Department of Computer Science and Engineering (CSE)
BRAC University

# Practice Problem Set 3.2

## CSE251 – Electronic Devices and Circuits

## DIODE CIRCUIT MODELS

Method of assumed states, Exponential Model, and
Piecewise Linear Models: CVD+R and CVD

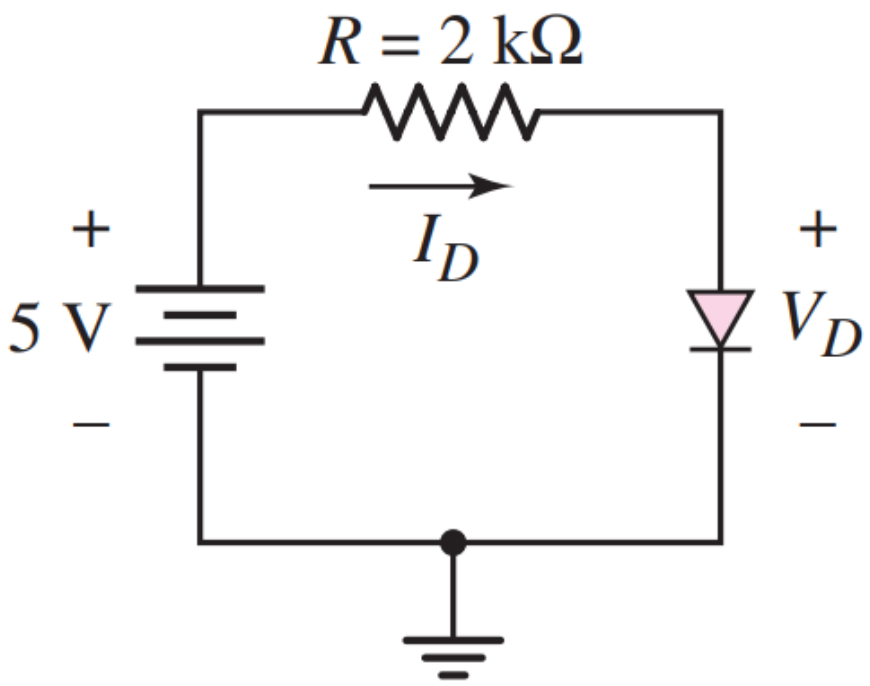
Course Description, COs, and Policies


Midterm and Final Questions

For any error or issues, contact purbayan.das@bracu.ac.bd

# Problem 1

- If the diode in the following circuit has a reverser saturation current $I_o = 10^{-13} A$, follow an iterative approach and write a program to determine $I_D$ and $V_D$. Assume the ideality factor $\eta = 1$ and the thermal voltage $V_T = 25\ mV$.



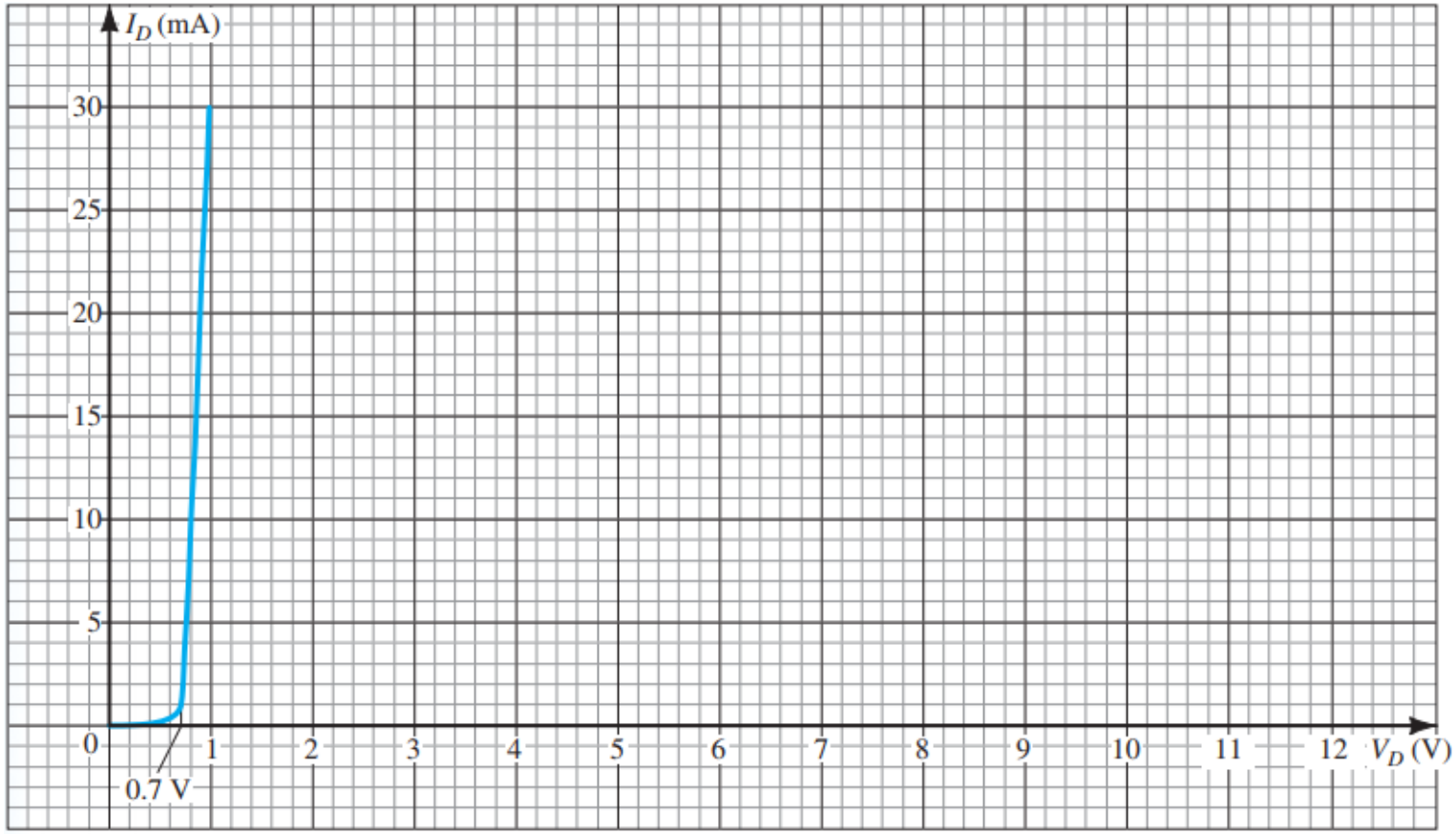

Hint: There will be two simultaneous equations: one is the diode's current-voltage relation and the other is the result of applying KVL around the loop.

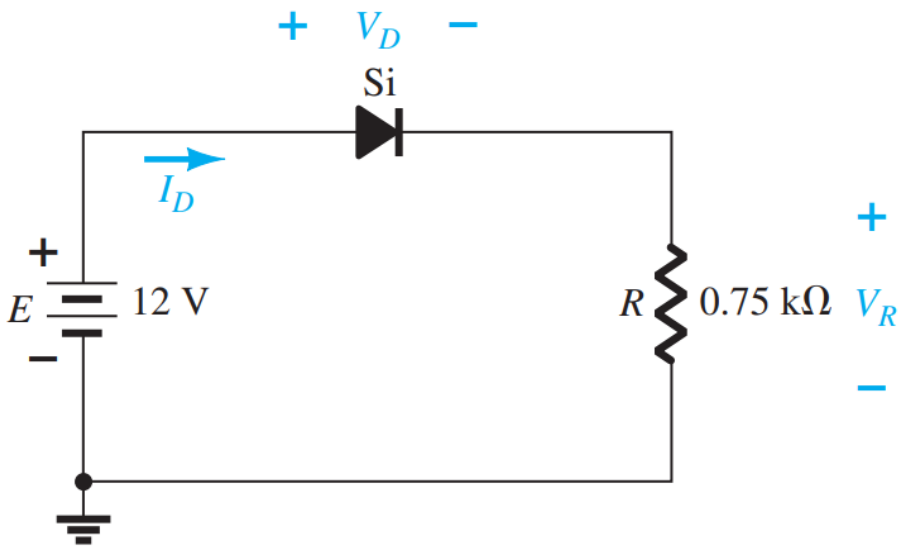
$$I_D = I_o\left(e^{\frac{V_D}{\eta V_T}} - 1\right) \text{ and } I_D = -\frac{1}{2}V_D + \frac{5}{2}$$

Take an array of $V_D$ with values in a reasonable range. For example, from $0.400\ V$ to $0.800\ V$. For each $V_D$, evaluate $I_D$ using both the equations. The value of $V_D$ for which both the equations of $I_D$ yields the closest value is the answer.

# Problem 2

- The $I - V$ characteristic of the diode in the following circuit has been plotted below. Determine $I_D$ and $V_D$.

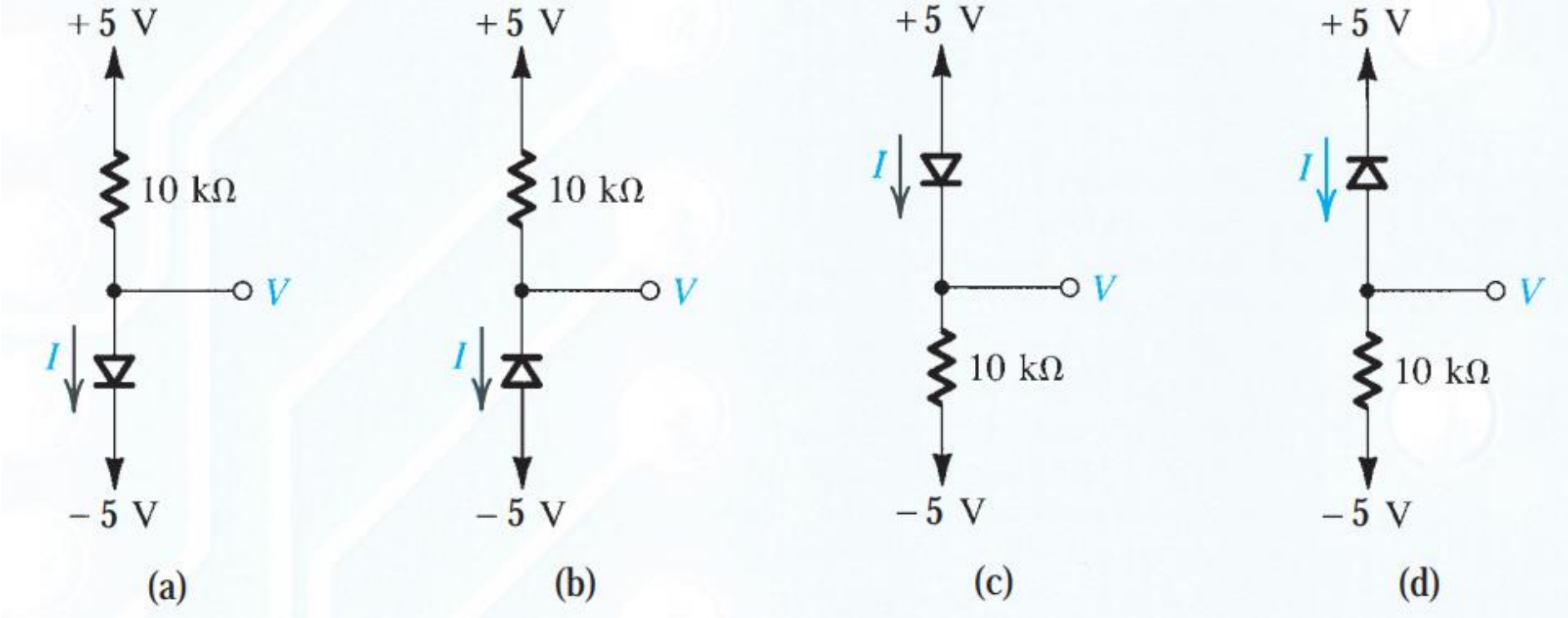



Ans: $\boldsymbol{I_D = 15\ mA, V_D = 0.82\ V}$

# Problem 3

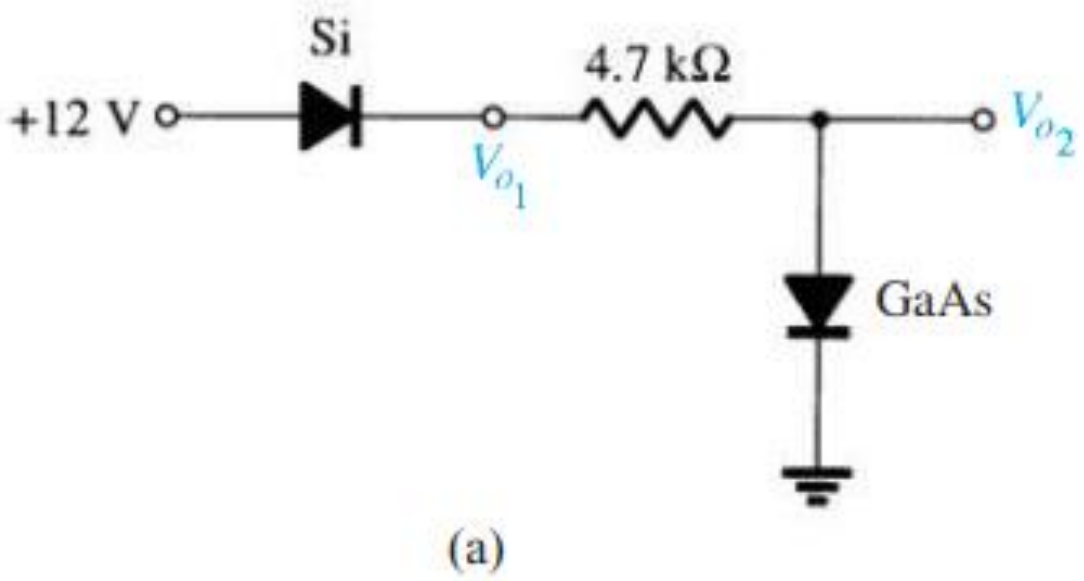
- For the circuits shown below, using ideal diode model, find the values of the voltages and currents indicated.

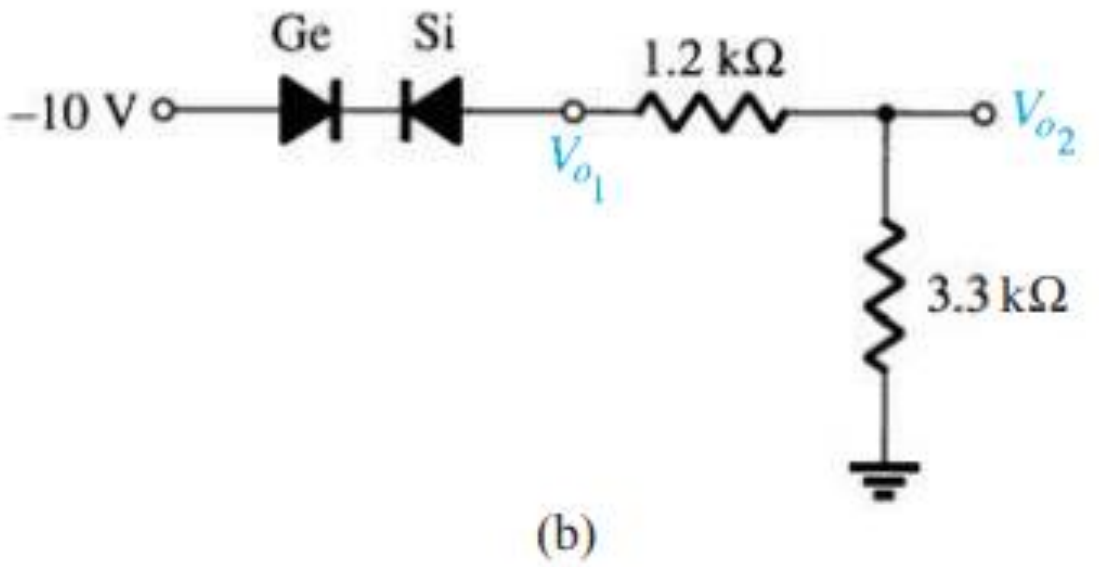



Ans: $(a)\ I = 1\ mA, V = -5\ V; (b)\ I = 0\ mA, V = 5\ V; (c)\ I = 1\ mA, V = 5\ V; (d)\ I = 0\ mA, V = -5\ V$

# Problem 4

- Determine $V_{o_1}$ and $V_{o_2}$ for the circuits shown below. Use $CVD + R$ Model with $V_{D_{o,\,Si}} = 0.7\,V$, $r_o = 20\,\Omega$, $V_{D_{o,\,Ge}} = 0.3\,V$, $r_o = 10\,\Omega$, and $V_{D_{o,\,GaAs}} = 1.2\,V$, $r_o = 5\,\Omega$.

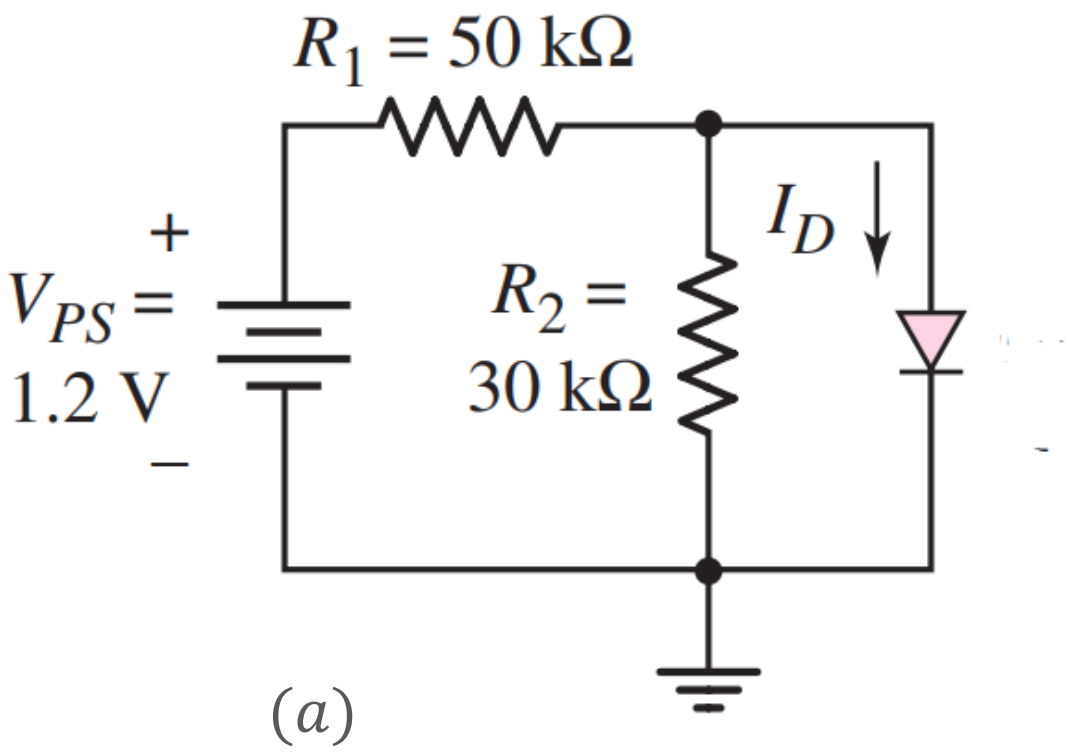


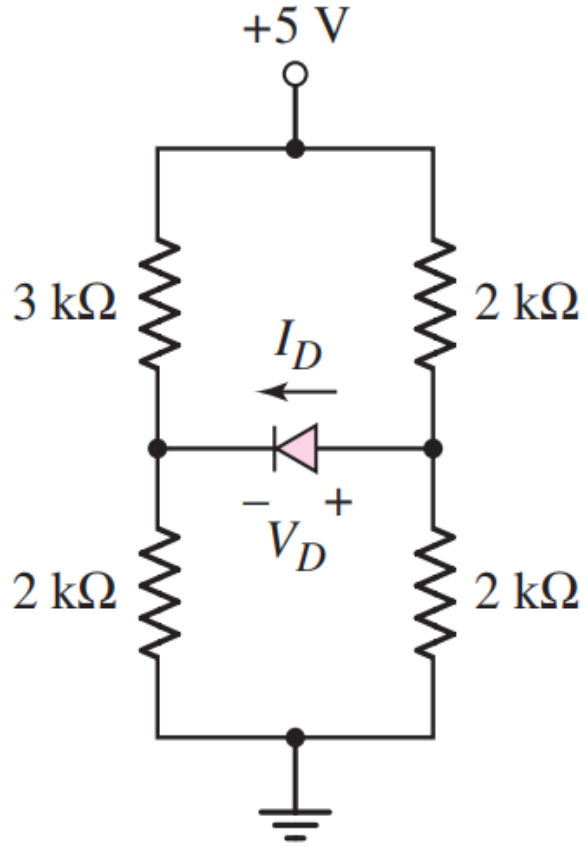

Ans: $(a)\ V_{o_1} = 11.3\,V, V_{o_2} = 1.21\,V; (b)\ V_{o_1} = 0\,V, V_{o_2} = 0\,V$

# Problem 5

- For the circuits shown below, using CVD model (with $V_{D_o} = 0.7\ V$), find $I_D$.




$(a)$

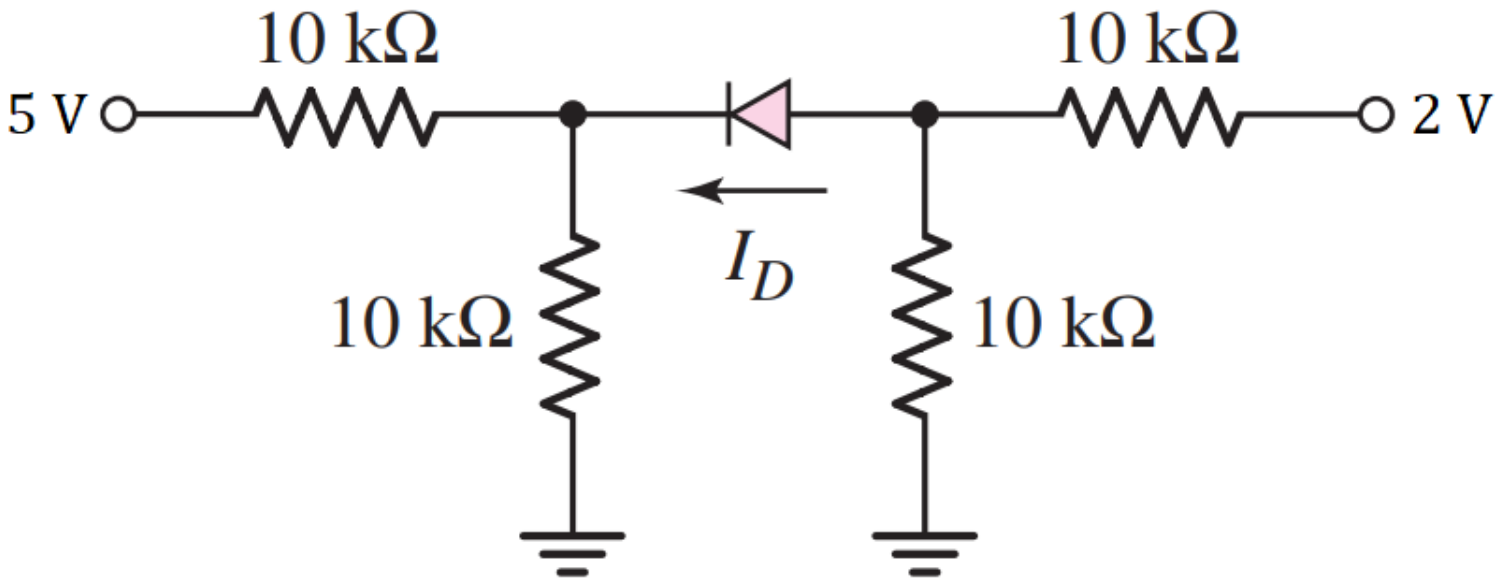



$(b)$

Ans: $(a)\ I_D = 0\ mA; (b)\ I_D = 0\ mA$

# Problem 6

- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $I_D$.

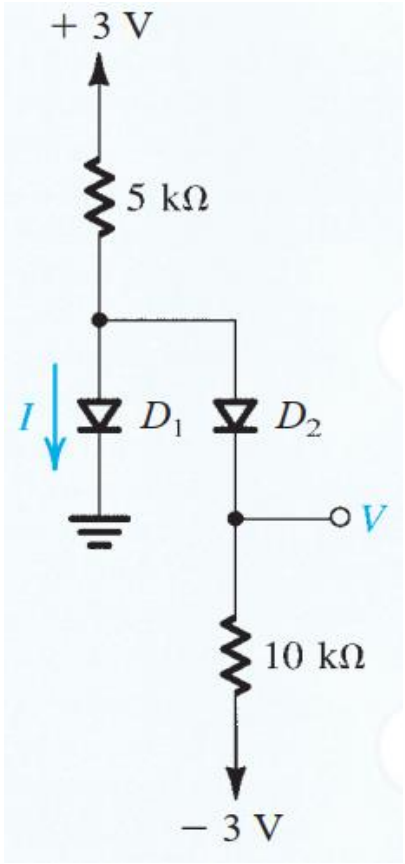



Ans: $\boldsymbol{I_D = 0\ mA}$

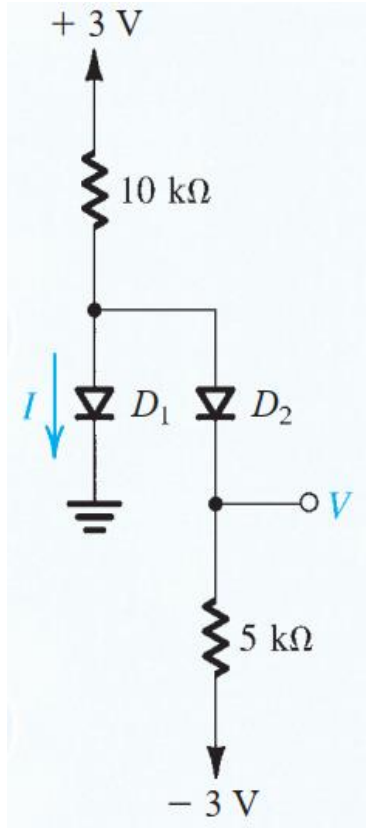
# Problem 7

- For the circuits shown below, using ideal diode model, find the values of the voltages and currents indicated.

$(a)$



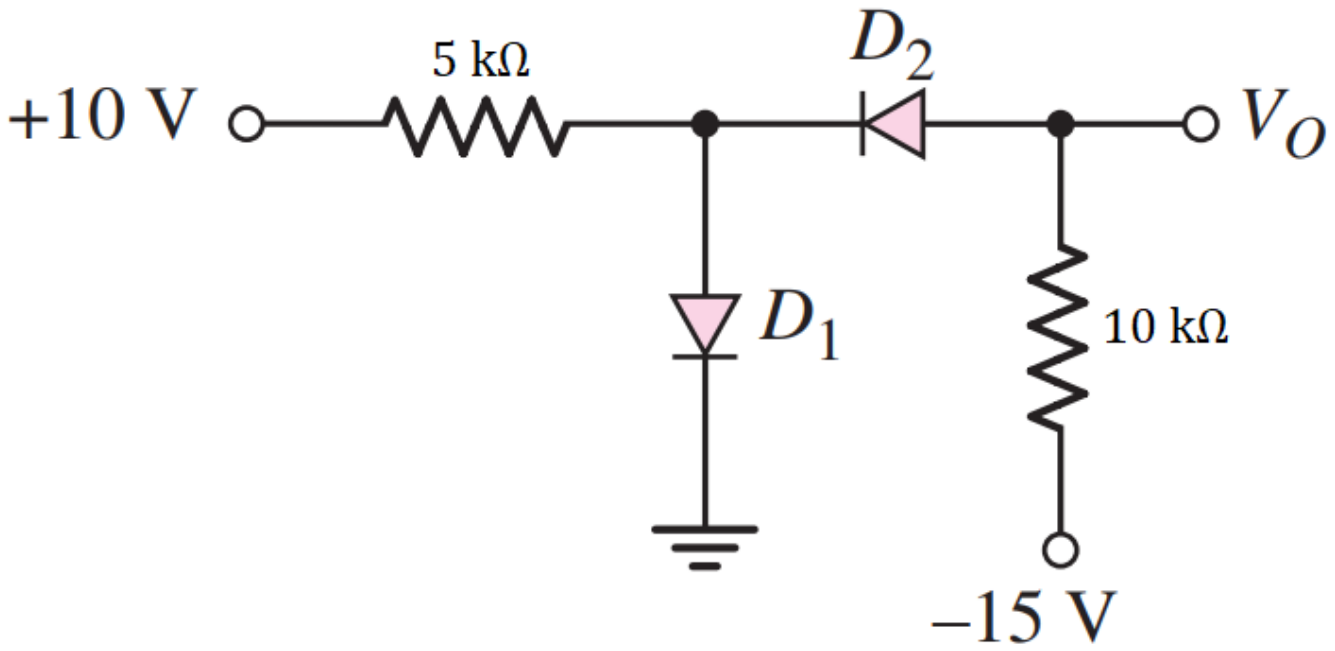

$(b)$




Ans: $(a)\ D_1\ ON, D_2\ ON, I = 0.3\ mA, V = 0\ V; (b)\ D_1\ OFF, D_2\ ON, I = 0\ mA, V = -1\ V$

# Problem 8

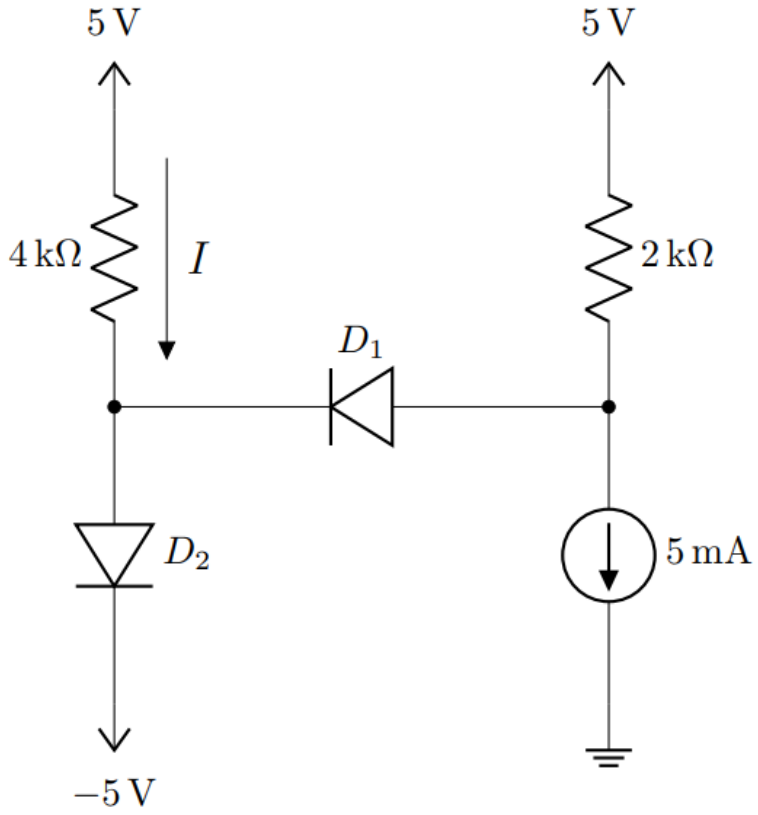
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $V_O$.




Ans: $\boldsymbol{D_1\ ON, D_2\ OFF, V_O = -15\ V}$

# Problem 9

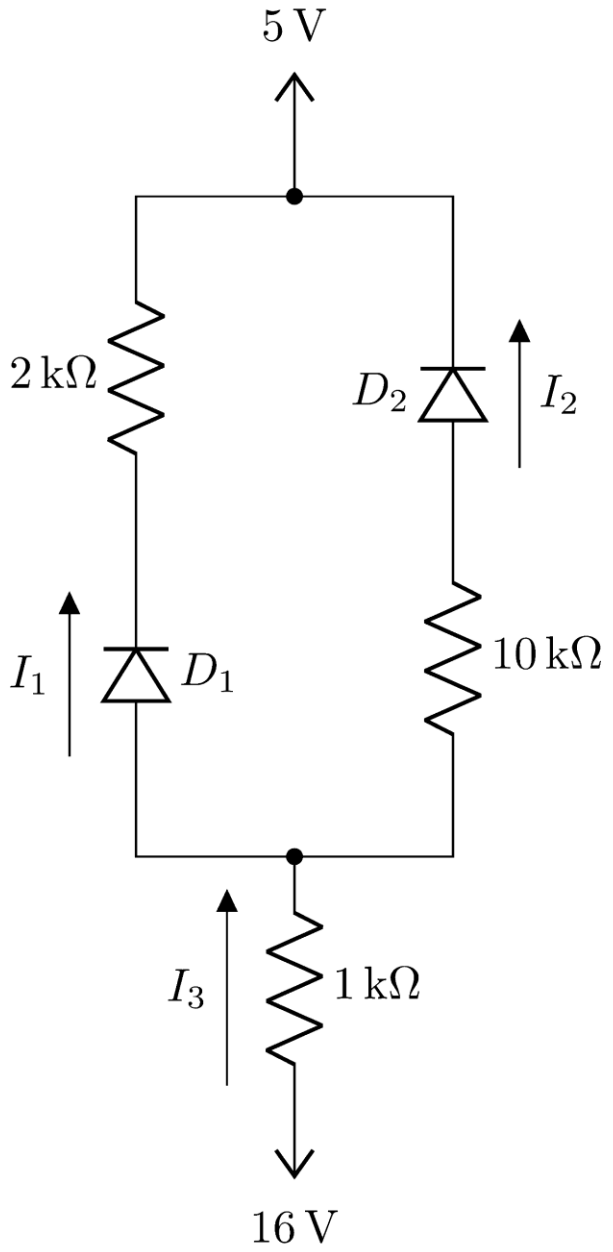
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $I$.




Ans: $\boldsymbol{D_1\ OFF, D_2\ ON, I = 2.325\ mA}$

# Problem 10

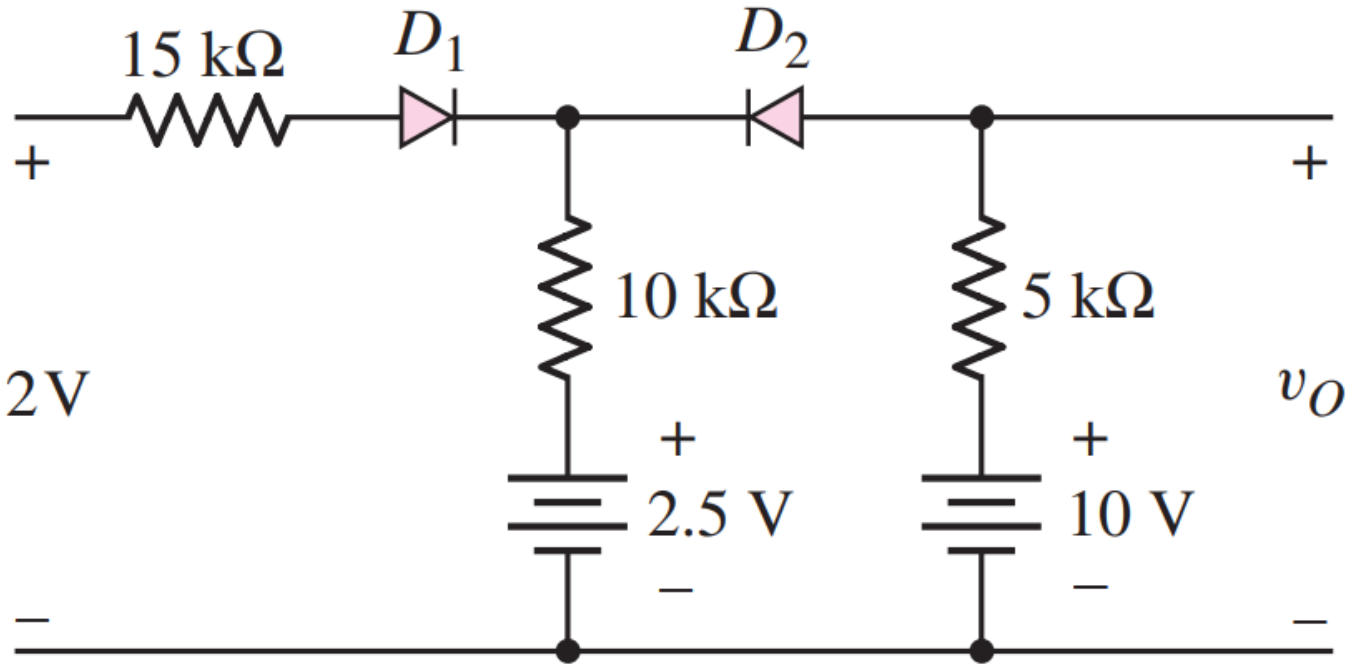
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $I_1$, $I_2$, and $I_3$.




Ans: $\boldsymbol{D_1\ ON, D_2\ ON, I_1 = 3.22\ mA,\ I_2 = 0.64\ mA,\ I_3 = 3.86\ mA}$

# Problem 11

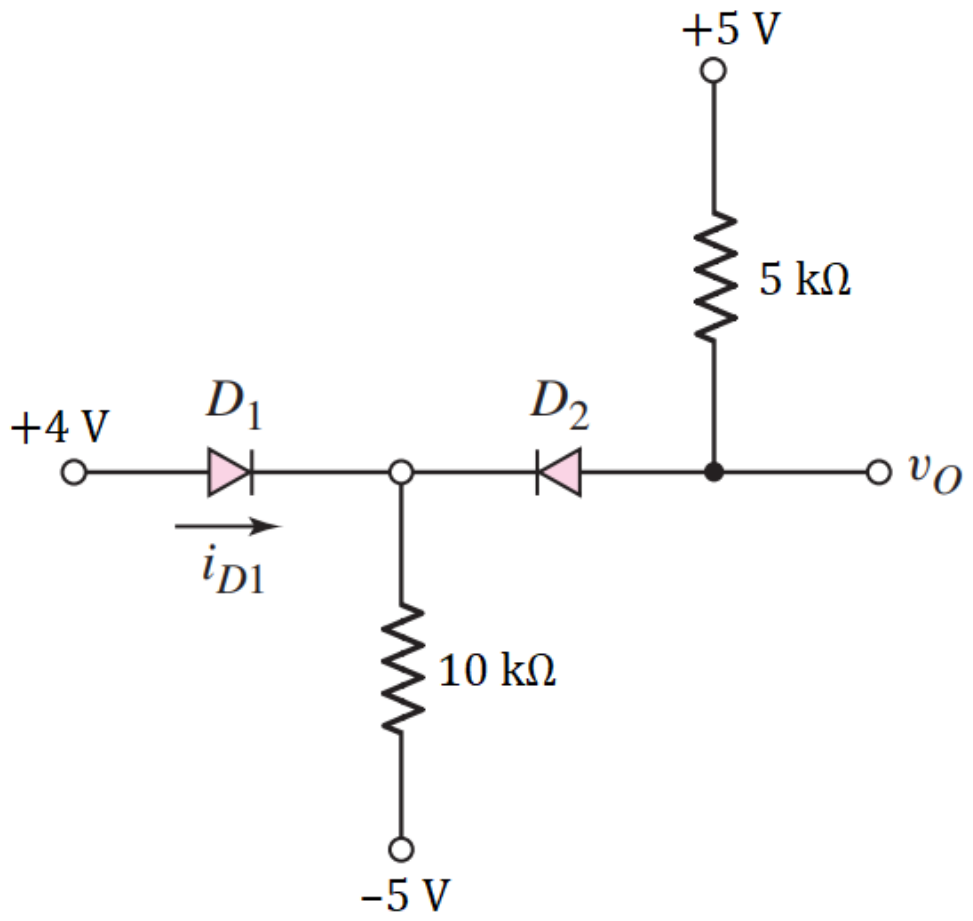
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $v_O$.




Ans: $\boldsymbol{D_1\ OFF, D_2\ ON, v_O = 7.735\ V}$

# Problem 12

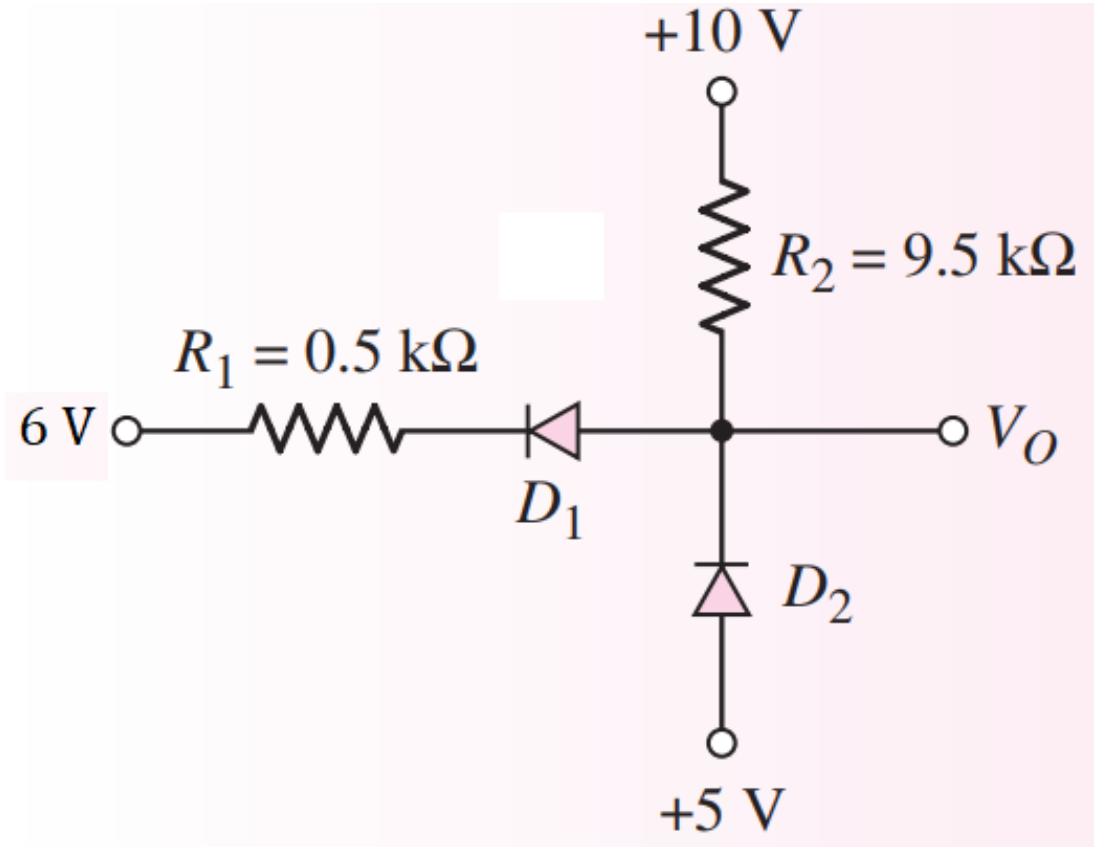
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $v_O$.




Ans: $\boldsymbol{D_1\ ON, D_2\ ON, v_O = 4\ V}$

# Problem 13

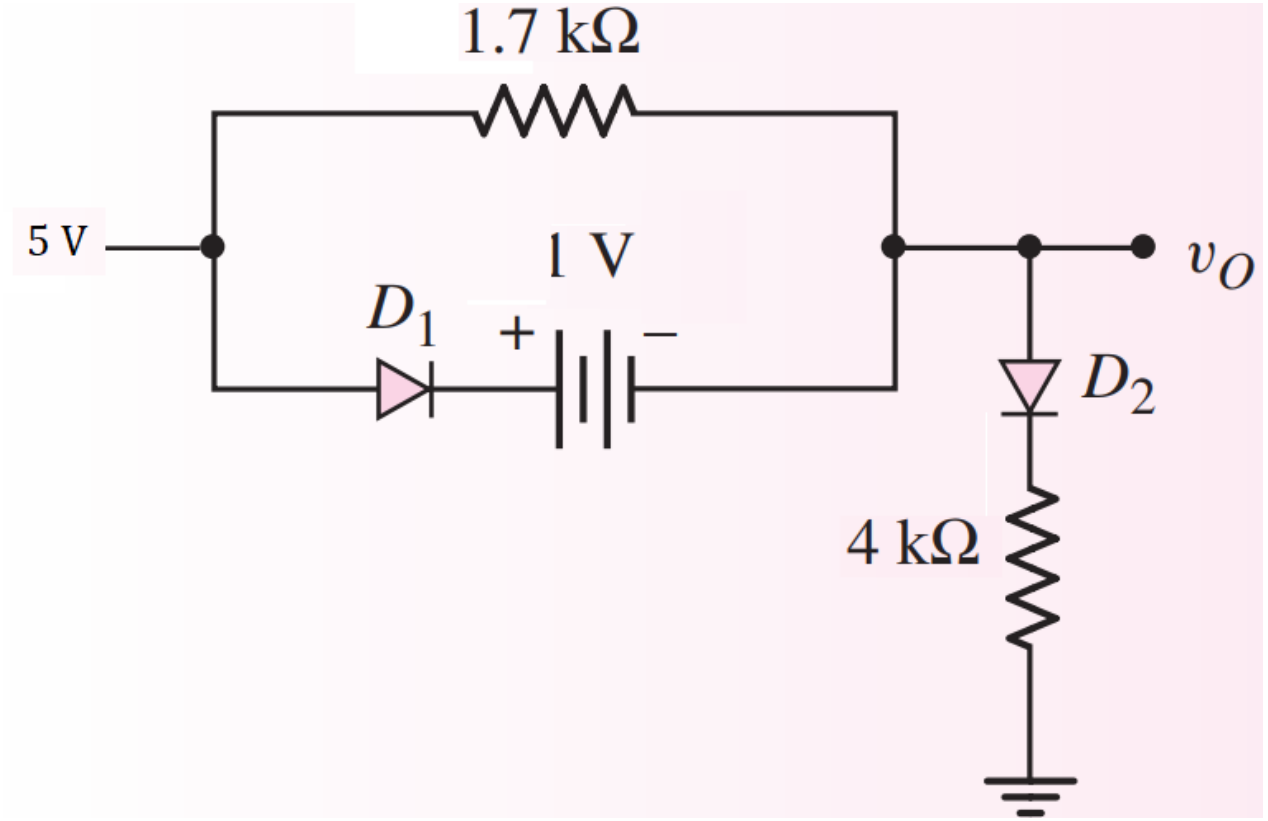
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $V_O$.




Ans: $\boldsymbol{D_1\ ON, D_2\ OFF, V_O = 6.865\ V}$

# Problem 14

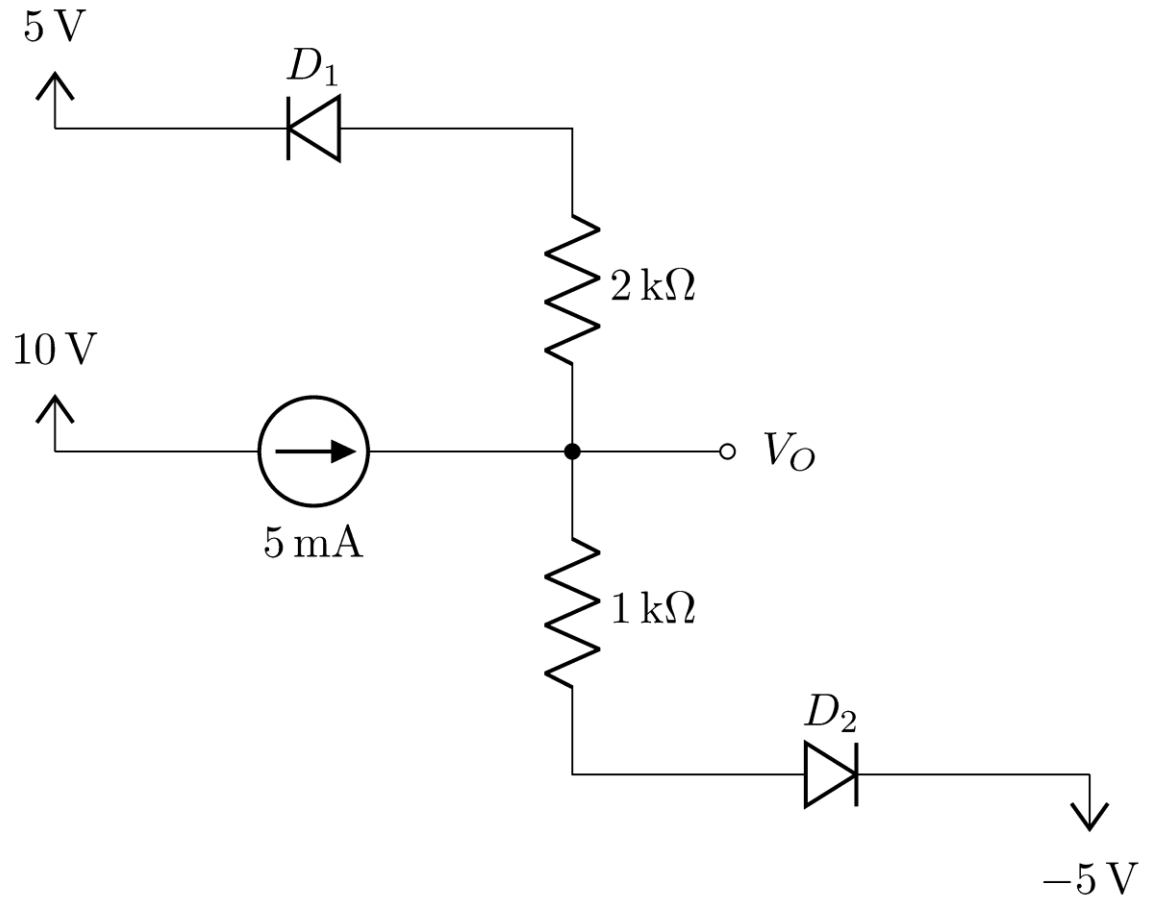
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $v_O$.




Ans: $\boldsymbol{D_1\ OFF, D_2\ ON, v_O = 3.72\ V}$

# Problem 15

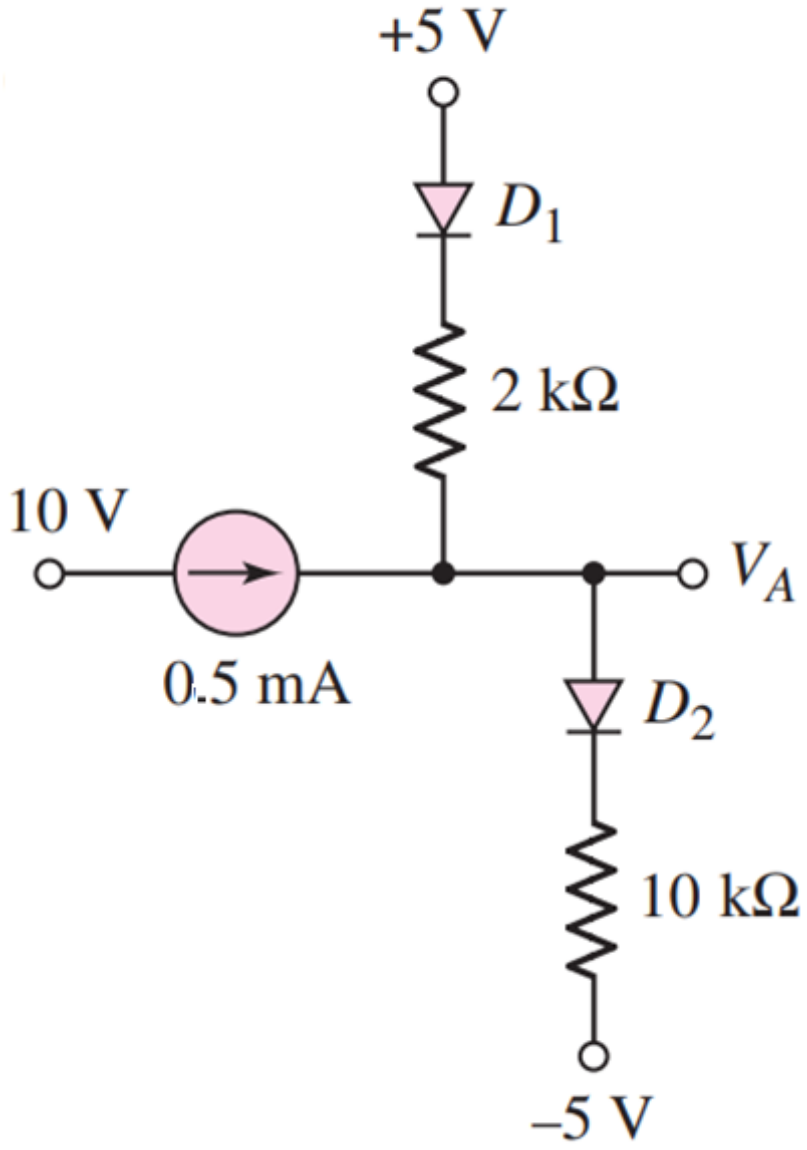
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $V_O$.




Ans: $\boldsymbol{D_1\ OFF, D_2\ ON, V_O = 0.7\ V}$

# Problem 16

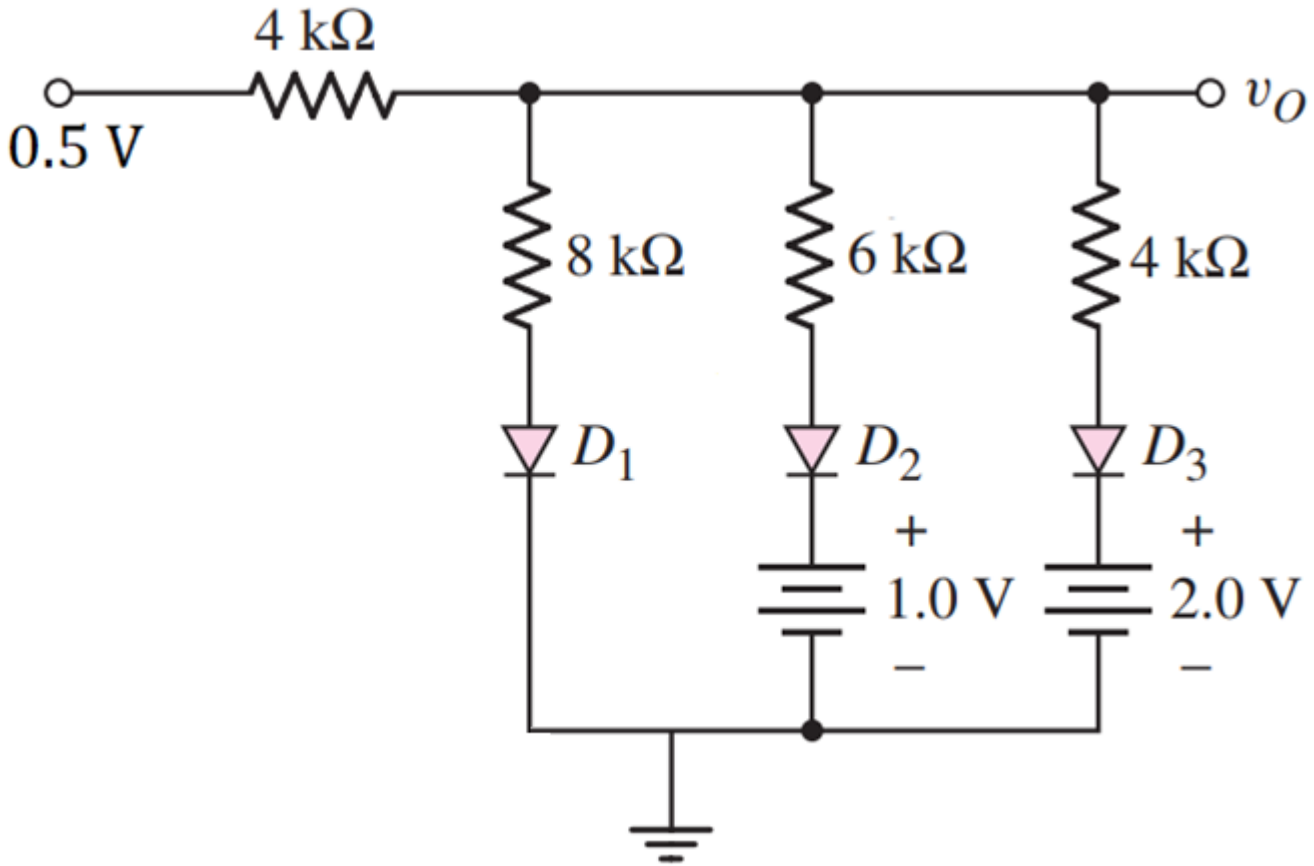
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $V_A$.




Ans: $\boldsymbol{D_1\ ON, D_2\ ON, V_A = 3.7\ V}$

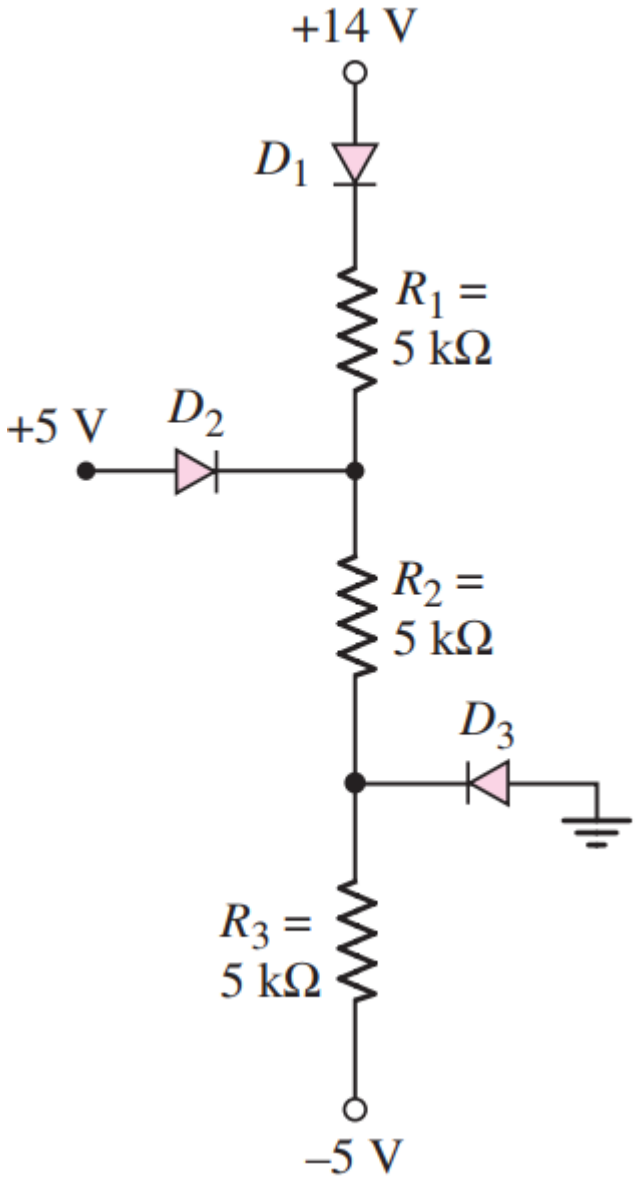
# Problem 17

- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), show that all the diodes remain off.



# Problem 18

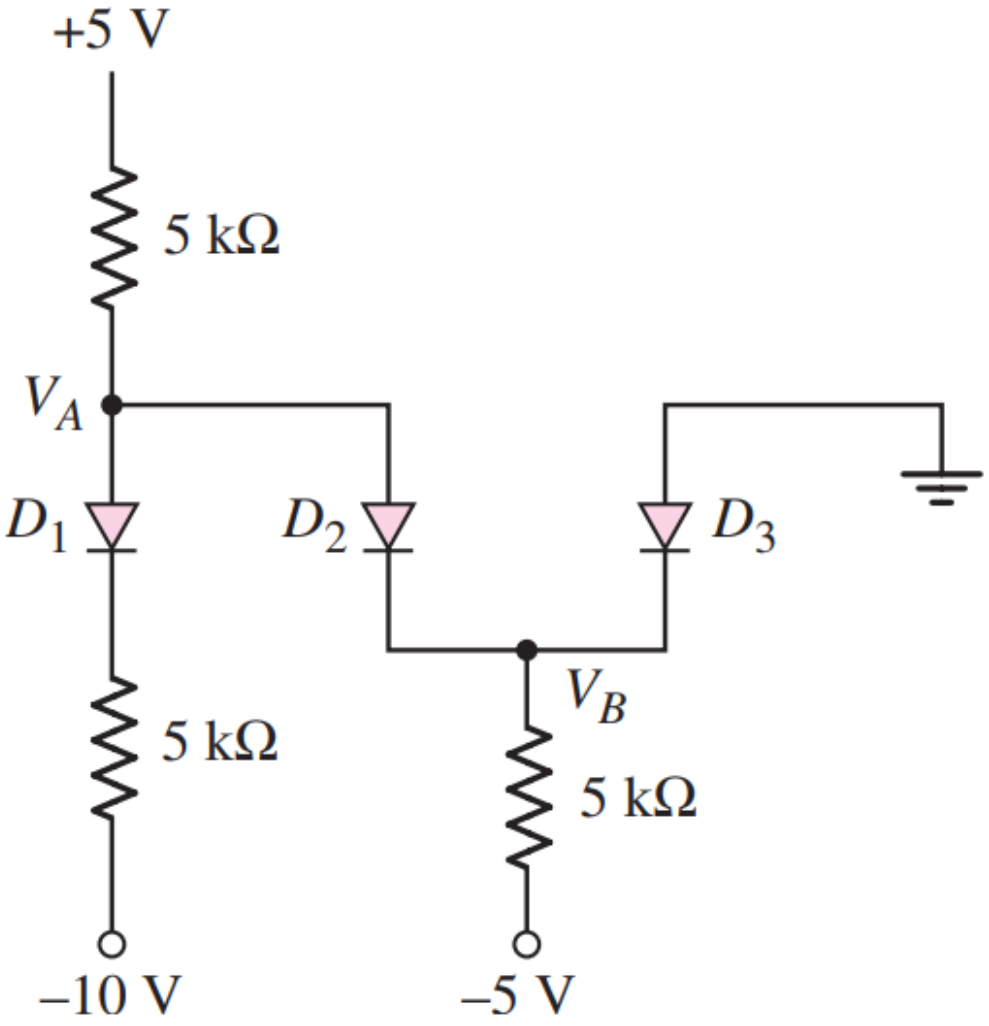
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\,V$), determine the voltage across $R_2$.




Ans: $\boldsymbol{D_1\ ON, D_2\ OFF, D_3\ OFF, V_{R_2} = 6.11\,V}$

# Problem 19

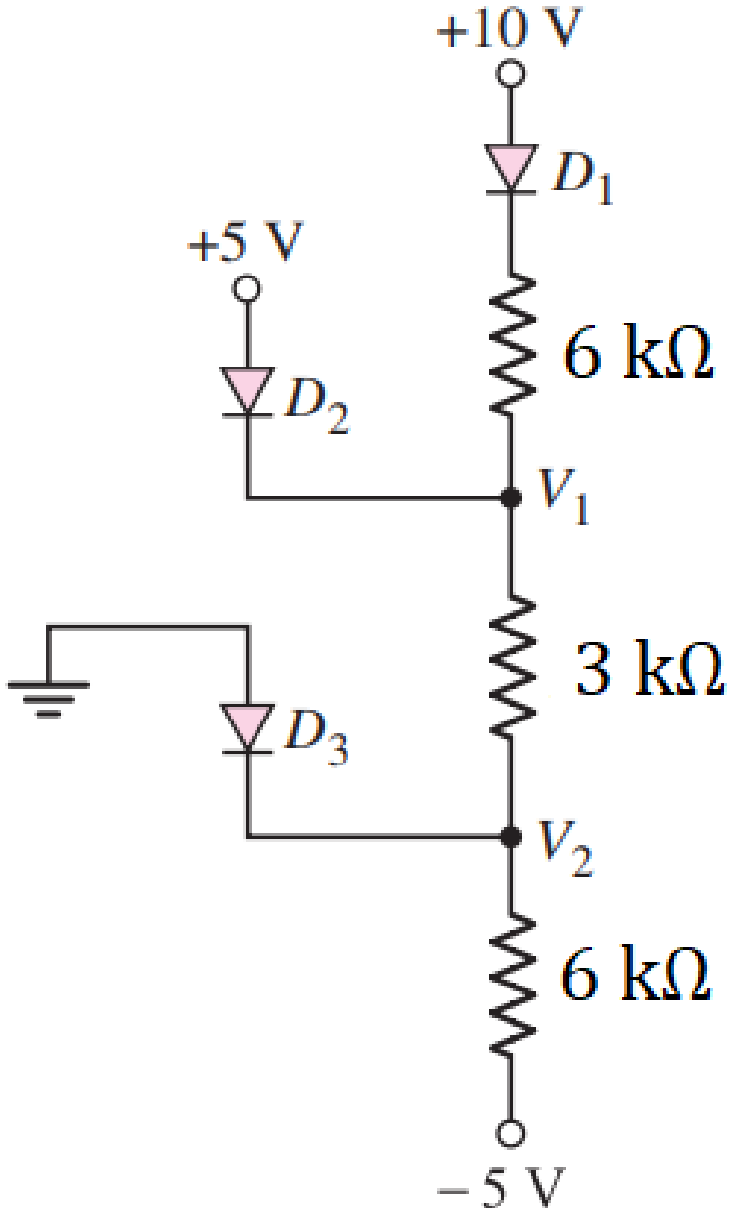
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\,V$), determine $V_A$ and $V_B$.




Ans: $\boldsymbol{D_1\ ON, D_2\ OFF, D_3\ ON, V_A = -2.16\,V, V_B = -0.65\,V}$

# Problem 20

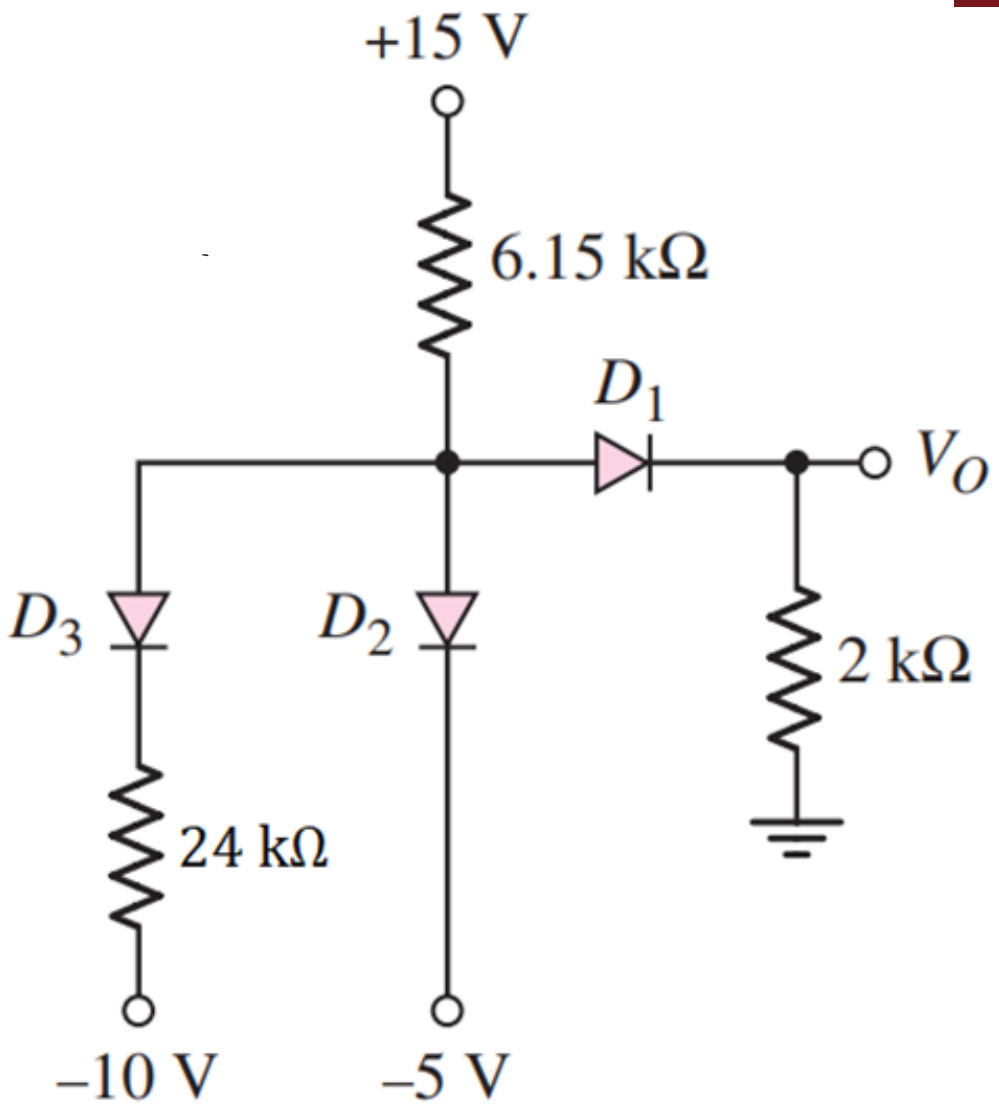
- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $V_1$ and $V_2$.




Ans: $\boldsymbol{D_1\ ON, D_2\ ON, D_3\ OFF, V_1 = 4.38\ V, V_2 = 1.23\ V}$

# Problem 21

- For the circuit shown below, using CVD model (with $V_{D_o} = 0.7\ V$), determine $V_O$.




Ans: $\boldsymbol{D_1\ OFF, D_2\ ON, D_3\ ON, V_O = 0\ V}$