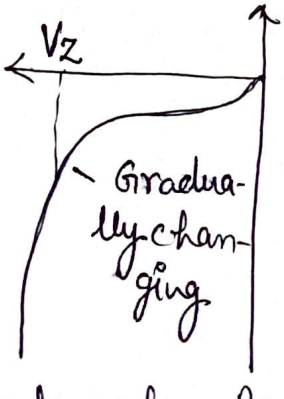
Comparision of Breakdown Mechanism.

Avalanche Breakdown	Zener Breakdown
1. Breaking of covalent bonds is due to accelerated charge carriers having large velocities and kinetic energy with adjacent atoms. This process is called carrier multiplication.	1. Breaking of covalent bonds is due to intense electric field across narrow depletion region. This generates large number of free electrons to cause breakdown.
2. This occurs for zener diode with V_Z greater than 6V.	2. This occurs for zener diodes with V_Z less than 6V.
3. The temprature cofficient is positive.	3. The temprature cofficient is negative.
4. The breakdown voltage increases as the junction temprature increases.	4. The breakdown voltage decreases as the junction temprature increases.
5. The VI characteristic of avalanche breakdown is gradually increases in reverse direction after breakdown.	5. The VI characteristics is of zener breakdown is very sharp in breakdown region.



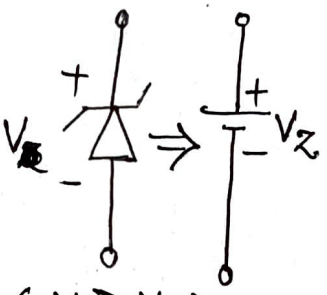
Avalanche Breakdown

Zener Breakdown

Zener Diode as Voltage Regulator

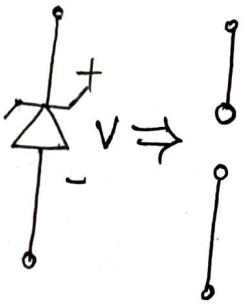
Zener Diode :—

A zener diode is a silicon pn junction semiconductor device, which is generally operated in its reverse breakdown region.



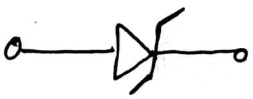
$(V \geq V_z)$

ON



$(V_z > V > 0)$

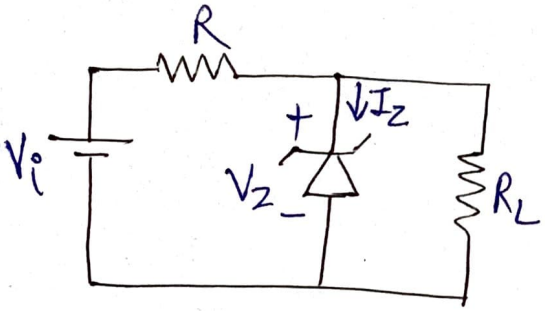
OFF



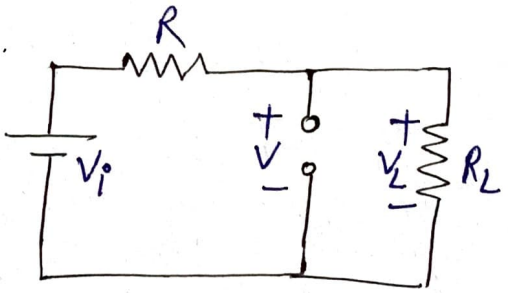
Symbol

Zener Diode Equivalent

V_i and R_L Fixed



Basic Zener Regulator



Determining the state of the zener diode

First step is to determine the state of the zener diode by removing it from the network.

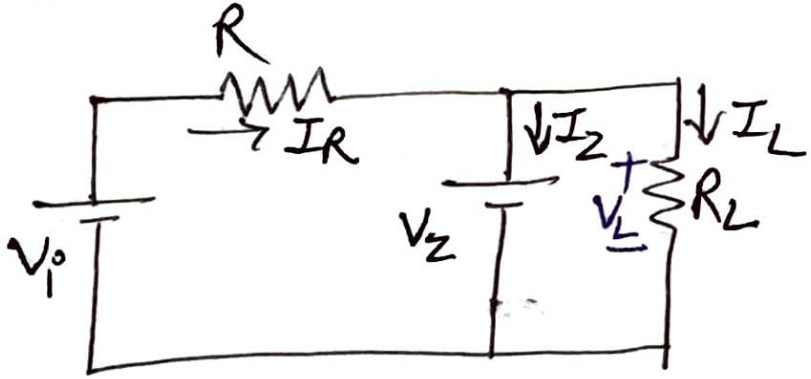
$$V = V_L = \frac{R_L V_i}{R + R_L}$$

If $V \geq V_Z$ Zener diode is ON

$V < V_Z$ Zener diode is OFF

For the ON state of diode

$$V_L = V_Z$$



According to the KCL

$$I_R = I_Z + I_L$$

$$I_Z = I_R - I_L$$

$$I_L = \frac{V_L}{R_L} \quad \& \quad I_R = \frac{V_R}{R} = \frac{V_i - V_Z}{R}$$

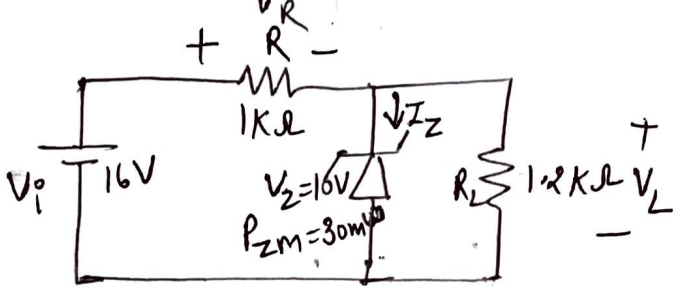
Power dissipated by the zener diode

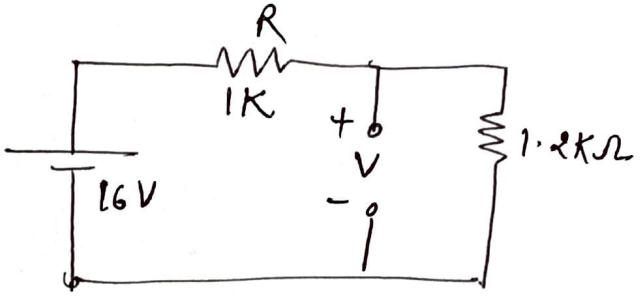
$$P_Z = V_Z I_Z$$

Ques- For the zener diode

a) determine V_L, V_R, I_z, P_z

b) repeat the part for $R_L = 3K\Omega$





(a) $V = \dfrac{R_L V_i}{R + R_L}$

$= \dfrac{1.2 \times 10^3 \times 16}{(1 + 1.2) \times 10^3}$

$V = 8.73\ V$

V is less than $V_z = 10V$ the diode is off

$V_L = V = \underline{8.73\ V}$

$V_R = V_i - V_L = 16 - 8.73V = \underline{7.27\ V}$

$I_z = \underline{0A}$

$P_z = I_z V_z = \underline{0W}$

(b) $R_L = 3K\Omega$

$V = \dfrac{R_L V_i}{R + R_L} = \dfrac{3 \times 10^3 \times 16}{(3+1) \times 10^3} = 12V$

$V = 12$ is greater than $V_z = 10V$ Diode is ON

$V_L = V_z = \underline{10V}$

$V_R = V_i - V_L = 16 - 10 = \underline{6\ V}$

$I_L = \dfrac{V_L}{R_L} = \dfrac{10}{3K\Omega} = 3.33mA$

$I_R = \dfrac{V_R}{R} = \dfrac{6}{1K\Omega} = 6mA$

$I_z = I_R - I_z = 6 - 3.33 = \underline{2.67\ mA}$

$P_z = V_z I_z = 10 \times 2.67 \times 10^{-3} = \underline{26.7\ mW}$

Liquid Crystal Display (LCD)

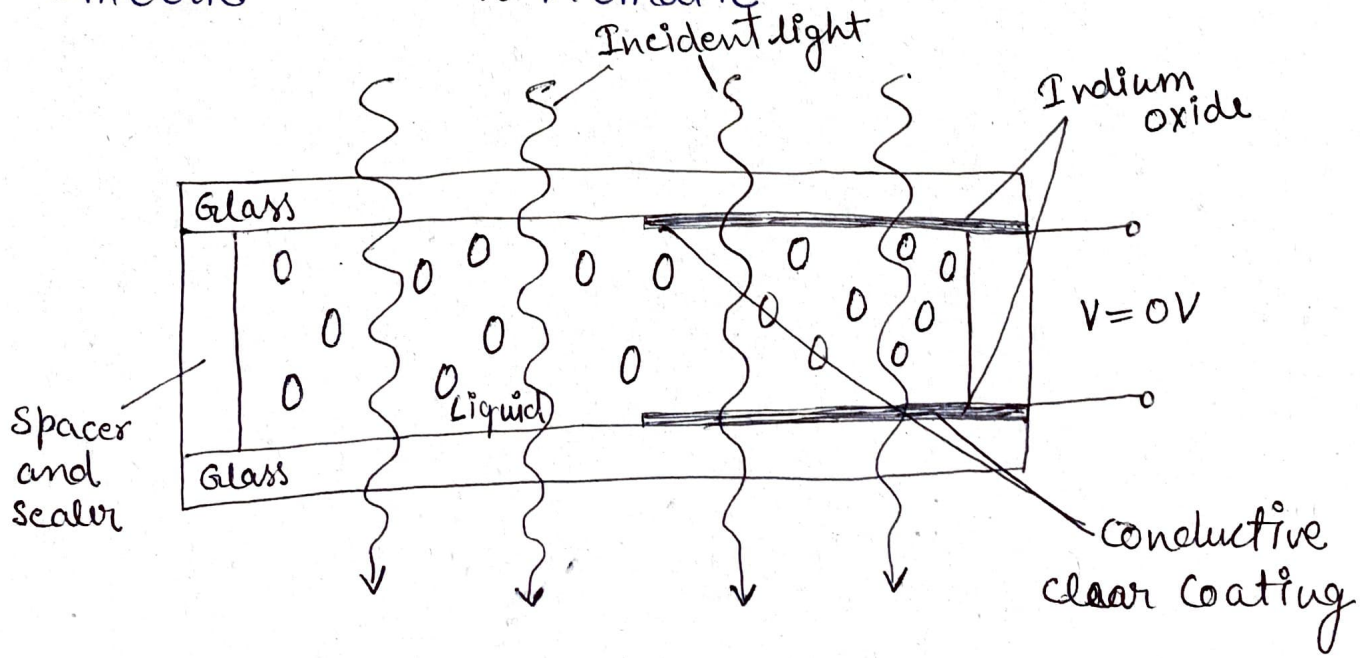
The Liquid Crystal Display use a special type of material called liquid crystals. These materials are unique as they posses the properties of liquids as well as solid crystals.

The LCDs are very special type of displays, because they do not convert the electrical energy into light like LED display.

Types of Liquid Crystals

The liquid crystals are made up of modules which are approximately cigar shaped. Depending on the different arrangements of these molecules, the liquid crystal are defined in three types:

1. Smectic
2. Nematic
3. Cholesteric



Nematic liquid Crystal

A liquid crystal is a material that flows like a liquid but whose molecular structure has some properties normally associated with solid. For light-scattering units the greatest interest in nematic liquid crystal, which have a crystal structure like above figure.

Smectic liquid crystal →

The structure of smectic liquid crystal has a molecules of rod shape arranged in layers. The orientation order is maintained in each layer over a long range.

Cholesteric Liquid Crystal →

In this type of crystal the rod shaped molecules in different layer are oriented at different angles. That means the orientation order is maintained in each layer. The difference betⁿ cholestric and Nematic crystals is the twist of molecules as we go from one layer to other.

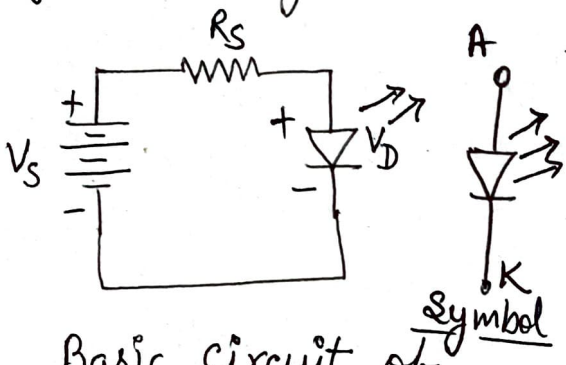
Application of LCD

*- 7-segment LCD displays are used in wrist watch and calculators.

Opto electronic Devices:—

Optoelectronics is the technology that combines optics and electronics. This field includes many devices based on the action of a pn junction.
Example → light emitting diode (LED), photodiode, optocoupler and laser diode.

Light Emitting Diode (LED):—



Basic circuit of LED

Operation →
A source voltage (V_S) is connected to resistor and an LED. The outward arrows symbolize the radiated light.
In forward-biased LED, free electrons cross the junction and fall into holes. These electrons fall from a higher to a lower energy level, they radiate energy as light.

LEDs are made of Gallium Arsenide (GaAs), Gallium Arsenide Phosphide (GaAsP) and Gallium Phosphide (GaP)

GaAs LED produces Infrared Light
GaAsP LED produces Red or Yellow colour light
GaP LED produces Red or Green colour light.

LED Voltage & Current → Resistor has the node voltage V_S on left and V_D on right with ohm's law series current

$$I_S = \frac{V_S - V_D}{R_S}$$

LED voltage drop is 1.5V to 2.5V
Current between 10 to 50 mA.

* Brightness of LED is depend on forward current.

Advantages →

1. LED has small size, light weight & low cost.
2. They are available in different spectral colours.
3. They have longer life as compared to lamps.
4. LEDs can easily interfaced with the other electronic circuits.

Disadvantages →

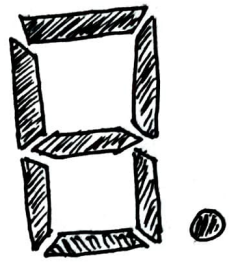
Output power is affected by changes in temperature
They need larger power for their operation
Overcurrent can damage it.

Applications →

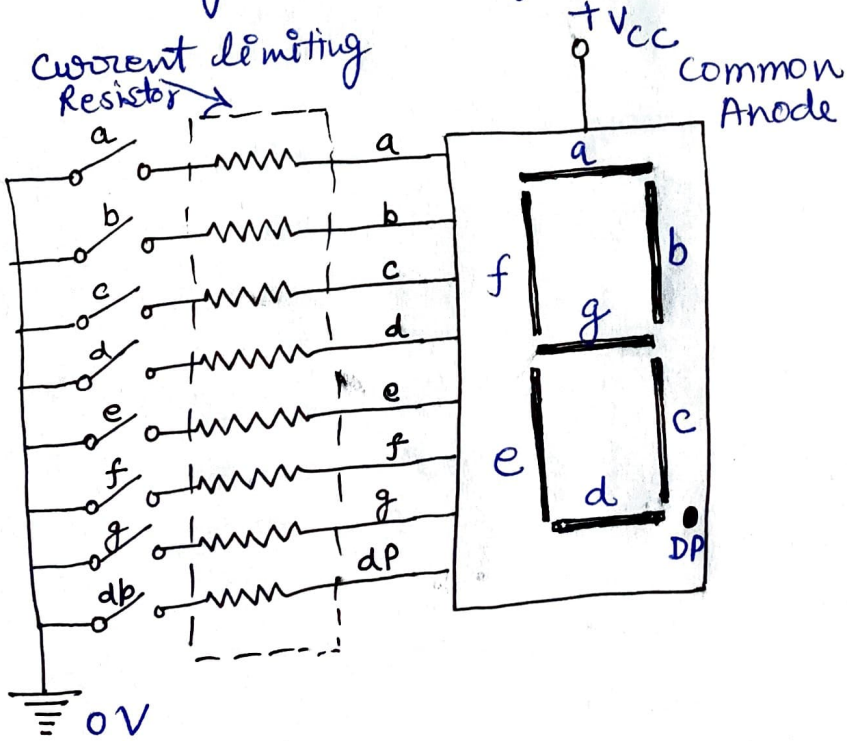
In the optocoupler
In the infrared remote control
As indicator in various electronic circuits.
In seven segment and alphanumeric display.

Seven Segment Display :-

7-Segment display is a application of Light Emitting Diode (LED). It consist of seven LEDs hence its ~~na~~ name is 7-segment display. These LEDs are arranged in a rectangular manner as shown in the given figure. Each of the seven LEDs are called as segment, because when illuminated the segment forms part of a numerical digit to be displayed. An additional 8th LED is sometimes used within the same package. thus allowing the indication of decimal point when two or more 7-segment displays are connected together to display numbers greater than ten.



7-Segment Display



Seven Segment Display Unit

Each one of the seven LEDs in the display is given a positional segment with one of its connection pins

being brought straight out of the rectangular plastic package. These individual LED pins are labelled from a to g representing each individual LED. The other LED pins are connected together and wired to form a common pin.

So by forward biasing the appropriate pins of the LED segments in a particular order, some segments will be light and others will be dark allowing the desired character pattern of the number to be generated on the display. This then allows us to display each of the 10 decimal digits 0 to 9 on the same 7-segment display.

Application of 7-segment display → 7-segment display can be used in digital calculators, digital electronic meters, digital clocks etc.