COEP TECHNOLOGICAL UNIVERSITY, PUNE

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Assignment : 04

Q.1)

Intrinsic semiconductor	extrinsic semiconductor
1) semiconductor in the pure form is known as intrinsic semiconductors.	The semiconductor, resulting from mixing of impurity in it is known as extrinsic semiconductor
2) their conductivity is low	Their conductivity is high.
3) electrical conductivity is function of temprecture alone	electrical conductivity is fuction of temprecture as well as no. of doped atoms.

Extrinsic semiconductors are of 2 types Namely,
(i) P type (ii) n type.

(i) P Type materials are the semiconductor materials doped with ~~an~~ trivalent impurity.
→ Majority charge carriers are holes.

(ii) n type materials are the semiconductor materials doped with a pentavalent impurity.
→ majority charge carriers are electrons.

Q-2

⇒ (i) Acceptor type impurities:-

⇒ (I) Acceptor impurities increase the hole concentration of semiconductor material.

(II) they are trivalent impurities and are dificient of electrons.

⇒ carriers contributed by them are holes.

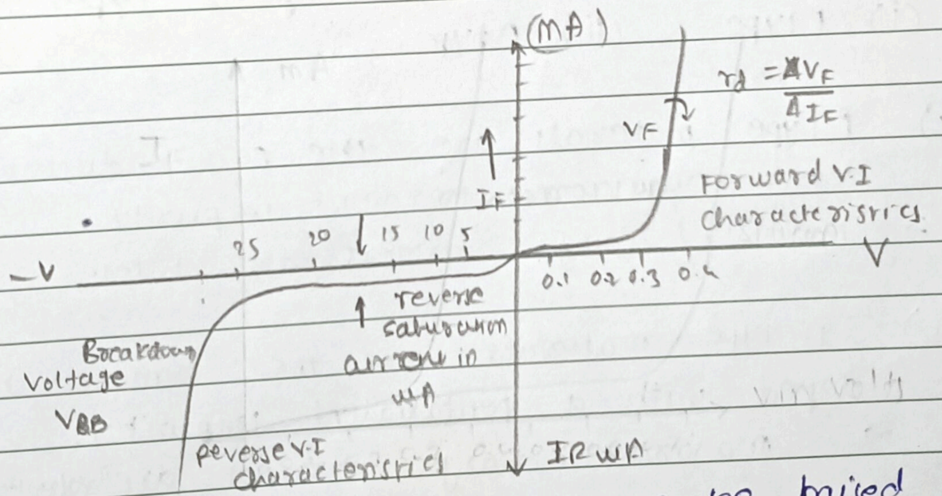
(ii) Donor type impurities:-

(I) Donor impurites increase the electron concentration in the semiconductor material.

(II) They are ~~tetiv~~ pentavalent impurites and are rich of electrons.

⇒ carries contributed by them are electrons.

Q. 3)



(i) A Junction Diode has to be baised in either forward or reverse manner.

(ii) when a P-N Junction diode is forward baised +ve terminal of the battery will repel

The holes on the P side and the electrons on the N side will be repelled by the negative terminal of the battery.

(ii) as a result the depletion layer which is created at Junction decreases and potential barrier will reduced.

(iii) Above the barrier potential when the votage is increased, large amount of current (I_F) flows through the P- N Junction.

(iv) This ~~cur~~ current is known as forward current. (I_F)

⇒ An ideal diode is a diode which acts as a perfect conductor in forward bais an as a perfect insulator in reverse baised condition.

Q.4 (i) peak inverse voltage is the highest voltage a semiconductor diode can withstand in reverse bais before it breaks down it is also known as breakdown voltage.

(ii) Forward baising :- when negative terminal of Battery is connected to 'N' side of semiconductor.
⇒ The current flows in large quantity due to majority charge carriers (electrons).
Reverse baising :- when negative terminal ~~of~~ of Battery is connected to 'P' side of semiconductor

the width of depletion layer and barrier potential increases. due to with semiconductor diode acts as an insulator.

(iii) potential barrier :- when PN junction is formed there is an initial diffusion of electrons and holes.

⇒ when electrons and holes occupy 2 different sides in a semiconductor a depletion region is generated which creates a potential difference.

(iv) depletion layer :- The layer formed due to diffusion of electrons and holes on the opposite sides.

(v) Reverse saturation current :- The small amount of current which flows through the diode in microamperes. in reverse bais. ~~is~~ K

Q5) ~~what is~~ zener diode :-

⇒ zener diode is a heavily doped P-N junction diode.

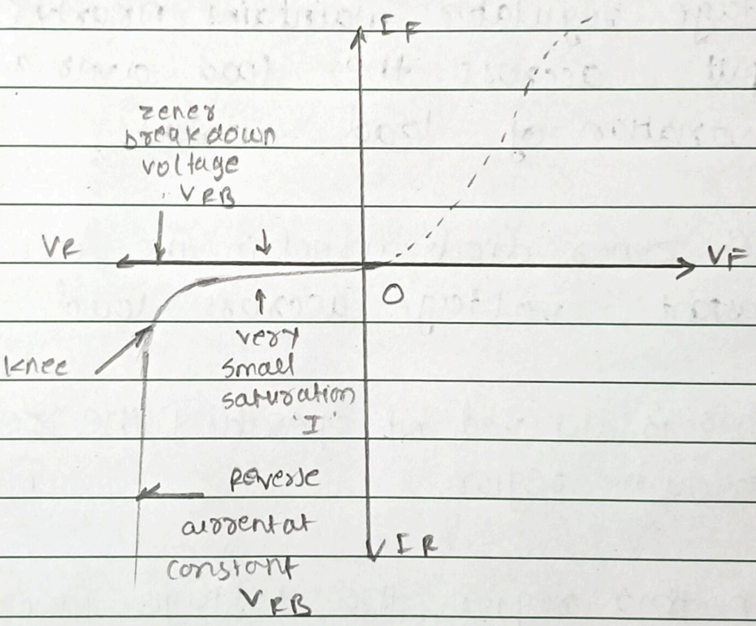
⇒ This diode is specially designed for voltage regulation

⇒ Forward bais characteristics of a zener diode are same as ordinary diode.

⇒ But it acts differently under reverse bias conditions.

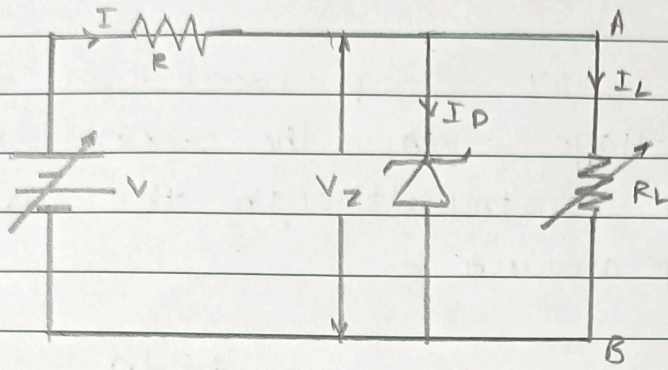
~~But~~ It has a very sharp breakdown voltage that the voltage accross the zener diode remains almost constant although the current varies by large amount

I - V characteristics of zener diode



⇒ since it is heavily doped breakdown occurs at very low voltage than ordinary diodes.

Q.6 Zener diode as a voltage regulator.



(i) Voltage regulator maintains nearly constant voltage output accross the load over a wide range of variation of load current

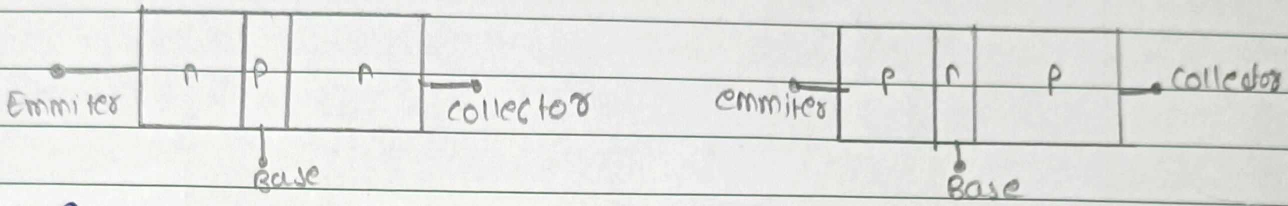
(ii) The zener diode used in the circuit maintains a constant voltage accross load terminals A and B

(iii) This is achived by operating the zener diode in Breakdown region.

(iv) In this region the voltage accross diode change very slightly over a large variation of zener current.

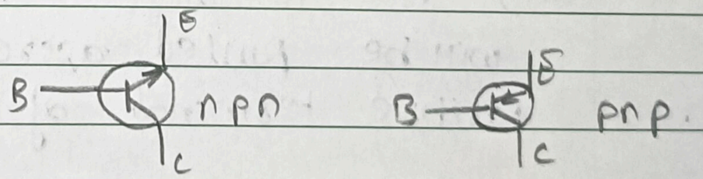
(v) Zener breakdown voltage must be lower than applied voltage.

Q.7) A BJT (Bipolar junction transistor)



⇒ Construction:-
(i) BJT has 3 layers of semiconductor materials.
(ii) These layers are arranged either in p-n-p or n-p-n sequence
(iii) In an npn transistor a p type semiconductor material is sandwiched between 2 n type materials ⇒ vice versa for pnp.
(iv) BJT has 2 back to back p-n junctions connected. ~~back~~ The central layer is called base.
⇒ one of the outer layer which is heavily doped is called emmiter and the one lightly doped is called collector.

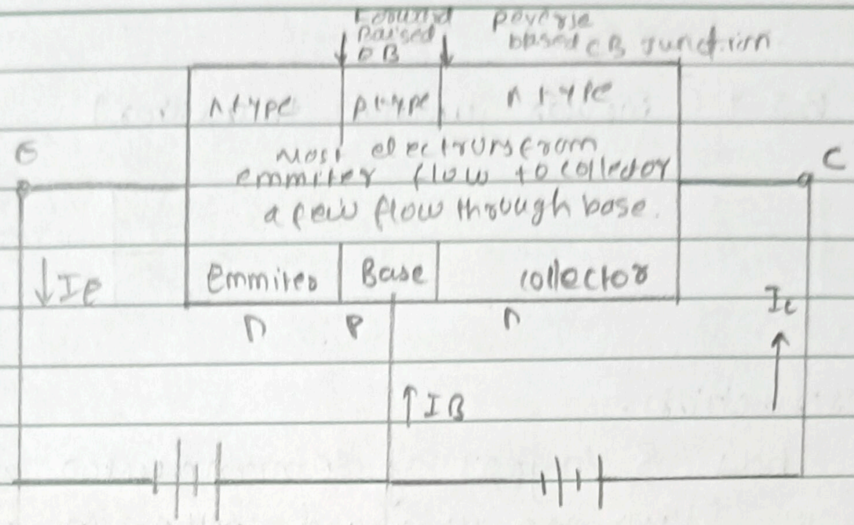
Working principle



(i) In BJT working occurs with the help of active regions.

(ii) Since there are 2 junctions (i) Emmiter - base and (ii) Collector - base junction.
→(I) Base emmiter junction is always a forward baised so that current flows through it.
(II) where as collector - base junction is always reverse bais.

Q-8



⇒ (i) EB Junction is a forward baised junction. Therefore the majority charge carriers from N type emmiter flow from emmiter to the base Junction

(ii) Only 2% of the electrons from the emmiter will recombine with holes in the base region because base is lightly doped.

(iii) Due to large CB bais voltage electrons will be pulled accross the CB junction by positive terminal of collector.

(iv) Thus collector collects 98% of the electrons emmited by the emmiter

The quantity of charge carriers crossing the emmiter to the base is controlled by base emmiter bais voltage.

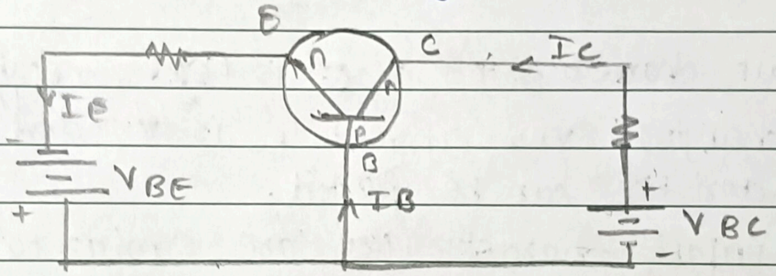
⇒ emmiter and collector controlled by base collector emmiter bai's voltage

Q.9 An npn or a pnp transistor can be used in 3 configurations.

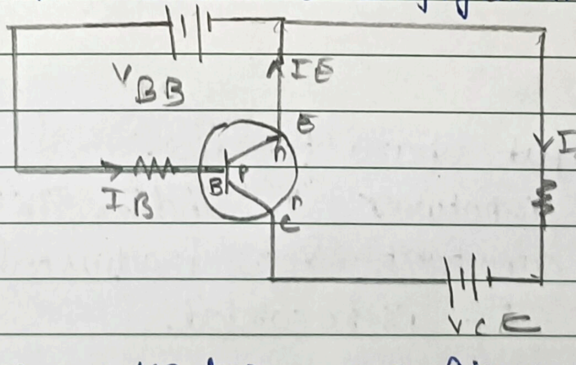
(i) common Base configuration (CB)
(ii) common Emmiter configuration (CE)
(iii) common collector configuration (CC)

Diagrams. (For npn transistors)

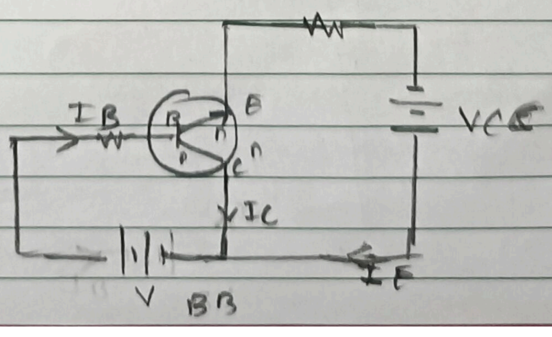
(i) common base configuration (CB)



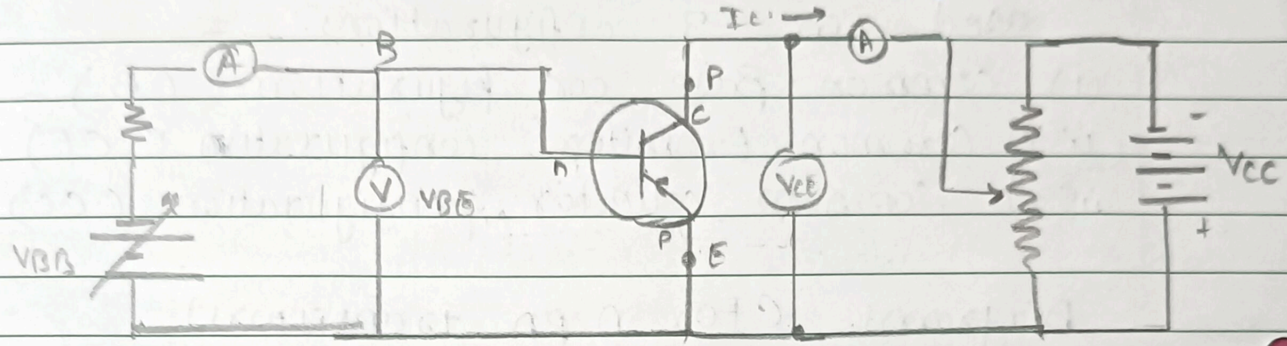
(ii) common Emmiter configuration (CE)



(iii) common collector configuration (CC)

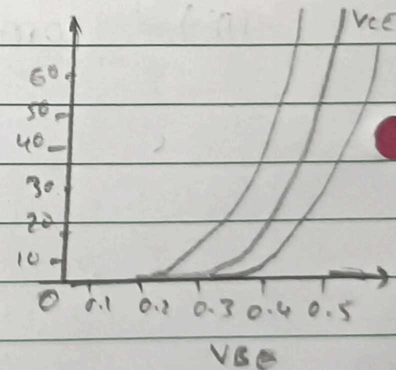


Q.10) BJT in common emmiter configuration.

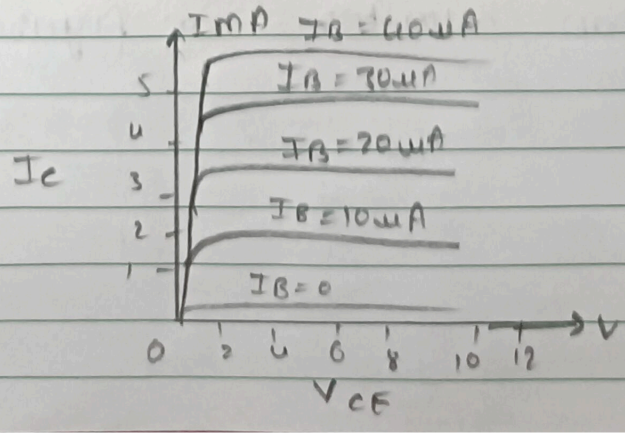


⇒ CE input characteristics. $V_{BB} = V_{in}$

(i) For input characteristics V_{CE} is kept constant
(ii) By changing V_{BE} current I_B is recorded and the characteristics can be plotted.
(iii) input characteristics are similar to characteristics of forward biased p-n juction. The value of I_B is very small in μA only.



⇒ CE output characteristics.
(i) output is between I_C and V_{CE}, I_B is kept constant. V_{CE} is adjusted and I_C is recorded.



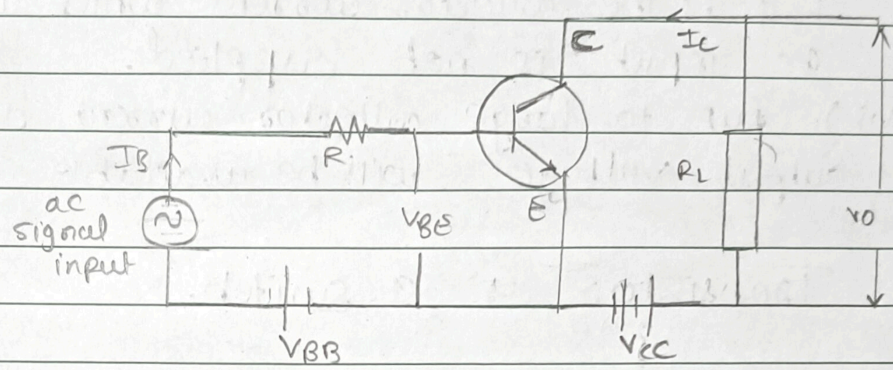
current gain

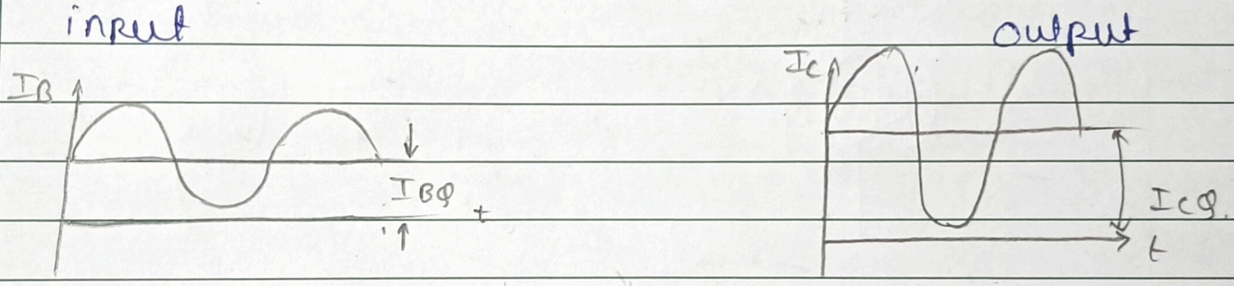
$$\beta_{dc} = \frac{\Delta I_C}{\Delta I_C}$$

can be used as current amplifying device.

Q.11) Transistor As an amplifier. (output 180° out of phase)

⇒ An (NPN) transistor in CE configuration.





→ (i) The AC signal is to be amplified is connected to the base circuit

(ii) the output is taken accross resistance R_L in collector circuit

(iii) The voltage V_{BE} is the summation of dc voltage V_{BB} and and AC input V_i the dc voltage V_{BB} is a bais voltage.

(iv) The magnitude of V_{BB} is such that it will always remain positively biased in both half cycles of input voltage.

(v) $I_B = I_{BQ}(dc) + I_{ac}$

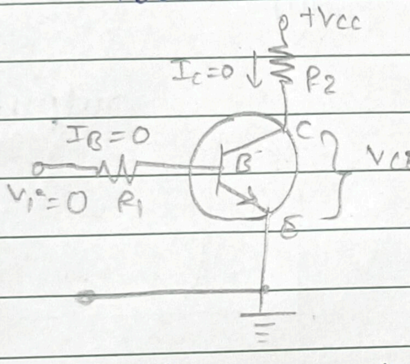
⇒ if I_B is changed slighty large change in I_C occours which flows through R_L

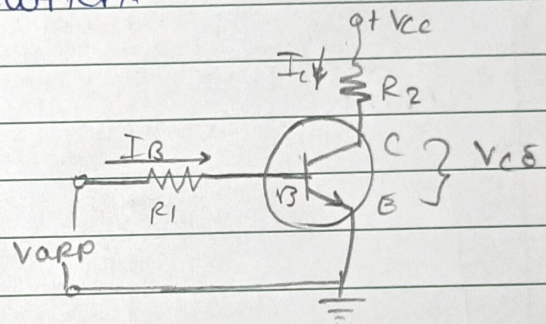
(vi) Amplified collector ac current is superimposed on the dc current I_{CQ}

I_{CQ} is the collector current which will flow if ac input is not supplied.

(vii) Due to large collector current an amplified output voltage will be available accross load.

Q.12. Transistor as a switch.





Off state of BJT

The base voltage is either at zero level or at an appropriate positive level

when $V_i = 0$ $I_B = 0$ and $I_C = 0$

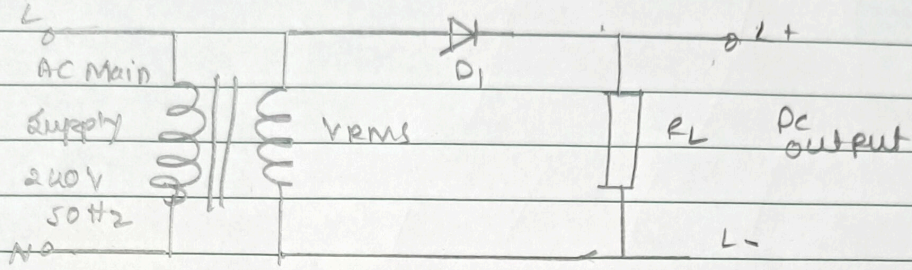
The transistor is cut off and acts as an open switch.

On state of BJT

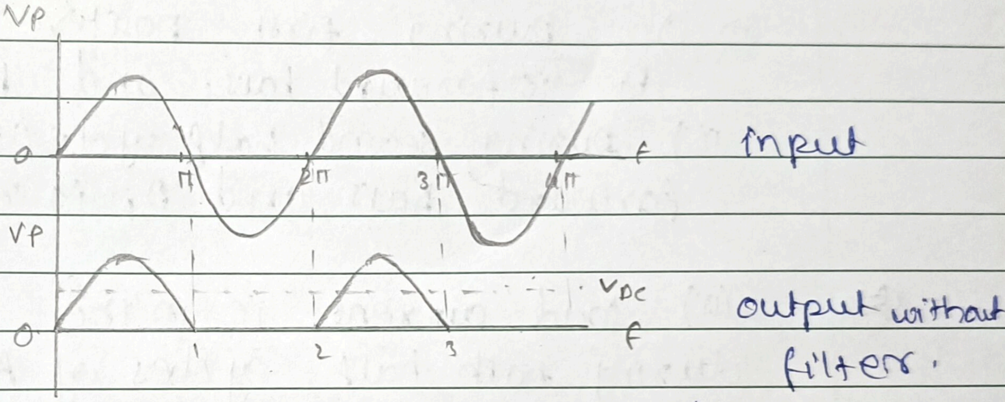
if V_i is at positive level and base current I_B is made high enough the transistor operates in saturation region.

under saturated condition large collector current I_C flows and transistor operates as open switch.

Q.13) (1) Half wave Rectifier circuit



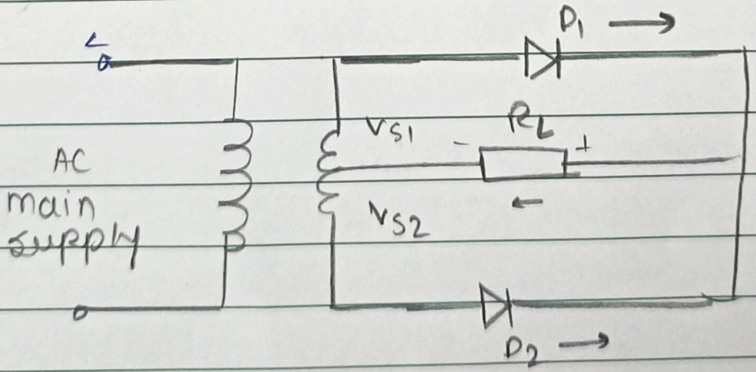
~~output~~ waveform (input)

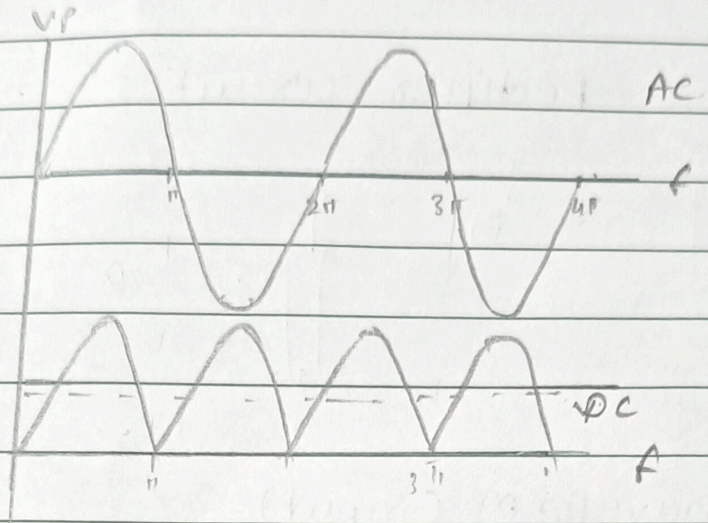


(1) Diode D_1 acts as forward biased during positive half cycle ∵ it is a P-N Junction. it conducts electricity

(2) Diode D_1 ~~acts~~ is reversed bias and acts as an insulator. so the negative half cycle gets eleminated

Q.14) (1) Full Wave Rectifier circuit. (centre tapped)





⇒ (i) During first positive half cycle D₁ is forward bais. and D₂ is reverse

(ii) During second half cycle (-ve) Diode D₂ forward bais and D₁ is reverse bais.

(iii) load current is in the same directi during both half cycles of AC input,

DC output $V_{dc} = 0.9 \times V_{RMS}$.

Ripple frequency = 2 times AC input freq

peak inverse voltage ⇒ peak inverse voltage accross diode in reverse biased condition is eq to two times the peak value of seconda voltage.

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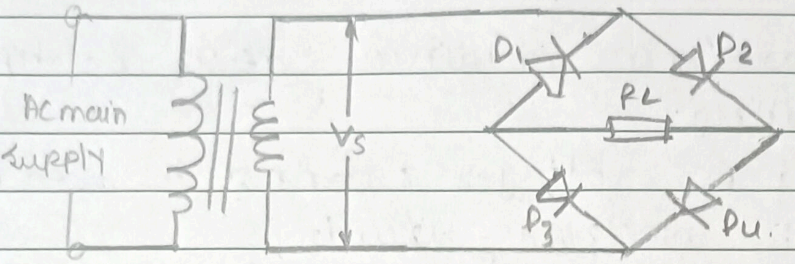
Q.15 Bridge Rectifier



⇒ It is a full wave rectifier.

⇒ 4 Diodes are used

⇒ no need of centre tap.

(I)

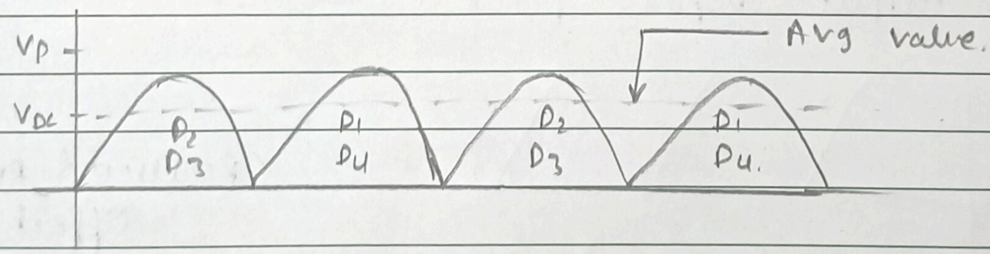
(i) For positive half cycle secondary voltages D_2 and D_3 are forward baised.

(ii) For current flows through diode D_2 load resistance R_L and D_3 to the other end of the secondary.

(II)

(i) During negative half of the secondary voltage diode D_1 and D_4 are conducting.

(ii) The current flows through diode D_4 resistor R_L and diode D_1 to other end of the secondary



⇒ Output Ripple frequency is double of the input AC frequency.

Q.16 Filter in Rectifier circuit.

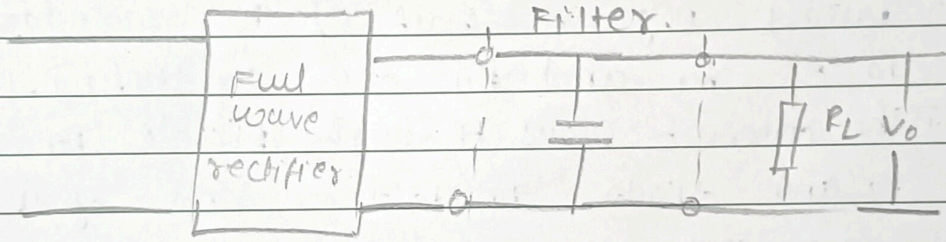
⇒ (i) Output waveform obtained after rectifying is pulsating.

(ii) Pulsating DC voltages cannot be used in most of the electronic circuits.

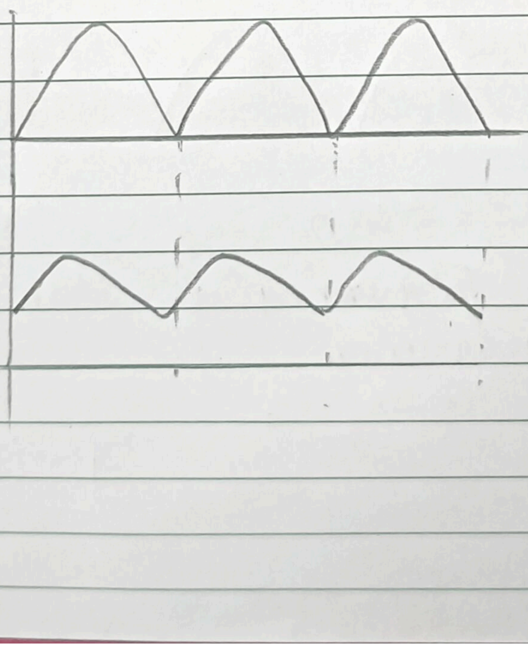
(iii) The Filter are used to Reduce pulsation in DC output of rectifiers are known as smoothing circuits or popularly as Ripple filters.

An example of filter circuits.

(a) Capacitor Filter.



⇒ output Before filter.



(Reduced ripple effect)

output with filter

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Q.17 For $\beta_{dc} = ?$

(i) $\alpha_{dc} = 0.9$

we know that.

$I_E = I_C + I_B$ — ①

$\beta_{dc} = \frac{I_C}{I_B}$ $\alpha_{dc} = \frac{I_C}{I_E}$ $\Rightarrow 1 - \frac{I_B}{I_E}$

$\cancel{\alpha_{dc}}$ -

divide ① with I_C on both sides

$\Rightarrow \frac{1}{\alpha} = 1 + \frac{1}{\beta}$

$\therefore \beta = \frac{\alpha}{1-\alpha} = \frac{0.9}{0.1} = 9$

(ii) $\Rightarrow$ $\alpha_{dc} = 0.98$

$\beta_{dc} = \frac{0.98}{0.02} = 49$

(iii) $\beta_{dc} = \frac{0.99}{0.01} = 99$

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Q.18 $I_E = ?$

$\beta = 50$

$I_B = 20 \mu A$

$\beta = \frac{I_C}{I_B}$

$I_C = 50 \times 20 \times 10^{-6} = 1 mA$

Now, $I_E = I_C + I_B$

$= 10^{-3} + 20 \times 10^{-6}$

$= 10^{-3} + 0.02 \times 10^{-3}$

$\boxed{I_E = 1.02 mA}$