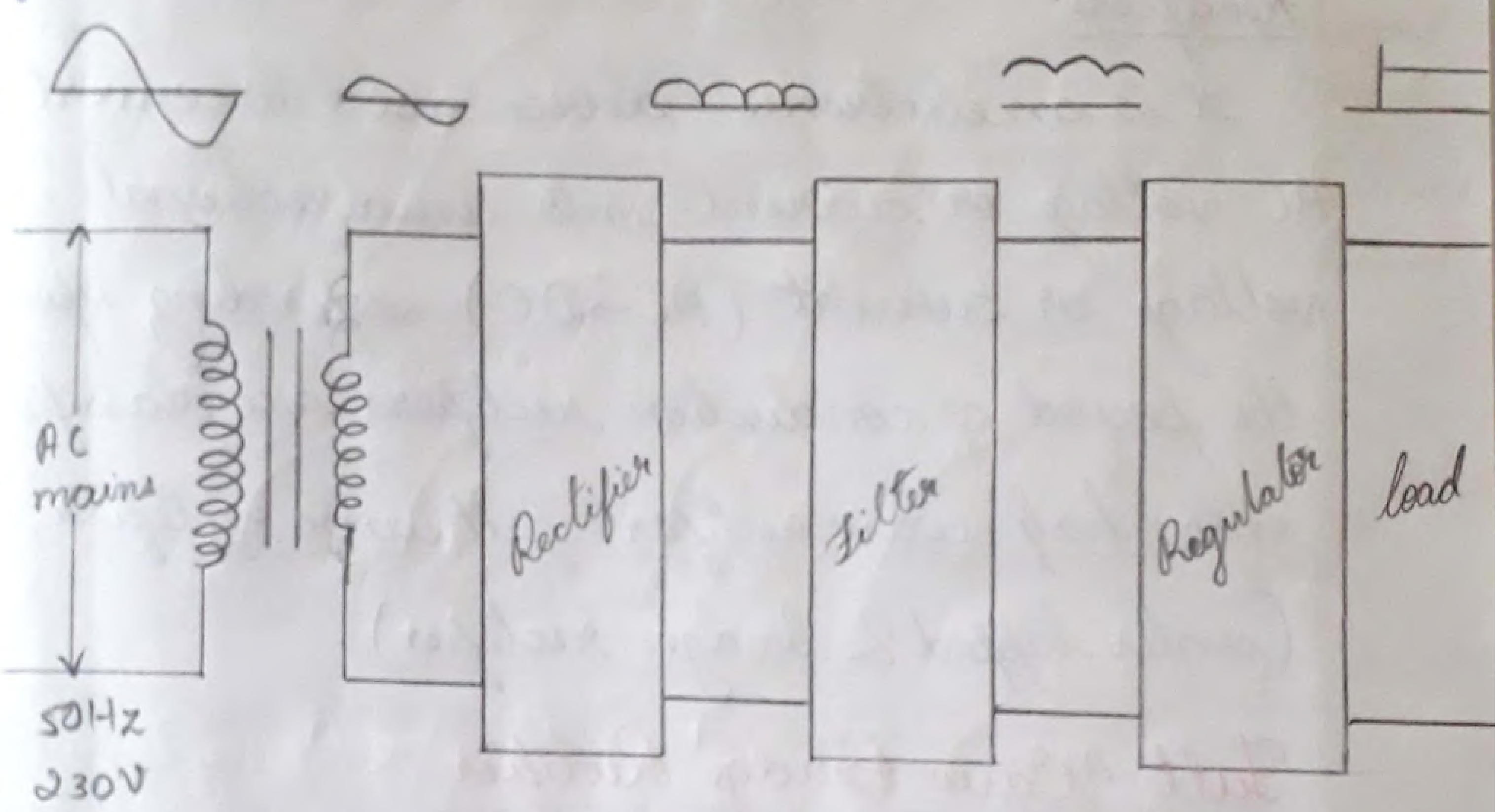
11/02/2020
Tuesday

Module-V

DC Power Supply



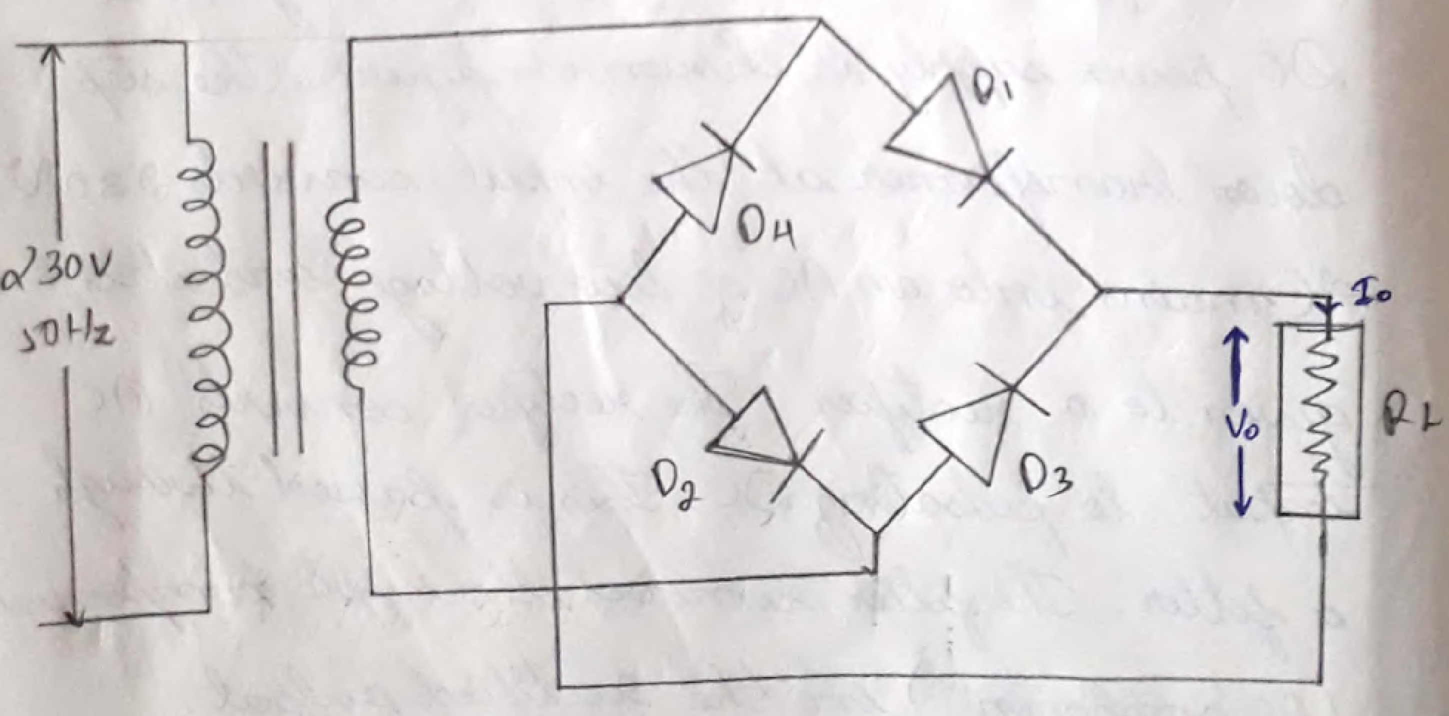
The general block diagram of a regulated DC power supply is shown in figure. The step down transformer at the input converts 230V AC mains into an AC of low voltage and it is given to a rectifier. The rectifier converts AC input to pulsating DC. This is passed through a filter. The filter removes the ripple component (AC component) in the rectified output.

A regulator is used in the final stage to give a constant DC output irrespective of load variations, input variations & temp. variations.

Rectifiers:

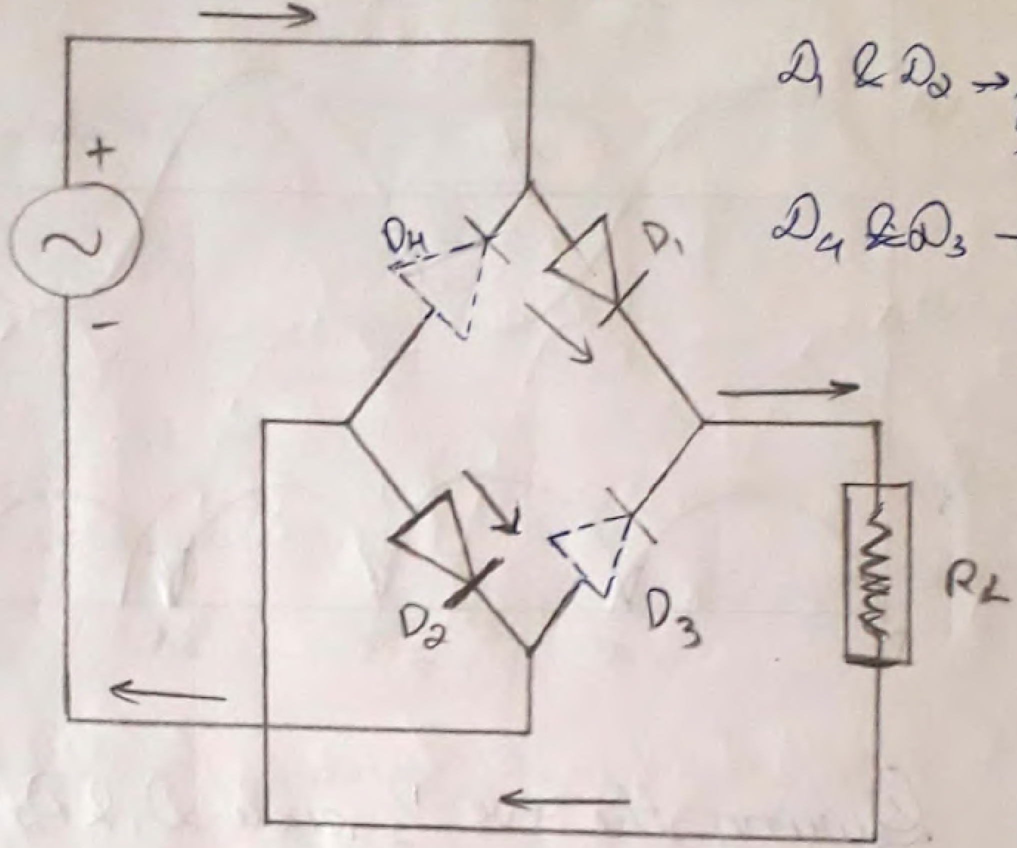
It is an electronic device used to convert AC voltage or current into unidirectional voltage or current (AC→DC). Depending upon the period of conduction rectifiers are classified into half-wave rectifier, full wave rectifier. (center tapped & bridge rectifier).

Full Wave Bridge Rectifier:



+ve half cycle

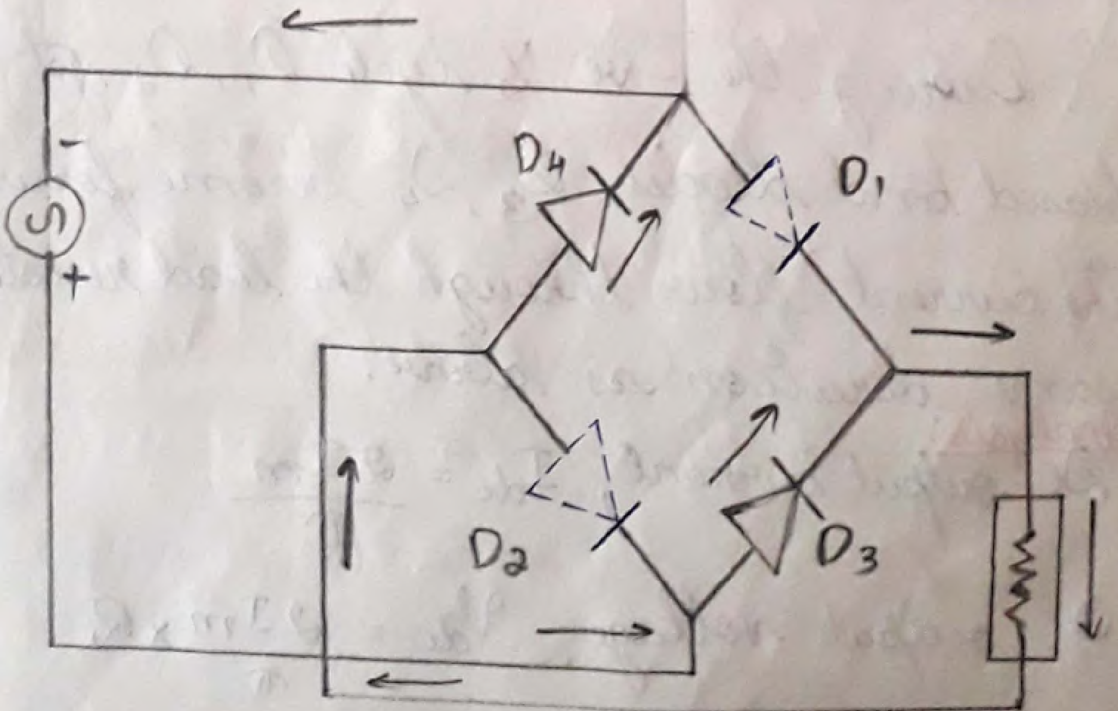
understanding

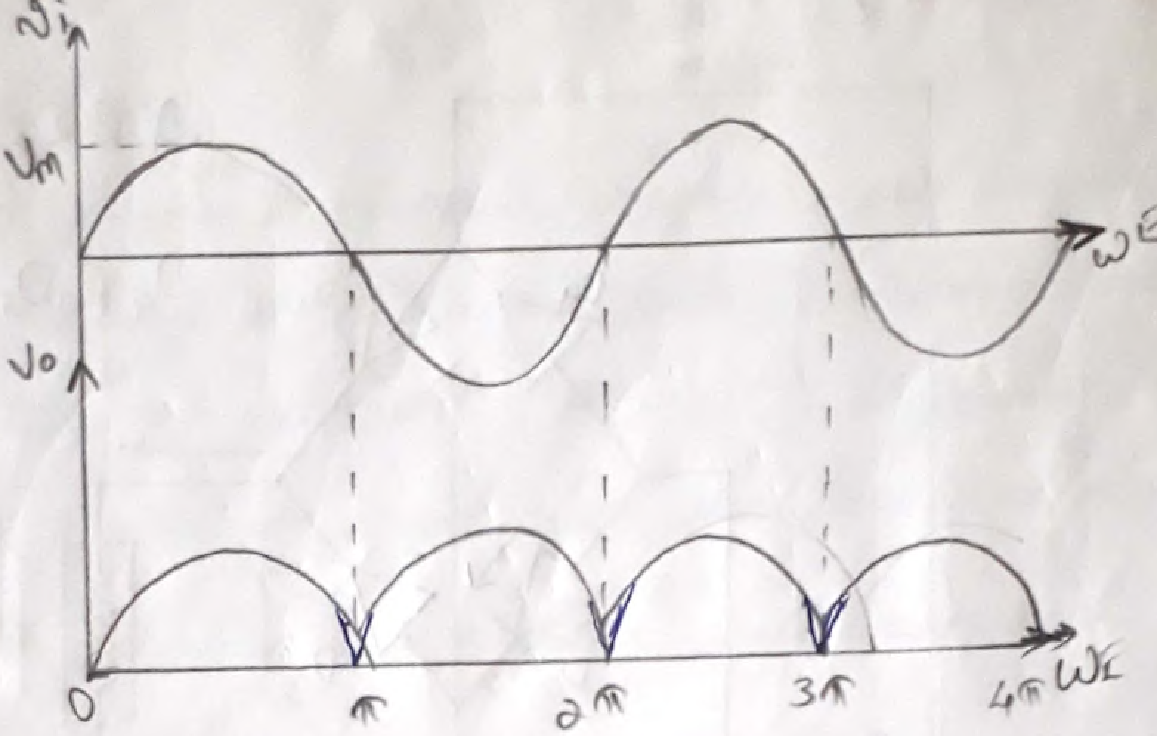


D_1 & D_2 → forward biased

D_4 & D_3 → Reverse biased

- ve half cycle





During the +ve ½ cycle D_1 & D_2 will be forward biased, D_3 & D_4 are reverse biased. Thus current flows through the load resistor R_L, in the direction shown in figure.

During the -ve ½ cycle D_1, D_2 get reverse biased and diodes D_3, D_4 become forward biased. The current flows through the load resistor in the same direction as above.

Analysis:

(a) DC output current, $I_{dc} = \frac{2 I_m}{\pi}$

(b) DC output voltage, $V_{dc} = \frac{2 I_m}{\pi} \times R_L$

c) RMS output current, $I_{rms} = \frac{I_m}{\sqrt{2}}$

d) RMS output voltage, $V_{rms} = \frac{I_m}{\sqrt{2}} \times R_L$

e) Ripple factor (r) = $\sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$

$= \underline{\underline{0.482}}$

(f) Peak inverse voltage, (PIV) = V_m [It is the max. voltage across the diode in the non-conducting state]

(g) Rectification efficiency,

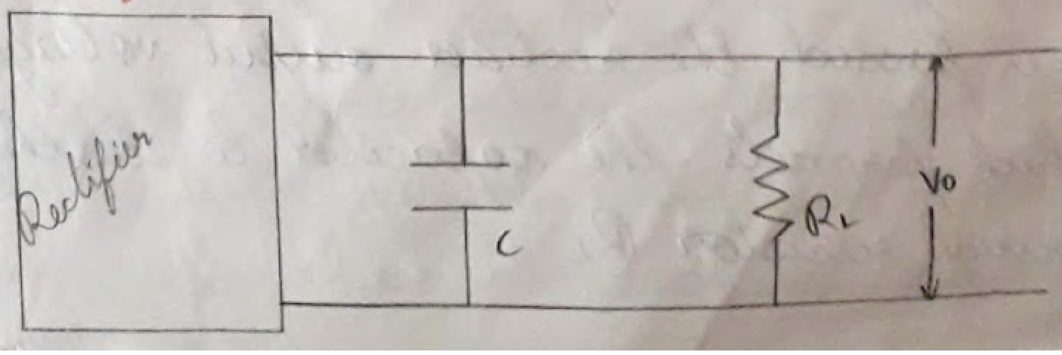
$$\eta = \frac{P_{dc}\ (\text{load})}{P_{ac}\ (i/p)} = \frac{I_{dc}^2 \cdot R_L}{I_{rms} \times R_L} \approx 81.2\%$$

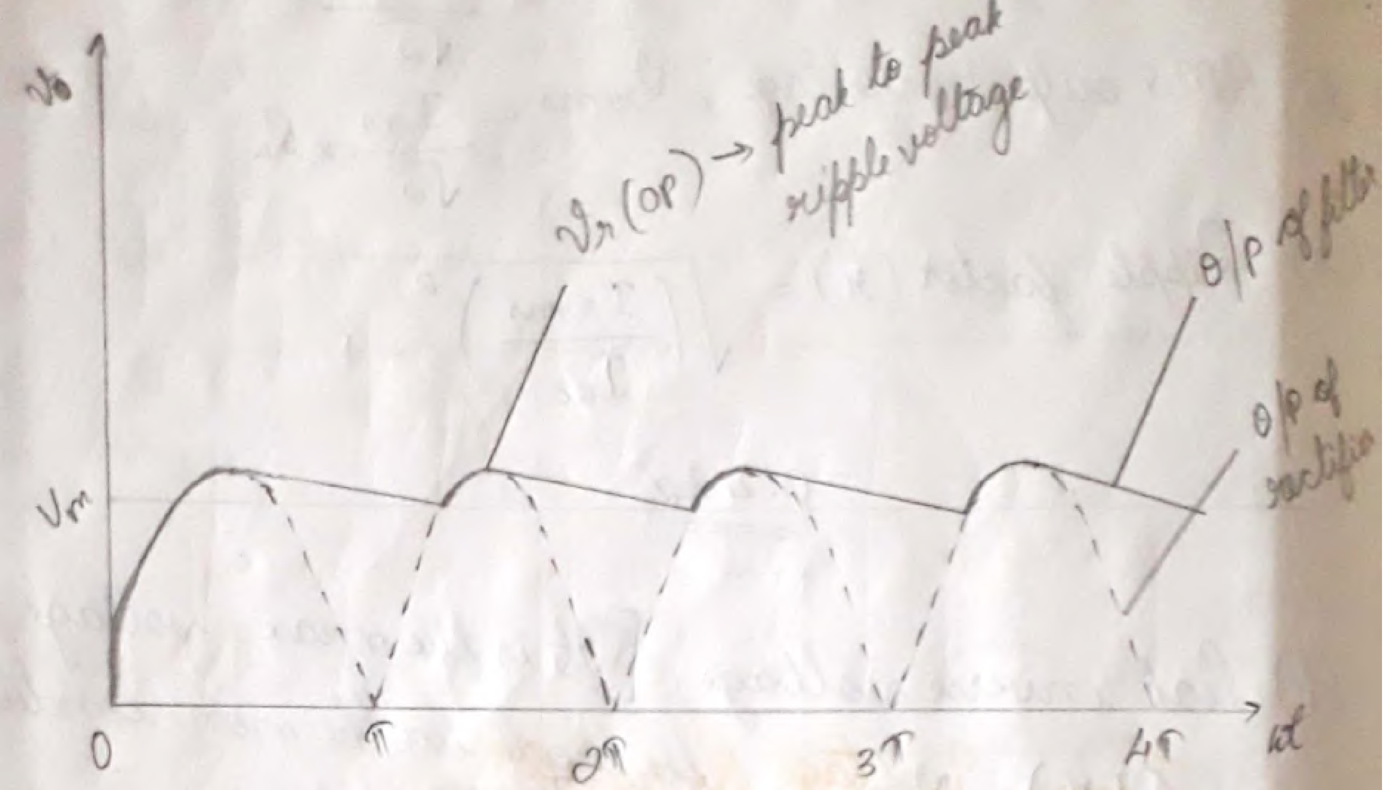
I_m = max. peak current.

V_m = max. peak voltage

Filters

Capacitor filter





Output of a rectifier is pulsating in nature and contains large ripple components the fn of filter is to remove the AC components or ripples without affecting the DC output voltage.

eg:- Capacitor filter.

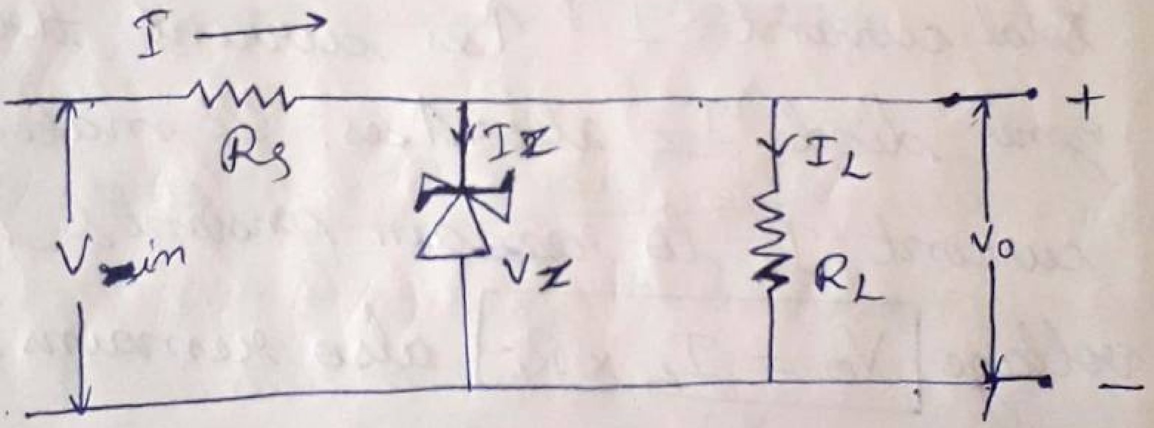
This is the simplest & cheapest filter when the rectifier output voltage is ↑ing the capacitor it charges to the peak voltage V_m. After the +ve peak is passed the rectifier output voltage ↓ses which permits the capacitor to discharge through resistor R_L.

To reduce ripple in the rectified output the capacitor must discharge slowly this means that the value of R_L should be as large as possible & therefore the capacitor filters are suitable for low current applications.

Ripple factor of filter ⇒ $\gamma = \frac{1}{4\sqrt{3}\, f C R_L}$

Voltage Regulator

Zener Voltage Regulator



The last stage in a regulated power supply is a voltage regulator which is used to maintain the DC output constant irrespective of variations in load current temp. etc. The breakdown property of a zener diode is ~~use~~ utilized in a zener regulator we know that for a zener diode. When break down occurs the voltage across the device remains almost constant with rapid rise in current.

The circuit diagram of a zener regulator is shown in figure when input voltage ↑ses. Total current I also ↑ses. We know that from circuit $\boxed{I = I_L + I_Z}$

For a zener ~~diode~~ diode under breakdown condit^n ang any ↑se in voltage corresponding ↑se in current through it. Therefore as the total current 'I' ↑ses current through zener diode I_Z also ↑ses. It makes load current I_L to remain constant & hence load voltage $\boxed{V_0 = I_L \times R_L}$ also remains constant.

Design of series resistor R_s.

In the circuit diagram, the series resister is connected to account for excess voltage. While selecting R_s the following pts may be noted.

→ When the input voltage is minimum & the load current is max^m. The current through the zener should be sufficient to operate it in its breakdown region.

$$R_s(max) = \frac{V_{in(min)} - V_0}{I_{Z(min)} + I_{L(max)}}$$

→ R_s iii. When input voltage is max^m & the load current is minimum the current through the zener should not exceed its max^m power dissipat^n capacity.

$$R_{s(min)} = \frac{V_{in(max)} - V_0}{I_{Z(max)} + I_{L(min)}}$$

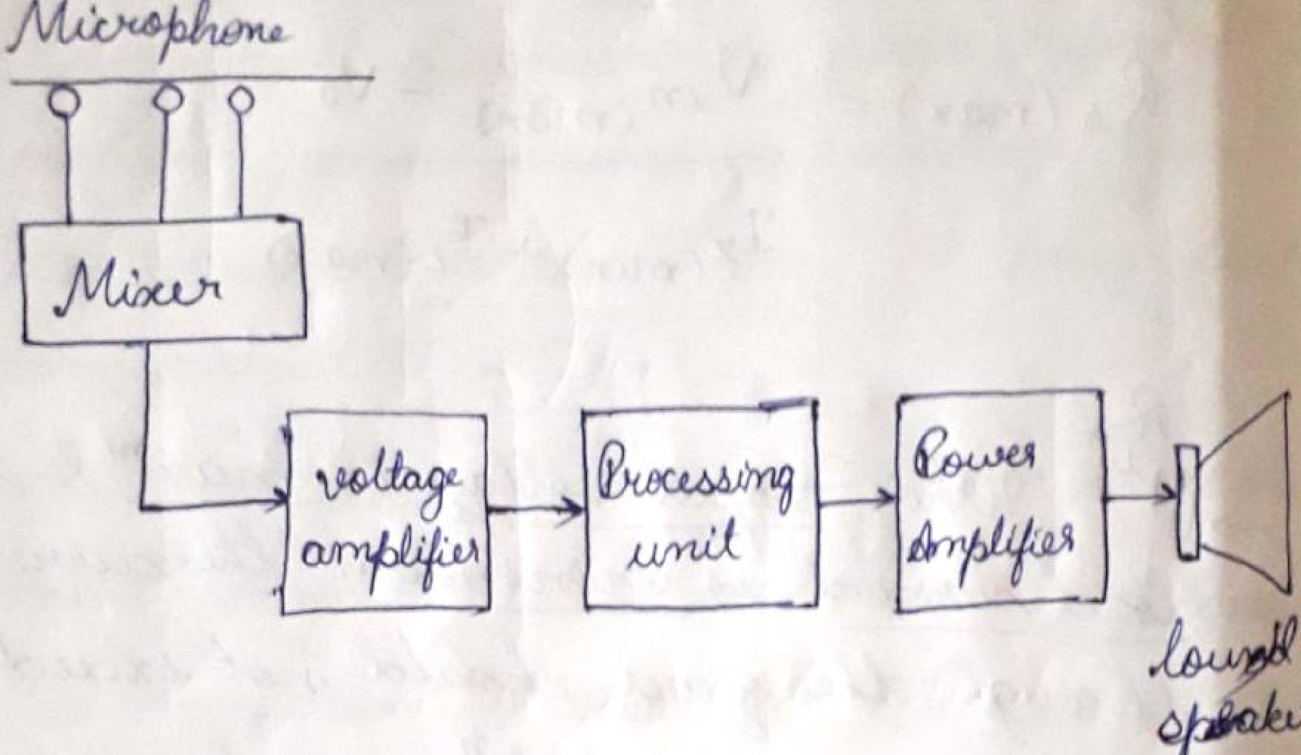
→ Hence R_s should be selected such that

$$\boxed{R_{s(min)} < R_s < R_{s(max)}}$$

This type of regulator is suitable when the load current varies from a finite mini^m. to a finite maxi^m value.

srikas

Public Address System



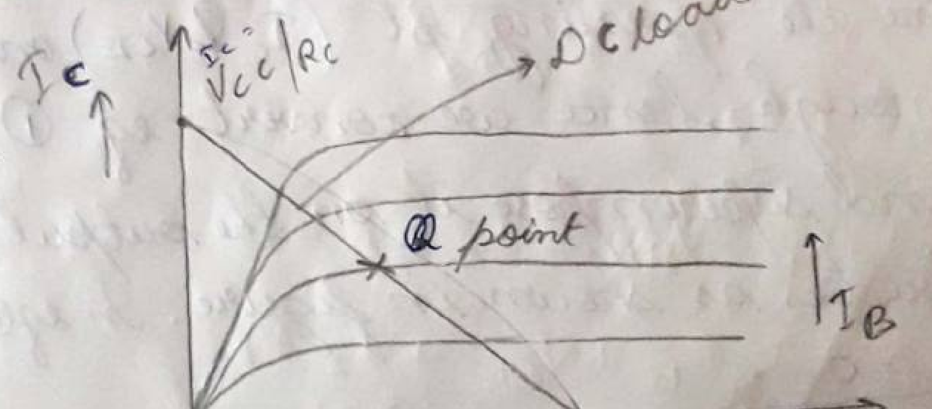
Public addressing system is an electronic sound amplification and distribution s/s with a microphone Amplifier & loud speaker. It is used to allow a person to address a large public. Simple public addressing S/s are often used in small venues such as school auditoriums, churches & shoping malls.

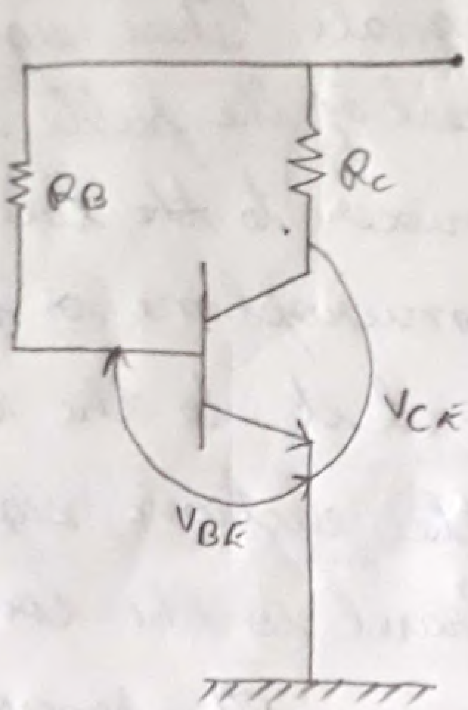
Public systems r made of 4 basic components the microphone, the audio mixer, an amplification device and loud speaker. ~~A microp~~

A microphone is the very basic component of public addressing s/s. It is a device that captures the voice of the speaker & convert it into electronic signals. These signals are then processed by the rest of the public addressing s/s's the task of mixer to ~~the~~ take the input from the ~~mic~~ microphone or no: of microphones & send it to the amplifier. The amplifier boost the electronic signal so that they can easily travel to the loud speaker through complex wires. The processing unit is to eliminate noise from the voltage amplifier output & processed for bass control. The power amplifier gives the desired power amplificatⁿ to the signal. The loud speaker converts the electronic signals into sound waves which people can understand.

Operating point / Q - Point / Quiesent Point

O/p characteristics of Transistor





simple transistor circuit

mesh rule.

$$V_{CC} = I_C R_C + V_{CE}$$

A transister should be operated in linear or active region when used as an amplifier. The biasing should be done in such a way that the output waveform should not deform due to any reason.

Collector loop equatⁿ is $V_{CC} = I_C R_C + V_{CE}$ → ① to determine the operating pt (I_C & V_{CE}) one equation is not enough hence we convert eq. ① into a graph and superimpose it on the output charactt characteristics as shown in figure. In eq① when

$I_C = 0$

$V_{CE} = V_{CC}$ → ②

When $V_{CE} = 0$

$$I_C = \frac{V_{CC}}{R_C} \longrightarrow (3)$$

These 2 pts can be joined together to form a straight line is known as <u>DC load line</u>.

Thus we can fix each pt of this load line as Q point depending on the output requirement, load requirement, gain requirements.

Once the Q pt is designed & fixed it should remain constant irrespective of internal or external variations. Any variation in Q pt may cause the transistor to deviate from its design region of operation.

Main parameters responsible for this variations are

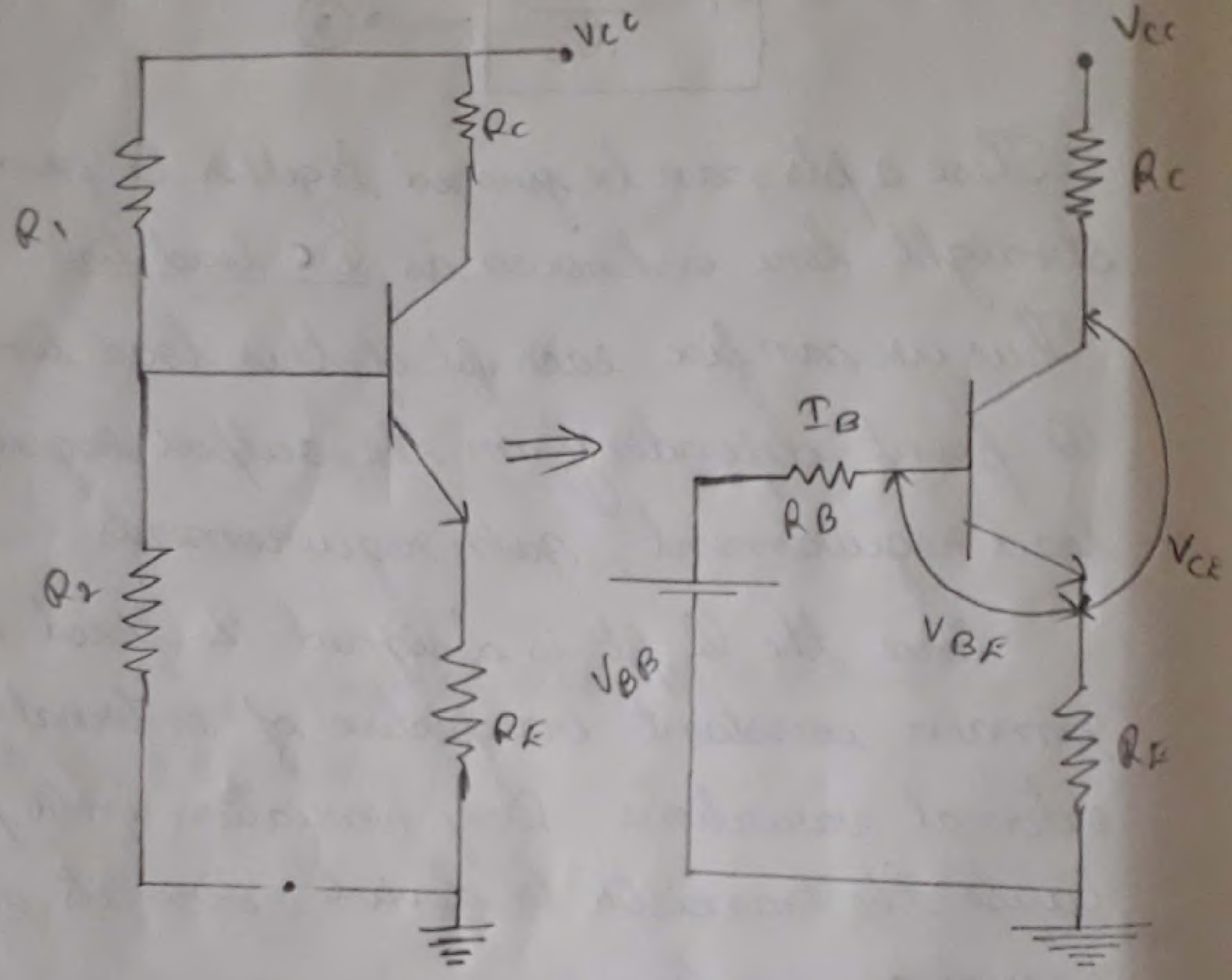
(i) variations in temp

(ii) fluctuations in power supply

(iii) aging of components etc.

* Biasing is used for establishing the desired Q point and to stabilise it against any variations.

Voltage Divider Biasing / Potential Divider Bias



$$V_{BB} = \frac{V_{CC} \times R_2}{R_1 + R_2} \longrightarrow (1)$$

Thevinin's equivalent:

$$R_B = R_1 || R_2 = \frac{R_1 R_2}{R_1 + R_2} \longrightarrow (2)$$

Base loop eqn

$$V_{BB} - I_B R_B - V_{BE} - I_E R_E = 0$$

$$V_{BB} = I_B R_B + V_{BE} + I_E R_E \longrightarrow (3)$$

Stability factor is defined as the variat^n in collector current with variation in leakage current. i.e,

$$S = \frac{\partial I_C}{\partial I_{CBO}}$$

To evatudle evaluate the performance of different biasing circuits stabilisat^n factor is defined.

$$S = 1 + \frac{R_B}{R_E}$$

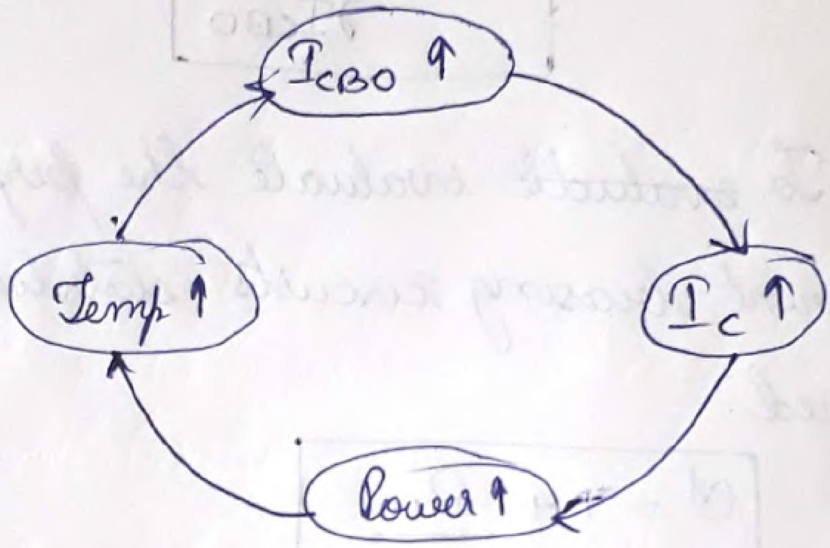
The value of stability factor is considerably improves with voltage divider bias.

Another advantage of voltage divider biasing is that it is thermally stable.

⇒ Thermal run away

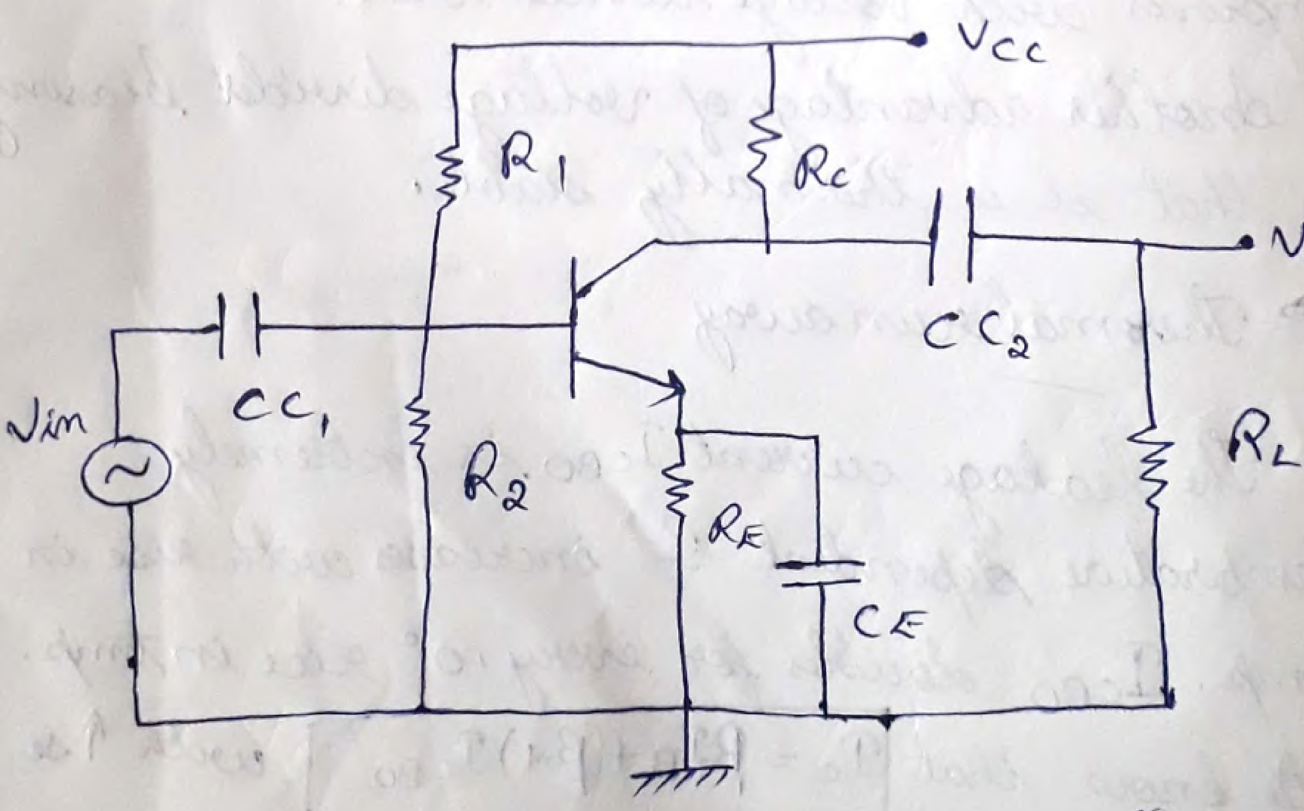
The leakage current I_{CBO} is extremely temperature dependent & increases with rise in temp. I_{CBO} doubles for every 10° rice in temp.

We know that $I_C = \beta I_B + (\beta+1) I_{CBO}$ with ↑se in I_{CBO} collector current ↑ses & collector power dissipatⁿ ↑ses. This is a ~~cut~~ cumulative process & may lead to destructⁿ of transistor. This phenomenon is known as thermal run away



Power
$P = V^2/R$
$P = I^2R$
$P = VI$

RC Coupled Amplifier



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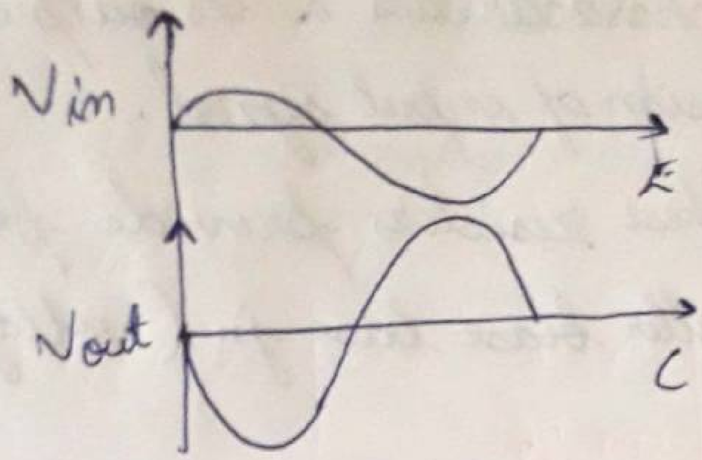


The circuit diagram of a common Emitter RC coupled amplifier is shown in figure. The signal to be amplified is applied to the base, & the output signal after amplificat^n is taken from collector. Emitter is made common to both input & output.

Amplificat^n is a process of increasing the signal strength by ↑sing the amplitude of a given signal without changing its characteristics. An RC coupled amplifier is a part of multi. stage amplifier where in different stages of amplifiers are connected using a combinat^n of resistor & capacitor & hence the RC coupled amplifier.

The input signal may be current signal, voltage signal or a power signal an amplifier will amplify the signal without changing its characteristics & its output will be a modified version of input signal.

R_1, R_2 → these resistors provide proper biasing at emitter ~~biase~~ base jn (voltage divider biasing.)

R_C → Collector resistance which decides the operating pt.

R_E → Emitter resistance to improve thermal stabilisation.

R_L → Load resistance across which the output is taken.

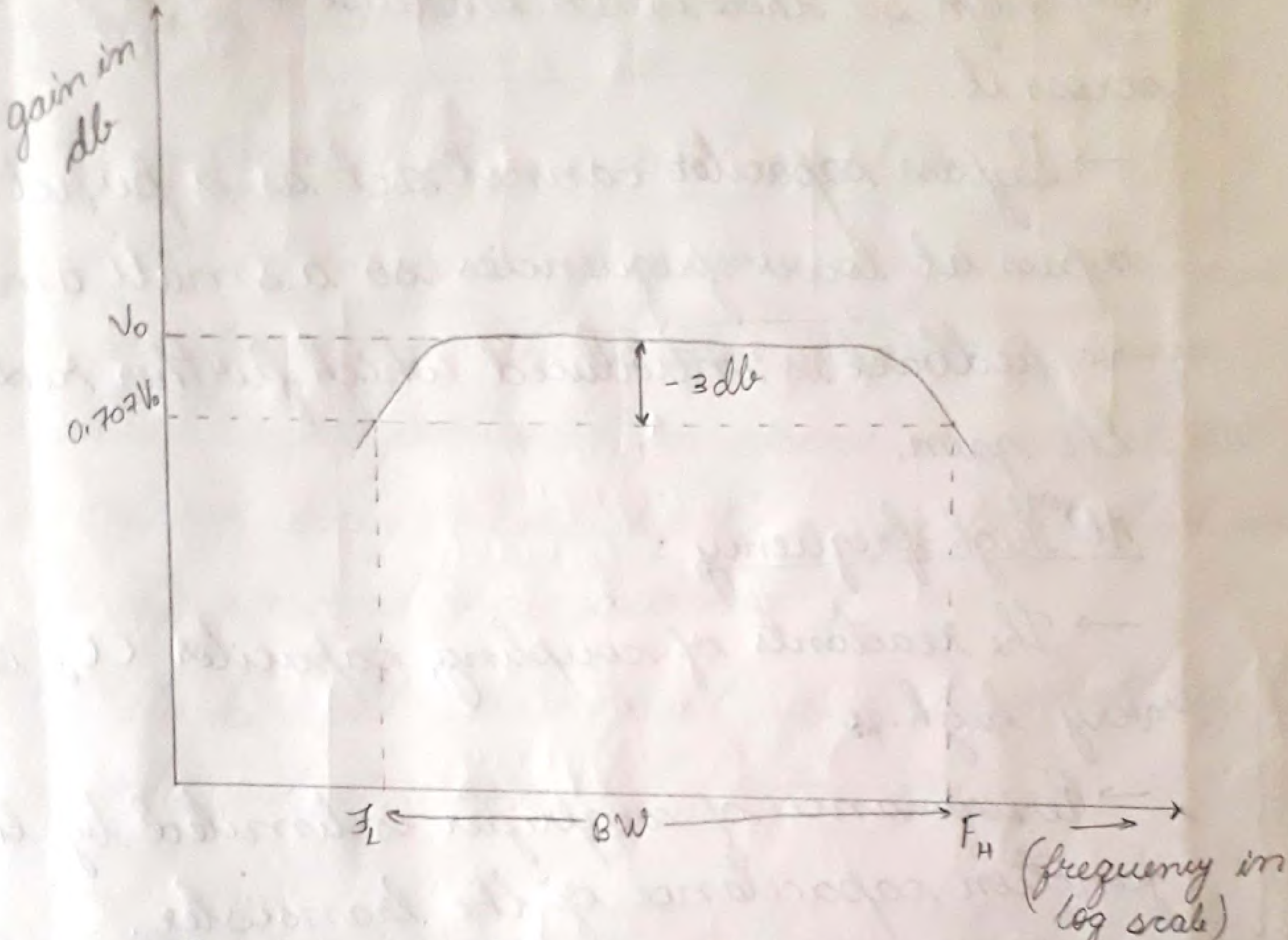
CC_1 → Input coupling capacitor through which the signal to be applied to the input ~~signal~~ terminal

CC_2 → Collector coupling capacitor to couple various stages when cascaded.

C_E → As the emitter bypass capacitor to provide -ve feedback.

V_{CC} → supply voltage.

Frequency Response



The ~ gives the variation of gain of an amplifier for different signal frequencies. The response is constant only in the middle frequency range, the gain at this frequency range is known as mid band region or gain. ~~Fo~~

$$\text{Gain in decibals} = 20 \log \left(V_o / v_{in} \right)$$

Reason for reduction of gain at very low and very high frequencies:

At very low frequencies:

→ The reactants of coupling capacitor CC_1 is very high so there is an increase in voltage drop across it.

→ Bypass capacitor cannot act as a perfect bypass at lower frequencies so a small amt of -ve feedback is introduced which further reduces the gain.

At very high frequency:

→ The reactants of coupling capacitor CC_2 is very high.

→ Performance of amplifier is limited by the junction capacitance of the transister.

Lower & Upper cut off frequencies (F_L & F_H)

In the frequency response plot we draw a pt where the magnitude of gain is $1/\sqrt{2}$ of the maximum gain the frequency corresponding to these pts r marked as F_L & F_H, since power at these frequencies is ½ the maxi^m power these frequencies are called half power frequencies. In log scale, $20 \log(0.707) = -3$ db or

$$20 \log(1/\sqrt{2}) = -3 \text{ db}$$

Bandwidth of an amplifier is a range of frequencies over which an amplifier can be used effectively. {Bandwidth (BW) = $F_H - F_L$}

Advantages of RC coupled amplifier

① It has a great frequency response the gain is uniform over the audio frequency range which is important for speech music etc ② It employs only resistors & capacitors which are cheap and it has low cost.

③ The circuit is compact due to small size & light wt of resistors & capacitors.

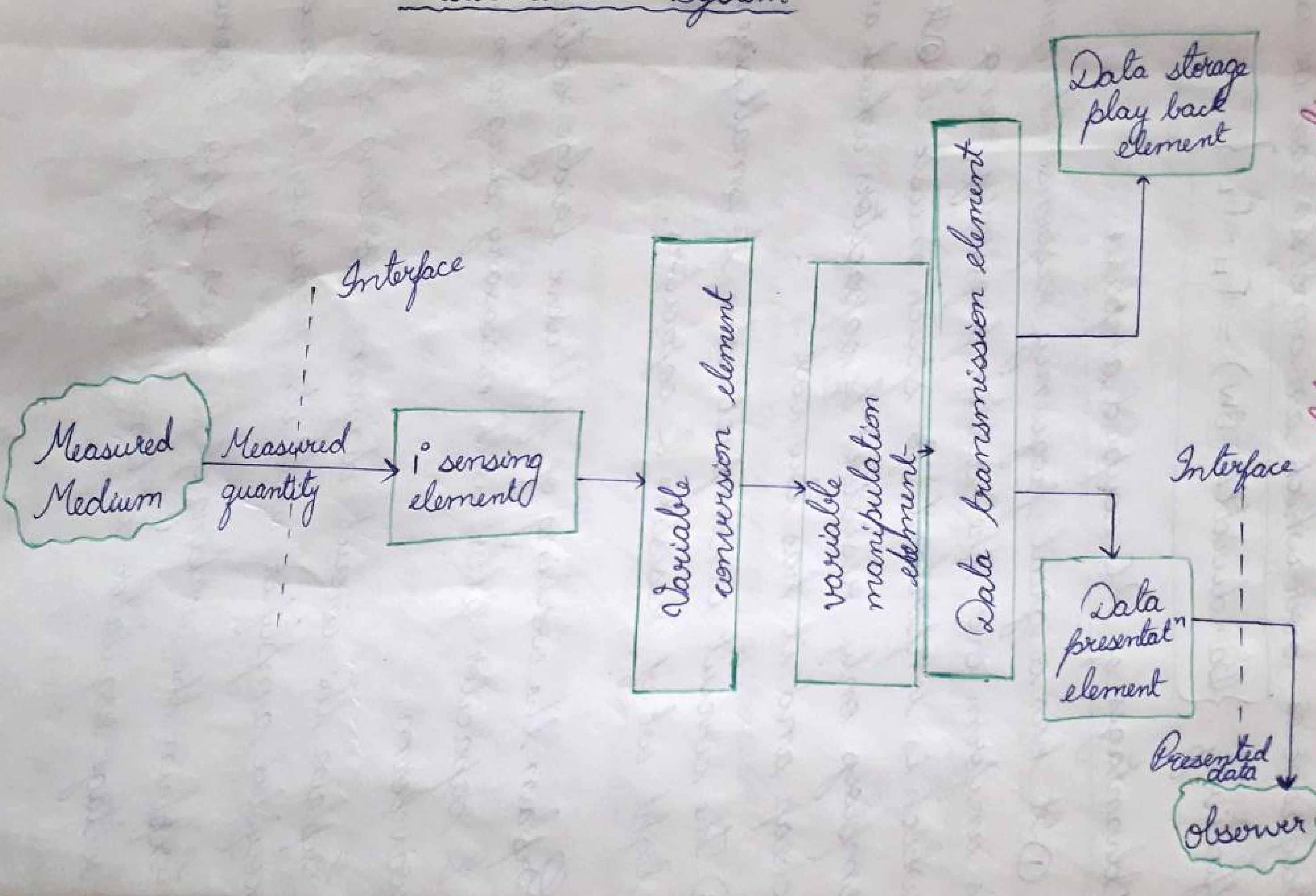
Q1) Explain the working of full wave bridge rectifier & capacitor filter with necessary diagram & waveform.

assignment last next weeks

Q2) Explain the circuit diagram working of RC coupled amplifier with its frequency response.

Q3) Explain the working of DC power supply & zener voltage regulator with neat diagram.

Measurement System



Generalised configuration of instruments

Sensing element - Converts the measured quantity to ~~an~~ electrical quantity. Thus it act as transducer. Measured quantity known as measurant act as the input of the primary sensing element.

The measurant is first detected by the 1° sensor. This act is then followed by the conversion of the measurant into an analog ~~el~~ electrical signal. This is done by transducer.

Variable conversion element : The o/p of 1° sensing element may be electrical signal of any form. It may be V, frequency or some other electrical parameter. Sometime this o/p is not suited to the s/s. For the instrument to perform a desired fn necessary to convert this output to other suitable form while preserving information content of original signal.

Suppose o/p is an analog form and the next stage of the s/s accept i/p signal only in digital form & therefore an A to D converter will have to be used for converting signals from analog to digital form for them to be acceptable for the next stage of the s/s.

Variable manipulation element: The fn of this element is to manipulate the signal presented to it preserving the orginal nature of the signal. Manipulatⁿ means only a change in numerical value of the signal.

eg:- Electronic Amplifier accept a small voltage signal an input & produces an o/p signal which is also voltage but greater magnitude. The voltage amplifier act as variable manipulation element.

Data transmission element: When the element of an instrument are actually physically separate it become necessary to transmit data from one to another. The element that perform this fn is called data transmission element.

Data presentation element: The information abt the quantity under measurement has to be conveyed to the personal handling the instrument or the s/s for monitoring, control or analysis purpose. In case data is to be monitored, visual display devices r needed these devices may be analog / digital indicating instruments like ammeter, voltmeter etc.