BRAC University
Dept. of Computer Science and Engineering

Assessment: Assignment 3
Due: 11:59 PM 27 October 2023
Full Marks: **65**

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

Name: _____

Student ID: _____

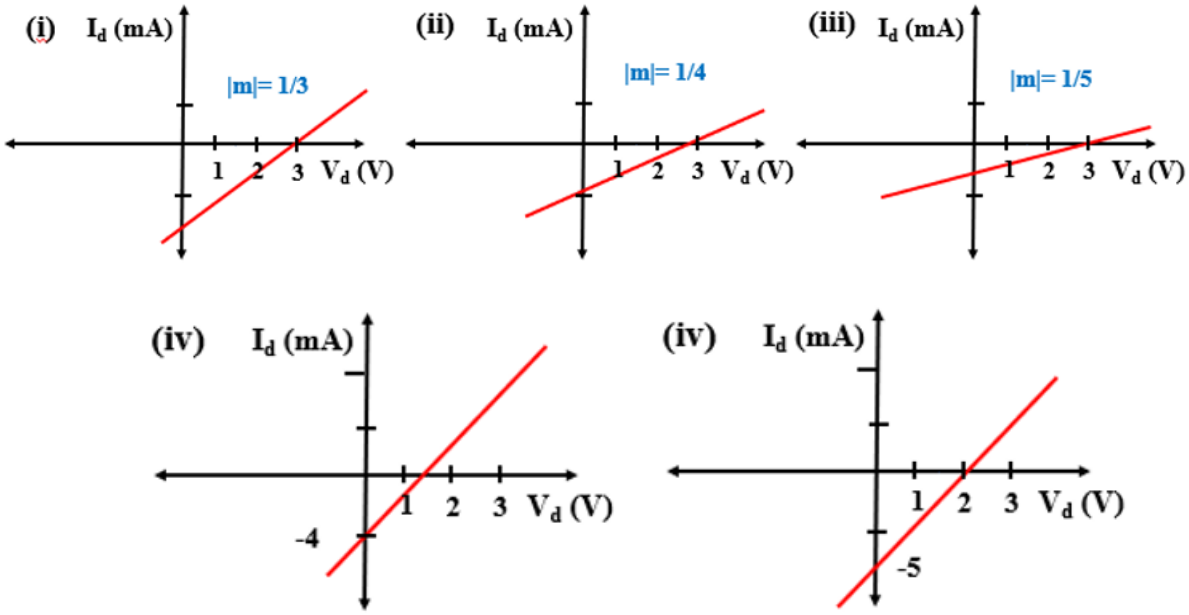
- ✓ Write down your student ID on the **top right corner of each of the pages**.
- ✓ Clearly write the solutions, along with the questions, on white paper with black ink (no need to use color pen, don't use pencils).
- ✓ Use **CamScanner**, or **Adobe Scan**, or **Microsoft Office Lens**, or any other 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/7NsJsGZ3bwP4CLfX7**

Question 1: 10 Marks

a) For the following sub-circuits, do the following: - Write down the equation representing this curve; - **Determine** the unknown parameters, - Label the I-V curve. [CO1] 5

i. A **3 V** voltage source
ii. A **5 mA** current source in parallel with a **5 kΩ**
iii. A **−10 V** voltage source with **3 kΩ**
iv. A short circuit
v. A current Source, $I_o = 5$ mA in parallel with a resistor. The slope of the curve is, $m = 5\ k\Omega^{-1}$

b) **Draw** the sub-circuit that will result in the following IV characteristics. [CO3] 5

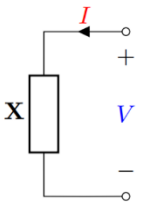


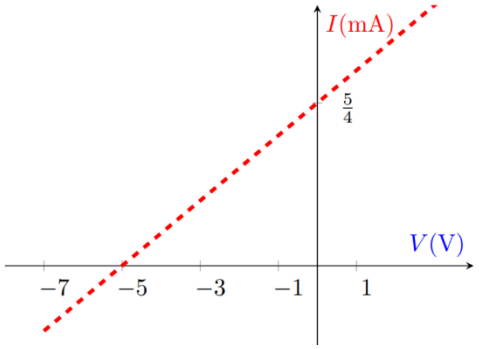
Question 2: 35 Marks

a) You are provided with the following circuit elements: [CO3] 5

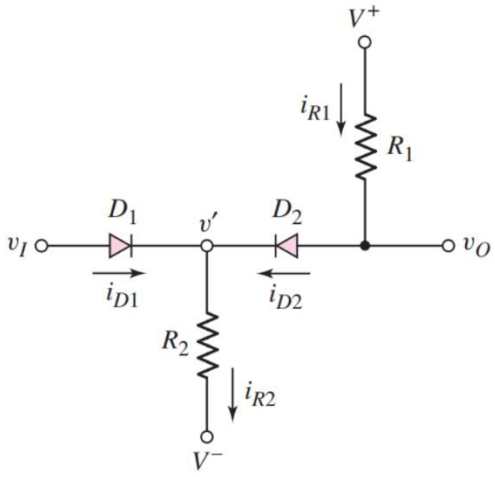
- **Two** 8 kΩ resistors
- A 3 V voltage source
- A 2 V voltage source

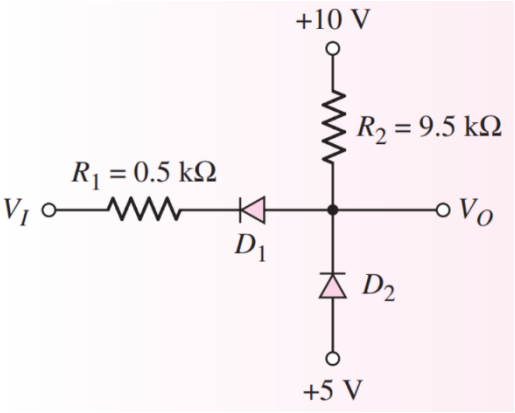
Can you **implement** a circuit element **X** that has an IV-characteristics, as seen in the **right** figure below, but by **ONLY USING THE ELEMENTS MENTIONED ABOVE**? The voltage polarity and current direction should be as shown in the left figure.





b) For the circuit **below (left)**, assume the following circuit parameters: $\boldsymbol{R_1 = 5\ \text{k}\Omega}$, $\boldsymbol{R_2 = 10\ \text{k}\Omega}$, $\boldsymbol{V_{DO} = 0.7\ \text{V}}$, $\boldsymbol{V^+ = 5\ \text{V}}$, $\boldsymbol{V^- = -5\ \text{V}}$. Determine v_o, i_{D1} and i_{D2} for $\boldsymbol{v_I = 0}$ and $\boldsymbol{v_I = 4\ \text{V}}$. [CO2] 3



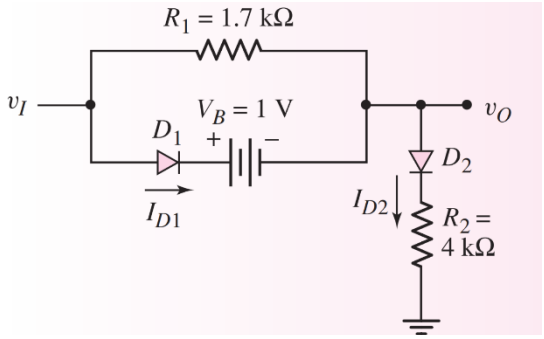


c) For the circuit **above (right).**, assume the following circuit parameters: $\boldsymbol{V_{DO} = 0.6\ \text{V}}$. Plot $\boldsymbol{v_o}$ versus $\boldsymbol{v_I}$, for $\boldsymbol{0 \le v_I \le 10\ \text{V}}$. [CO2] 7

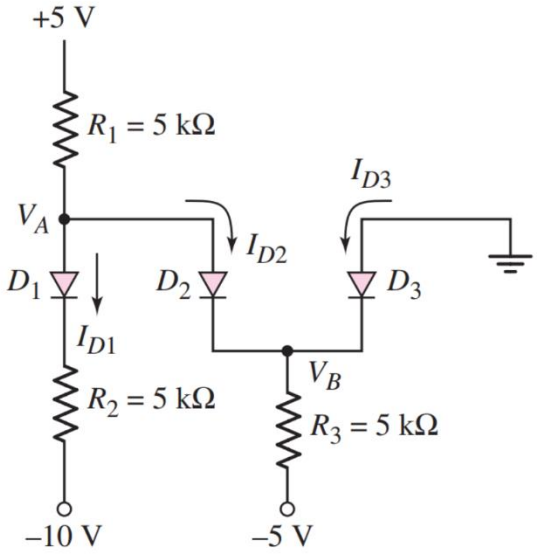
d) For the circuit below, the cut-in voltage for all the diodes are $\boldsymbol{V_{DO} = 0.7\ V.}$ [CO2] 10

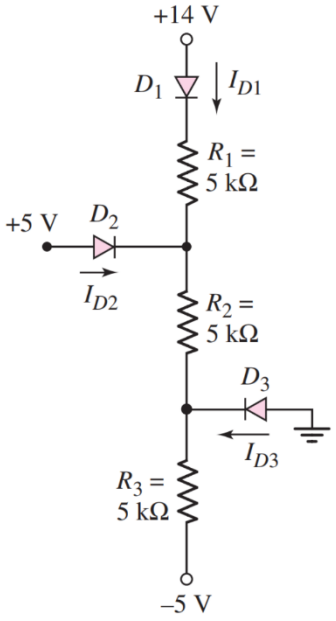
i. Let $\boldsymbol{v_I = 5\ V.}$ Assume both diodes are conducting. Is this a correct assumption? Why or why not? Determine $\boldsymbol{I_{R1}, I_{D1}, I_{D2}}$ and $\boldsymbol{v_O}$

ii. Repeat part (i) for $\boldsymbol{v_I = 10\ V}$



e) Determine the current in each diode ($\boldsymbol{I_{D1}, I_{D2}}$ and $\boldsymbol{I_{D3}}$) and the voltages $\boldsymbol{V_A}$ and $\boldsymbol{V_B}$ in the multi-diode circuit shown in the figure **below (left)**. Let, $\boldsymbol{V_{DO} = 0.7\ V}$ for each diode. [CO2] 5



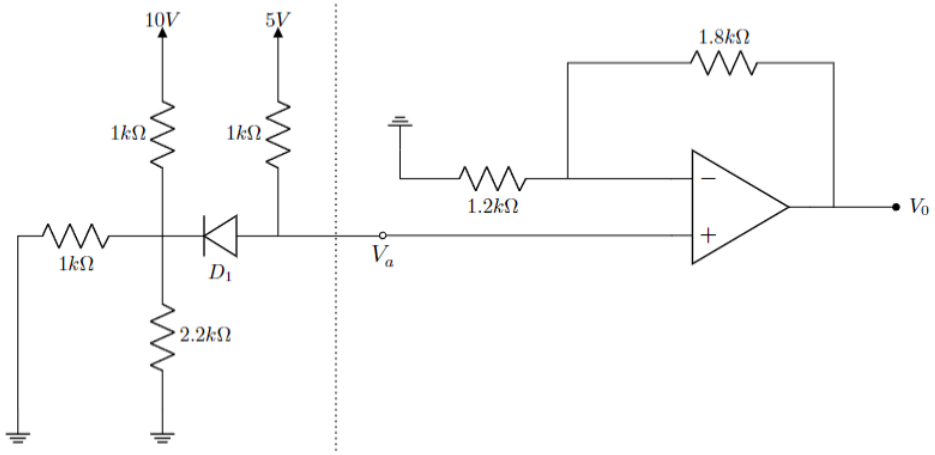


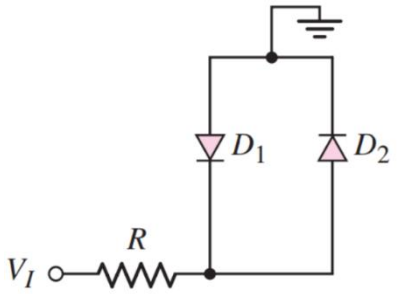
f) Determine $\boldsymbol{I_{D1}, I_{D2}}$ and $\boldsymbol{I_{D3}}$ and the voltages $\boldsymbol{V_A}$ and $\boldsymbol{V_B}$ for the circuit **above (right).** $\boldsymbol{V_{DO} = 0.7\ V}$ for each diode. [CO2] 5

Question 3: 20 Marks

The saturation voltages of the Op-Amp on the **left below**, are given as $+V_{\text{sat}} = +10\ \text{V}$ and $-V_{\text{sat}} = -10\ \text{V}$. The forward voltage drop of the diode, $\boldsymbol{V_{DO}}$ is $0.7\ \text{V}$. [CO2] 10

a) **Determine** the operating mode diode, D1. Verify your assumption with necessary calculations.
b) **Calculate** the voltage at –
   i. Node '$\boldsymbol{V_a}$'
   ii. Non-inverting terminal of the Op-Amp,
   iii. Inverting terminal of the Op-Amp.
c) Find out the output voltage, $\boldsymbol{V_O}$ of the Op-Amp.





d) The parameters of D1 and D2 in the circuit shown in **above right** are $V_{Do} = 1.7\ \text{V}$ and $r_f = 20\ \Omega$. The current in each diode is to be limited to $\boldsymbol{I_D = 15\ \text{mA}}$ for $\boldsymbol{V_I = \pm 5\ V}$. **Determine** the required value of R. [CO3] 5

e) Find $\boldsymbol{V_o, i_{D1}}$ and $\boldsymbol{i_{D2}}$ for $\boldsymbol{R = 1\ \text{k}\Omega}$. Assume diode constant voltage drop model with $\boldsymbol{V_{DO} = 0.7\ \text{V}}$. In each case, write down the states of the diodes (ON/OFF). You must verify your assumptions. [CO2] 5