CSE 350
Digital Electronics and Pulse Techniques

Diode Logic

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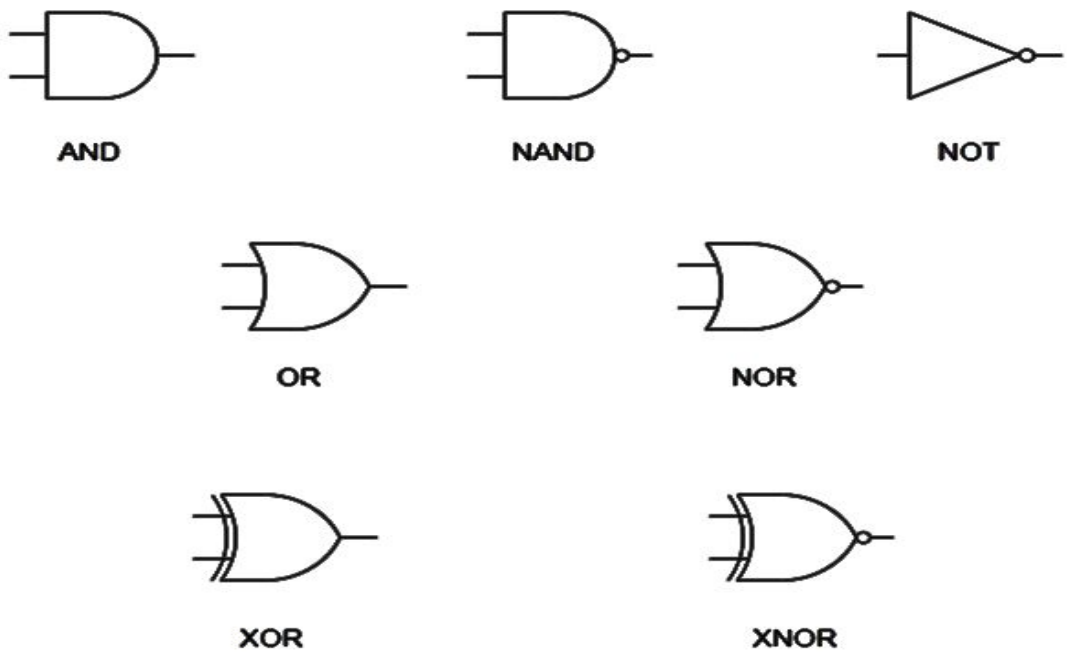
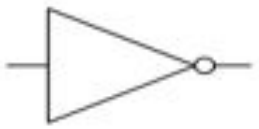
Abstract of Logic Gate:

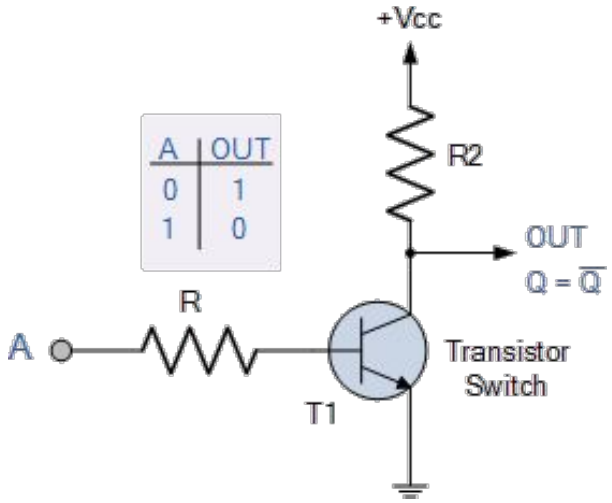


This gates are abstract, because they just represent logical operations.

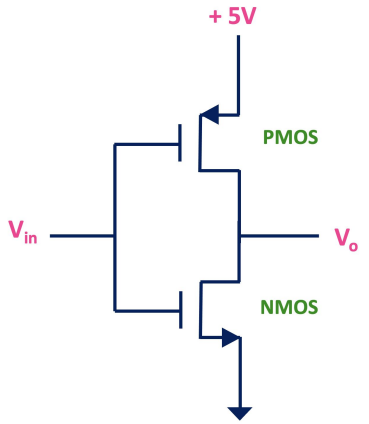
Logic families



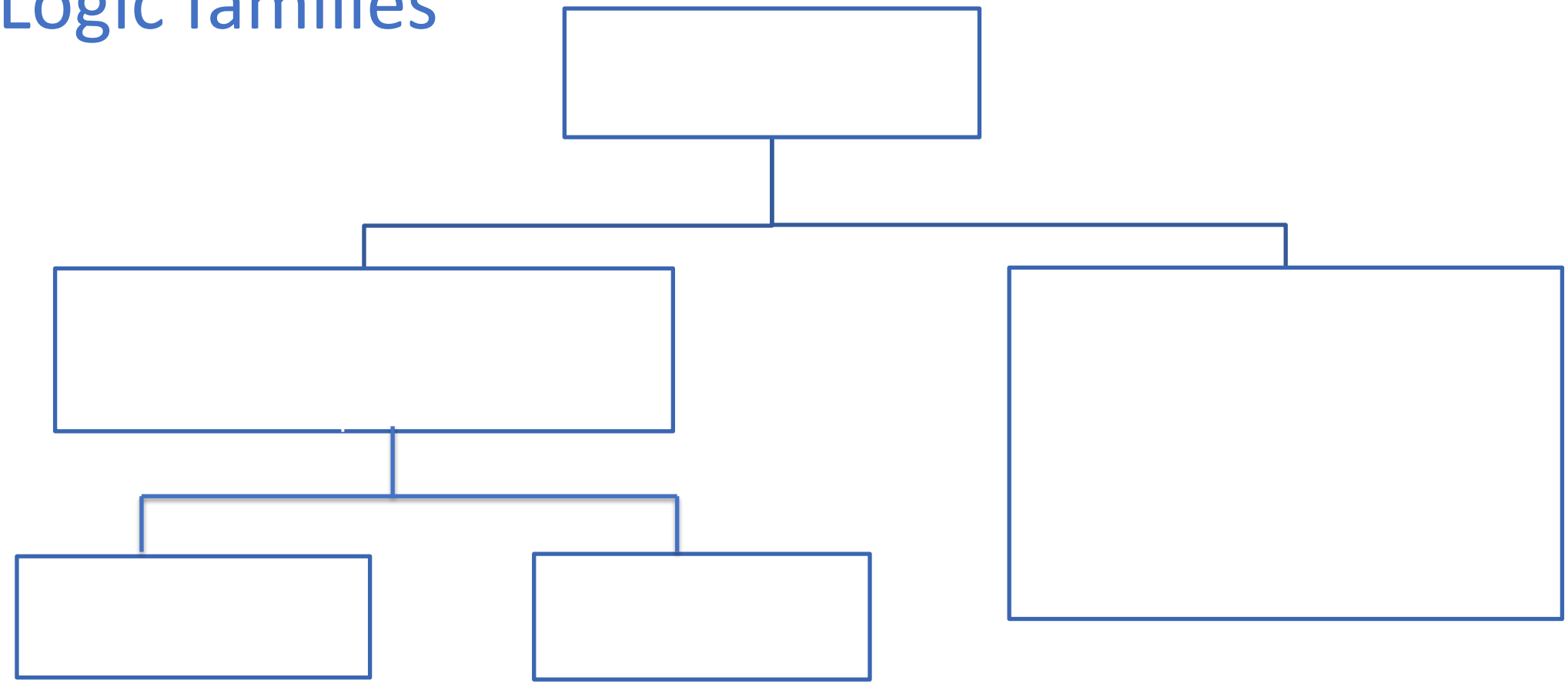
NOT



CMOS Inverter



Logic families



Logic families

Saturated Logic Family: Uses Saturation & Cutoff region of a BJT for implementation of logic states.

- Resistor Transistor Logic (RTL)
- Diode Transistor Logic (DTL)
- Direct Coupled Transistor Logic (DCTL)
- Integrated Injection Logic (IIL)
- High Threshold Logic (HTL)
- Transistor-Transistor Logic (TTL)

Unsaturated Logic Family: Uses Active & Cutoff region of a BJT for implementation of logic states.

- Schottky TTL
- Emitter Coupled Logic (ECL)

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Logic families

Unipolar Logic Family: JFET, MOSFET etc. single charge carrier-based transistor logic families.

- PMOS Logic Family
- NMOS Logic Family
- CMOS Logic Family

Diode logic

OR gate and AND gate
Design Techniques,

- For each input we need a **series resistance** and a **diode**
- Output will be connected with GND or VDD
- For OR gate output will be connected to the GND via **pull down** resistance
- For AND gate output will be connected to the VDD via **pull up** resistance.
- Series resistance will be small.
- Pull up / Pull down resistance will be large.

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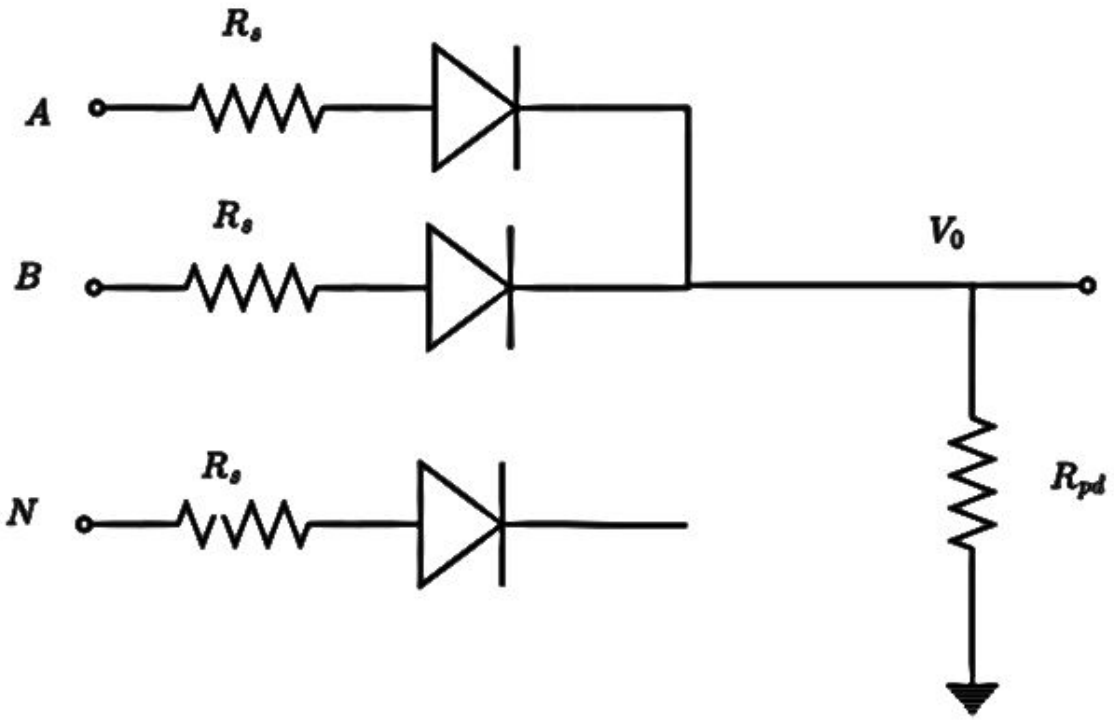
Diode logic

OR Gate

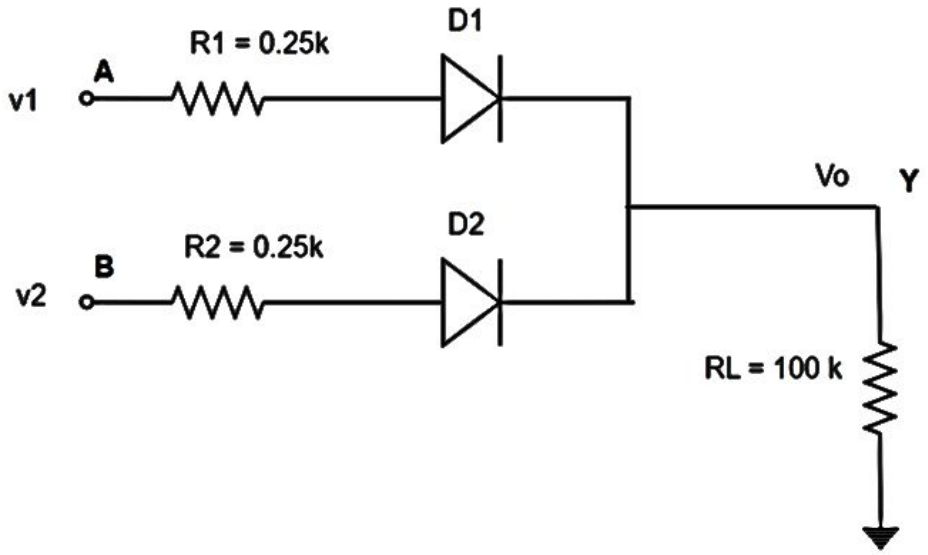
Series and pull down resistance can be chosen as

$$R_s = 1\ k\Omega$$
$$R_{pd} = 100\ k\Omega$$



Diode logic

Two input OR Gate



A	B	V1	V2	Vo	Y
0	0	0V	0V		
0	1	0V	5V		
1	0	5V	0V		
1	1	5V	5V		

Assume: Logic 1 means 5 V on input side. Logic 0 means 0 voltage/GND

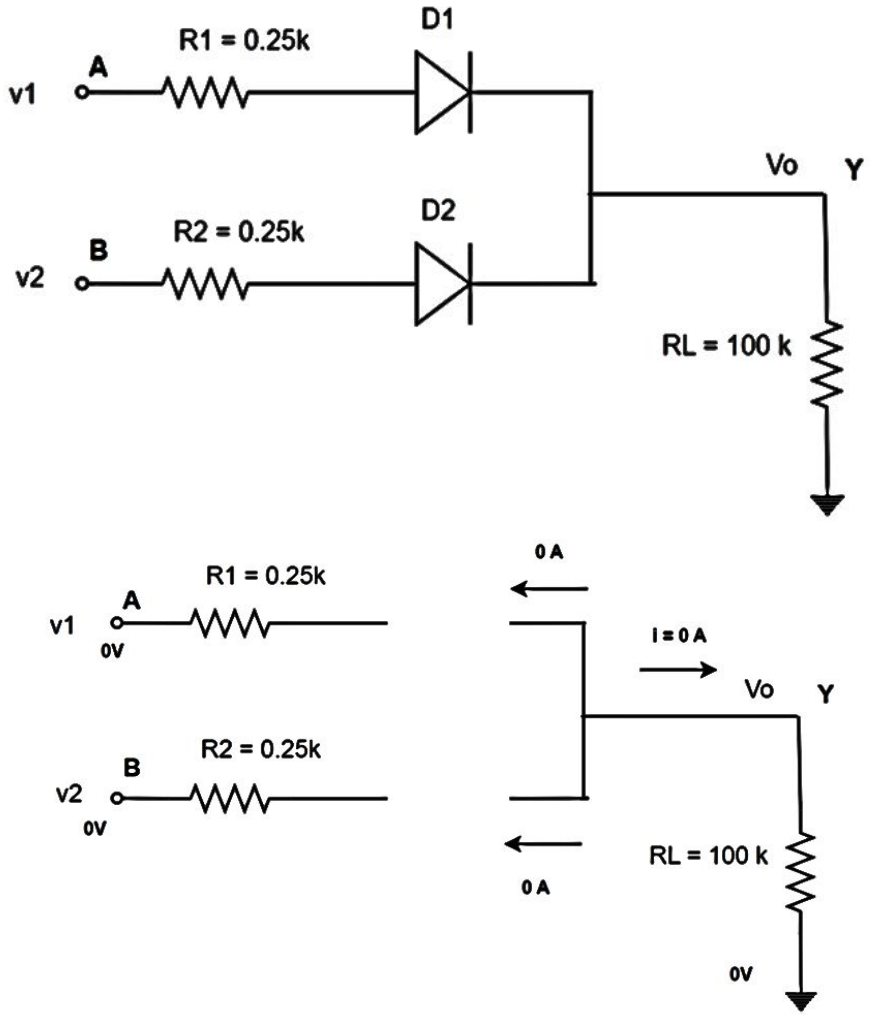
Diode logic

Case 1: A = 0, B = 0

First thing to check whether diodes are on or off.
FACT: We need at least 0.7 V to turn on any diode.
Conclusion: D1 and D2 are OFF.

$$\frac{Vo\ -0}{RL} = i = 0\ \Rightarrow Vo = 0\,V$$

$$Y = 0\ (\ logic)$$



Diode logic

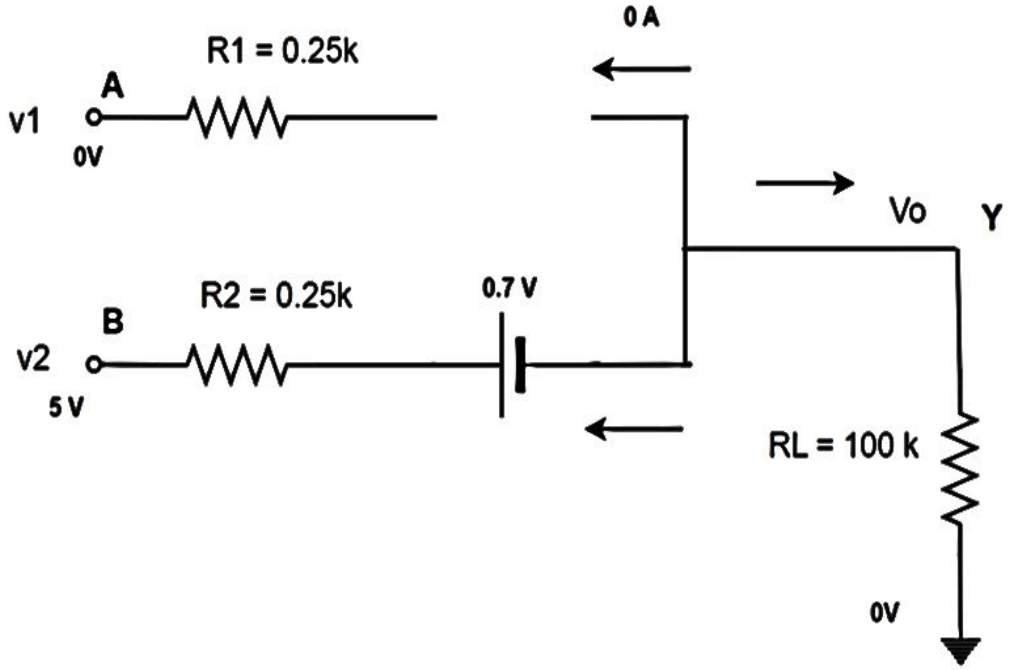
Case 2: A = 0, B = 1

First thing to check whether diodes are on or off.

Here: D1 will be OFF and D2 will be ON

$$\frac{Vo - 0}{100\,k} + \frac{(Vo + 0.7) - 5}{0.25k} = 0 \Rightarrow Vo = 4.2893\,V$$

$$Y = 1\,(logic)$$



Diode logic

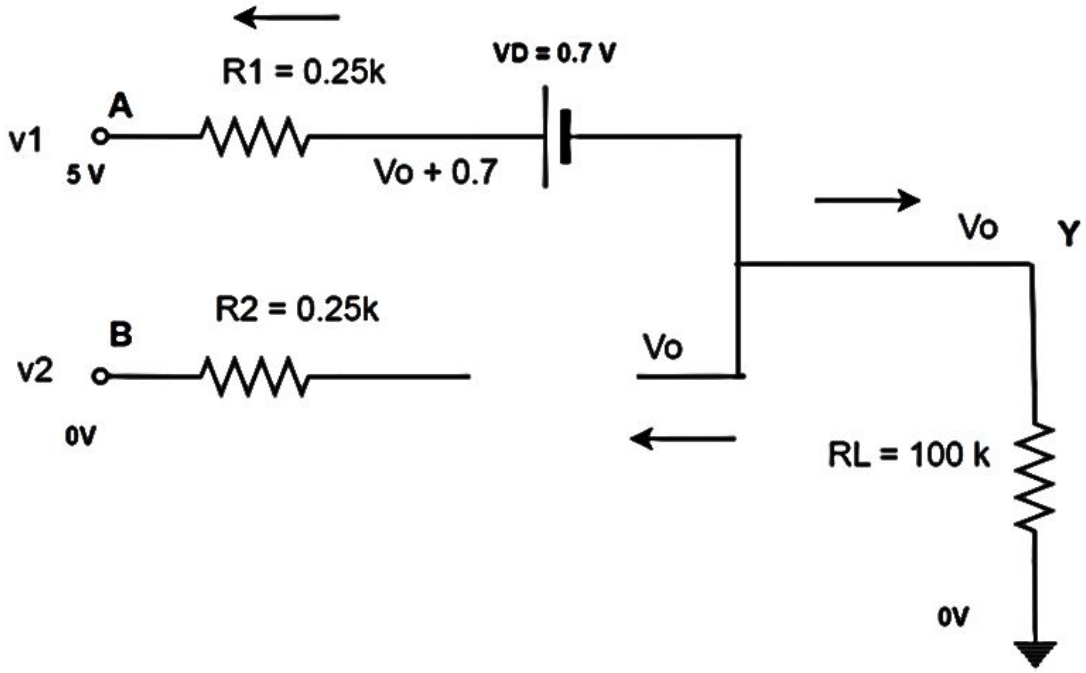
Case 3: A = 1, B = 0 (symmetrical to case 1)

First thing to check whether diodes are on or off.

Here: D1 will be ON and D2 will be OFF

$$\frac{Vo - 0}{100\,k} + \frac{(Vo + 0.7) - 5}{0.25k} = 0 => Vo = 4.2893\,V$$

$$Y = 1\ (logic)$$

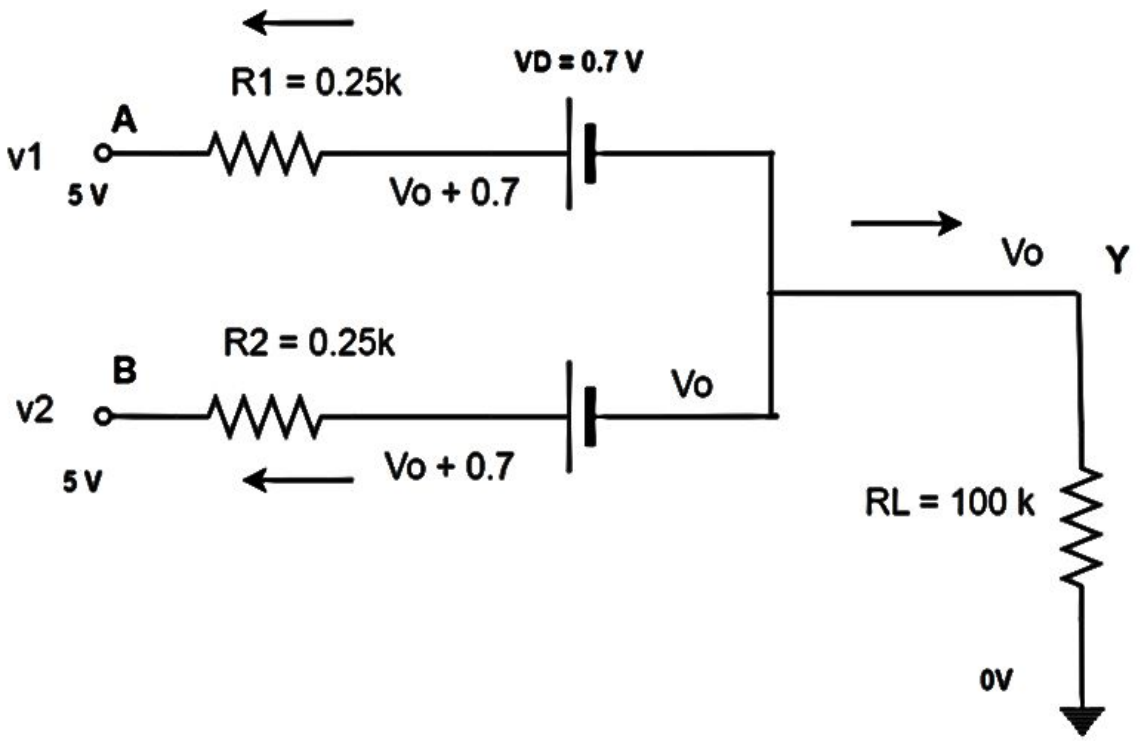


Diode logic

Case 4: A = 1, B = 1

First thing to check whether diodes are on or off.

Here: D1 will be ON and D2 will be ON



$$\frac{Vo-0}{100\ k}+\frac{(Vo+0.7)-5}{0.25k}+\frac{(Vo+0.7)-5}{0.25k}=0$$

$$=> Vo = 4.2946\ V$$

$$\boldsymbol{Y = 1\ (logic)}$$

Diode logic

Two input OR Gate Findings

#4.28 V , 4.29 V

logical High and Low can be Different at input and output side

VOH = 4.28 V

(lowest of the outputs values that can be considered as logic 1)

A	B	V1	V2	Vo	Y
0	0	0V	0V	0 V	0
0	1	0V	5V	4.2893V	1
1	0	5V	0V	4.2893V	1
1	1	5V	5V	4.2946 V	1

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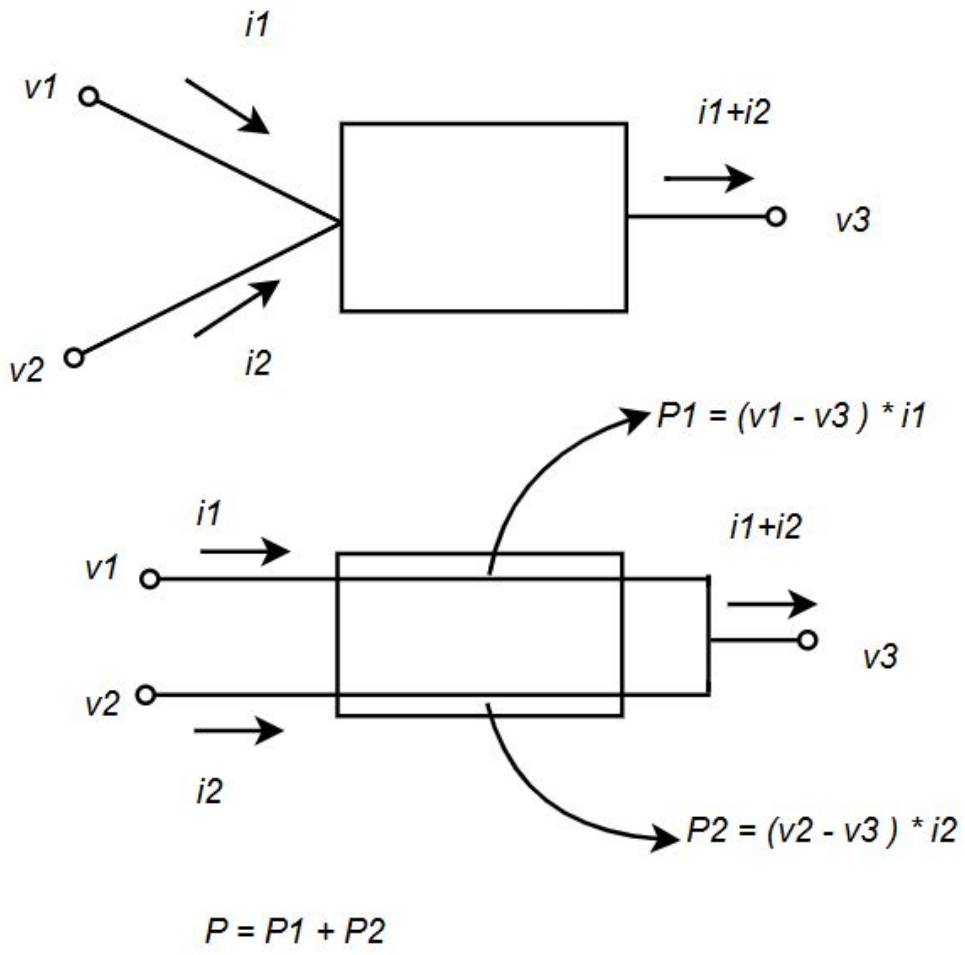
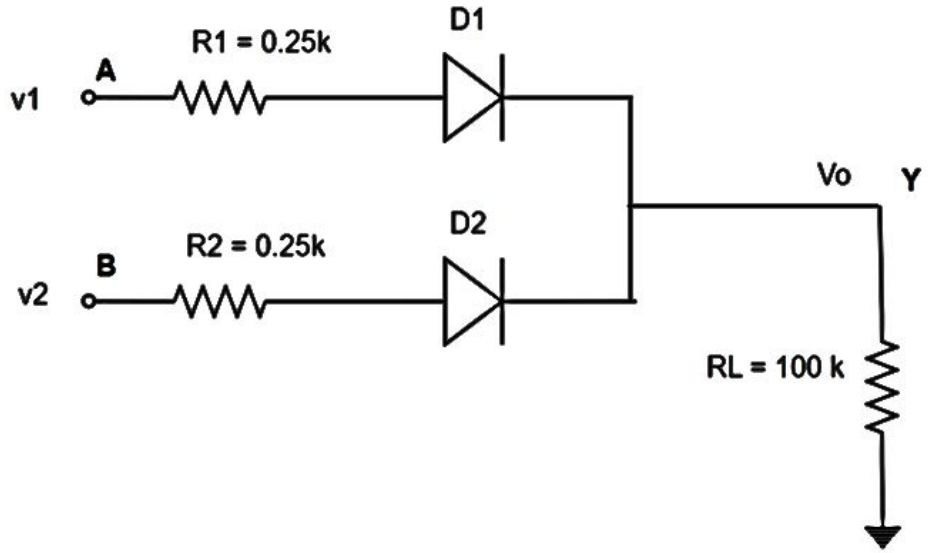
Power Dissipation Calculation

Theory:



Max Power Dissipation

Example: Find the max power dissipation of the given circuit.



Max Power Dissipation

Max power dissipation will be in the case 4

$$V_0 = 4.2946\ V$$

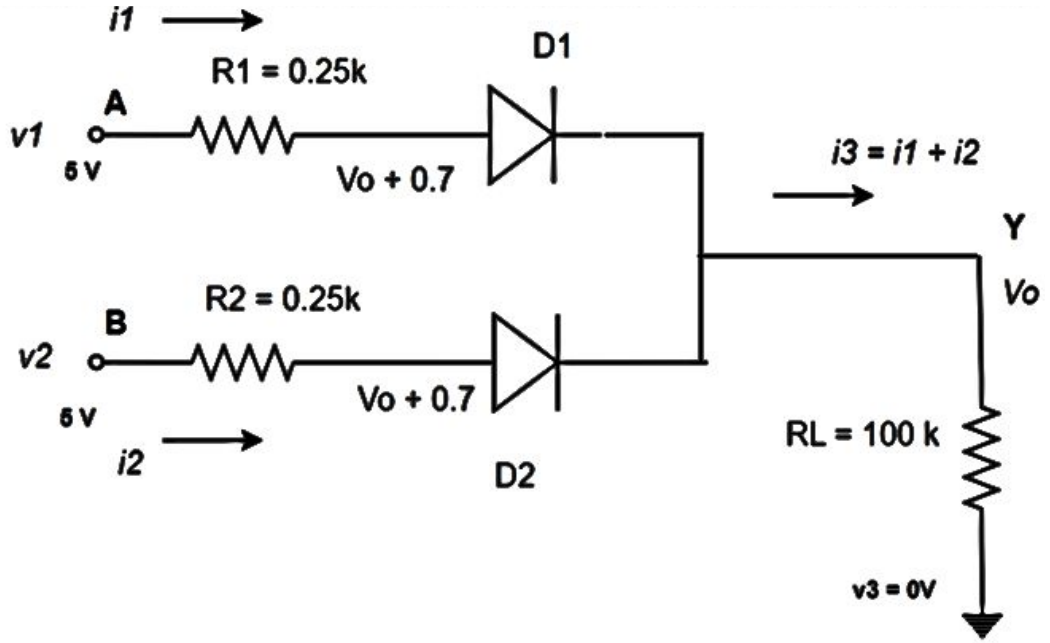
$$i1 = \frac{5 - (V_0 + 0.7)}{0.25\ k} = 0.0216\ mA$$

$$i2 = i1$$

$$i_3 = \frac{V_0 - 0}{100k} = 0.042946\ mA$$

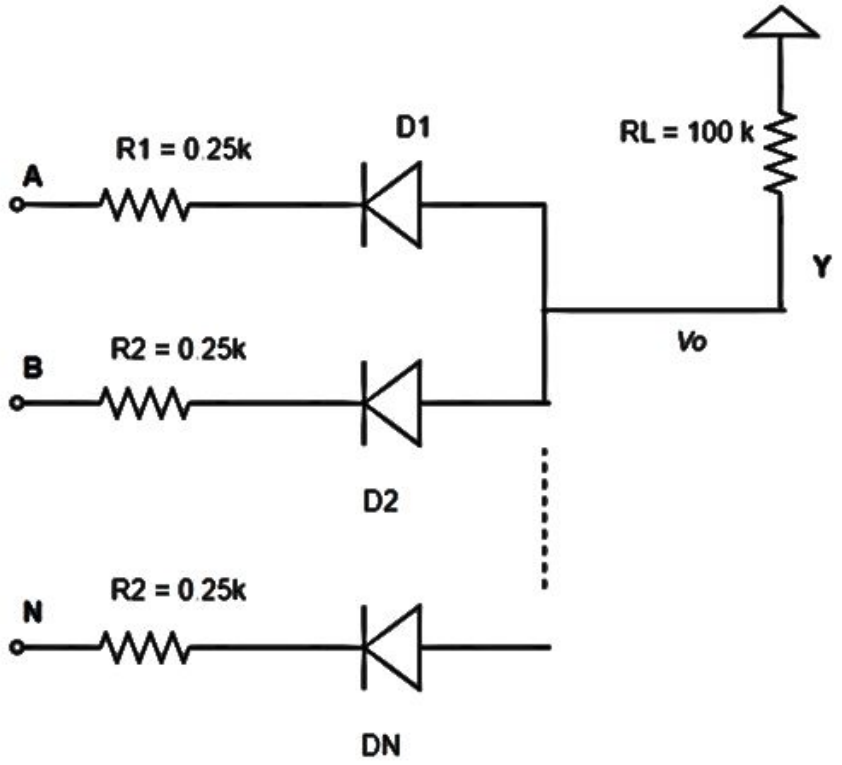
$$P = (5 - 0) * i_1 + (5 - 0) * i_2 = \ 0.216\ mW$$

$$Or\ P = (5 - 0) * i_3 = 0.216\ mW$$



Diode logic

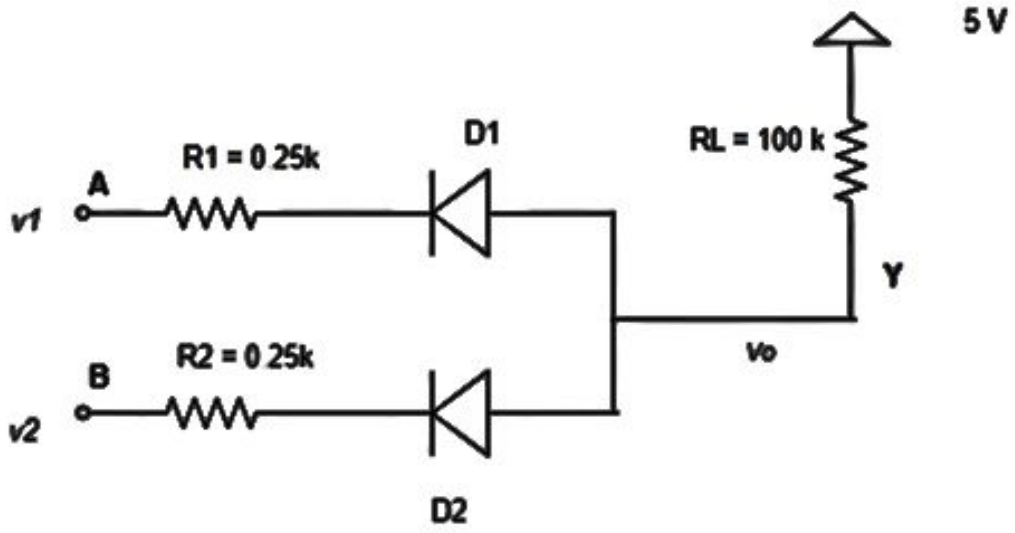
AND gate:



Diode logic

Exercise: Analysis the four possible input and fill the table. Also find the V_{OL} for this circuit.

A	B	V1	V2	Vo	Y
0	0	0V	0V		
0	1	0V	5V		
1	0	5V	0V		
1	1	5V	5V		



Hints: Logical low voltage at the output side --□ Highest voltage for which the output is considered to be 0 or logic low.

Diode logic

Try yourself,

1. Design a logic circuit, $Y = A(B + C)$ using diode logic.
2. For the given circuit find the maximum power and average power.