

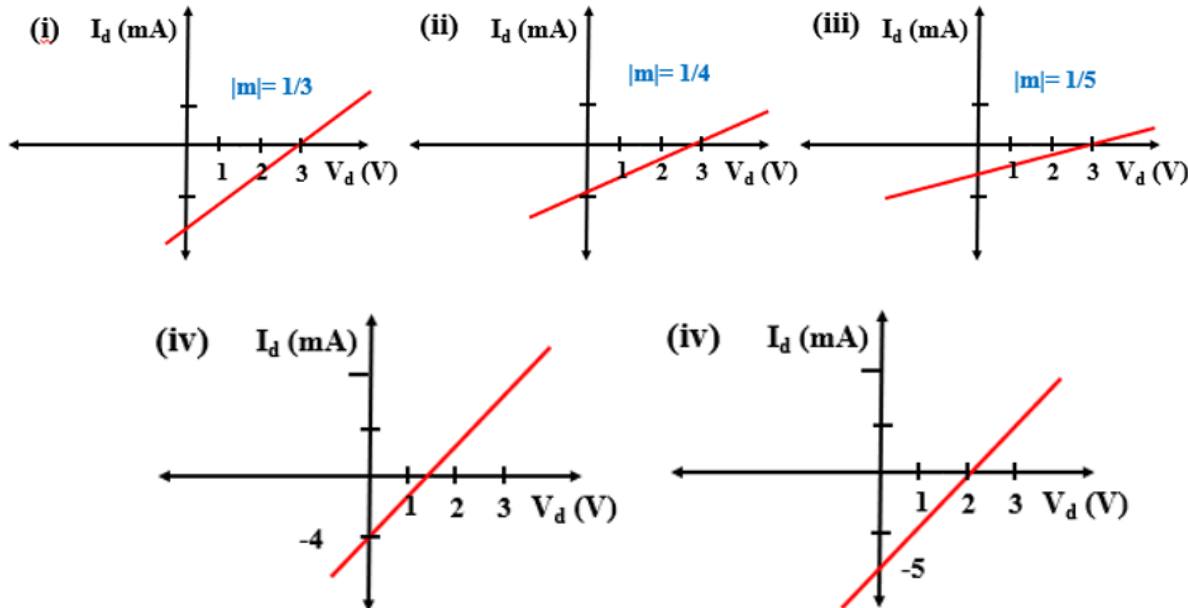
- ✓ Write down your student ID on the **top right corner of each of the pages**.
- ✓ Clearly write the solutions, along with the questions, on white paper with black ink (no need to use color pen, don't use pencils).
- ✓ Use **CamScanner**, or **Adobe Scan**, or **Microsoft Office Lens**, or any other 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 [CO1] 5
curve; - **Determine** the unknown parameters, - Label the I-V curve.
- i. A 3 V voltage source
 - ii. A 5 mA current source in parallel with a 5 k Ω
 - iii. A -10 V voltage source with 3 k Ω
 - 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 Ω^{-1}

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



Question 2:

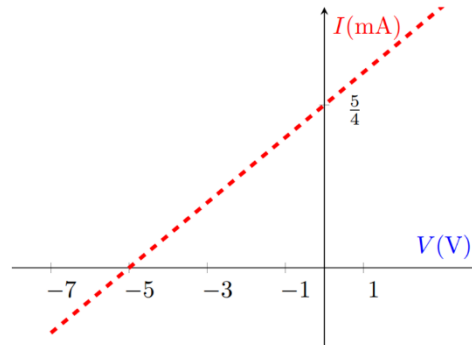
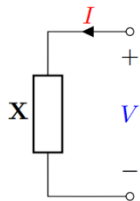
35 Marks

a) You are provided with the following circuit elements:

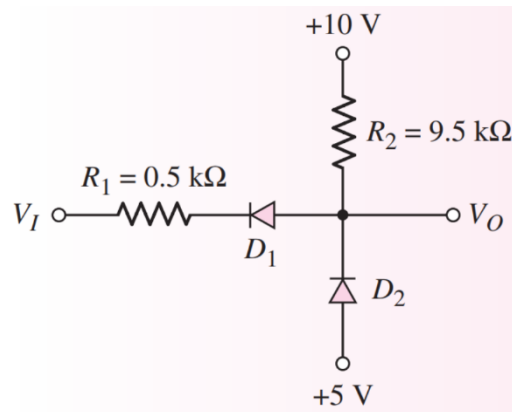
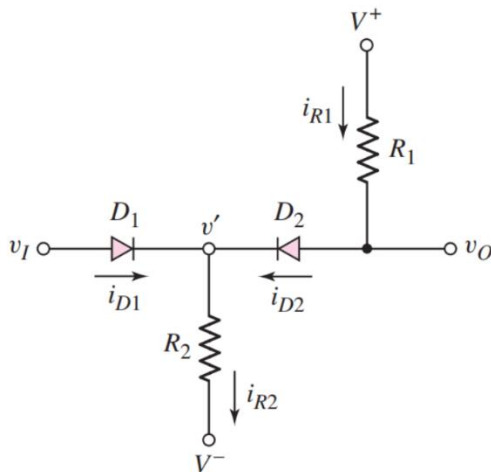
[CO3] 5

- Two $8\text{ k}\Omega$ 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: $R_1 = 5\text{ k}\Omega$, $R_2 = 10\text{ k}\Omega$, $V_{D0} = 0.7\text{ V}$, $V^+ = 5\text{ V}$, $V^- = -5\text{ V}$. Determine v_o , i_{D1} and i_{D2} for $v_I = 0$ and $v_I = 4\text{ V}$. [CO2] 3



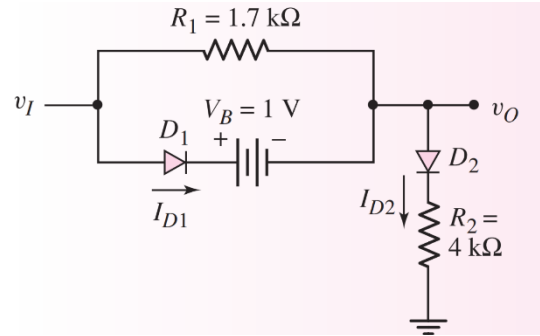
c) For the circuit **above (right)**, assume the following circuit parameters: $V_{D0} = 0.6\text{ V}$. Plot v_o versus v_I , for $0 \leq v_I \leq 10\text{ V}$. [CO2] 7

d) For the circuit below, the cut-in voltage for all the diodes are $V_{D0} = 0.7 \text{ V}$.

[CO2] 10

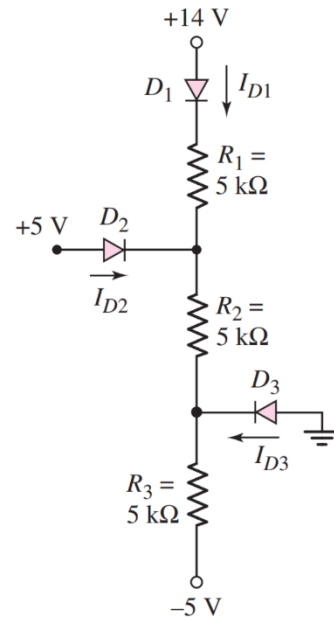
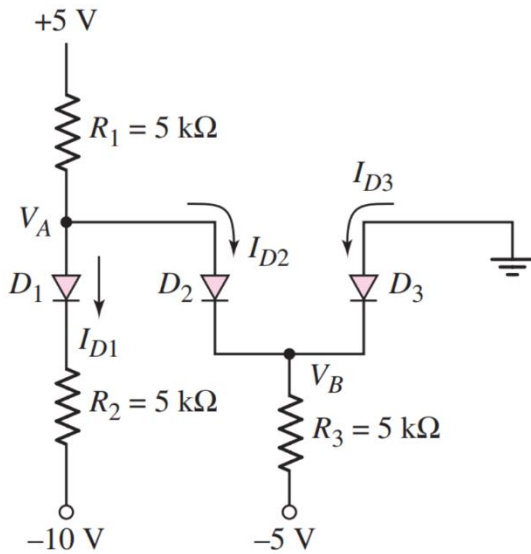
i. Let $v_I = 5 \text{ V}$. Assume both diodes are conducting. Is this a correct assumption? Why or why not? Determine I_{R1} , I_{D1} , I_{D2} and v_O

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



e) Determine the current in each diode (I_{D1} , I_{D2} and I_{D3}) and the voltages V_A and V_B in the multi-diode circuit shown in the figure **below (left)**. Let, $V_{D0} = 0.7 \text{ V}$ for each diode.

[CO2] 5



f) Determine I_{D1} , I_{D2} and I_{D3} and the voltages V_A and V_B for the circuit **above (right)**. $V_{D0} = 0.7 \text{ V}$ for each diode.

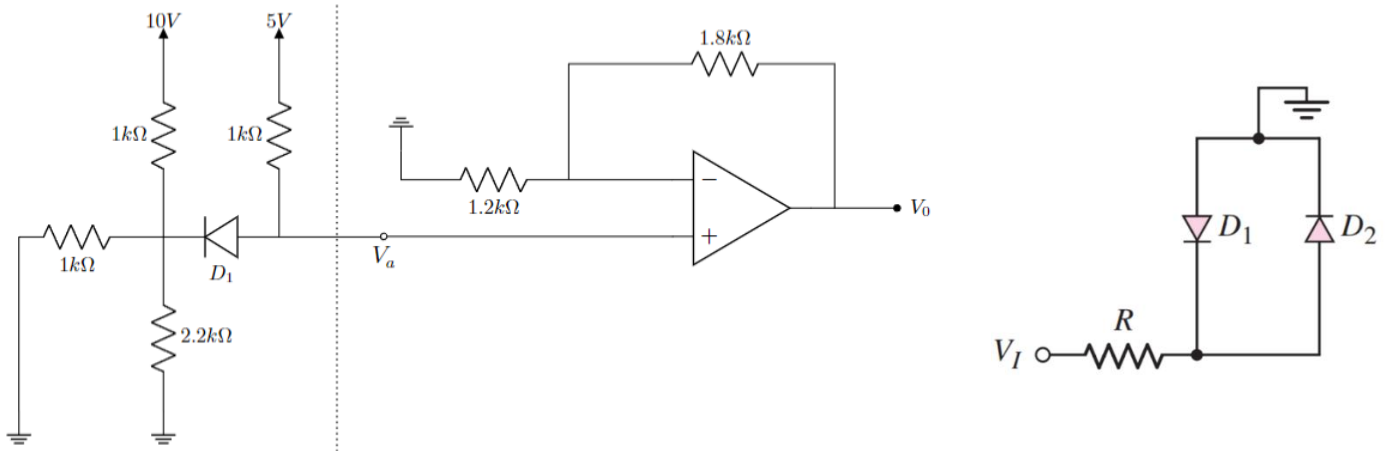
[CO2] 5

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, V_{D0} is 0.7 V .

- Determine** the operating mode diode, D_1 . Verify your assumption with necessary calculations.
- Calculate** the voltage at –
 - Node ' V_a '
 - Non-inverting terminal of the Op-Amp,
 - Inverting terminal of the Op-Amp.
- Find out the output voltage, V_o of the Op-Amp.



- The parameters of D_1 and D_2 in the circuit shown in **above right** are $V_{D0} = 1.7 \text{ V}$ and $r_f = 20 \Omega$. The current in each diode is to be limited to $I_D = 15 \text{ mA}$ for $V_I = \pm 5 \text{ V}$. **Determine** the required value of R . [CO3] 5
- Find V_o , i_{D1} and i_{D2} for $R = 1 \text{ k}\Omega$. Assume diode constant voltage drop model with $V_{D0} = 0.7 \text{ V}$. In each case, write down the states of the diodes (ON/OFF). You must verify your assumptions. [CO2] 5

