BRAC University
Dept. of Computer Science and Engineering

Assessment: Assignment 1
Due: 12 PM 10 October 2023
Full Marks: **50**

Semester:	Fall 2023
Course Code:	CSE251
Section:	**21**
Course Name:	Electronic Devices and Circuits

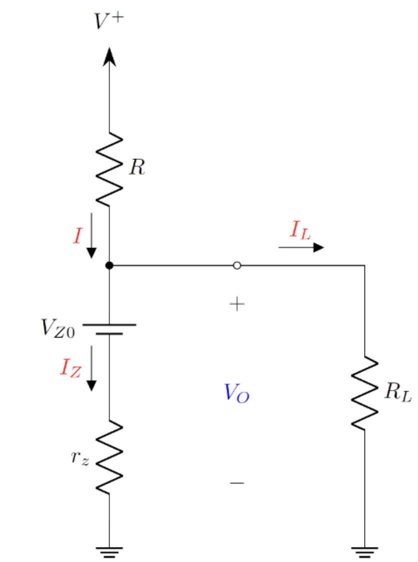
Name: ____________________

Student ID: ____________________

- ✓ Write down your student ID on the **top right corner of each of the pages**.
- ✓ Clearly write the solutions, along with the questions, on white paper with black ink (no need to use color pen, don't use pencils).
- ✓ Use **CamScanner**, or **Adobe Scan**, or **Microsoft Office Lens**, or any other software to scan the pages and make a **single PDF file**.
- ✓ After creating the PDF, make sure that **(a)** there are no pages missing, **(b)** all of the pages are legible, **(c)** your student ID on each page are visible.
- ✓ Please note, **collaboration ≠ copying**. You are allowed to discuss the questions and clear confusion you might have, but you have to write your solutions independently and be able to explain your answers during a random viva.
- ✓ **[Very Important]** Rename the PDF in the following format: **"A1_StudentID_FullNameWithoutSpace.pdf"**. For example, if my student ID is 12345678 and my name is Shadman Shahid, the filename should be **"A1_12345678_ShadmanShahid.pdf"**.
- ✓ **Submission Link:** https://forms.gle/UhtL5NgJ5sVW3MU56

Question 1: 8 Marks

For $\boldsymbol{R} = 80\ \Omega$, $\boldsymbol{R_L} = 15\ \text{k}\Omega$, $\boldsymbol{r_z} = 30\ \Omega$, $\boldsymbol{V_{ZO}} = 4\ \text{V}$, and $\boldsymbol{I_Z} = 1\ \text{mA}$.



a) Find $\boldsymbol{V_O}, \boldsymbol{I_L}$ [CO2] 4

b) Find $\boldsymbol{I}, \boldsymbol{V^+}$. [CO2] 4

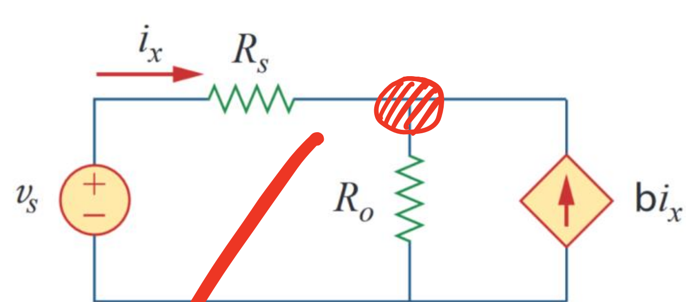
a) $V_o = V_{Z0} + I_z r_z = (4 + 0.03)\,V = \boxed{4.03\,V}$

$I_L = \frac{V_o}{R_L} = \frac{4.03}{15}\,mA = \boxed{0.2687\,mA}$.

b) $I = I_L + I_z = (0.269 + 1)\,mA = \boxed{1.269\,mA}$

$V^+ = V_o + IR = (4.03 + 1.269 \times 0.08)\,V = \boxed{4.1315\,V}$

Question 2: 12 Marks

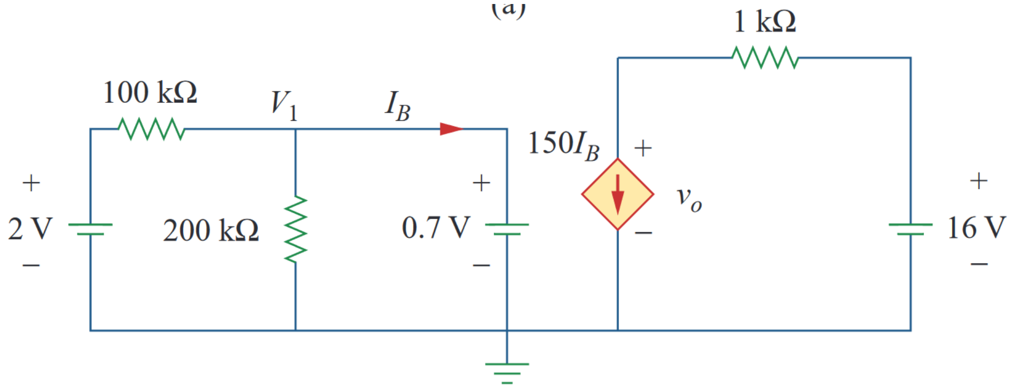


a) Analyze the circuit in the Figure above to find $\boldsymbol{i_x}$ in terms of $\boldsymbol{v_S}, \boldsymbol{R_S}, \boldsymbol{R_O}$, and $\boldsymbol{b}$. [CO1] 2

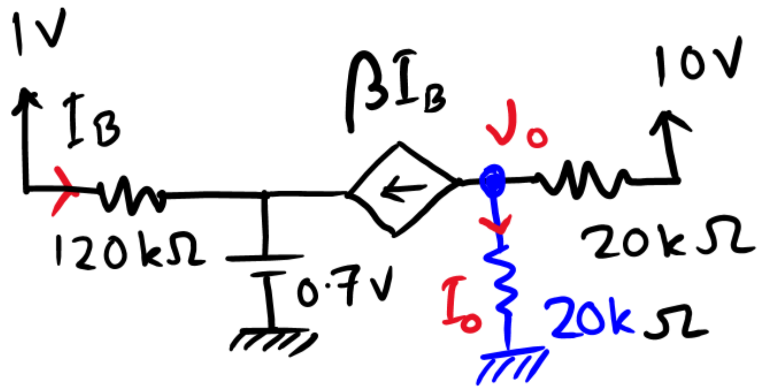
KCL :

$$i_x + b i_x = \frac{v_s - i_x R_s}{R_o} \Rightarrow \boxed{i_x = \frac{v_s}{R_o(1+b) + R_s}}$$

(a)



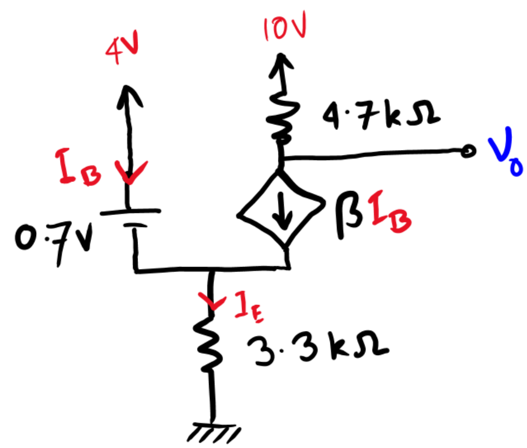
b) For the above circuit, find the value of $\boldsymbol{v_o}$. [CO2] 4



c) In the above circuit, $\beta = 120$. Find the current $\boldsymbol{I_O}$ and $\boldsymbol{v_o}$ from the given circuit. [CO2] 6

Question 3: 10 Marks

In the adjacent circuit $\boldsymbol{\beta = 80}$.



a) Derive an expression of $\boldsymbol{I_E}$ in terms of $\boldsymbol{I_B}$ and $\boldsymbol{\beta}$. [CO1] 2

b) Find the value of the currents $\boldsymbol{I_E}$., and $\boldsymbol{I_B}$. [CO2] 3

c) Find the value of the voltage at the output node $\boldsymbol{v_o}$. [CO2] 2

d) Express $\boldsymbol{v_o}$ in terms of $\boldsymbol{I_B}$ and $\boldsymbol{\beta}$. Thereafter, determine how $\boldsymbol{v_o}$ would change for changing the value of $\boldsymbol{\beta}$. Show the change in $\boldsymbol{v_o}$ for $\boldsymbol{\beta = 50}$ and $\boldsymbol{\beta = 20}$. [CO2] 3

2b) $I_B = \frac{2-0.7}{100} - \frac{0.7}{200} = \boxed{9.5\ \mu A}$. [KCL at V_1]

$\therefore v_o = 16 - 1 \times 150 I_B = \boxed{14.575\ V}$. [KVL at right loop]

2 Solution (c):

$I_B = \frac{1-0.7}{120}\ mA = 2.5\ \mu A$:

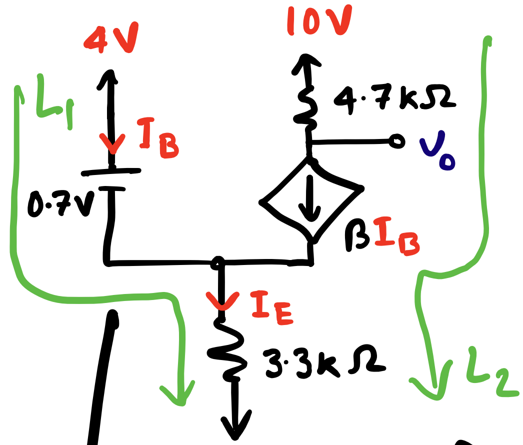
$\beta I_B = (80 \times 2.5 \times 10^{-3})\ mA$
$= 0.2\ mA$

KCL at v_o: $\beta I_B = \frac{10 - v_o}{20} - \frac{v_o}{20}$

$\Rightarrow v_o = \left(\frac{10}{20} - 0.2\right) 10 = \boxed{3V}$

$I_o = \frac{3}{20}\ mA = \boxed{0.15\ mA}$

Q.3



a) $I_E = I_B + \beta I_B$

b) Taking KVL along L_1: $\boxed{4 - 0.7 - 3.3 I_E = 0}$

$\Rightarrow I_E = \frac{3.3}{3.3}$ mA $= 1$ mA

$I_B = \frac{I_E}{\beta + 1} = \frac{1}{81}$ mA.

c) $V_o = 10 - 4.7 \beta I_B$

$= 10 - 4.7 \times \frac{80}{81}$

$= 5.36$ V

KVL along line L_2:

d) $V_o = 10 - 4.7 \beta I_B$

When; $\beta = 50$,

$I_B = \frac{I_E}{\beta+1} = \frac{1}{51}$

$\therefore V_o = 10 - 4.7 \times \frac{50}{51}$

$= 5.392$ V

$\beta = 20$

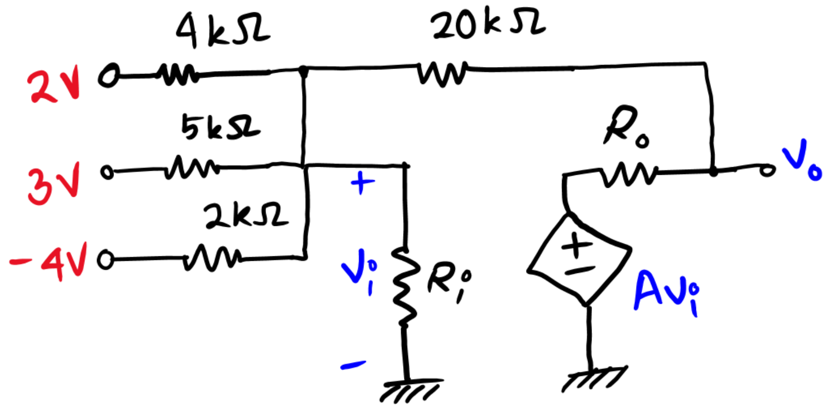
$I_B = \frac{I_E}{\beta+1} = \frac{1}{21}$

$V_o = 10 - 4.7 \times \frac{20}{21}$

$= 5.524$ V

V_o will remain almost constant.

Question 4: 10 Marks



In the above circuit $A = 50$, $R_i = 80\ \text{k}\Omega$ and $R_o = 800\ \Omega$. Answer the following questions

a) Write the node equations for the nodes indicated by v_i and v_o. [CO1] 4

b) Solve the node equations to find the values of v_i and v_o. [CO2] 3

c) Can circuit theorems based on linearity principle (such as superposition principle) be applied to the above circuit? Explain in short why or why not. [CO1] 3

Solution:

a) At node v_i:

$$\frac{2-v_i}{4} + \frac{3-v_i}{5} + \frac{-4-v_i}{2} = \frac{v_i - v_o}{20} + \frac{v_i}{80} \quad \text{.......(i)}$$

At node v_o:

$$\frac{v_i - v_o}{20} + \frac{Av_i - v_o}{0.8} = 0 \quad \text{--------(ii)}$$

b) Simplifying:

(i) becomes:

$$v_i\left(\frac{1}{4}+\frac{1}{5}+\frac{1}{2}+\frac{1}{20}+\frac{1}{80}\right)-v_o\left(\frac{1}{20}\right)=\frac{2}{4}+\frac{3}{5}-\frac{4}{2}$$

$$\therefore\ 1.0125v_i-0.05v_o=-0.9 \quad \text{------ (iii)}$$

(ii) becomes:

$$v_i\left(-\frac{1}{20}-\frac{50}{0.8}\right)+v_o\left(\frac{1}{0.8}+\frac{1}{20}\right)=0$$

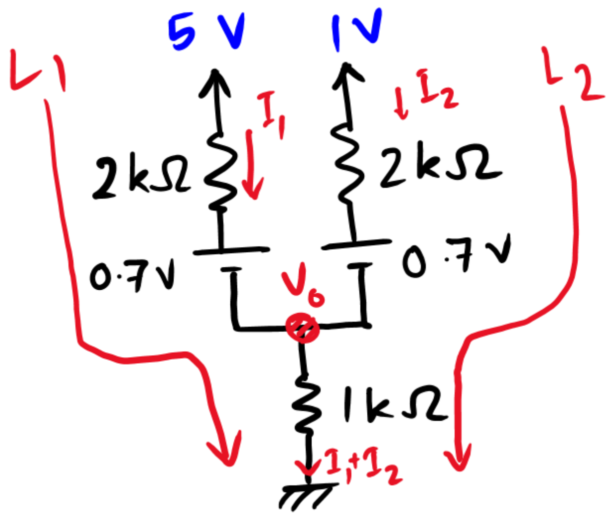
$$-62.55v_i+1.3v_o=0 \quad \text{------ (iv)}$$

Solving (iii) & (iv) we get:

$$\boxed{\begin{aligned} v_i &= 0.645\ \text{V} \\ v_o &= 31.0807\ \text{V}\end{aligned}}$$

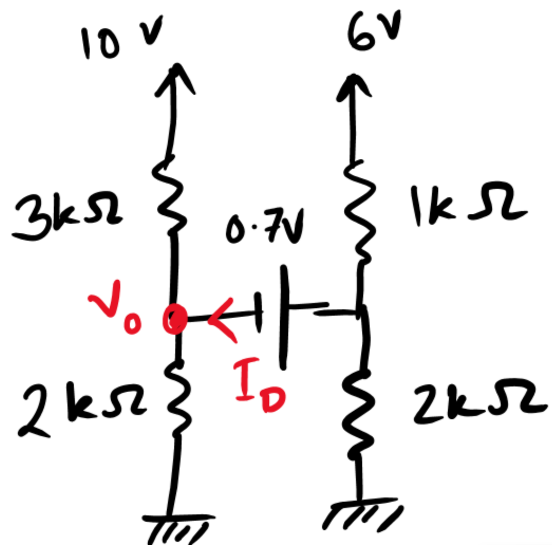
c) Yes! Because all the circuit elements are linear. (Even the voltage dependent voltage source, because the voltage dependence (Av_i) is linear.)

Question 5: 10 Marks



a) Write down the two KVL equations for the lines (loops) indicated by the red lines L_1 and L_2. [CO1] 3

b) Solve the circuit to find v_O, I_1 and I_2. You may use either mesh analysis or nodal analysis. [CO2] 4



c) Analyze the circuit to find v_O and I_O. [Use any technique of your choice.] [CO2] 3 (a,b) KVL at L_1: $5 - 2I_1 - 0.7 - (I_1 + I_2) = 0$

$$3I_1 + I_2 = 4.3 \quad \text{------- (i)}$$

KVL at L_2: $1 - 2I_2 - 0.7 - (I_1 + I_2) = 0$

$$I_1 + 3I_2 = 0.3 \quad \text{------- (ii)}$$

Solving:

$$\boxed{\begin{aligned} I_1 &= 1.575 \text{ mA} \\ I_2 &= -0.425 \text{ mA} \\ V_o &= (I_1 + I_2) \times 1 = 1.15 \text{ V} \end{aligned}}$$

c) $$\frac{10 - V_o}{3} + \frac{6 - (V_o + 0.7)}{1} = \frac{V_o}{2} + \frac{V_o + 7}{2}$$

Shortcut:

$$V_o\left(\frac{1}{3} + \frac{1}{2}\right) + (V_o + 0.7)\left(\frac{1}{1} + \frac{1}{2}\right) = \frac{10}{3} + \frac{6}{1}$$

$$V_o = \frac{3.33 + 6 - 0.7 \times 1.5}{1/3 + 1/2 + 1 + 1/2} = \boxed{3.55 \text{ V}}$$

$$I_o = \frac{V_o - 10}{3} + \frac{V_o}{2} = \boxed{-0.375 \text{ mA}}$$