \quad 1$$

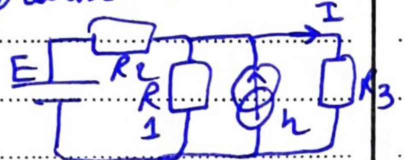
⇒ the diode is reverse ⇒ Open circuit

⇒ the current flowing R_3 is $\eta = 20mA$ 1

3/ if we reverse the diode ⇒

$$V_1 = R_3\eta - \frac{R_1}{R_1+R_2}E = +5v > 0 \quad 1$$

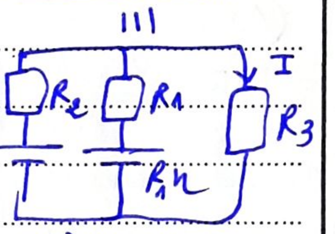
⇒ the diode is forward ⇒ Short circuit



MILMAN

⇓

$$I = \frac{V_t}{R_3} = \frac{\frac{E}{R_2}+\eta}{R_3\left(\frac{1}{R_2}+\frac{1}{R_1}+\frac{1}{R_3}\right)}$$



$$\Rightarrow I = \frac{R_1(E+R_2\eta)}{R_1R_3+R_2R_3+R_1R_2} \quad 1$$

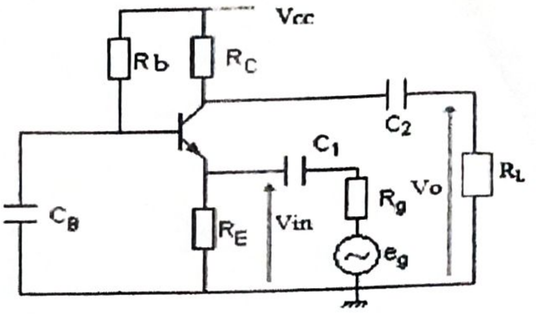
$$I = \frac{20}{3}mA = 6{,}66\ mA$$

الاسم: ....

اللقب: ....

الشعبة: .... الفوج: ....

B

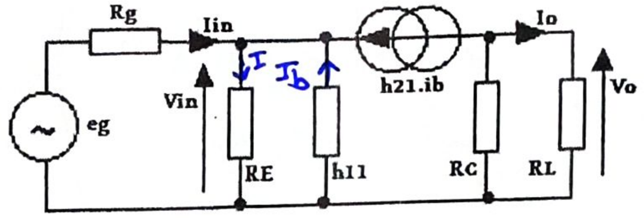


5pts. Exercise 4: Lets consider the opposite amplifier circuit:

1/ **Determinate** the base resistor R_b to have the operating point **Q** at the midpoint (middle) of the static charge.

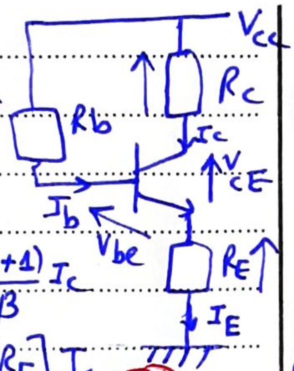
Considering the equivalent AC circuit below:

2/ **Find** the voltage gain G_v and the input impedance Z_{in}?



Given: $R_g=100\Omega$, $R_E=1k\Omega$, $R_C=R_L=10k\Omega$., $h11=5\ k\Omega$, $h21=\beta=100$, $h_{22}=0$, $Vbe=0{,}6\ v$, $Vcc=20v$.

the charge loop



$V_{CE}+R_C I_C+R_E I_E-V_{cc}=0$

$\Rightarrow V_{CE}=V_{cc}-R_C I_C-R_E\frac{(\beta+1)}{\beta}I_C$

$\Rightarrow V_{CE}=V_{cc}-\left[R_C+\left(\frac{\beta+1}{\beta}\right)R_E\right]I_C$ (0,5)

Q in the middle of static charge.

$\Rightarrow V_{CE_Q}=\frac{V_{cc}}{2}\Rightarrow I_{C_Q}=\frac{V_{cc}-V_{CE}=\frac{V_{cc}}{2}}{R_C+\left(\frac{\beta+1}{\beta}\right)R_E}$

calculating $\Rightarrow I_{C_Q}=0{,}908\ mA$

(0,5)

then $I_{b_Q}=\frac{I_{CQ}}{\beta}=9{,}08\ \mu A$

the attack loop $V_{cc}-R_b I_b-V_{be}-R_E I_E=0$

$\Rightarrow V_{cc}-V_{be}=\left[R_b+(\beta+1)R_E\right]I_b$ (0,5)

then we have $R_b=\frac{V_{cc}-V_{be}-(\beta+1)R_E I_b}{I_b}$

calculating: $R_b=2{,}04\ M\Omega$ (0,5)

We have $G_V=\frac{V_o}{V_{in}}$

$V_{in}=-h_{11}\times I_b$ — ⓐ (0,5)

$V_o=-\beta I_b\times(R_C//R_L)=-\beta\frac{R_C R_L}{R_C+R_L}\times I_b$ — ⓑ (0,5)

$\frac{ⓑ}{ⓐ}\Rightarrow G_V=+\beta\frac{R_C R_L}{h_{11}(R_C+R_L)}$ (0,5)

Calculating $G_V=100$ (0,5)

$Z_{in}=\frac{V_{in}}{I_{in}}$

We have KCL $\Rightarrow I_{in}+\beta i_b+I_b=I$

$\Rightarrow I_{in}=I-(\beta+1)I_b$

$I=\frac{V_{in}}{R_E}\Rightarrow I_{in}=\frac{V_{in}}{R_E}-(\beta+1)I_b$

ⓐ $\Rightarrow I_b=\frac{-V_{in}}{h_{11}}\Rightarrow$

$I_{in}=\frac{V_{in}}{R_E}+\frac{V_{in}(\beta+1)}{h_{11}}\Rightarrow\frac{I_{in}}{V_{in}}=\frac{1}{R_E}+\frac{(\beta+1)}{h_{11}}$

$\Rightarrow\frac{1}{Z_{in}}=\frac{1}{R_E}+\frac{(\beta+1)}{h_{11}}\Rightarrow Z_{in}=R_E\,//\,\frac{h_{11}}{\beta+1}$ (0,5)

Calculating $Z_{in}=47{,}17\ \Omega$ (0,5)