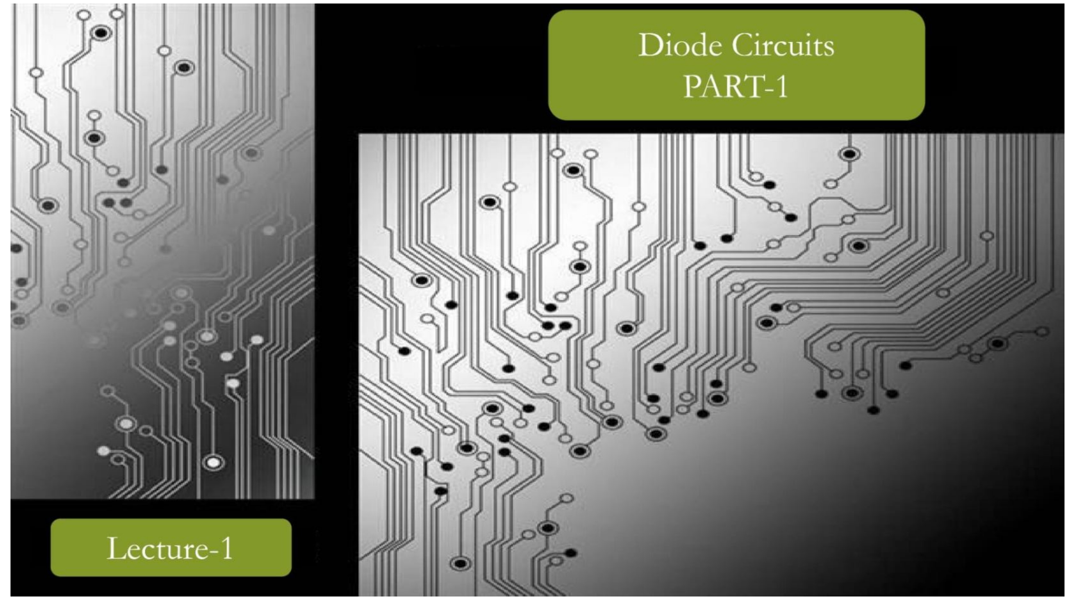
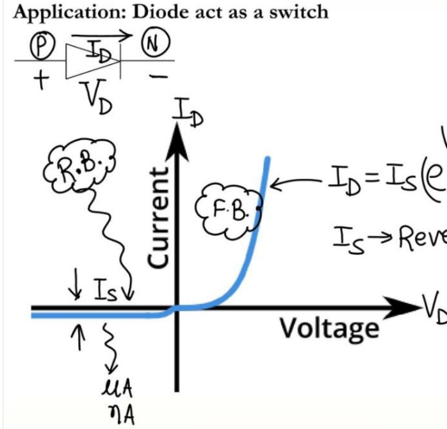


Diode Circuits

1. Diode with respect D.C.
2. clipper Circuits
3. clamper circuits
4. D.C. power supply $\rightarrow$ (Rectifiers + Filter + Zener regulator)
5. Small signal model of the diode.

Diode with D.C .Source

Application: Diode act as a switch



$I_D = I_S\left(e^{V_D/\eta V_T} - 1\right)$

$I_S \rightarrow$ Reverse saturation current [μA (or) nA]

$\eta \rightarrow$ ideality factor

$\eta = 1 \rightarrow$ Ge

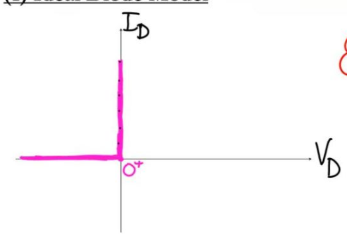
$\eta = 2 \rightarrow$ Si

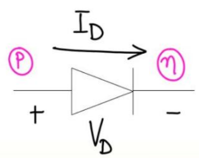
V_T : Thermal voltage

$V_T = \frac{T}{11,600}$ $\rightarrow$ (kelvin)

Diode Models

(1) Ideal Diode Model





① If $V_D < 0$ ⇒ $I_D = 0$ ⇒ P —o o— n open circuit

R.B.

\+ (-2V) -

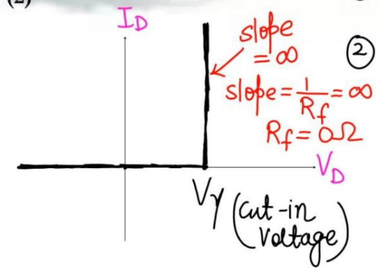
or P - 2V + n

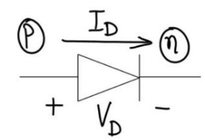
② If $V_D > 0$ ⇒ $I_D \neq 0$ ⇒ P —•—•— n short circuit (I_D)

F.B.

P n (I_D) + 2V -

(2)



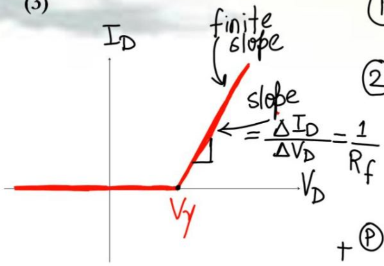


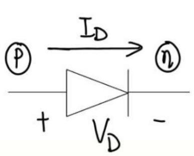
① If $V_D < V_\gamma$: $I_D = 0$ ⇒ P —o o— n open circuit

② If $V_D > V_\gamma$: $I_D \neq 0$

P + V_D - n ⇒ P + V_γ - n (I_D)

(3)

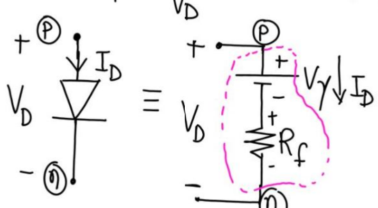




① If $V_D < V_\gamma$: $I_D = 0$ ⇒ P —o o— n open circuit

② If $V_D > V_\gamma$: $I_D \neq 0$

P (I_D) + V_D - n ⇒ P + V_γ - R_f n (I_D)



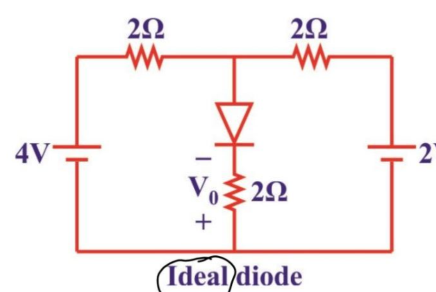
$V_D - V_\gamma - I_D R_f = 0$

$$I_D = \frac{V_D - V_\gamma}{R_f}$$

Note: Si diode $V_\gamma \simeq 0.7$ Volt
Ge diode $V_\gamma \simeq 0.3$ volt

Question.1

Find Vo in the given circuit



Procedure:

① Let Diode is off

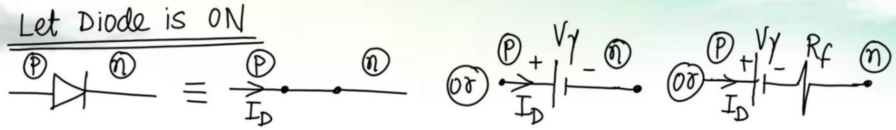
P —▷|— n ≡ P + o V_D o - n

$V_D = ?$

If $V_D < 0$ or $V_D < V_\gamma$
⇒ Yes diode is really off.

If $V_D > 0$ or $V_D > V_\gamma$
⇒ Diode is ON

② Let Diode is ON

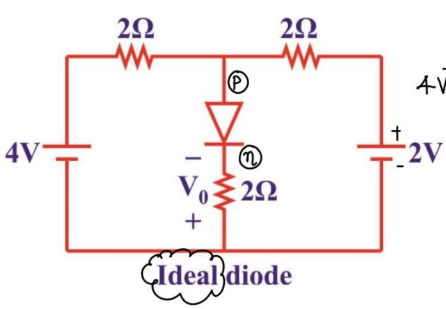


If $I_D > 0$ or I (P to N) ⇒ Diode is really ON

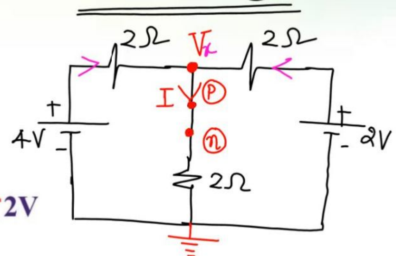
If $I_D < 0$ or I (N to P) ⇒ Diode is Off

Question.1

Find Vo in the given circuit



Sol^n Let diode is ON



$$\frac{4-V_x}{2} + \frac{2-V_x}{2} = \frac{V_x - 0}{2}$$

$$6 - 2V_x = V_x$$

$$3V_x = 6$$

$$V_x = 2V$$

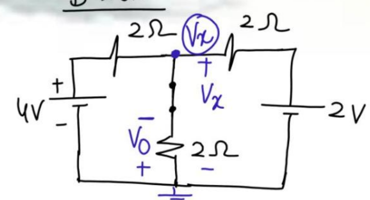
$$I = \frac{V_x - 0}{2}$$

$$I = \frac{2}{2} = 1A$$

$I = 1A$
(P to N)

(Diode is really ON)

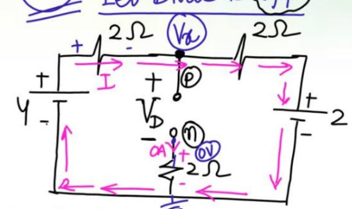
D→ON



$V_x = 2V$

$\boxed{V_0 = -2V}$ Ans.

OR Let Diode is Off



$$V_D = V_x = 3V$$

$V_D > 0 \Rightarrow$ (D → ON)

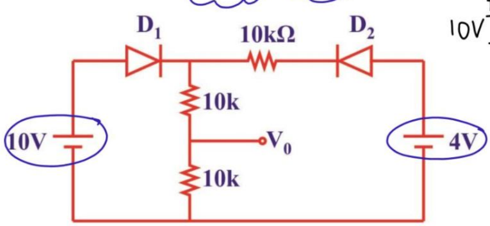
$$I = \frac{4-2}{2+2} = \frac{2}{4} = \frac{1}{2} = 0.5A$$

$V_x = 4 - 2I = 4 - 2 \times 0.5 = 3V$

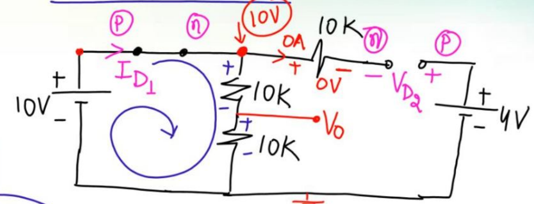
Diode is ON, Our Assumption is wrong.

Question.2

Find Vo, Assume Diodes are Ideal



Let D_1 ON & D_2 off



$10 - 10I_{D_1} - 10I_{D_1} = 0$

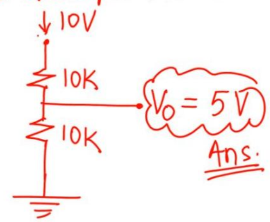
$I_{D_1} = \frac{10}{20} = \frac{1}{2}\ mA = 0.5mA$ (p to N)

$D_1 \to ON$

$V_{D_2} = 4 - 10 = -6V$

$D_2 \to off$

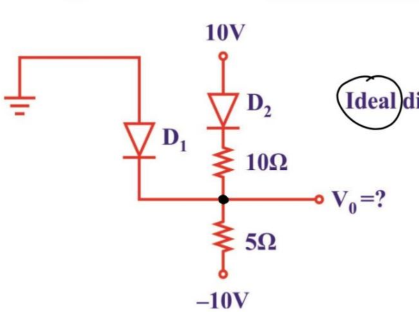
Our Assumption is correct.



$V_0 = 5V$ Ans.

8 AM

Question.3



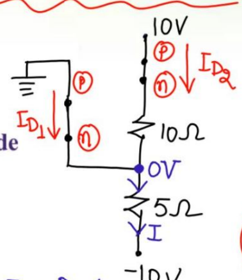
Ideal diode

KCL ⇒ $I_{D_1} + I_{D_2} = I$

$I_{D_1} = 2 - 1 = 1A$ (P to N)

$D_1 \to ON$

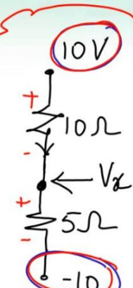
Let D_1 ON, D_2 ON



$I = \frac{0-(-10)}{5} = 2A$

$I_{D_2} = \frac{10-0}{10} = 1A$ (P to N)

$D_2 \to ON$



$V_x = \frac{10 \times 5}{15} + \frac{-10 \times 10}{15}$

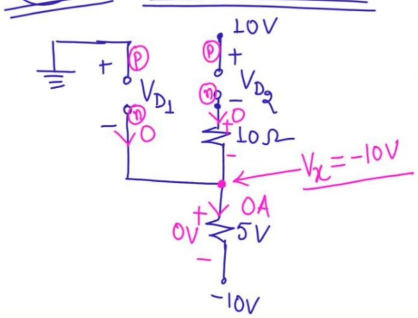
$V_x = \frac{-50}{15}$

Our Assumption is correct.

$V_0 = 0V$ Ans.

OR

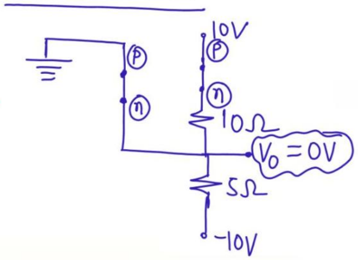
Let D_1 off, D_2 off



$V_{D_1} = 0 - (-10) = 10V$ (D_1 ON)

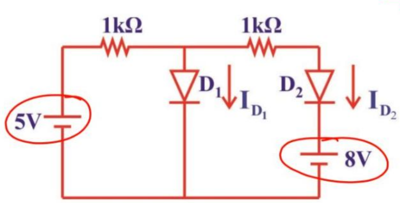
$V_{D_2} = 10 - (-10) = 20V$ (D_2 ON)

D_1 ON & D_2 ON

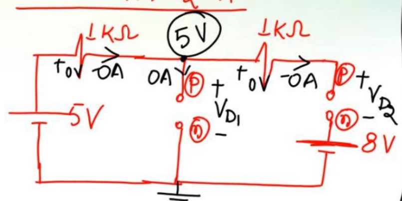


Question.4

Assume Diodes are Ideal



Let D_1 off, D_2 off

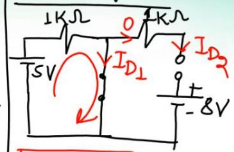


$V_{D_1} = 5V$ (D_1 ON)

$V_{D_2} = 5 - 8 = -3V$ (D_2 off)

✓ D_1 ON & D_2 off

✓ D_1 ON, D_2 off

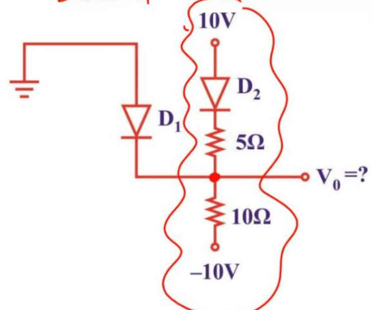


$\boxed{I_{D_2} = 0A}$

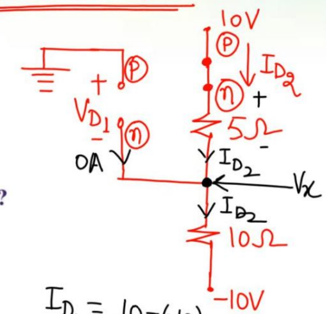
$I_{D_1} = \frac{5}{1K} = 5mA$

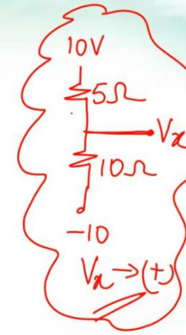
Question.5

D → ideal



Let D_1 off, D_2 ON





$I_{D_2} = \frac{10-(-10)}{10+5} = \frac{20}{15} = \frac{4}{3} A$ (p to N)

($D_2 \to$ ON)

$V_{D_1} = 0 - V_x = -3.33V$

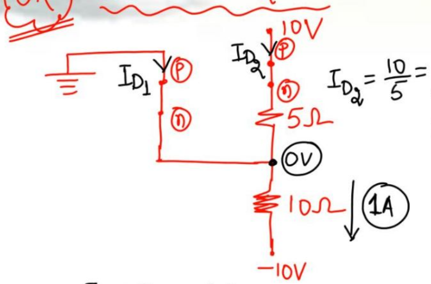
($D_1 \to$ off)

$V_x = 10 - 5 I_{D_2}$

$= 10 - 5 \times \frac{20}{15} = 10 - \frac{20}{3} = \frac{30-20}{3} = \frac{10}{3} = 3.33V$

Our Assumption is correct. ($V_0 = V_x = 3.33V$)

OR Let D_1 ON & D_2 ON



$I_{D_2} = \frac{10}{5} = 2A$ (p to N)

(D_2 ON) ✓

D_1 off, D_2 ON

$I_{D_1} + I_{D_2} = 1A$

$I_{D_1} = 1A - 2A = -1A$

$I_{D_1} = -1A$ (p to N)

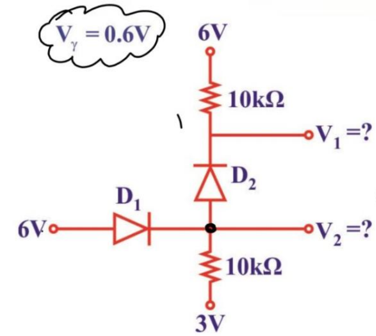
$\Rightarrow +1A$ (N to p) (D_1 off)

Diode Circuits
PART-2

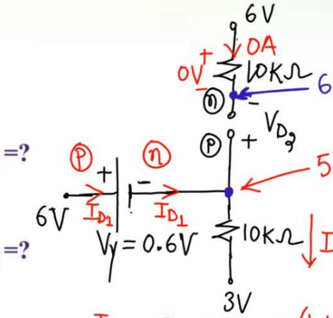
Lecture-2

Question.6

$V_\gamma = 0.6V$



Let D_1 ON, D_2 off



$V_{D_2} = 5.4 - 6 = -0.6V$

$D_2 \rightarrow$ off

$I = \frac{5.4-3}{10K} = \frac{2.4}{10K} = 0.24mA$

$I_{D_1} = I = 0.24mA$ (p to N)

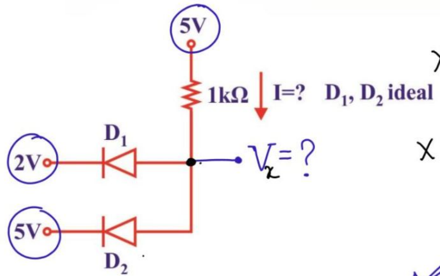
D_1 ON

Our assumption is correct.

$V_1 = 6V$
$V_2 = 5.4V$

Ans.

Question.7



Possibilities

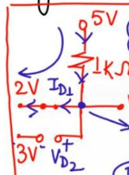
× (1) D_1 ON, D_2 ON ⇒ Not possible ⟹ Violation of KVL

× (2) D_1 OFF, D_2 off ⇒ Not possible ⟹ $V_x = 5V$ ⟹ D_1 ON forcely

× (3) D_1 off, D_2 ON

If D_2 ON $\xrightarrow{\text{forcely}}$ D_1 ON

✓ (4) D_1 ON, D_2 off ✓



$I_{D_1} = \frac{3}{1K} = 3mA$

D_1 ON

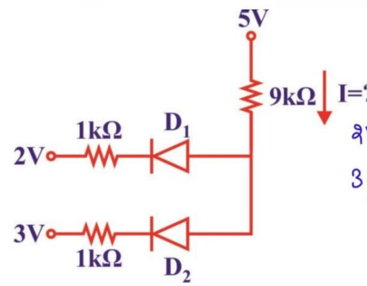
V_x → 2V

D_2 off

I = 3mA Ans.

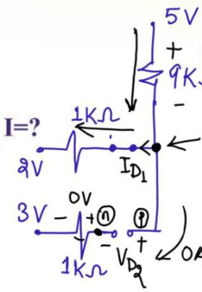
$V_x = 2V$ Ans

Question.8



Ideal diode

Let D_1 ON, D_2 off



$I_{D_1} = \frac{5-2}{10K} = \frac{3}{10K} = 0.3mA$ (ptoN) (D_1 → ON)

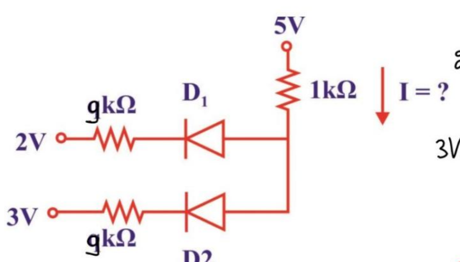
$V_x = 5 - 9K \times 0.3mA = 5 - 2.7 = 2.3V$

$V_{D_2} = V_x - 3 = 2.3 - 3 = -0.7V$

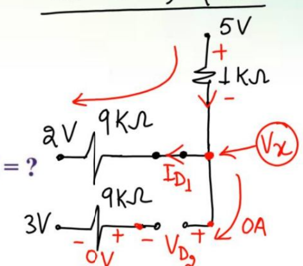
D_2 → off

$\boxed{I = 0.3\,mA}$ Ans.

Question.9



Let D_1 ON, D_2 off



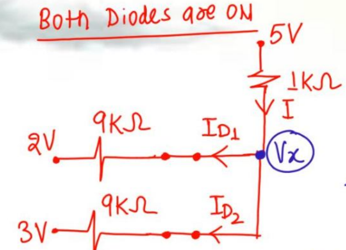
$I_{D_1} = \frac{5-2}{10K} = 0.3mA$ (D_1 ON)

$V_x = 5 - 1K \times 0.3mA = 4.7V$

$V_{D_2} = V_x - 3 = 4.7 - 3 = 1.7V$

D_2 ON

Both Diodes are ON



$\frac{5-V_x}{1K} = \frac{V_x-2}{9K} + \frac{V_x-3}{9K}$

$9(5-V_x) = 2V_x - 5$

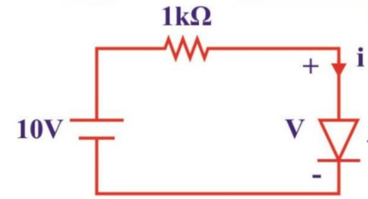
$45 - 9V_x = 2V_x - 5$

$50 = 11V_x$

$\boxed{V_x = 50/11}$ Volt

$I = \frac{5-V_x}{1K} = 5 - 50/11$ mA

Question.10



$i = \frac{V-0.7}{500}$ Amp ; when $V \geq 0.7V$

$= 0$; when $V < 0.7V$

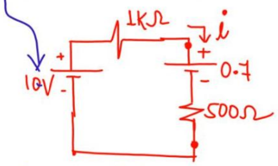
Find i in the circuit

$V_\gamma = 0.7V$

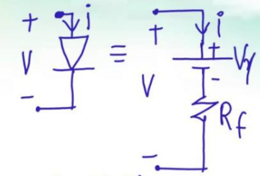
$D \rightarrow ON$

$i = \frac{V-0.7}{500}$ Amp

$\boxed{V_\gamma = 0.7V \quad R_f = 500\,\Omega}$

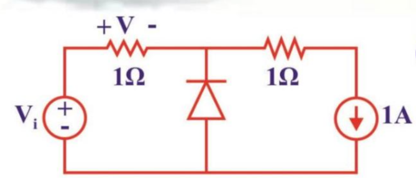


$i = \frac{10-0.7}{1500\,\Omega} = \frac{9.3}{1500}$ Amp



$i = \frac{V-V_\gamma}{R_f}$

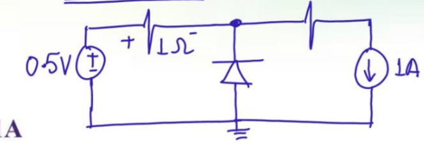
Question.11



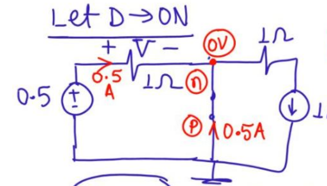
In the circuit shown, the diode is ideal. The Voltage V is given by

(a) Min (Vi, 1) (b) Max (Vi, 1)
(c) Min (-Vi, 1) (d) Max (-Vi, -1)

$V_i = 0.5V$



Let $D \rightarrow ON$



$(D \rightarrow ON)$

$\boxed{V = 0.5V}$

(a)

$V_i = 1V$

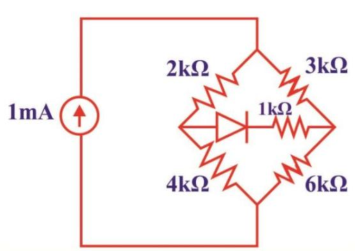
? check

)

Student's Assignment-1

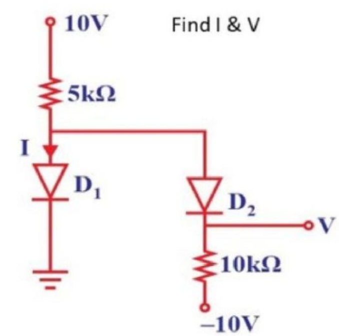
Question.1

The diode in the circuit given below has V_{on}=0.7V, but is ideal otherwise. The current (in mA) in the $4k\Omega$ resistor is _______.



Question.2

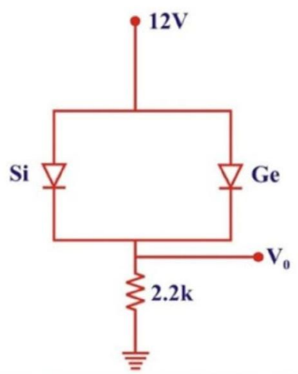
Find I & V



Question.3

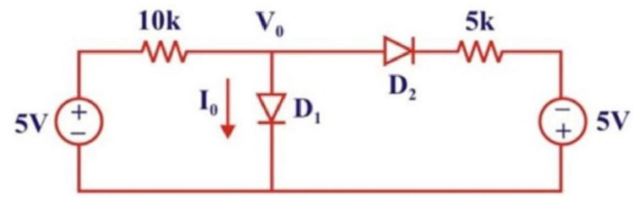
In the following figure. Find out the voltage V_0 .

Given cut-in voltage for Si = 0.7V
Cut-in voltage for Ge = 0.3V



Question.4

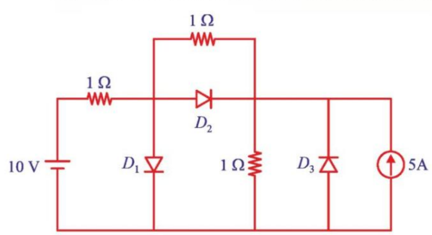
Find the value of I_0 and V_0.



Assume diode to be ideal.

Question.5

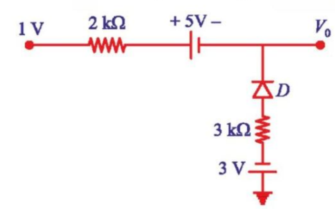
What are the states of the three ideal diodes of the circuit shown in figure?



(a) D_1 ON, D_2 OFF, D_3 OFF
(b) D_1 OFF, D_2 ON, D_3 OFF
(c) D_1 ON, D_2 OFF, D_3 ON
(d) D_1 OFF, D_2 ON, D_3 ON

Question.6

What is the output voltage Vo for the circuit shown below assuming an ideal diode?



(a) $-\frac{18}{5}$V (b) $\frac{18}{5}$V
(c) $-\frac{13}{5}$V (d) $\frac{13}{5}$V