Regulated Power supply

Introduction :-

def" :- Electronics :-

It is a branch of science that deals with the study of flow and control of electrons and their behaviour and effect on vaccume tubes gases or semiconductors.

Electronic device :-

the —"— which controls the flow of e^- is called the electronic device. These are the building blocks of the electronic circuits.

Electronic Circuit :-

An —"— is a complete course of conductors through wires with which current can travel.

The electronic circuits using tubes or transistors require a DC source or DC power.

In general DC power for electronic circuits is obtained from commercial AC line source by which applying an rectifier filter combination system called as DC power supply.

DC power supply is one that supplies the DC voltage to its load.

The rectifier filter circuit combination constitutes an ordinary power supply. The DC voltage from an ordinary power supply remains constant, as long as the AC m voltage or load is unaltered or unchanged. However many of the devices requires that DC voltage which remains constant irrespect to the change in Ac voltage. such devices are called voltage regulating devices. This constitutes regulated c power supply.

Ordinary DC power supply :-

In ——— " ——— or unregulated DC power supply consist of rectifier and a filter circuit. Initially the voltage from the mains is given to the transformers from which it is moved towards the rectifiers. The rectifiers are consisting of diodes which will ~~remove~~ the ~~unwanted~~ AC into DC.

These variations in DC output voltage may cause inaccurate operation of many electronic devices. ∴ ordinary power supply is not good for many electronic applications and is replaced by regulated power supply.

The voltage regulation can be expressed in terms of load applied to the circuit. It is expressed as ~~% voltage regulation~~

$$\% \text{ voltage regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

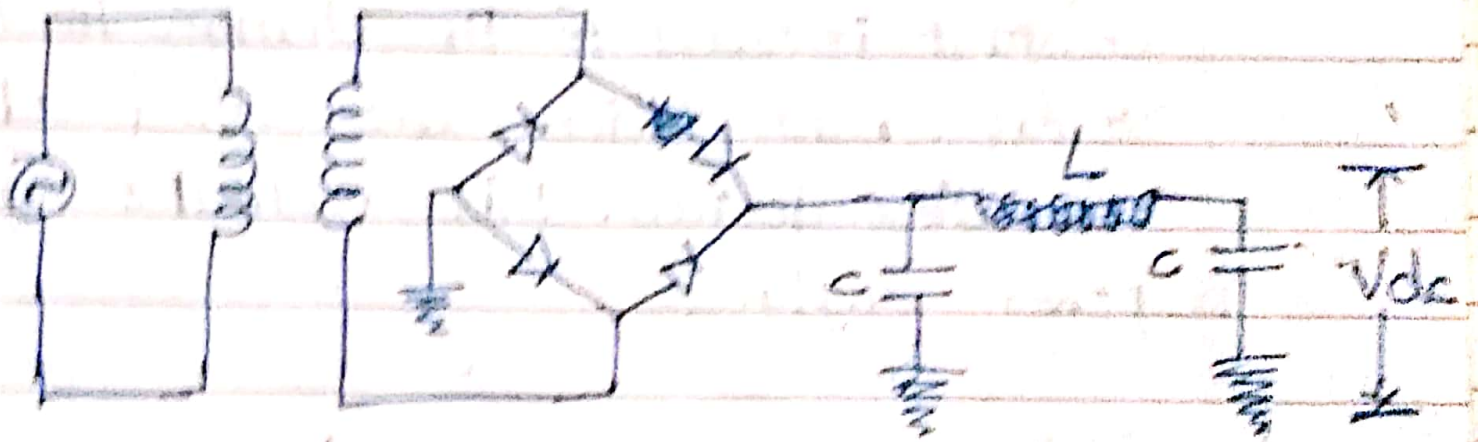
where V_{NL} is the voltage across zero load or no load.

V_{FL} = the voltage across full load.

Regulated Power Supply :-

Def" :- A regulated power supply is a DC power supply which maintains the output voltage constant irrespective of the fluctuating AC mains or load variations.

The output from the rectifier is a pulsating DC. These pulsations are due to the presence of some AC voltage. To remove this AC voltage a filter circuit is connected. It consist of combination of capacitors which will remove the unwanted AC voltage. The filter circuit produces a steady DC voltage across the load.

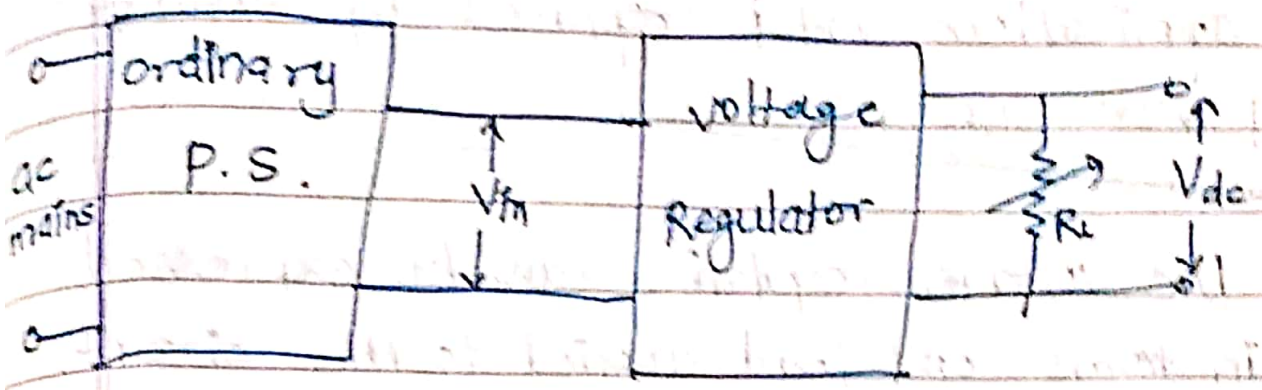


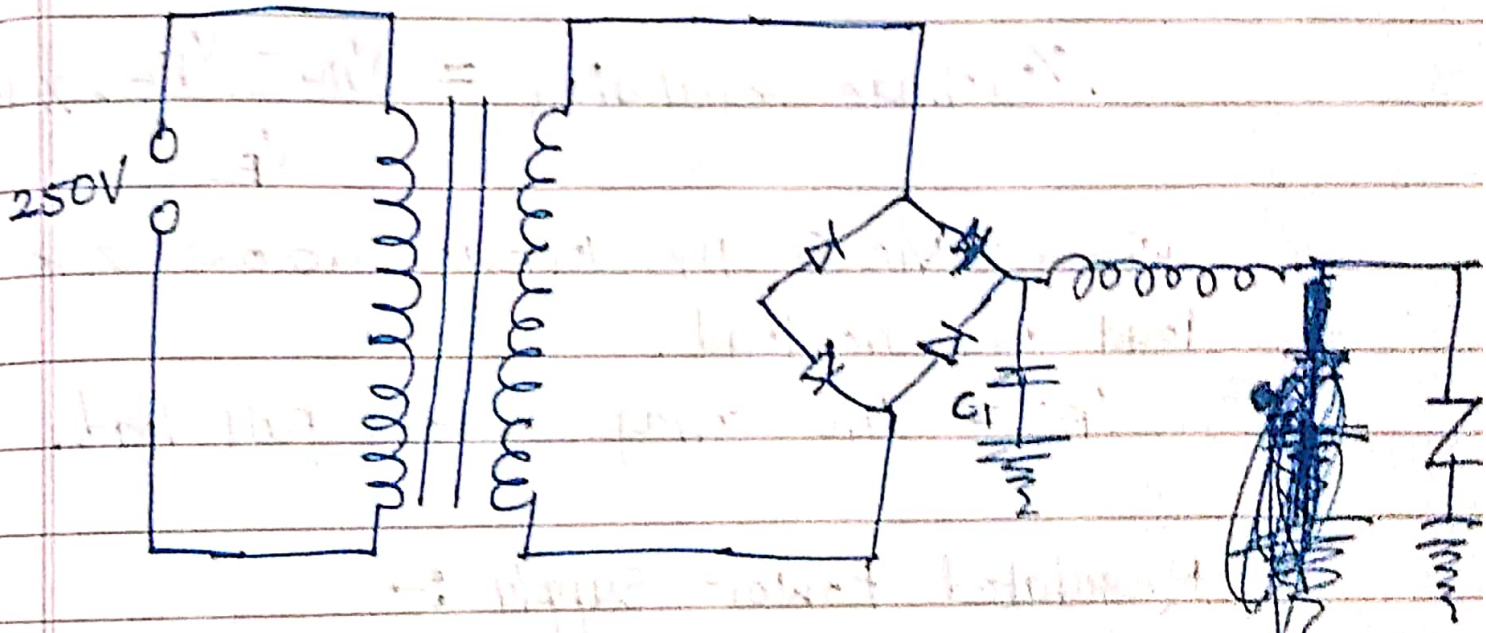
Drawbacks / Limitations of ~~Regulated~~ Ordinary DC power supply :-

① The DC output voltage changes directly with the change in input AC voltage.

② The DC output voltage decreases as the load current increases. this is due to the voltage dropped across the transformer, rectifier and filter circuit.

A regulated power supply consist of an ordinary power supply and voltage regulating device. Its block diagram is represented as follows :-





In DC power supply or unregulated power supply consists of rectifier and a filter circuit. Initially the voltage from mains is given to the transforms from which it is moved towards the rectifiers.

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Need for regulated power supply :-

The regulated power supply produces a constant DC output voltage which is required for many electronic equipments. In ordinary power supply the voltage regulation is poor or it is varying. This disadvantage of ordinary power supply gives rise to the need of regulated power supply. The following 2 reasons explains the need of regulated power supply:

① There are fluctuations in the AC voltage which causes the electronic devices not performing in accurate manner.

To obtain the satisfied output we need regulated power supply.

② The fluctuations caused due to the components of the power supply produces inaccurate output voltage. The fluctuation is due to the internal resistance offered by the components of O.P.S. ∴ to obtain the accurate output from the electronic circuits regulated power supply is used.

Types of voltage regulators :-

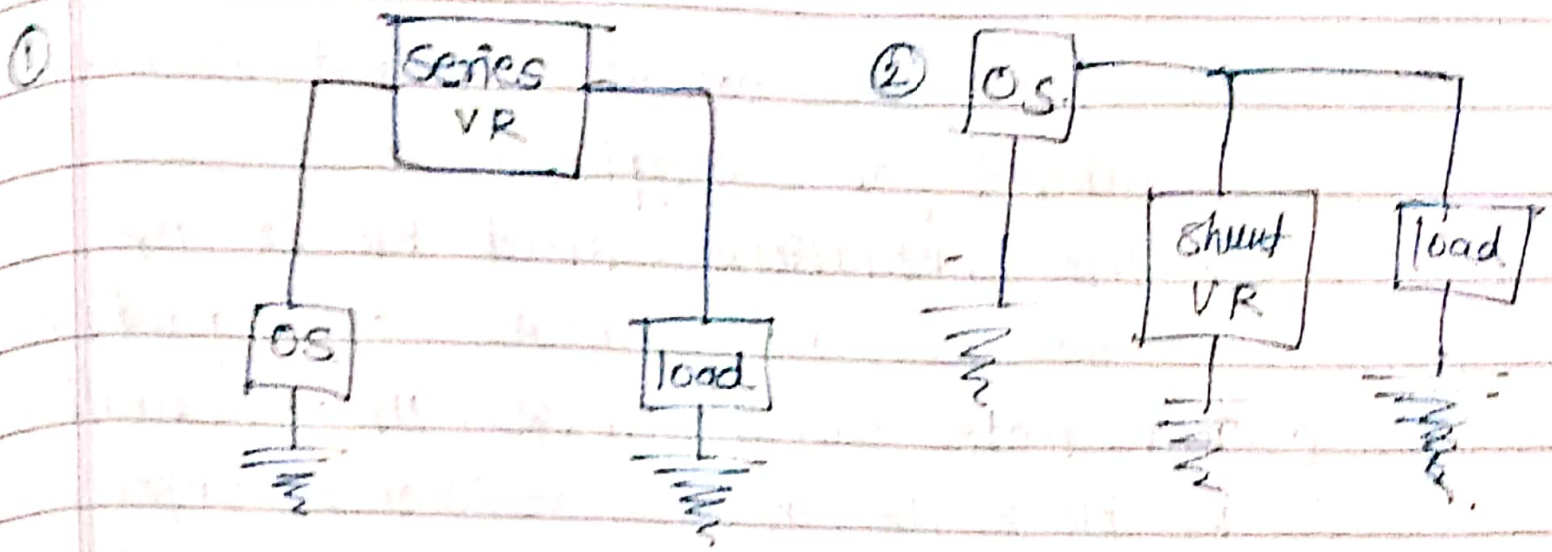
Def^{n} :- A device which maintains constant output voltage irrespective of fluctuations or variations in input AC mains is called voltage regulator.

There are 2 types of voltage regulators :-

Series voltage regulator :- ② Shunt voltage regulator.

——" —— is connected in series with the load of the circuit whereas the shunt regulator is connected in parallel with the load of the circuit.

In both case the output voltage is maintained.



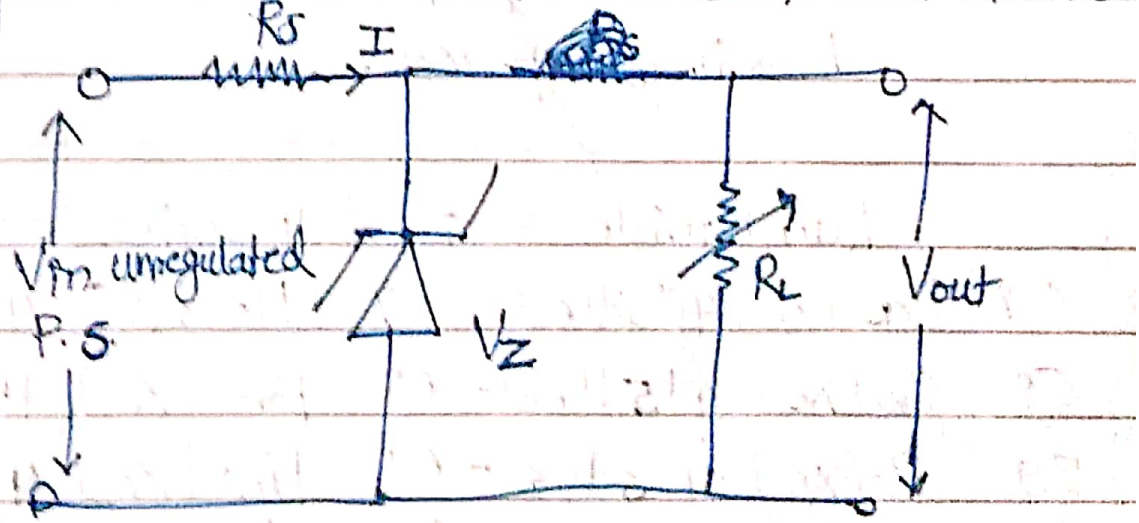
① For low voltages zener diode alone is sufficient. Low voltages upto range of 50V can be obtained by connecting a zener diode along with a transistor. It is called as transistorised regulated power supply. This power supply produces the voltage below 50V by the internal load current, if it is further increased the breakdown of the junction may occur.

② For high voltages :-

For voltages greater than 50V glow tubes are used along with vacuume tube amplifiers. such power supplies are called tube power supplies and are used for the proper operation of vacuume valves.

Zener diode as voltage regulator :-

When zener diode is operated in the zener region or breakdown region the voltage across it is constant for a large change of current through it. This characteristic permits it to be used as voltage regulator. As long as the input voltage is greater than the zener voltage, the zener diode operates in the breakdown region and maintains the constant voltage across the load. The series limiting resistance is connected to the load



Working / Operation of zener diode as regulator :-

The zener diode will maintain constant voltage across the load inspite of changes in load current or input voltage. As the load current increases the zener current decreases so that the current through resistance

R_s is constant. As output voltage remains constant. The reverse would be also true if the input voltages changes. i.e. the circuit will also operate for the changes in input voltages. The input voltage Vin should increase for the more current flow across the Zener, the voltage drop across Rs will remain constant.

Limitation / Drawback of voltage regulator:-

① It has low efficiency for high currents.

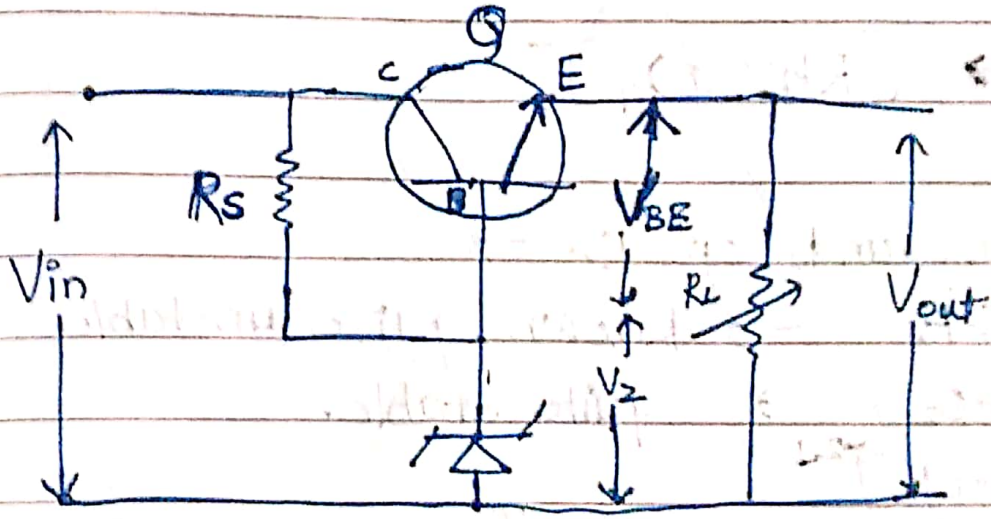
② The output voltage changes due to the Zener Impedence as we have

$V_{out} = V_z + I_z Z_z$, changes in load current produces change in zener current. Thus output voltage also changes. ∴ The use of this circuit is limited to only such devices where variations in load current and input voltage are small.

Transistor series voltage Regulator :-

A transistor is connected in series along with a Zener diode. The circuit is called as transistor series voltage regulator because the load current passes through the series transistor along with Zener diode.

The unregulated DC supply is fed to the input terminal and the regulated output is obtained across the load.



In the circuit, the base voltage of the transistor Q is held relatively constant across the Zener diode.

If the output voltage decreases the increased base-emitter voltage causes transistor to conduct more, thereby increasing the output voltage. As a result the output voltage is

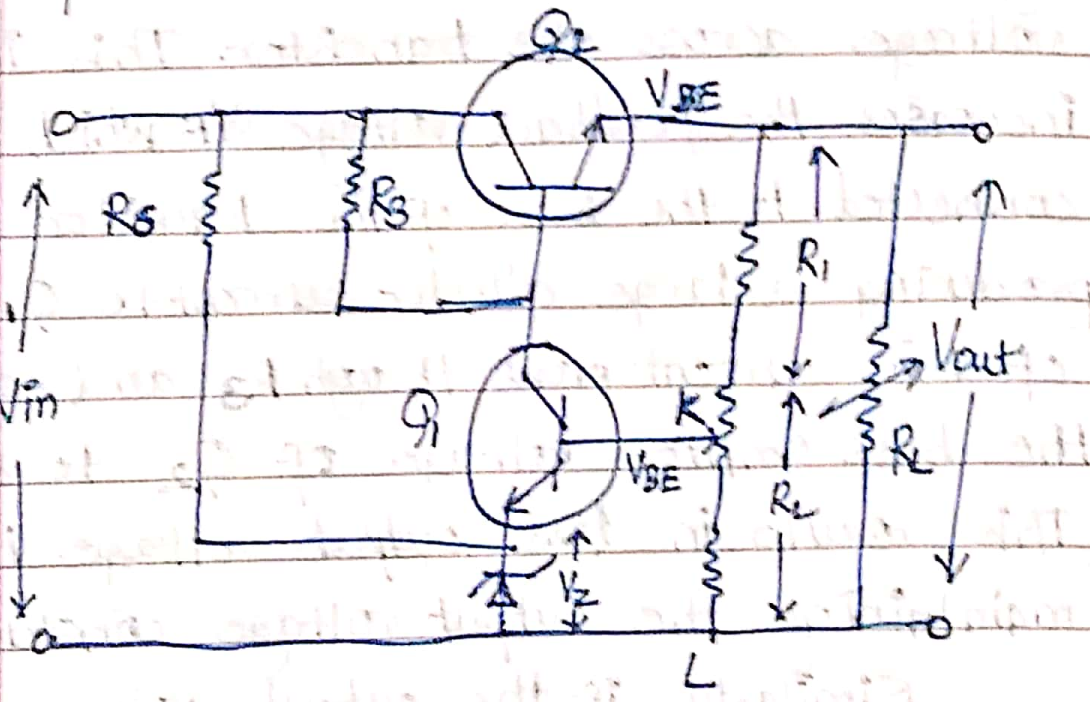
maintained constant.

If the output voltage ↑ the demand base emitter voltage causes transistor to conduct less. thereby reducing the output voltage. Hence, the output voltage is maintained at constant level.

The advantage of this regulator is that the zener diode current is reduced by a factor β and therefore the effect of zener Impedence is reduced. and constant output is obtained.

Series Feedback Voltage Regulator:-

The circuit consist of a negative feedback transistor to hold the output voltage almost constant inspite of change in the input voltage or load current. A transistor is connected in series with the another transistor present in the circuit.



The transistor Q_2 is called as pass transistor becaz all the load current passes through it. The circuit consist of voltage divider that consist of R_1 & R_2. These act like the voltage dividers which supply the output voltage and gives it as a negative feedback voltage to the base of the transistor Q_1. The feedback voltage

V_F controls the collector current of Q_1.

Working :-

The unregulated DC supply is given to the voltage regulator.

Suppose the output voltage ↑ due to any reason, this causes an increase in voltage across the transistor. This in turn increases the feedback voltage V_F which is connected to the base of the transistor Q_1. producing a large collector current to Q_1. Most of this current flows thrugh R_3 and causes the base emitter voltage of Q_2 to decrease. This results in less output voltage i.e. maintaining the output voltage constant.

Similarly, if the output voltage ↓, the feedback voltage V_F also ↓ this reduces the current through Q_1 & R_3. This means more base-emitter voltage at Q_2 and more output voltage. Thus maintaining constant output votage.

$R_1 - R_2$ represents the voltage divider which provides the feedback voltage. The feedback fraction is given by

$$m = \frac{V_F}{V_{out}}$$

where V_F is feedback voltage.
It can also be represented in terms of combination of resistances i.e.

$$m = \frac{V_F}{V_{out}} = \frac{R_2}{R_1 + R_2} \quad \text{---(1)}$$

The voltage gain of this circuit is given by

$$A = \frac{1}{m}$$

$$A = \frac{R_1 + R_2}{R_2} = \frac{R_1}{R_2} + \frac{R_1}{R_2} \quad \text{---(2)}$$

Eqn (2) represents the voltage gain in terms of combination of resistances.

Consider the feedback voltage $V_F = V_Z + V_{BE}$

$V_F = m V_{out}$

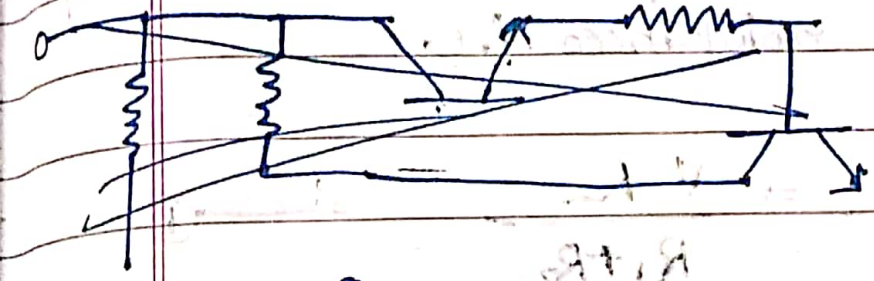
$$m V_{out} = V_Z + V_{BE}$$

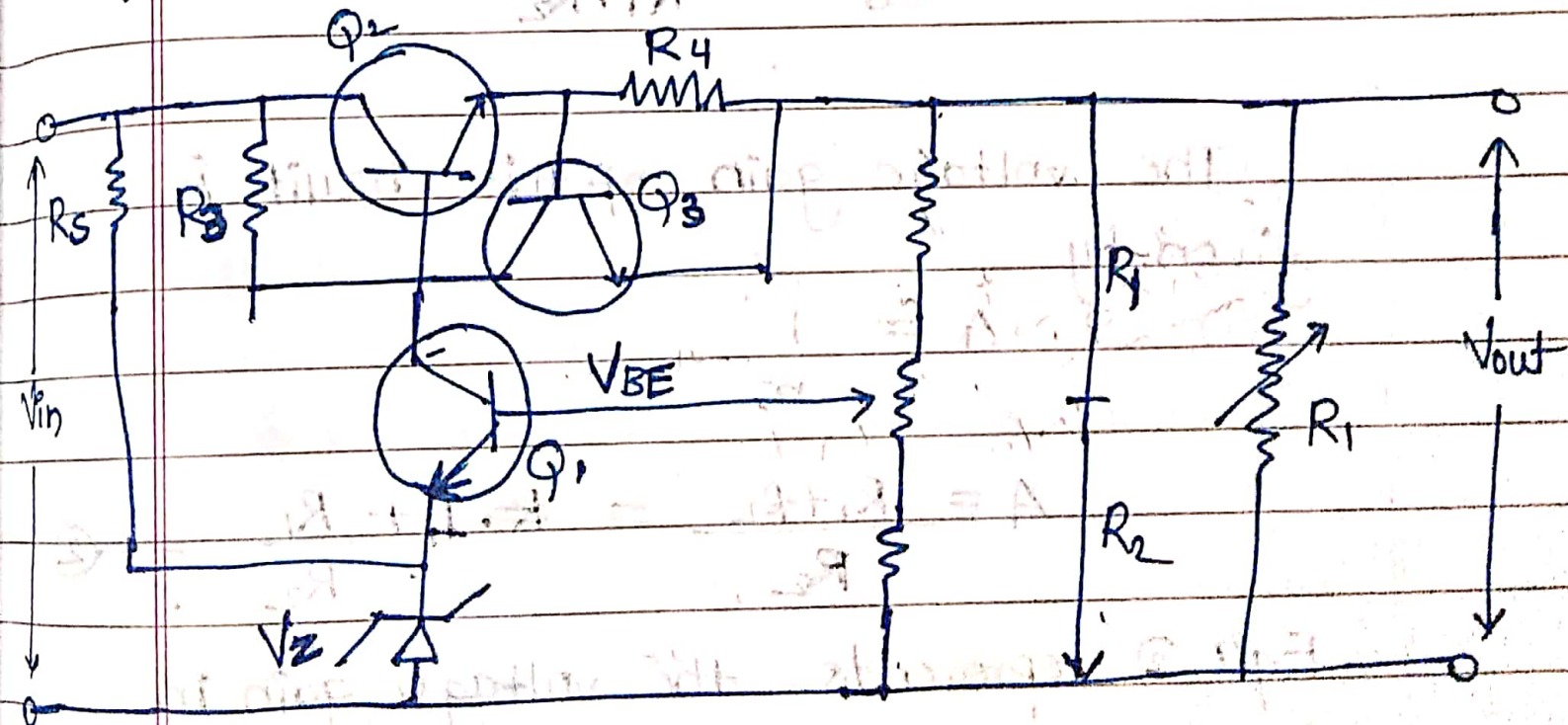
$$V_{out} = \frac{V_Z + V_{BE}}{m}$$

$$V_{out} = A(V_z + V_{BE}) \quad \text{---} \quad (3)$$

Thus, the output voltage is A times the zener voltage & Base-emitter voltage.

✱ Short Circuit Protection :-





The transistor series feedback voltage regulator has only one drawback i.e. any series regulator can be destroyed by continuous excessive load current, if the load is shorted. To avoid this short circuit a current limiting circuit is added to series regulator. It consist of a transistor and a resistor.

When the load current is normal the voltage across R_4 is small and the circuit works same as series feedback voltage regulator.

If the load current becomes excessive the voltage across R_4 becomes larger which turns the transistor Q_3 to work / conduct. The collector current of Q_3 flows through R_3 decreasing the base voltage of Q_2. The decrease in base voltage of Q_2 reduces the conduction of pass transistor preventing further increase in load current. Hence, the output is maintained constant without any short circuit.