

# EHB211E Basics of Electrical Circuits

## MIDTERM I

*Duration: 120 Minutes*

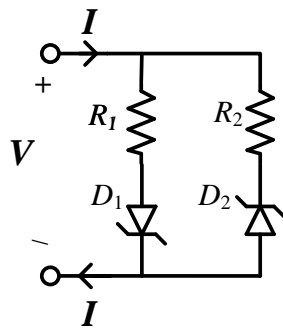
*Grading: 1) 30%, 2) 40%, 3) 30%*

*Exam is in closed-notes and closed-books format*

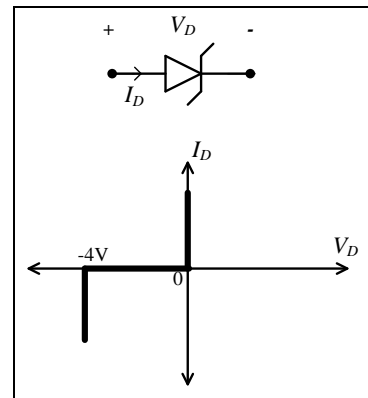
*For your answers please use the space provided in the exam sheet*

**GOOD LUCK!**

1. Consider the two-terminal element shown below. Sketch the ***V-I characteristics*** of this element ( $V$  for  $x$ -axis;  $I$  for  $y$ -axis). For the zener diodes, use the model shown below; the Zener diode model has ***-4V*** breakdown voltage. Suppose that  $R_1=R_2=R$ .

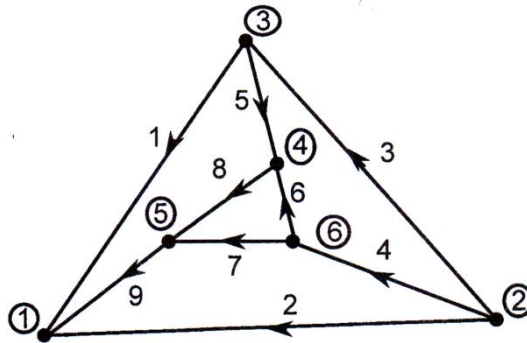


*Two-terminal element*



*Zener Diode Model*

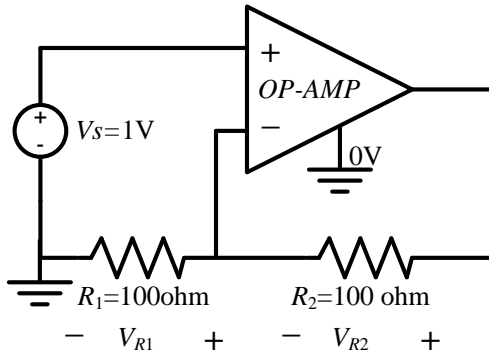
2. Consider the circuit graph shown below. It has 6 nodes and 9 edges.



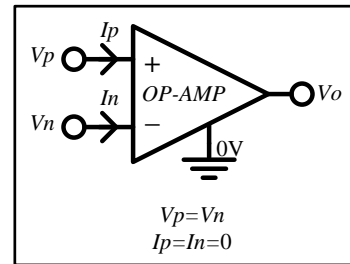
- Take **node-4** as a reference. Find matrices  $A$  and  $M$  where  $A \times I_{edge} = 0$  and  $M \times V_{node} = V_{edge}$ .
- Determine a **proper tree** to find all voltage and current values of edges. Given that  $V_1=1V$ ,  $V_2=2V$ ,  $V_5=1V$ ,  $V_7=2V$ ,  $V_8=3V$ ;  $I_3=1A$ ,  $I_4=3A$ ,  $I_6=3A$ ,  $I_9=1A$ .
- Determine fundamental cut-sets and write down related **KCL** equations in matrix form. Find the values of  $I_1$ ,  $I_2$ ,  $I_5$ ,  $I_7$ , and  $I_8$ .
- Determine fundamental loops and write down related **KVL** equations in matrix form. Find the values of  $V_3$ ,  $V_4$ ,  $V_6$ , and  $V_9$ .

3. For the op-amp in the circuit, use the model shown below.

- Draw a **graph model** of the circuit. How many nodes and edges does your graph have? Note that the op-amp has four terminals.
- Determine the **voltage** values of  $R_1$  and  $R_2$  ( $V_{R1}$  and  $V_{R2}$ ).



*Op-amp based circuit*



*Op-amp Model*