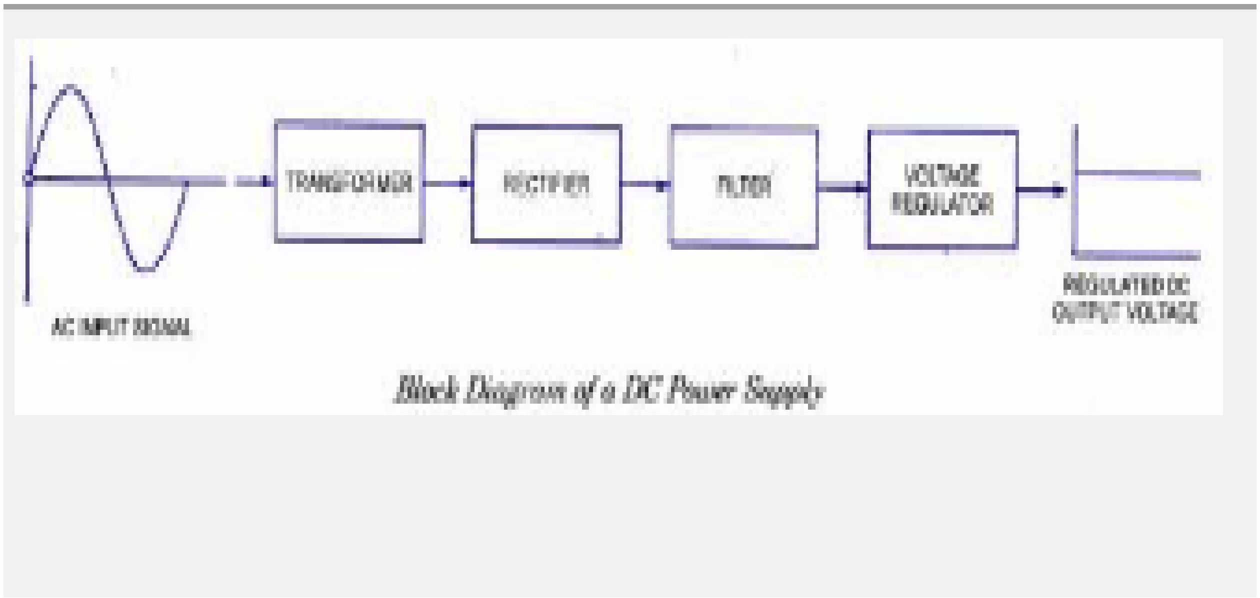
Module - 1

- **Power supplies**

The part of equipment that converts **ac** into **dc** is called **dc** power supply.

Block Diagram of a DC power supply

Transformer Rectifier Filter Voltage Regulator



Ac Input Signal

Regulated Output Voltage

The basic power supply is constituted by four elements. **A transformer, a rectifier, a filter and a regulator**

The output of the dc power supply is used to provide a constant dc voltage across the load.

* Transformer is used to step up or step down (usually to step down) the supply voltage as per need of electronic device.

* Rectifier is a device which convert **ac** into **dc.**

* The output voltage from a rectifier circuit has a pulsating character . It contains unwanted **ac** components along with **dc** component. To reduce **ac** components from a rectifier output voltage a filter circut is required.

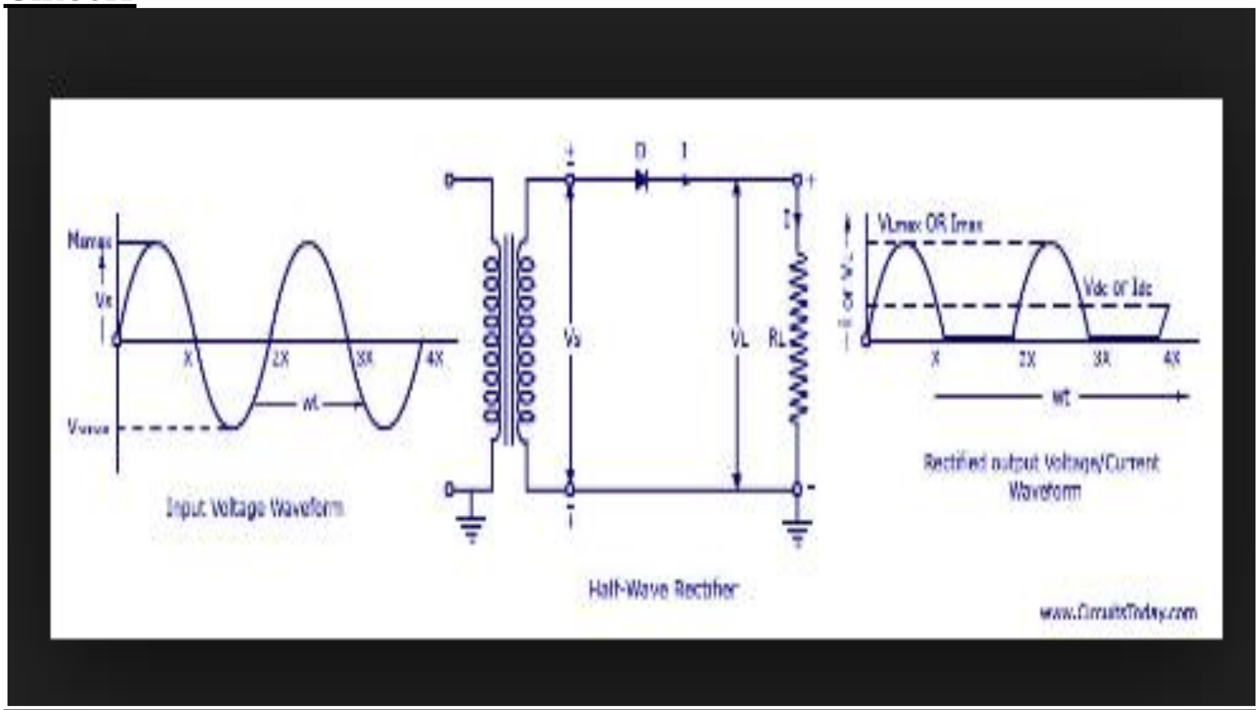
* Filter is device which passes dc component to the load and blocks ac component.

* The output of a rectifier filter combination a voltage regulator is required to provide constant dc voltage at the output.

Rectifier May be either half wave or full wave type.

1) **Half wave rectifier**

<u>CIRCUIT</u>



The half wave rectifier circuit using a diode and a load resistance R_L. The diode is connected in series with the secondary of the Transformer and the load resistor R_L, The Primary of the Transformer is being connected to the ac supply mains.

<u>WORKING</u>

During positive half cycle of the Input ac voltage. Upper end of the Secondary winding is positive with respect to lower end, the diode is forward biased. and conducts current. The waveform of output current and output voltage are of same shape as that of the Input ac voltage.

During the negative half cycles of the input voltage the upper end of the secondary winding is negative with respect to lower end, the diode is reverse biased and does not concuct current.

RIPPLE FACTOR

The pulsating output of a rectifier can be considered to contain a dc component and ac component called the ripples. The ripple current is undersirable and its value should be the smallest possible in order to make the rectifier effective.

* Ripple factor is definded as the ratio of rms of output ripple voltage or current to the corresponding dc value.

The Advantages and Disadvantages of a Half Wave Rectifier

Advantages

* Simple circuit and low cost

Disadvantages

1) Ripple factor high and an elaborate filtering is required
2) Rectification efficiency is high
3) Transformer utilization factor is low

*** Application**

Battery Charging

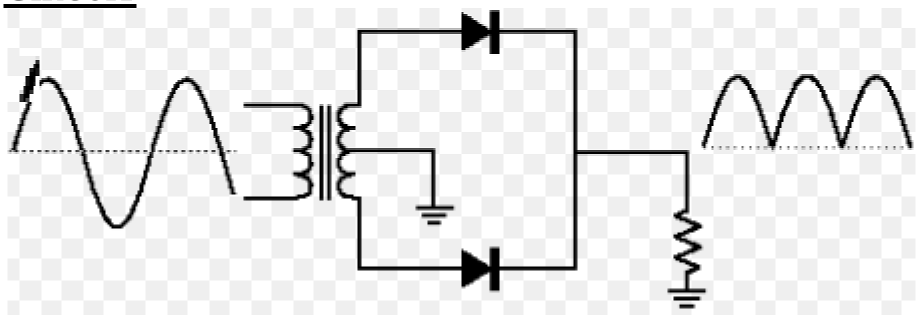
***Full Wave Rectifier**

In fullwave Rectifier both half cycles of the input are utilized. There are two types of full wave rectifier circuit namely

1) Centre – Tap Full Wave Rectifier, 2) Bridge Rectifier

Centre – Tap Full Wave Rectifier

CIRCUIT



The ac input is applied through a transformer. The anodes of the two diodes D_1 and D_2 are connected, to the opposite ends of the transformer secondary, and two Cathodes are connected also through the load resistance R_L and back to the Centre of the Transformer.

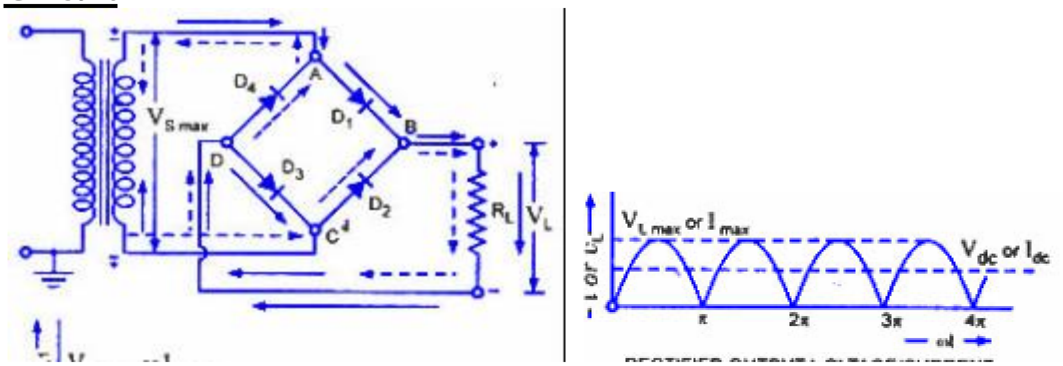
WORKING

When the top of the transformer secondary winding is positive , say during the Ist half cycle of the supply, the anode of diode D_1 is positive with respect to cathode and anode of diode D_2 is negative with respect to cathode. Thus only diode D_1, Conductes, being forward biased and current. Flows from cathode to anode of diode D_1, through load Resistance R_L positive.

During the second half - cycle of the input voltage the polarity is reversed. Making the bottom of the 2^o winding positive with respect to centre tap and thus diode D_2 is forward biased and D_1 is reverse biased. The current flows through the load resistance R_L.

Bridge Rectifier

Circuit



In the bridge circuit four diodes are connected in the form of a wheat stone bridge.

Working

When the upper end of the Transformer 2^o winding is positive . Diodes D_1 and D_3 are forward biased and the current flows through arm AB, enters the load at positive terminal, leaves the load at negative terminal and returns back flowing through are DC. The diodes D_2 and D_4 are reverse biased and the flow of current is indicated by solid arrows infigure.

In the second half of the Input cycle the lower end of the **ac** supply becomes positive, diodes D_2 and D_4 becomes forward biased and current flows through CB enters the load at positive terminal, leaves the load at negative terminal, and return back flowing through arm DA. Flow of current has been shown by dotted arrows in the figure.

Merits and Demerits of Full Wave Rectifier over Half Wave Rectifier

Merits

1) The Rectification efficiency of full wave rectifier is double of that of a half wave rectifier.
2) The Ripple voltage is low so simple filtering circuit is required.
3) Higher output Voltage, higher output power and higher TUF

Demerits

1) Full wave Rectifier needs more circuit elements and is costlier.

Merits and Demerits of Bridge Rectifiers over Centre Tap Rectifier

Merits

1) No centre tap is required in the Transformer secondary
2) PIV is half that of Centre-tap Rectifier
3) TUF in bridge Rectifier is higher than that of a centre -tap Rectifier.

Demerits

1) The total voltage drop in diodes becomes double of that in case of Centre -tap rectifier
2) Losses are Increased
3) Rectification efficiency is reduced

Comparison of Rectifiers

Sl.. .No.	Parameter	Half wave Rectifier	Full wave Centre-tap Rectifier	Bridge Rectifier
1.	Number of boides	1	2	4
2.	Idc	$\underline{Im}$	$\underline{2\ Im}$	$\underline{2Im}$
3.	Irms	$\frac{Im}{2}$	$\frac{Im}{2}$	$\frac{Im}{2}$
4.		1.21	0.482	0.482
5.		40.6%	81.2%	81.2 %
6.	TUF	28.7%	57.4%	81.2%
7.	Regulation	$\frac{RF}{RL}$	$\frac{RF}{RL}$	$\frac{2RF}{RL}$

Filter Circuits

The output from any of the rectifier circuit is not purely **dc** but also has some **ac** components called ripples.

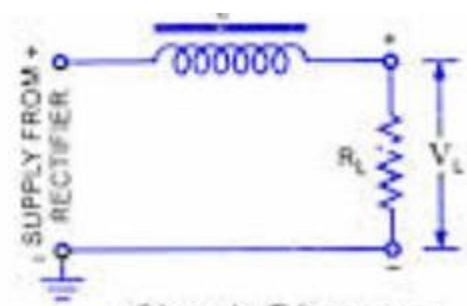
It becomes essential to reduce the ripples from the pulsating dc supply available from rectifier circuits to the minimum. This is achieved by using a filter or smoothing circuit which removes (or filters out) the ac components and allows only the dc component to reach the load.

* A Filter ciruite is a device that converts pulsating out put of a rectifier into a steady dc level .

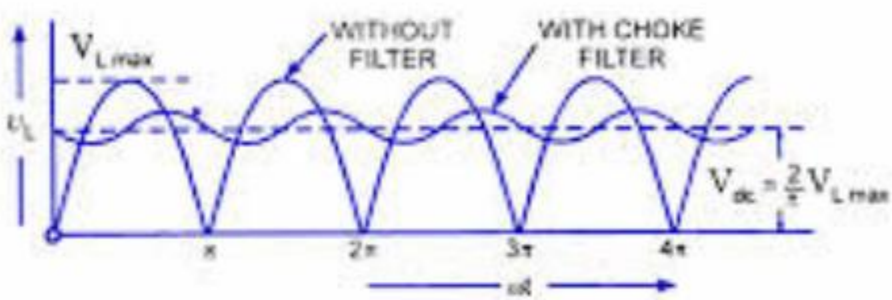
* A filter Circuite generaly a combination of Indector L and Capacitors C. The filter action of Land C depends upon the facts that and inductor allows dc only and capaciter allows ac only to pass. So a suitable Land C network can effectively filter. Out (Low Remove) the ac components from the rectified output.

Commonly used filter circuits are (a) series inductor filter (b) Shunt capacitor filter (c) choke input filter (d) Capacitor input or filter.

1) <u>Series Inductor filter</u> (L)



Circuit Diagram



* A high value inductor or choke L is connected in series with the rectifier element and the load. The filtering action of an Inductor filter depends upon its property of opposing any change in the current flowing through it.

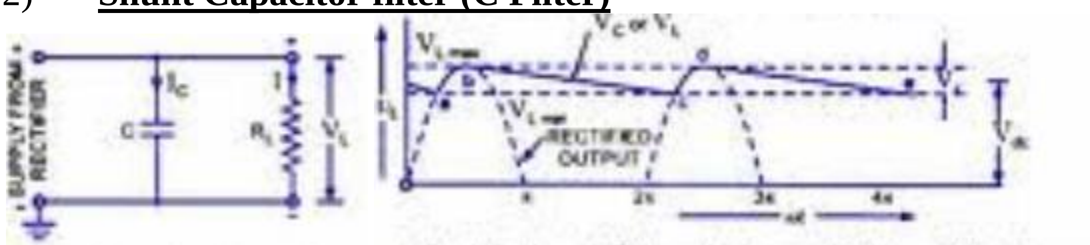
* When the output current of the rectifier increases above a certian value , energy stored in it in the from of Magnetic field and this energy is given up when the out put current falls below the average value.

* Thus by placing a choke coil in series with the rectifier output and load, any sudden change in current that might have occured in the circuit without an Inductor is smoothed out by the presence of the Inductor L.

Ripple Factor

The ripple decreases with decrease in RL . So Inductor filter is more efficient for small load Resistance RL.

2) **Shunt Capacitor filter (C Filter)**



Circuit Diagram *Rectified and Filtered Output Voltage Waveforms*

This is the most simple from of the filter circuit and this arrangement a high value capacitor C ois applied across the output terminal. During the concuction period capacitor gets charged and stores up energy in the electrostatic field and discharges through the load resistance RL delivering energy to it during non conduction period. ac components or ripples get reduced.

A large value capacitor C in shut with the load Resistor RL . When the Rectifier Output voltage is increasing, the Capacitor charges to the peak voltage $V_L$max. After the positive peak is passed the rectifier output voltage falls, which permits the capacitor to discharge through resistor R_L. To reduce the ripple in the rectified output, allow the capacitor to discharge slowly. The value of R_L should be large as possible reduce the ripple factor.

Ripple Factor

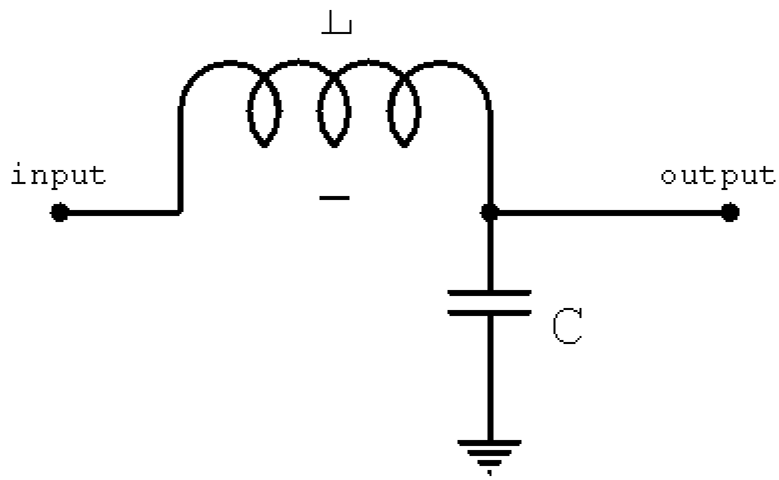
Advantages

1. Low cost
2. Light Weight
3. Good Characteristics
4. Simple

Application

1. Radio Transistor
2. Battery Eliminators

3) **L - Section or Choke Input or LC filter**



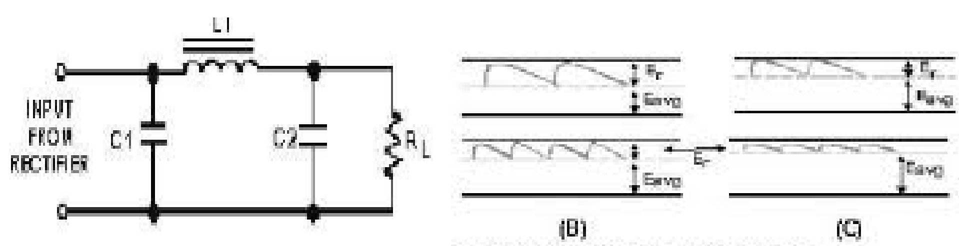
It consists of an Inductor L in series and capacitor C in shunt with the load. For an Inductor filter, the ripple factor is directly proportional to load resistance and for a Capacitor filter the ripple factor is inversely proportional.

The Choke L on the Input side of the filter allows dc to pass but opposes the flow of ac components. Any fluctuation that remains in the current even after passing through the choke are largely by-passed around the load by the shunt capacitor.

Ripple Factor,

Ripple factor is independent of load Resistance RL

4) **π Filter**

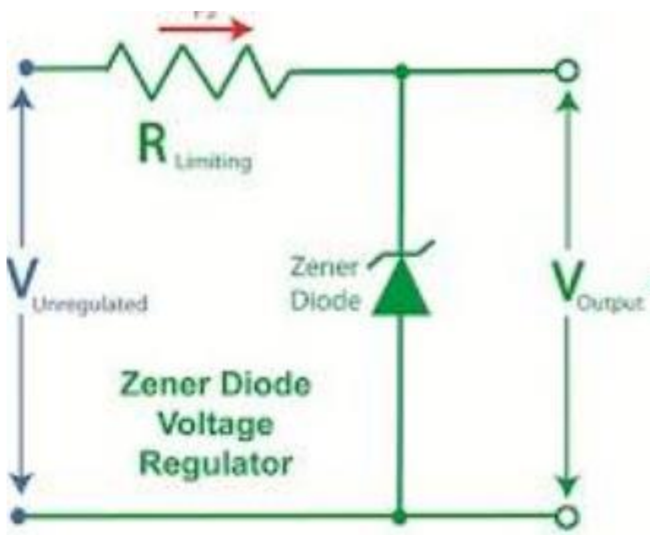


It consists of one inductor and two capacitor connected across its each end. The three components are arranged in shape of Greek letter Pi. It is also called capacitor input Pi filter. The input capacitor C_1 is selected to offer very low reactance to the repel frequency hence major parts of filtering is done by C_1. Most of the remaining repels are removed by the combining action of L and C_2. This circuit gives much better filter then LC filter. C_1 is still directly connected across the supply and would need high pulse of current if load current is large. This filter is used for the low current equipment's

Voltage Regulators

Voltage Regulators are used to maintain the dc output constant irrespective of variations of load current,input voltage and temperature.

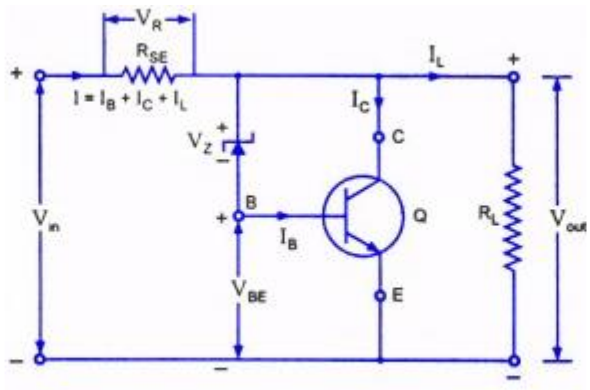
1) **Zener Shunt Regulator**



When the input increases, total current also increases($I=I_Z+I_L$).for a zener diode, under break down condition ,any increase in voltage causes increase in current through it.total current increases ,I_z increases,load current I_L remains constant.

$V_0=I_LR_L$

2)Transistor Shunt Voltage Regulator



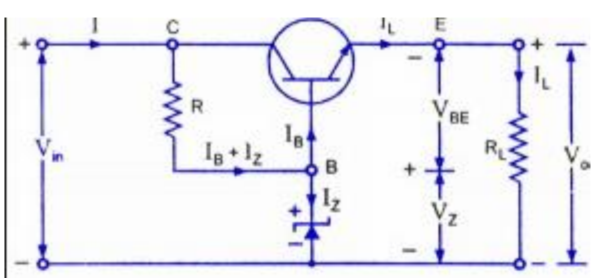
Transistor Shunt Voltage Regulator

Operation

(i) When the supply (or input) voltage increase which will cause the output voltage V_{out} to increase. An increase in output voltage V_{out} will result in decrease of V_{BE} because V_z is fixed and decrease in V_{BE} will reduce the level of conduction. This will lead to increase in the collector-emitter resistance of the transistor causing an increase in collector to emitter voltage and as a result the output voltage will be reduced. Thus output voltage will remain constant. Similar explanation can be given for decrease in supply voltage.

(ii) consider the effect of change in load on the output voltage — current is increased by decrease in R_L. Under such a situation the output voltage V_{out} tends to fall and, therefore, V_{BE} tends to increase. As a result the conduction level of the transistor will increase leading to decrease in the collector-emitter resistance. The decrease in the collector-emitter resistance of the transistor will cause the slight increase in input current to compensate for the decrease in R_L. Thus the output voltage being equal to I_L R_L remains almost constant.

3)Transistor Series Voltage Regulator



Transistor Series Voltage Regulator

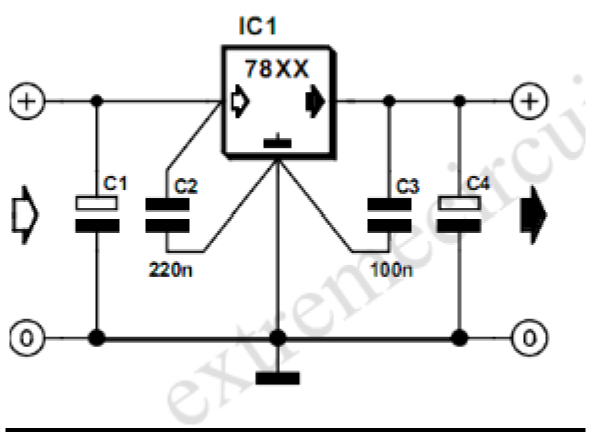
Operation

If the input (or supply) voltage increases, it causes increase in V_{out} and V_{BE} resulting in increase in base current I_B and therefore, increase in collector current I_c ($I_c = \beta\ I_B$). Thus with the increase in supply voltage, supply current I increases causing more voltage drop in series resistance R_{SE} and thereby reducing the output voltage. This decrease in output voltage is enough to compensate the initial increase in output voltage. Thus output voltage remains almost constant. Reverse happens should the supply voltage decrease.

If the load resistance R_L decreases, output current I_L increases and this increase in output current is supplied by decrease in base and collector currents I_B and I_c. Thus the input current I remains almost constant causing no change in voltage drop across series resistance R_{SE}. Thus output voltage V_{out} being the difference of supply voltage (fixed) and series resistor drop V_R (fixed) remains constant. Reverse happens should the load resistance increase.

REGULATOR ICS

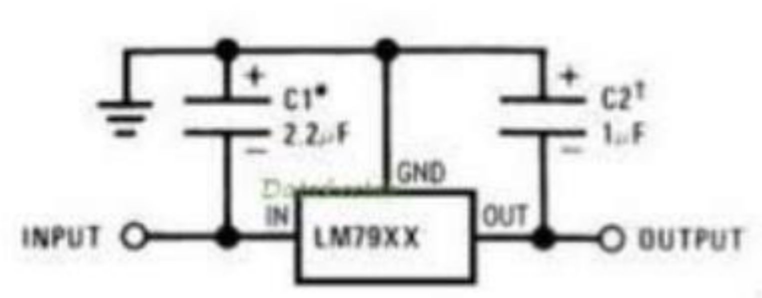
78xx



The **78xx** is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. For ICs within the family, the *xx* is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx line are positive voltage regulators: they produce a voltage that is positive relative to a common ground. There is a related line of **79xx** devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide positive and negative supply voltages in the same circuit.

78xx ICs have three terminals these devices support an input voltage anywhere from a couple of volts over the intended output voltage, up to a maximum of 35 to 40 volts depending on the make, and typically provide 1 or 1.5 amperes of current.

79xx



This is a Negative Voltage Regulator Circuit. Some circuits need the dual power supply (Ex: +12V / 0V / -12V). There we need fixed negative power supply, especially for digital electronic circuits. This voltage regulator circuit designed using Fixed Negative Voltage Regulator IC. 79xx series regulator ICs (Ex: 7905, 7908) for this circuit. The supply voltage is between -8V to -30V and you need to decide output voltage according to the supply voltage of your circuit. The supply voltage of regulator IC must be greater than -2V or more, than the output voltage of its. By last two numbers of regulator IC indicates the output voltage of its.