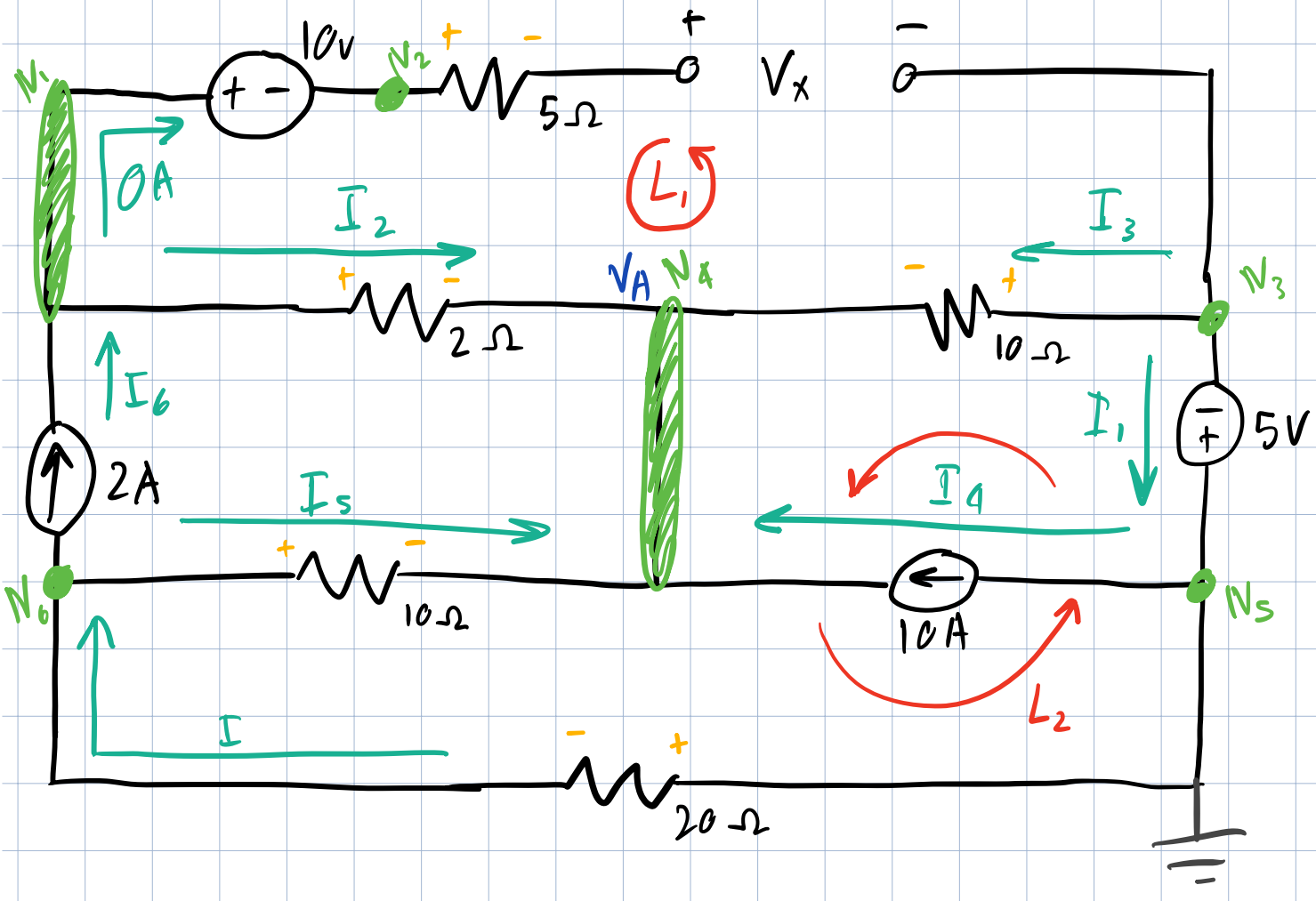
Problem One: Find V_x, V_A, and I



BCA: 3 backyards - 2 current sources = 1 unknown

NVA: 6 nodes - 1 ground - 2 voltage sources = 3 unknowns

Use Branch current analysis

Find Currents

$I_6 = 2A$

KCL at V_1: $I_2 = I_6$

Currents

$I_6 = 2A$

$I_2 = 2A$

$I_2 = I_6$

$= 2A$

$I_4 = 10\,A$

KCL at N_3: $I_3 + I_1 = 0$

$I_3 = -I_1$

KCL at N_6: $I = I_5 + I_6$

$I = I_5 + I_6$

$= I_5 + 2$

KCL at N_5: $I_1 = I_4 + I$

$I_1 = I_4 + I$

$= 10 + (I_5 + 2)$

$= 12 + I_5$

$I_3 = -12 - I_5$

$I_4 = 10\,A$

$I = I_5 + 2$

$I_1 = 12 + I_5$

Solve for I_5

KVL on L_2:

$$10I_5 + 20I - 5 - 10I_3 = 0$$

$$10I_5 + 20(I_5 + 2) - 5 - 10(-12 - I_5) = 0$$

$$2I_5 + 4(I_5 + 2) - 1 - 2(-12 - I_5) = 0$$

$$2I_5 + 4I_5 + 8 - 1 + 24 + 2I_5 = 0$$

$$8I_5 = -31$$

$$I_5 = -3.875$$

Solve for I

$$I = I_5 + 2$$

$$= -1.875 \text{ A}$$

Solve for V_A

$$V_A = 0 - 5 - 10I_3$$

$$= -5 - 10(-12 + I_5)$$

$$= 76.25 \text{ V}$$

Solve for V_x

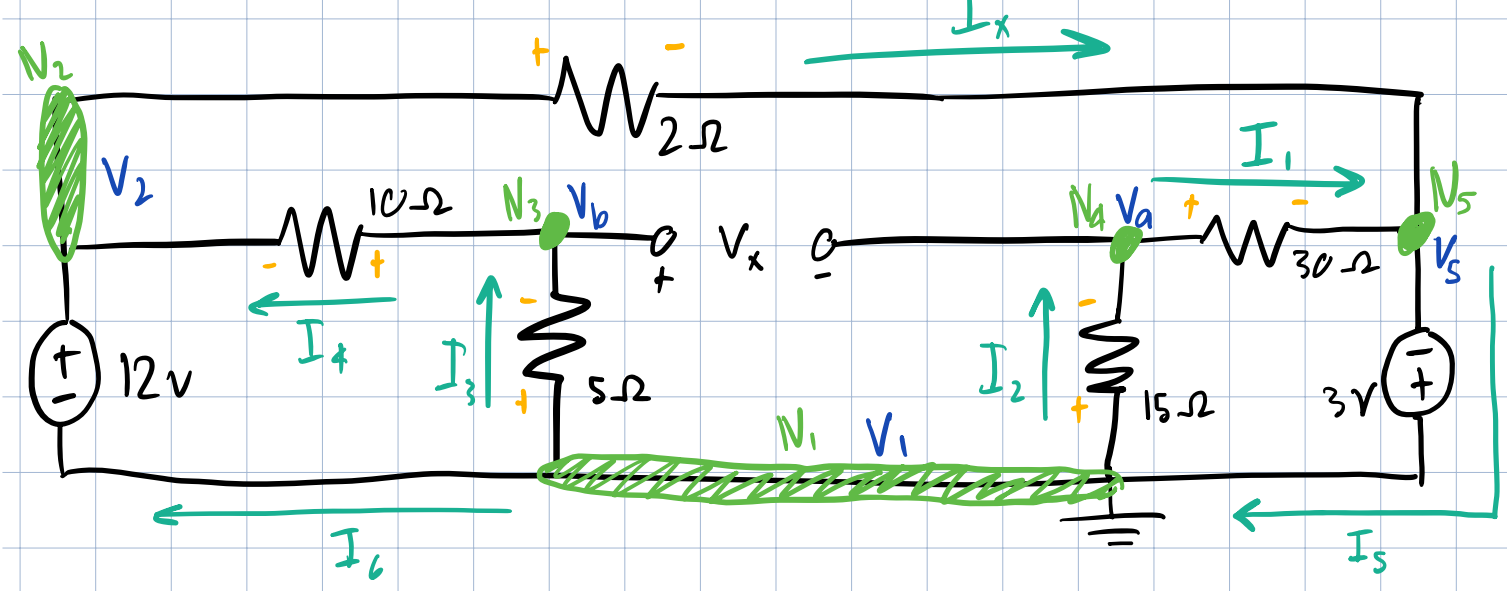
KVL on L_1:

$-2I_2 + 10I_3 + V_x + 5 \cdot 0 + 10 = 0$

$-2(2) + 10(-12 + I_5) + V_x + 10 = 0$

$V_x = 75.25\ V$

Problem Two: Solve for V_x and I_x



BCA: 3 backyards - 0 current sources = 3 unknowns

NVA: 5 nodes - 1 grand - 2 voltage sources = 2 unknowns

Use Node voltage analysis

Find voltages:

KCL at N_3:

$I_4 = I_3$

Voltages

$V_1 = 0V$

$$\frac{V_b - V_2}{10} = \frac{0 - V_b}{5}$$

$$V_b - (12) = -2V_b$$

$$3V_b = 12$$

$$V_b = 4$$

KCL at N_4:

$$I_1 = I_2$$

$$\frac{V_a - V_5}{30} = \frac{0 - V_a}{15}$$

$$V_a - V_5 = -2V_a$$

$$3V_a = V_5$$

$$V_a = \frac{-3}{3}$$

$$= -1V$$

Solve for V_x

$$V_x = V_b - V_a$$

$$= 5V$$

$V_2 = 12V$

$V_5 = -3V$

$V_b = 4V$

$V_a = -1V$

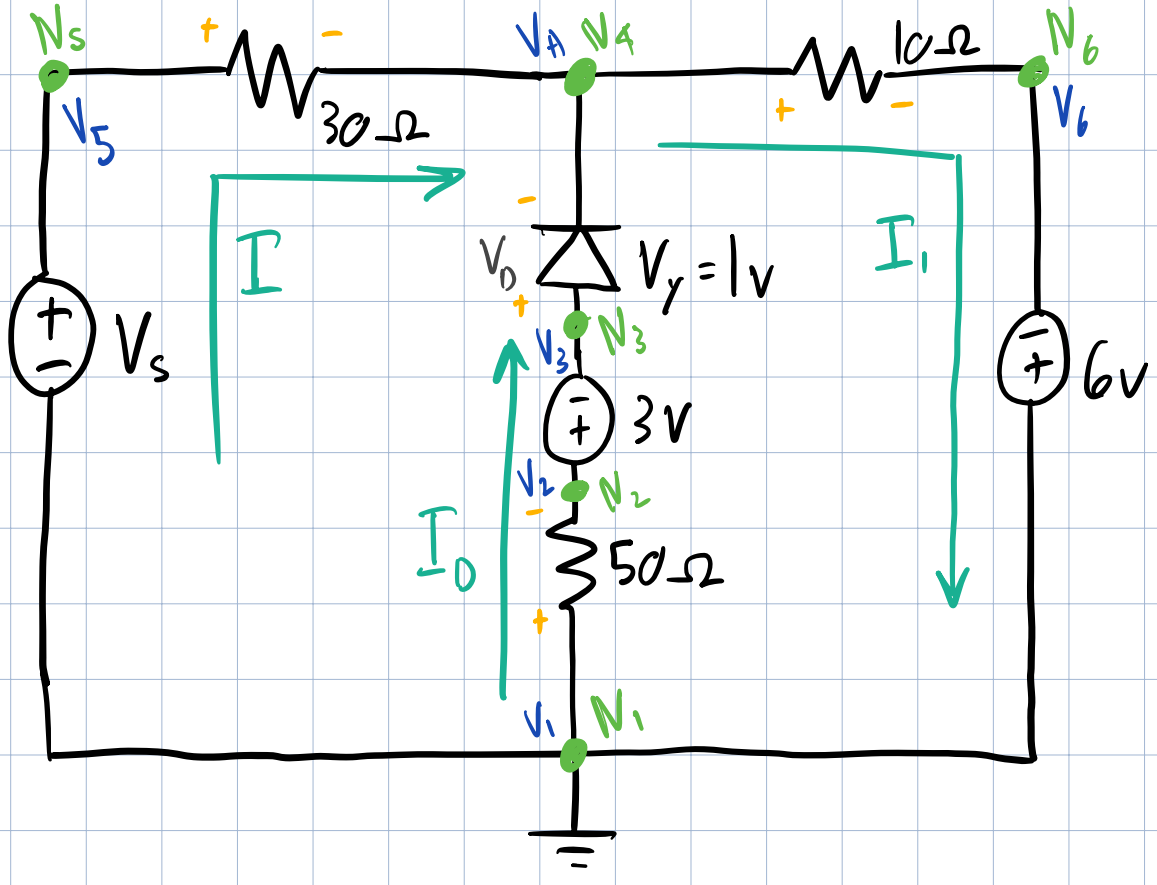
Solve for I_x over the 2Ω resistor

$$I_x = \frac{V_2 - V_3}{2}$$

$$= \frac{12+3}{2}$$

$$= \frac{15}{2} V$$

Problem 3: Find V_s so the diode is ON and OFF. Find I and V_A



Solve with diode OFF

Use Node Voltage Analysis because its easier

NVA: 6 Nodes - 1 ref - 3 voltage sources = 2 unknowns

Solve for voltages

Known Voltages

$V_1 = 0V$

$V_5 = V_s$

$V_6 = -6V$

$V_A = \frac{V_s - 18}{4}$

$V_2 = 0V$

$V_3 = -3V$

KCL at V_4:

$I = I_1$

$\frac{V_s - V_A}{30} = \frac{V_A - V_6}{10}$

$V_s - V_A = 3(V_A + 6)$

$V_s - V_A = 3V_A + 18$

$-4V_A = 18 - V_s$

$V_A = \frac{V_s - 18}{4}$

KCL at V_2

$I_D = I_D$

$0 = \frac{V_1 - V_2}{50}$

$0 = 0 - V_2$

$V_2 = 0$

$V_3 = V_2 - 3$

$= -3V$

Solve for $V_D > V_x$

$$V_D = V_3 - V_A$$

$$V_D = -3 - \frac{V_S - 18}{4}$$

Dicde en when $V_D > V_y$

$$-3 - \frac{V_S - 18}{4} > 1$$

$$-12 - V_S + 18 > 4$$

$$-V_S > -2$$

$$V_S < 2V$$

Solve for I over the 30-Ω resister

$$I = \frac{V_S - V_A}{30}$$

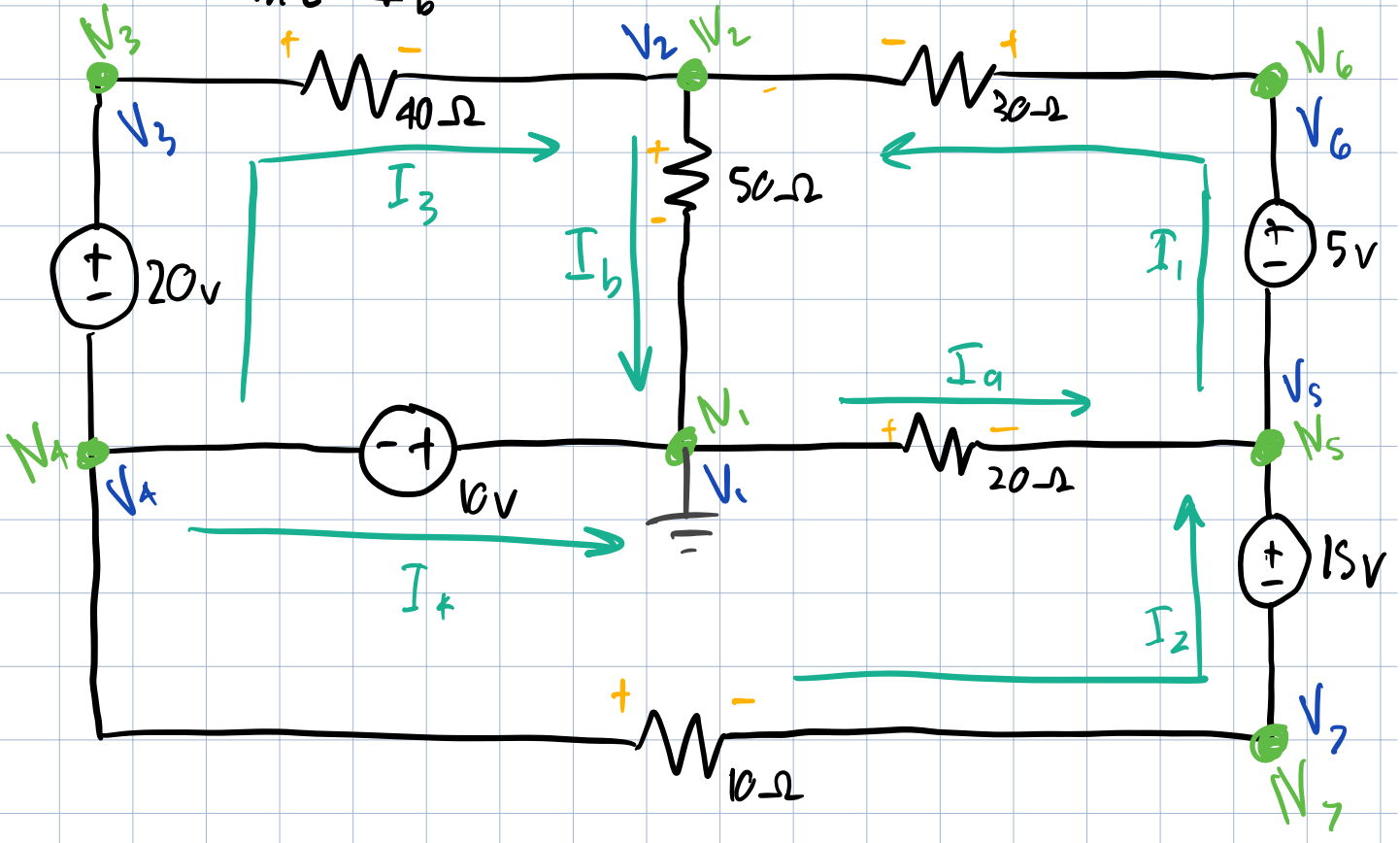
$$= \frac{V_S - \frac{V_S - 18}{4}}{30}$$

$$= \frac{\frac{4V_S - V_S + 18}{4}}{30}$$

$$= \frac{3V_S + 18}{4} \cdot \frac{1}{30}$$

$= \frac{V_5 + 6}{40}$

Problem 4: Determine all node voltages in terms of I_a and I_b



Use Node Voltage Analysis

7 Nodes - 1 Ref - 4 voltage sources = 2 unknowns

Find voltages

$20 I_a = V_1 - V_5$

$V_5 = -20 I_a$

Known Voltages

$V_1 = 0V$

$V_4 = -10V$

$V_3 = 10V$

$50 I_b = V_2 - V_1$

$V_2 = 50 I_b$

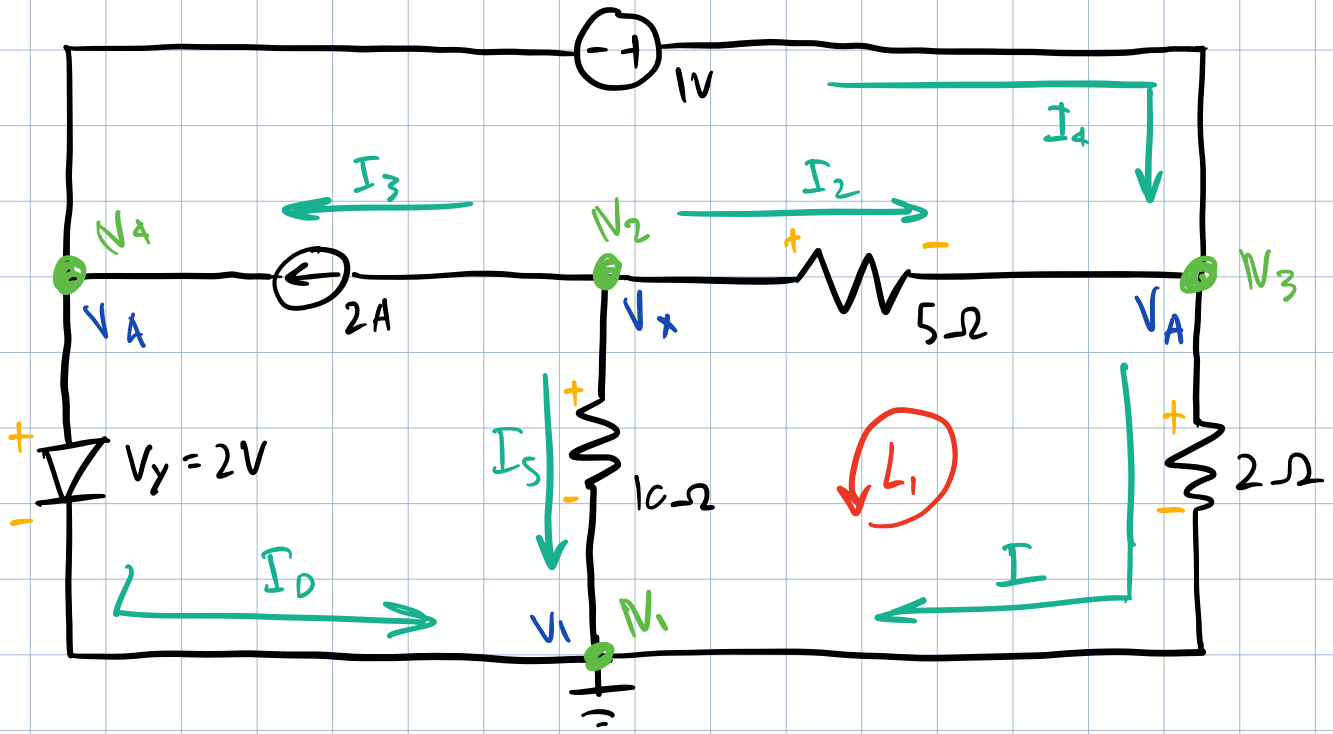
$V_5 = -20 I_a$

$V_6 = -20 I_a + 5$

$V_7 = -20 I_a - 15$

$V_2 = 50 I_b$

Problem 5



Solve assuming the diode is ON

BCA: 3 backgrounds - 1 current sence = 2 unknowns

NVA: 4 nodes - 1 ref - 2 voltage sources = 1 unknown

Use Node Voltage Analysis

Find Voltages

KCL at N_2

$$0 = I_3 + I_2 + I_5$$

$$0 = 2 + \frac{V_x - V_A}{5} + \frac{V_x - V_1}{10}$$

$$0 = 20 + 2(V_x - 3) + (V_x - V_1)$$

$$0 = 20 + 2V_x - 6 + V_x$$

$$-3V_x = 14$$

$$V_x = -\frac{14}{3}$$

Solve for I_D

KCL at N_1:

$$I_D + I_5 + I = 0$$

$$I_D + \frac{V_x - V_1}{10} + \frac{V_A - V_1}{2} = 0$$

$$10I_D + \left(-\frac{14}{3} - 0\right) + 5(3 - 0) = 0$$

$$10I_D = -15 + \frac{14}{3}$$

$$I_D = -\frac{31}{30}\ A$$

Voltages

$V_1 = 0V$

$V_4 = 2V$

$V_A = 3V$

$V_x = -\frac{14}{3}$

Diode is CFF

Solve assuming diode is CFF

BCA: 2 backwards - 1 current source = 1 unknown

NVA: 4 Nodes - 1 Ref - 1 voltage source = 2 unknowns

Use Branch Current Analysis

Solve for currents

KCL at N_1:

$I_5 = -I$

KCL at N_2:

$I_3 + I_2 + I_5 = 0$

$2 + I_2 - I = 0$

$I_2 = I - 2$

KVL at N_3:

$I_4 + I_2 = I$

$I_4 + I - 2 = I$

Currents

$I_D = 0A$

$I_5 = -I$

$I_3 = 2A$

$I_2 = I - 2$

$I_4 = 2A$

$I = \frac{10}{17} A$

$I_4 = 2$

KVL on L_1:

$2I + 5I_2 - 10I_5 = 0$

$2I + 5(I - 2) - 10(-I) = 0$

$2I + 5I - 10 + 10I = 0$

$17I = 10$

$I = \frac{10}{17}$

Solve for V_D

KCL at N_1:

$I_D + I_5 + I = 0$

$(V_4 - V_1) + I_5 + I = 0$

$V_4 = -I_5 + I$

$= 2I$

$= \frac{20}{17}$ V

Diode must be OFF