ID:	Name:

Brac University

Semester: Summer 2024
Course Code: CSE251
Electronic Devices and Circuits
Section: 01-27

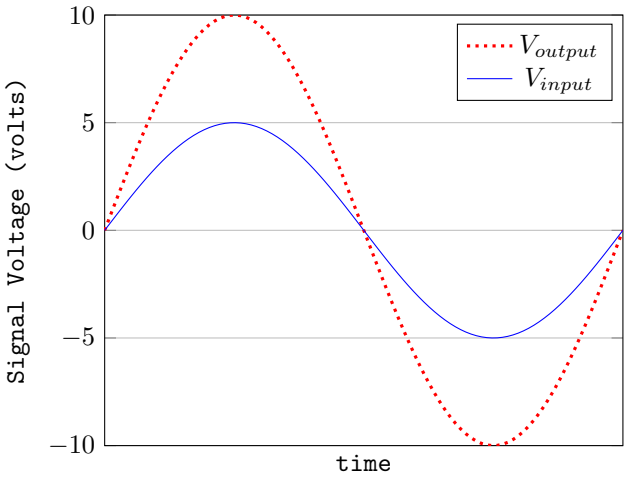
Set 01

Assessment: *Midterm Exam*
Duration: 1 hour 40 minutes
Date: 13 July, 2024
Full Marks: 30

Instructions: Answer **any 3 out of 5** questions. Read the questions carefully.

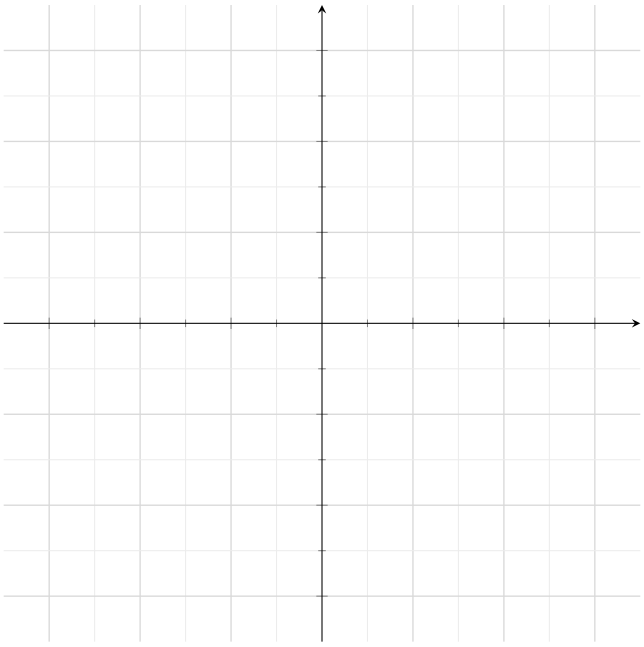
■ Question 1 of 5 *[CO1, CO2, CO3] [10 marks]*

Michael Scott wants to make a phone call to his assistant, Dwight Schrute, but the outdated phone system keeps failing as the signal is too weak by the time it reaches Dwight. Dwight plans on designing a device to help Michael make the call. The device will take the weak signal as input and give a strong signal at its output without changing the waveshape and polarity of the signal as shown in the following figure.



(a) **[1 mark]** What is a virtual ground? **Explain** briefly.

(b) **[2 marks]** **Analyze** the figure above and **draw** the VTC graph of the device in the graph given below. **Label** the graph properly.



(c) **[3 marks]** **Design** circuit for the device based on the waveshapes in the figure shown above.

(d) **[4 marks]** Dwight calculates his yearly sales using the following function. **Design** a device to help Dwight implement the function, f where x, y, and z will be the inputs of the device.

$$f = -3\frac{dz}{dt} + 6x + 9\int(y)dt$$

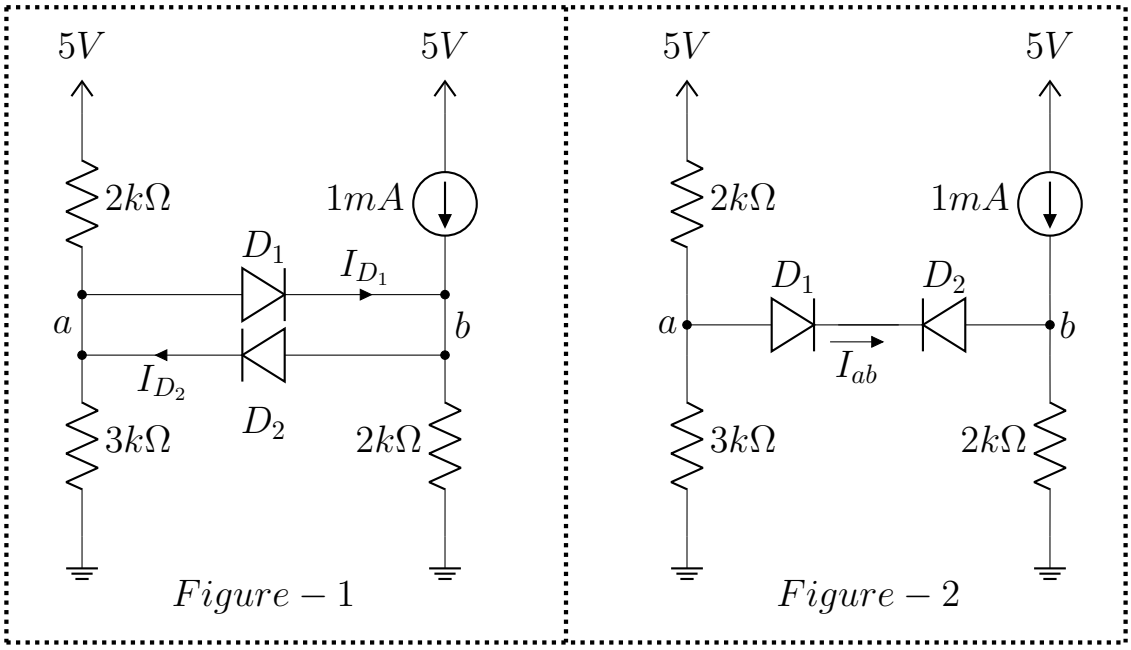
■ Question 2 of 5 *[CO1, CO2, CO3] [10 marks]*

(a) **[2 marks] State** the conditions to verify the assumptions regarding the operating states of an ideal diode model.

(b) **[2 marks] Calculate** the voltages at node a and b in Figure-1 if both of the diodes are disconnected.

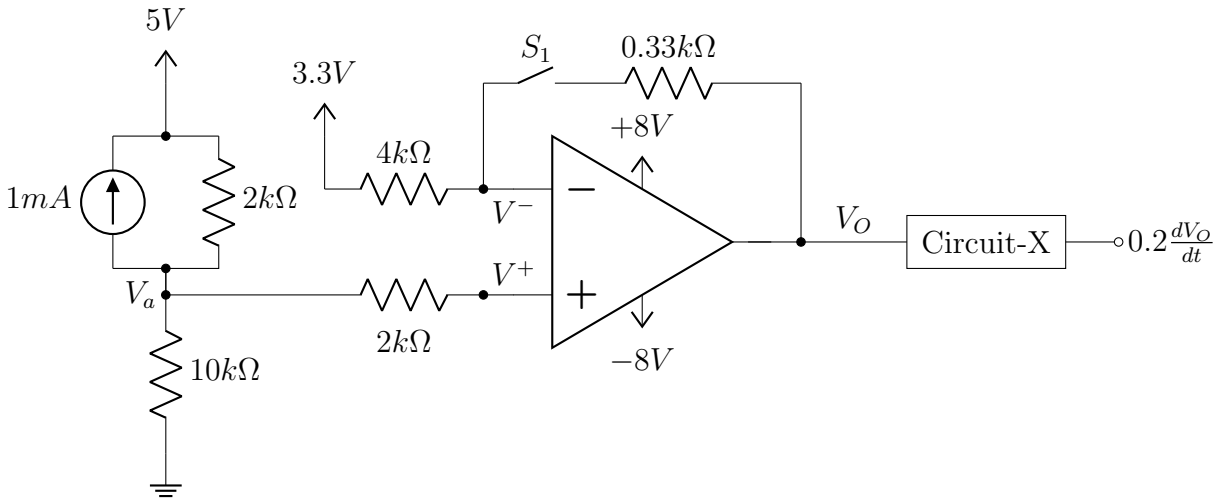
(c) **[4 marks] Analyze** the circuit in Figure-1 and **calculate** I_{D_1} and I_{D_2} using the method of assumed states. You must **validate** your assumptions. **Use** the CVD model with $V_{D_0} = 0.7V$ for both diodes.

(d) **[2 marks] Analyze** the circuit in Figure-2 and **calculate** I_{ab}.



■ Question 3 of 5 *[CO1, CO2, CO3] [10 marks]*

The circuit diagram has a switch S_1 which is shown to be 'open' in the figure. The output V_O is passed through an unknown block of 'Circuit-X' and a differentiated result is generated.



(a) **[1 mark] State** the equation of gain of an inverting amplifier.

(b) **[3 marks] Calculate** the values of V_a and $V+$.

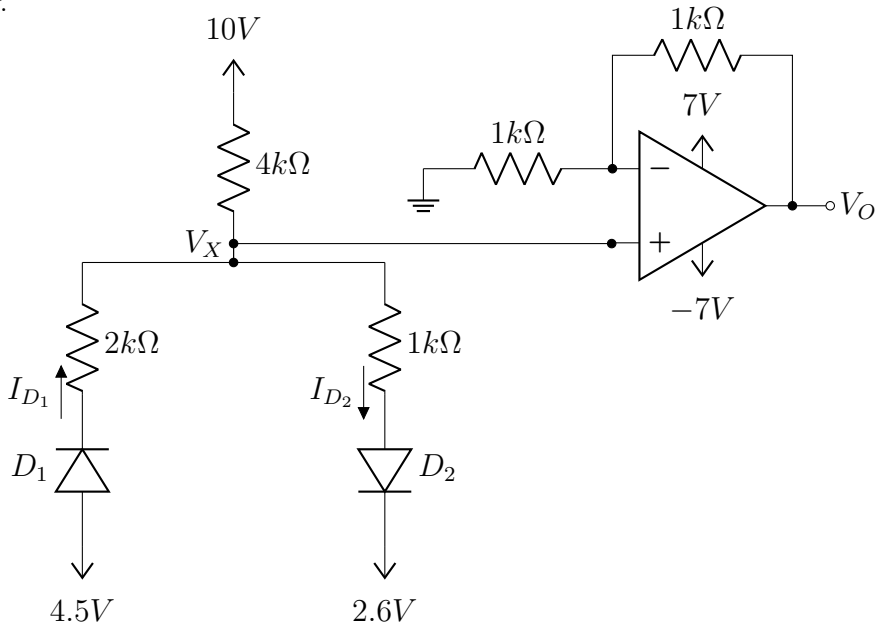
(c) **[2 marks] Determine** V_O when the switch S_1 is closed.

(d) **[2 marks] Determine** V_O when the switch S_1 is open.

(e) **[2 marks] Design** the 'Circuit-X'. **Assume** any value if necessary.

■ Question 4 of 5 *[CO1, CO2, CO3] [10 marks]*

Consider the following circuit with an ideal op-amp and two diodes. The diodes D_1 and D_2 have V_{D_0} of 0.5V and 0.6V respectively.



(a) [**1 mark**] **State** the equivalent circuit model of an ideal diode in reverse bias.

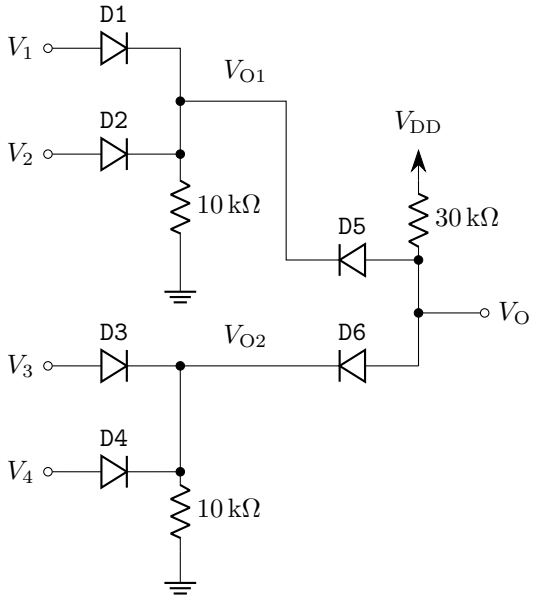
(b) [**7 marks**] **Analyze** the circuit and **calculate** V_X, I_{D1}, and I_{D2}. **Use** method of assumed states. You must **validate** your assumptions.

(c) [**2 marks**] **Determine** the output voltage, V_O.

■ Question 5 of 5 *[CO1, CO2, CO3] [10 marks]*

In the adjacent circuit $V_{\text{DD}} = 5\,\text{V}$ and other parameters are as follows:

Input Voltages	**Diode Barrier Voltages**
$V_1 = 2.0\,\text{V}$	For `D1`: $V_{\text{D1}} = 0.3\,\text{V}$
$V_2 = 2.2\,\text{V}$	For `D2`: $V_{\text{D2}} = 0.7\,\text{V}$
$V_3 = 2.4\,\text{V}$	For `D3`: $V_{\text{D3}} = 0.5\,\text{V}$
$V_4 = 2.5\,\text{V}$	For `D4`: $V_{\text{D4}} = 0.9\,\text{V}$
For `D5 & D6`: $V_{\text{D5}} = V_{\text{D6}} = 1\,\text{V}$	



Based on the given circuit, answer the following questions.

(a) [**2 marks**] **Draw** the I-V characteristics of a diode using the constant voltage drop with resistance (CVD+R) model. Clearly indicate the different operating modes on your graph.

(b) [**3 marks**] **Determine** the values of V_{O1} and V_{O2}.

(c) [**2 marks**] **Calculate** the value of V_{O}.

(d) [**3 marks**] Solve the circuit to find V_{O}, assuming $V_3 = -2\,\text{V}$ and $V_4 = -3\,\text{V}$, while all other voltages remain unchanged. **Identify** the states of the diodes `D3` and `D4`. [**Hint:** You may need to use the method of assumed states in order to determine V_{O2}.]