ADF practise questions

1. Define the following:
   a. Regulator
   b. Rectifier
   c. Efficiency
   d. Ripple factor
   e. Amplifier

Regulator: An amplifier is an electronic device that increases the voltage, current, or power of a signal.

Rectifier: An electrical device used to convert ac voltage into pulsating dc voltage.

Efficiency: The efficiency of a rectifier is the ratio of its DC output power to its AC input power. It is a measure of how well the rectifier converts alternating current (AC) into direct current (DC).

Ripple Factor: The ripple factor (RF) of a rectifier is a measure of the amount of alternating current (AC) in the output signal. It's calculated as the ratio of the root mean square (RMS) value of the AC component to the RMS value of the DC component:

Rectifier type	Ripple factor
Half-wave	1.21
Full-wave	0.483

Amplifier: An amplifier is an electronic device that increases the voltage, current, or power of a signal.

2. Recall the equivalent circuit of a diode and represent it using a neat diagram.

There are three Equivalent circuit model of diode

1. Ideal diode model:

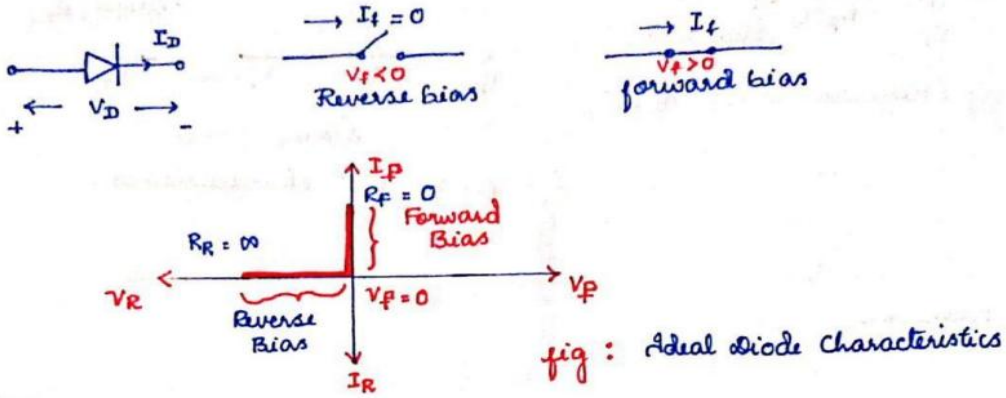


fig : Ideal Diode Characteristics

- An ideal diode offers zero forward resistance and infinite reverse resistance.
- The forward voltage drop is zero and reverse current is also zero.

2. Approximate model/Practical model:

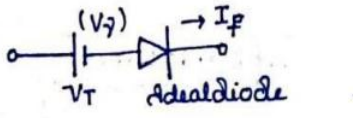


fig : Approximate Model

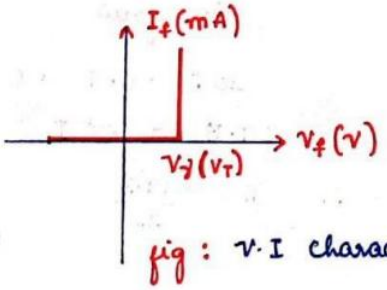


fig : V-I characteristics

- A practical diode offers zero forward resistance and infinite reverse resistance.
- The forward voltage drop is not zero.

3.Piecewise Linear Model:

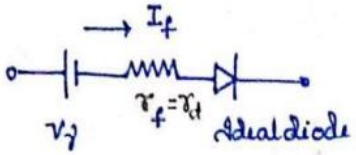


fig : Piecewise Linear Model

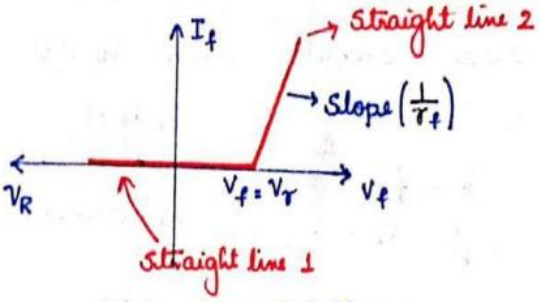


fig : V-I characteristics.

When the forward characteristics of a diode is straight-line approximation then it is called piecewise linear characteristics.

3 . Describe what a PN junction diode is, and explain how it operates in both forward and reverse bias conditions.

PN junction Diode:

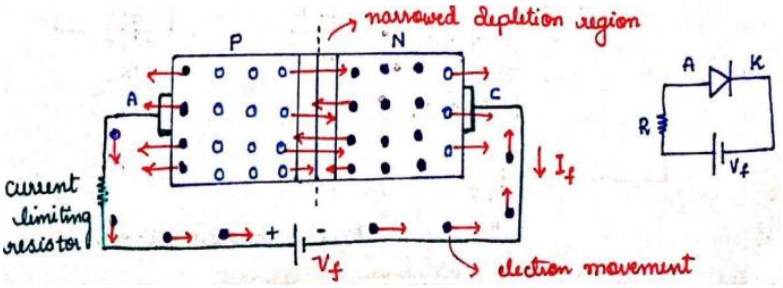
• When P-type and N-type semiconductors are placed in contact with one another, it forms a PN junction.

• PN junction forms a popular semiconductor device called diode

• A diode is a two terminal semiconductor device which conducts only in one direction offering a low resistance when forward biased and high resistance when reverse biased.

Forward Biasing PN-Junction:

- PN Junction is said to be forward biased when the positive terminal of battery is connected to p-type and negative terminal of battery is connected to n-type as shown in below fig.If the applied voltage is less than the barrier potential, there will be no conduction
- When the applied voltage is more than the barrier potential, then the holes on p-side which are positively charged gets repelled from positive terminal and driven towards junction.
- Similarly the electrons on n-side which are negatively charged gets repelled from negative terminal and move towards the junction.
- This result in the reduction of barrier potential, hence resulting large current known as forward current starts flowing as shown in fig.

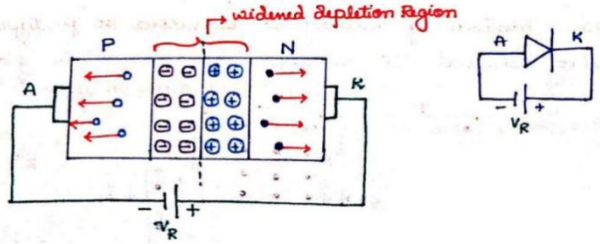


Reverse Biasing PN-Junction:

- PN Junction is said to be reverse biased when the positive terminal of battery is connected to n-type and negative terminal of battery is connected to p-type as shown in below fig.

When PN junction is reverse biased, then the holes on p-side of junction are attracted towards negative terminal and the electrons on n-side of junction are attracted towards positive terminal of battery.

- Thus holes on p-side and electrons on n-side move away from the junction thereby increase the barrier potential.
- If the barrier voltage is increased, majority charged carriers cannot cross the junction and there is no current flow across the junction.
- Minority charge carriers cross the junction and leads to a small current flow called reverse current as shown in fig.



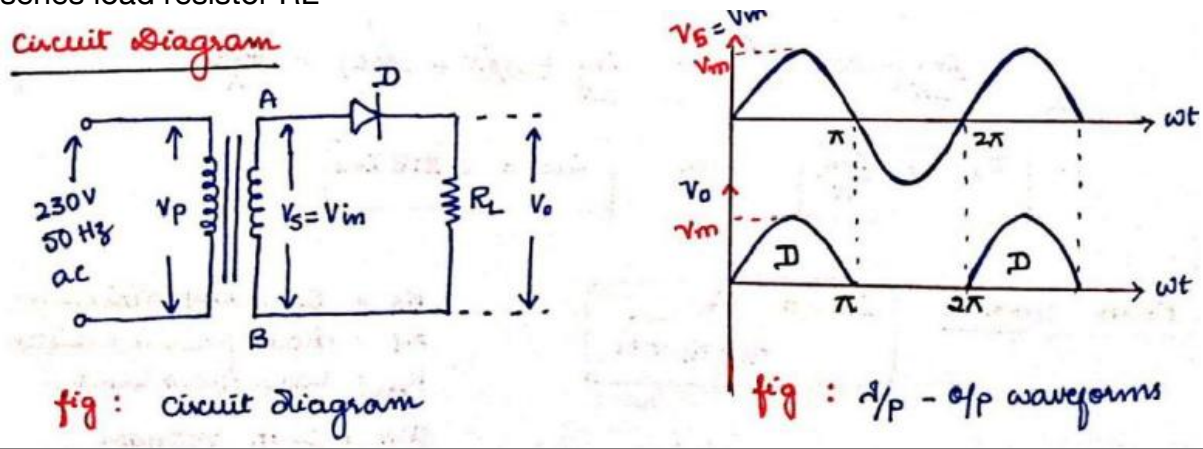
4. Explain what a rectifier is, and describe how a Half-wave rectifier operates, including a labeled diagram.

An electrical device used to convert ac voltage into pulsating dc voltage.

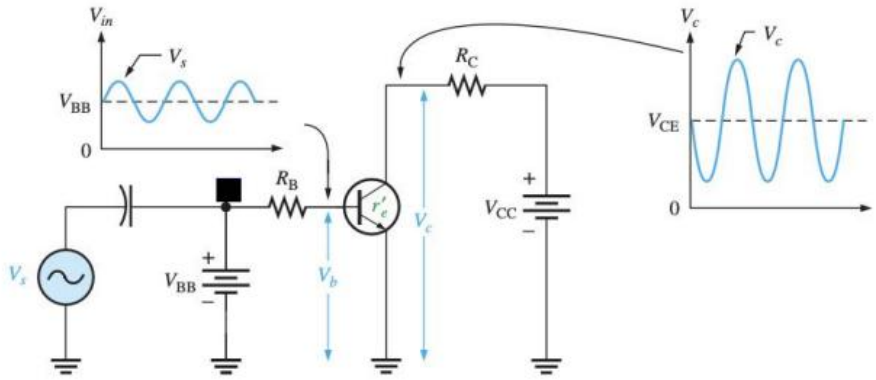
Half-wave rectifier:

- Rectifiers which conducts current or voltage only during one half cycle of ac input is called half wave rectifier.

- Fig shows half wave rectifier, which single diode acts as half wave rectifier.
- AC input supply to be rectified is applied through transformer to diode D and series load resistor RL



5. Explain how a BJT operates as a voltage amplifier in the active region.



A transistor amplifies current because the collector current is equal to the base current multiplied by the current gain β.

The base current in a transistor is very small compared to the collector and emitter currents. Because of this, the collector current is approximately equal to the emitter current.

An ac voltage, Vs, is superimposed on the dc bias voltage VBB by capacitive coupling as shown.

The forward-biased base-emitter junction presents a very low resistance to the ac signal. This internal ac emitter resistance is designated r'_e in Figure and appears in series with R_B. The ac base voltage is

$$V_b = I_e r'_e$$

The ac collector voltage, V_c, equals the ac voltage drop across R_C.

$$V_c = I_c R_C$$

Since $I_c \cong I_e$, the ac collector voltage is

$$V_c \cong I_e R_C$$

V_b can be considered the transistor ac input voltage where $V_b = V_s - I_b R_B$. V_c can be considered the transistor ac output voltage. Since *voltage gain* is defined as the ratio of the output voltage to the input voltage, the ratio of V_c to V_b is the ac voltage gain, A_v, of the transistor.

$$A_v = \frac{V_c}{V_b}$$

Substituting $I_e R_C$ for V_c and $I_e r'_e$ for V_b yields

$$A_v = \frac{V_c}{V_b} \cong \frac{I_e R_C}{I_e r'_e}$$

The I_e terms cancel; therefore,

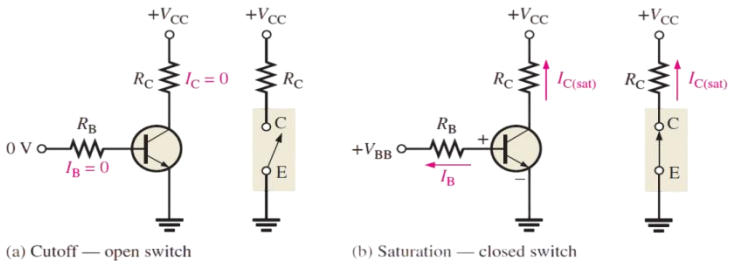
$$A_v \cong \frac{R_C}{r'_e}$$

$$\boldsymbol{A_v \cong \frac{R_C}{r'_e}}$$

The equation shows that the transistor in the Figure provides amplification in the form of voltage gain, which is dependent on the values of RC and r'e.

Since RC is always considerably larger in value than r'e , the output voltage for this configuration is greater than the input voltage.

6. Describe how a bipolar junction transistor (BJT) functions as a switch.



(a) Cutoff — open switch (b) Saturation — closed switch

The figure illustrates the basic operations of a BJT as a switching device.

In Fig (a) the transistor is in cut off region because the base emitter junction is not forward biased.
Hence the equivalent circuit indicates there is open switch between emitter and collector.
In Fig (b) the transistor is in saturation region because the base emitter and the base collector junctions are forward biased and the base current is made large enough to cause the collector current to reach its saturation value.

Hence the equivalent circuit indicates there is closed switch between emitter and collector.

Conditions in cutoff
A transistor is in the cutoff region when the base-emitter junction is not forward-biased. Neglecting leakage current, all of the currents are zero, and VCE is equal to VCC.

$$V_{CE(cutoff)} = V_{CC}$$

Conditions in Saturation
When the base-emitter junction is forward-biased and there is enough base current to produce a maximum collector current, the transistor is saturated. The formula for collector saturation current is

$$I_{C(sat)} = \frac{V_{CC} - V_{CE(sat)}}{R_C}$$

Since **VCE(sat)** is very small compared to VCC, it can usually be neglected. The minimum value of base current needed to produce saturation is

$$I_{B(min)} = \frac{I_{C(sat)}}{\beta_{DC}}$$

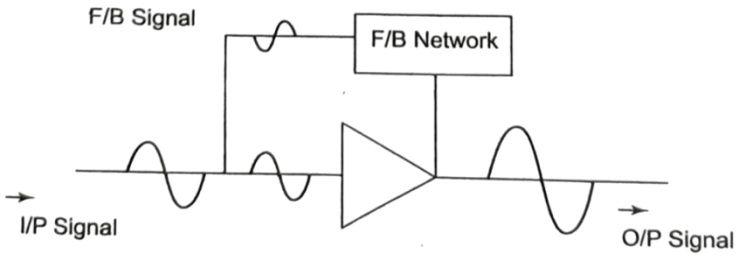
Normally, **IB** should be significantly greater than **IB(min)** to ensure that the transistor is saturated.

7. Illustrate and show the operation of a negative feedback amplifier, and list its properties

Negative Feedback Amplifiers:

If the input signal and the feedback signal are in opposite phase, the resultant input signal is the difference of input and feedback signals. This is called negative feedback.

Negative feedback is also known as degenerative or inverse feedback.



Negative feedback amplifier

The voltage gain with negative feedback is given by

$$A_f = \frac{A}{(1+\beta A)}$$

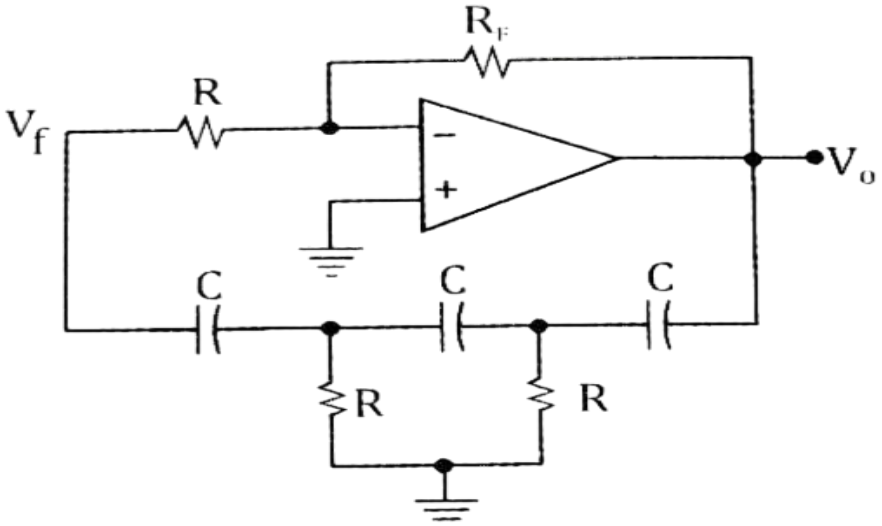
Negative feedback induces desirable modifications in circuit performance.
Though negative feedback reduces the overall gain of the amplifier, it has numerous advantages and hence widely used in amplifier circuits.

Properties of negative feed-back

1.Reduced gain
2. Increased bandwidth
3. Increased stability
4. Decreased Noise
5. Modified Input impedance and Output Impedance.

8. Illustrate and show the working principles of an RC phase shift oscillator with a neat diagram. Examine the equations governing its operation.

The circuit of an RC phase shift oscillator is shown in Fig. The circuit consists of three RC stages as shown. Each of the three RC stages in the feedback loop can provide a maximum phase shift of approximately 90°.



Oscillation occurs at the frequency for which the total shift through the three RC stages is 180° (Each stage provides 60° phase shift). The op-amp in inverting mode provides the additional phase shift of 180° to meet the requirement for oscillations