Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1) Attempt any TEN of the following: 20

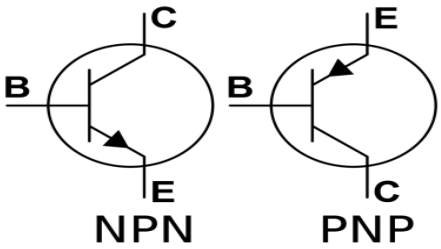
a) Define active components. Give one example
(Definition – 1Mark, one example – 1Mark)

Ans.

The electrical components which are capable of amplifying or processing electrical signals are called active components. Example: Diode, Transistor etc.

b) Draw the symbols of npn & pnp transistors.
(Correct symbols – 1 Mark each).

Ans.



c) State two applications of tunnel diode.
(Correct applications- 1 mark each)

Ans.

1. High speed switches
2. High frequency oscillator
3. Micro wave generators and amplifiers

d) Define bandwidth of Amplifier.
(Correct definition- 2 marks)

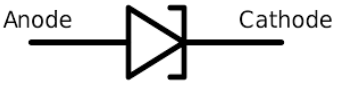
Ans. Bandwidth:

The range of frequency over which the voltage gain of an amplifier remains constant is known as bandwidth of an amplifier.

e) Draw symbols of
(i) LED and
(ii) Tunnel diode
(Correct symbols – 1 Mark each).

Ans.

Symbol of LED



Symbol of TUNNEL DIODE

f) Give applications of IC (any two)
(Any Two correct applications- 1 mark each)

Ans.

1. Digital Watch
2. PDAs
3. MP3 Players
4. Mobile phones
5. Digital cameras
6. Calculators
7. PCs and other related peripherals
8. Aircrafts
9. Space Vehicles
10. RADAR
11. Communication Systems
12. Radio

g) State the need of filter.
(Correct answer- 2 marks)

Ans.

Need of the filter:

The output of a rectifier contains ac and dc components. If such a dc is applied in an electronic circuit, it will produce noise and therefore to keep the ac components away from the load, filter circuits are used, which removes the ac components and allows only dc components to reach the load.

It also removes ripples from the rectified output.

h) Write two applications of oscillators.
(Any Two correct applications- 1 mark each)

Ans. Applications:

1. Oscillators are used for providing the carrier frequency to modulator circuits.
2. Oscillators can be used for frequency generation in electronics circuits.
3. Oscillators are used in radios.
4. Oscillators are used in TV transmitters.
5. Oscillators are used to generate clock signals that regulate computers.
6. Oscillators are used to generate clock signals in quartz clocks.

i) Define static resistance and dynamic resistance of diode.
(Correct definition: 1 mark each)

Ans. (i) Static resistance:

The resistance of a diode at the operating point can be obtained by taking the ratio of V_F and I_F. The resistance offered by the diode to the forward DC operating conditions is called as **"DC or static resistance".**

$$R_F = \frac{V_F}{I_F}$$

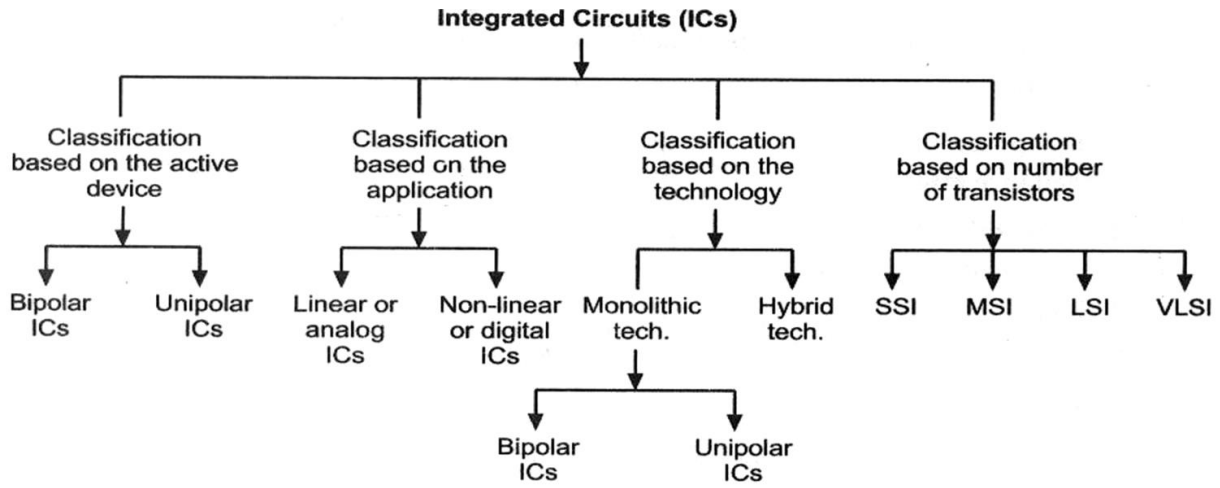
(ii) Dynamic resistance:

The resistance offered by a diode to the AC operating conditions is known as the **"Dynamic Resistance".** It is the ratio of change in voltage to the resulting change in current.

$$r_{ac} = \frac{\Delta V_F}{\Delta I_F}$$

j) Give classification of ICs
(Any Two classification: 1 mark each)

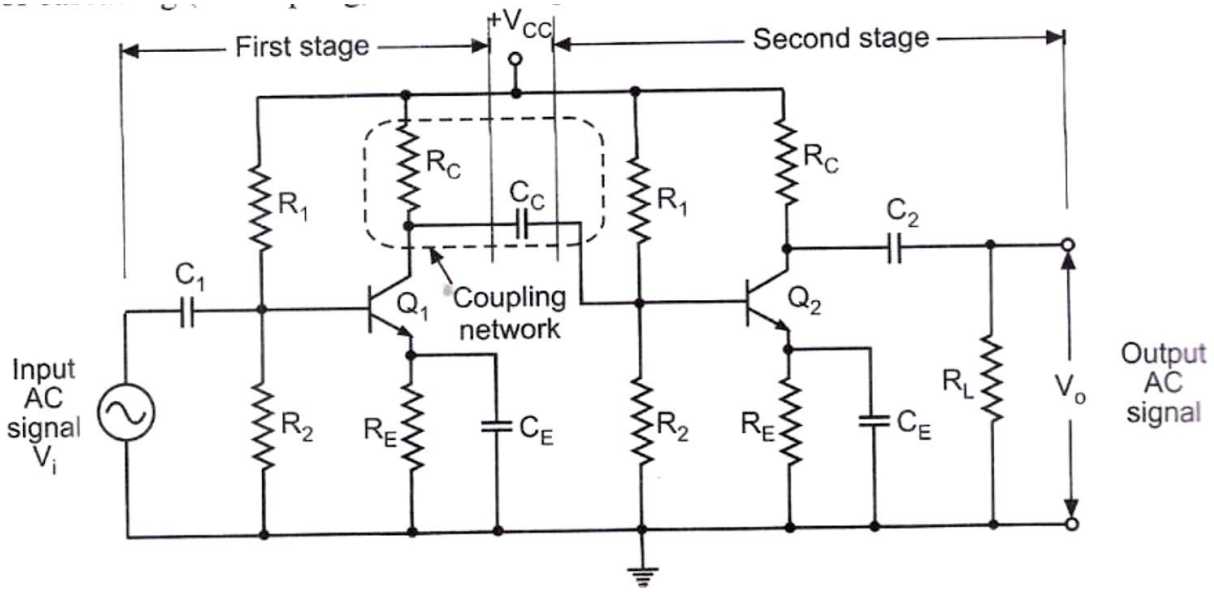
Ans.



Classification of integrated circuits (ICs)

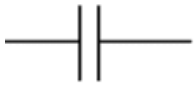
k) Draw the circuit diagram of two stage RC coupled transistor amplifier
(Correct labeled diagram - 2 Marks)

Ans.

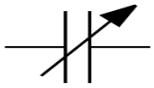


l) Draw symbols of fixed and variable capacitor
(Correct symbols – 1 Mark each).

Ans.



(i) Fixed capacitor

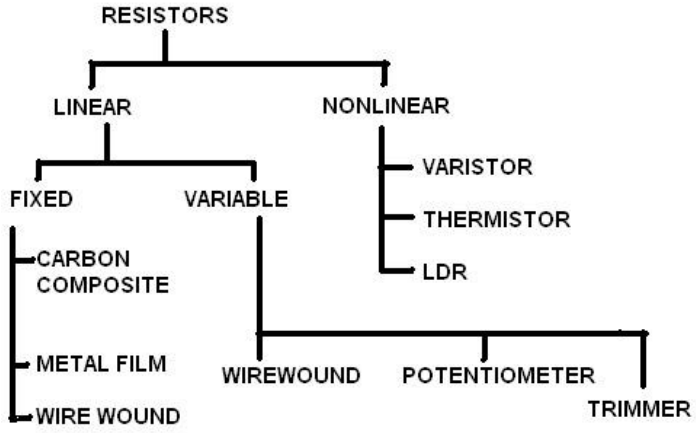


(ii) variable capacitor

Q.2) Attempt any FOUR of the following: 16

a) State the different types of Resistor. State any four specifications of Resistors.
(Types – 2 marks, Any four specifications – 2 marks)
(Note: Metal films with Thin and Thick film types can be considered)

Ans.



Specifications of resistor:

- Temperature Coefficient.
- Size or value of a resistor
- Power Dissipation / wattage
- Tolerance
- Thermal Stability
- Frequency Response.
- Power De-rating.
- Maximum Temperature.
- Maximum Voltage.

b) Explain operating principle of Varacter Diode.
(Diagram 2 Marks, Principle – 2 Marks)

Ans.

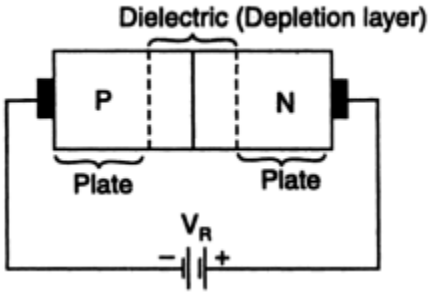


Fig: Reverse Biased PN junction

Operating principle:

The Varactor or varicap is a diode that exhibits the characteristics of a variable capacitor. The depletion layer created by the reverse bias acts as a capacitor dielectric whereas, the P and N regions acts as capacitor plates. When the reverse bias voltage increases, the depletion layer widens. This increases the dielectric thickness which in turn reduces the capacitance. When the reverse bias voltage decreases, the depletion layer narrows down. This decreases the dielectric thickness, which in turn increases the capacitance.

c) Explain operation of npn transistor with neat diagram.
(Diagram – 2 marks, operation - 2 marks)

Ans. Diagram:

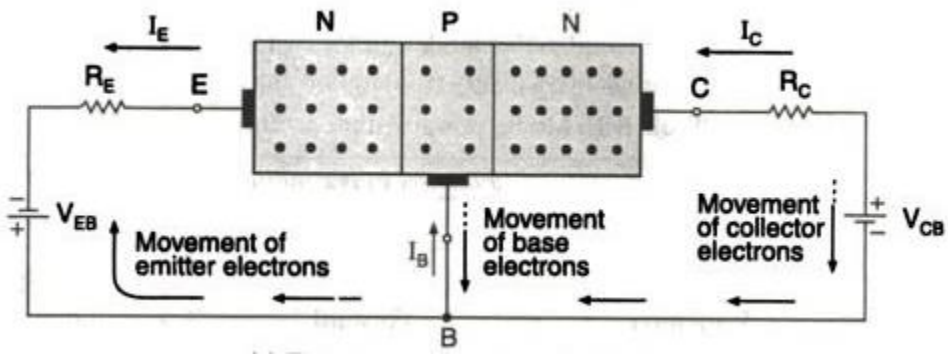


Fig: Operation of NPN transistor

- Above fig shows NPN transistor with forward biased emitter-base junction and reverse biased collector-base junction.
- The forward bias causes the electrons in the N-type emitter to flow towards the base. This constitutes the emitter current I_E.
- As these electrons flow through the P-type they tend to combined with holes. As the base is likely doped and very thin therefore only a few electrons (2%) combine with holes to constitute base current I_B.
- The remaining electrons (98%) cross over in to the collector region to constitute collector current I_C.
- In this way almost the entire emitter current flows in the collector circuit. It is clear that emitter current is sum of collector and base current.
  $\mathbf{I_E = I_B + I_C}$

d) Compare BJT and JFET.
(Any four points: 1M each)

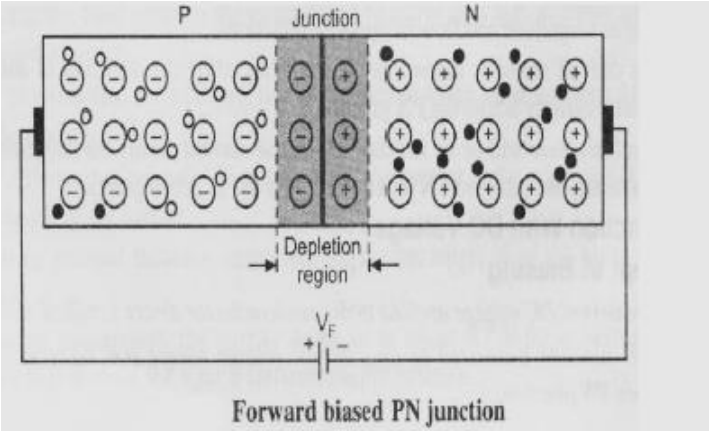
Ans.

Sr. no.	BJT	JFET
1.	It is bipolar device i.e. current in the device is carried by electrons and holes.	It is unipolar device i.e. current in the device is carried by either electrons or holes.
2.	It is current controlled device i.e. base current controls the collector current.	It is voltage controlled device i.e. voltage at the gate terminal controls the amount of current flowing through the device.
3.	Input resistance is low, of the order of several KΩ	Input resistance is very high, of the order of several MΩ
4.	It has positive temperature coefficient of resistance at high current levels i.e. current increases as the temperature increases.	It has negative temperature coefficient of resistance at high current levels i.e. current decreases as the temperature increases.
5.	It suffers from minority carrier	It does not suffer from minority

	storage effects and therefore has lower switching speeds and cut-off frequency.	carrier storage effects and therefore has higher switching speeds and cut-off frequency.
6.	It is more noisy as compared to FET.	It is less noisy.
7.	It is complicated to fabricate as an IC and occupies more space on the IC chip.	It is much simpler to fabricate as an IC and occupies less space on the IC chip.
8.	Thermal break down can occur.	Thermal break down cannot occur.

e) Explain operation of P-N junction in forward biased condition
(Diagram 2 Marks, explanation – 2 Marks)

Ans.



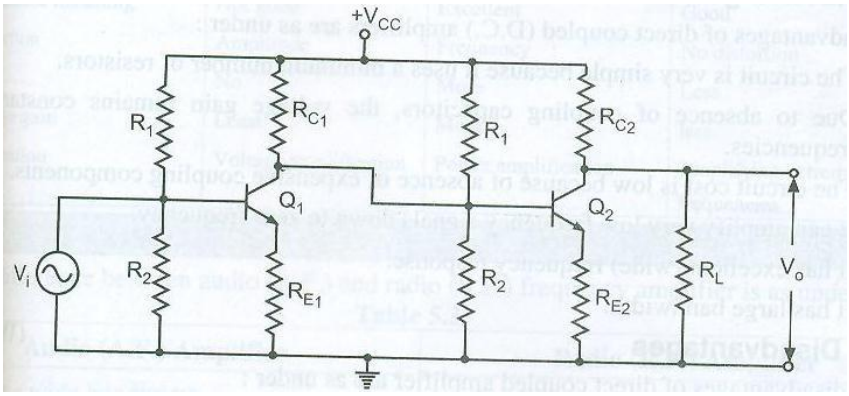
Forward biased PN junction

- If the P-region (anode) is connected to the positive terminal of the external DC source and N-side (cathode) is connected to the negative terminal of the DC source then the biasing is said to be "forward biasing".
- Due to the negative terminal of external source connected to the n-region, free electrons from N-side are pushed towards the P-side. Similarly the positive end of the supply will push holes from P-side towards the N-side.
- With increase in the external supply voltage V, more and more number of holes (P-side) and electrons (N-side) start travelling towards the junction as shown in figure.
- The holes will start converting the negative ions into neutral atoms and the electrons will convert the positive ions into neutral atoms. As a result of this, the width of depletion region will reduce.

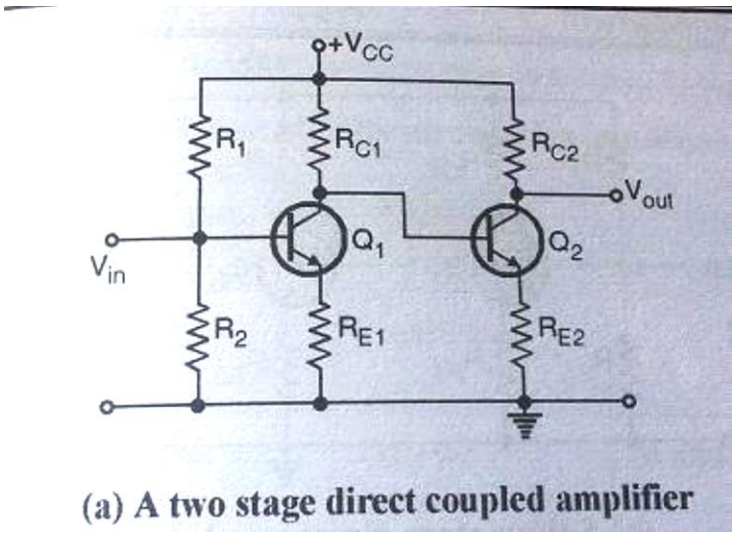
- Due to reduction in the depletion region width, the barrier potential will also reduce. Eventually at a particular value of V the depletion region will collapse. Now there is absolutely no opposition to the flow of electrons and holes.
- Hence a large number of electrons and holes (majority carriers) can cross the junction under the influence of externally connected DC voltage.

f) Draw and explain direct coupled amplifier with its frequency response.
(Diagram – 2marks, explanation – 1 mark, frequency response – 1 mark)

Ans



OR

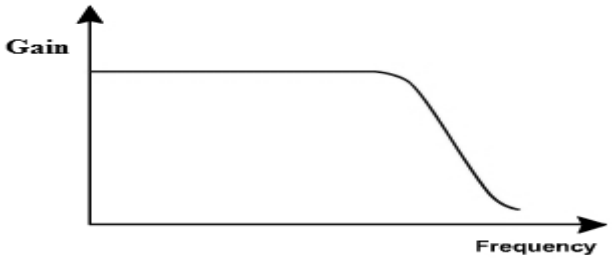


(a) A two stage direct coupled amplifier

Explanation:

- There is no capacitor used for coupling one stage to the other. Q1 and Q2 are the transistors, Vcc is the dc supply, R1, R2, Rc1, Rc2, R_{E1}, R_{E2} are the biasing elements. i.e. o/p of Q1 i.e., collector of Q1 is connected to base of Q2.
- The input AC signal is applied to base of Q1, o/p at collector of Q1 is connected directly to base of Q2. final output is obtained at collector of Q2. Hence it is called direct coupled amplifier.
- Due to the absence of coupling capacitors, the gain does not reduce on the lower frequency side.
- The amplifier can amplify even the dc signals.

Frequency response:

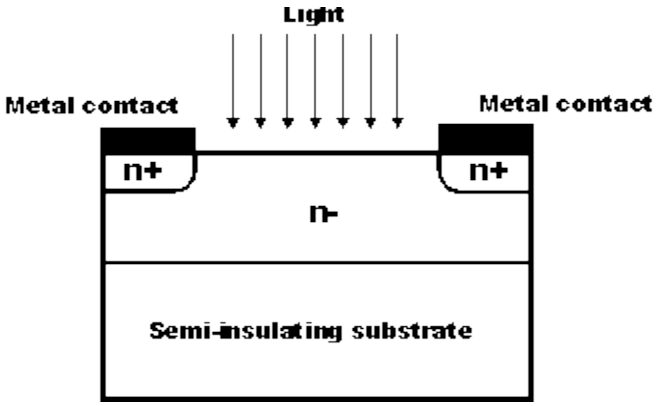


Q.3) Attempt any FOUR of the following: 16

a) Draw and explain construction of LDR. Also explain its working principle. (Diagram -1M; Explanation of construction: 1M; Working principle: 2M)

Ans: LDR

Construction:



Construction:

The structure of a light dependent resistor consists of a light sensitive material which is deposited on an insulating substrate such as ceramic. The material is deposited in zigzag pattern in order to obtain the desired resistance & power rating. This zigzag area separates the metal deposited areas into two regions. Then the ohmic contacts are made on the either sides of the area. Materials normally used are cadmium sulphide, cadmium selenide, lead sulphide, indium antimonide and cadmium sulphonide.

Working Principle:

An LDR works on the principle of photo conductivity, which is an optical phenomenon in which the material's resistivity reduces when the light is absorbed by the material.

When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy is incident on the device more & more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing and hence it is said that the resistance of the device has decreased.

b) Explain the mechanism of zener breakdown in zener diode.
(Diagram: 1M; Explanation: 3M)

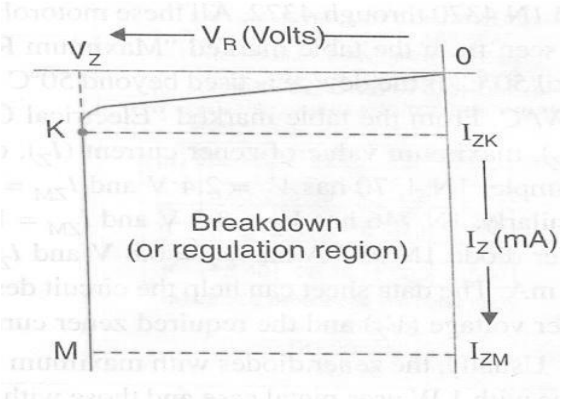
Ans. Zener diode:

The zener diode is a silicon PN junction device, which differs from a rectifier diode. It is operated in the reverse break down region. The breakdown voltage of a zener diode is set by carefully controlling the doping level during manufacture. When a reverse voltage across a diode is increased, a critical voltage called breakdown voltage is reached at which the reverse current increases sharply.

The reverse breakdown of a PN junction may occur either due to avalanche or zener effect.

The zener breakdown occurs when the electric field across the junction, produced due to reverse voltage, is sufficiently high. This electric field exerts a force on the electrons in the outer most shell. This force is so high that the electrons are pulled away from their parent nuclei and become free carriers. This ionization, which occurs due to the

electrostatic force of attraction, is known as zener effect. It causes an increase in the number of free carriers and hence an increase in the reverse current.



c) Draw the construction of n-channel JFET and describe its working.
(Diagram: 1M; Working along with correct diagram:3M)

Ans.

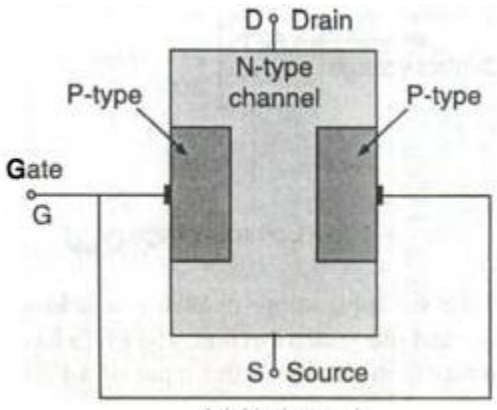
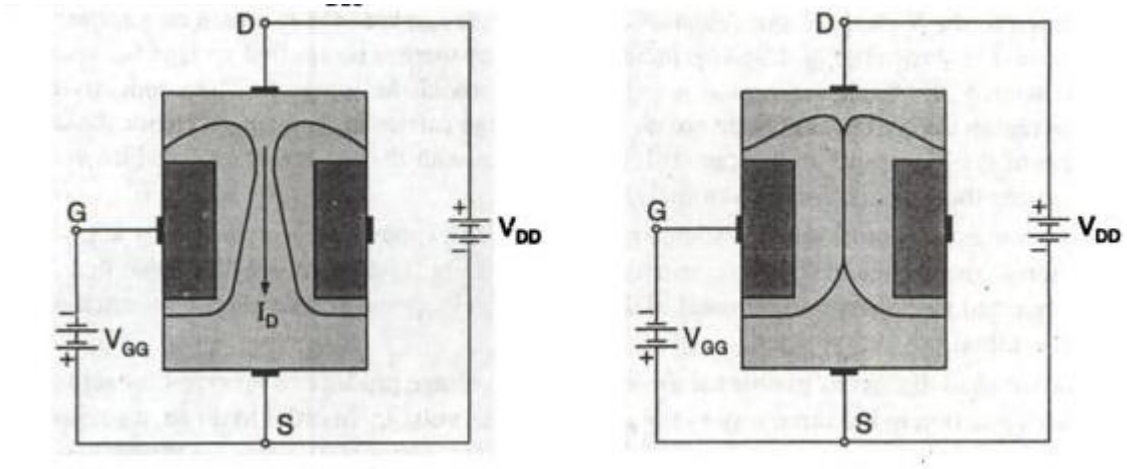


Fig. Construction of JFET

Consider an N-channel JFET as shown in fig. Here the P type Gate and N type channel constitute P-N junction. This P-N junction is always reverse biased in JFET operation. This reverse bias is applied by the voltage VGS. This reverse bias forms a depletion region within the channel when there is no applied voltage between the drain and the source. The depletion layer is symmetrical around the junction

Working:



When voltage is applied between the drain and source with DC supply V_{DS}, electrons flow from source to drain through the narrow channel existing between the depletion regions. This causes a drain current I_D to flow from drain to source. The value of drain current is maximum, when no external voltage is applied between gate and source. This maximum drain current is denoted by I_{DSS}.

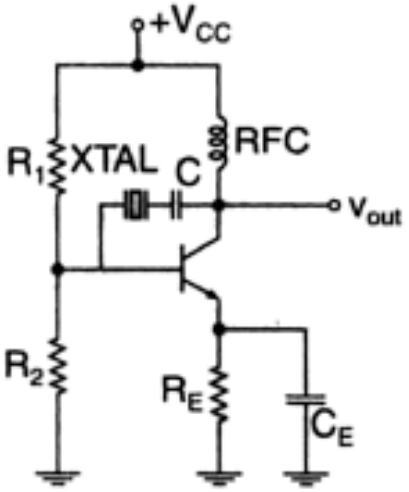
It is observed that the channel is narrower at the drain end. This happens because amount of reverse bias is not same throughout the length of P-N junction.

When the gate to source voltage V_{GS} is increased above zero, the reverse bias voltage across gate to source increases. As a result, the width of the depletion region increases. This reduces the width of the channel and thus controls the drain current I_D. When V_{GS} is increased further, a stage is reached at which two depletion regions touch each other as shown in the fig. This voltage between gate and source at which drain current pinches off is called pinch off voltage and is denoted by V_P

d) Draw and explain circuit diagram of crystal oscillator.
(Diagram: 2M; Explanation: 2M)

Ans.

It uses a piezoelectric crystal as a resonant tank circuit. It is made of quartz and provides a high degree of frequency stability. A quartz crystal has a property known as piezoelectric effect. According to this effect, when an ac voltage is applied across a quartz crystal, it vibrates at the frequency of the applied voltage. Conversely if a mechanical force is applied to the vibrating quartz crystal, then it generates an ac voltage.



The crystal is connected as a series element in the feedback path from collector to base. Resistors R_1, R2, R3 provide voltage divider stabilized dc bias circuit. C_E provides ac bypass from emitter resistor and RFC (Radio Frequency Choke) provides for dc bias while decoupling any ac on the power lines from affecting the output signal.

Capacitor C blocks any dc between collector and base. The oscillators start with noise signal in the circuit. The noise gets amplified and the output is fed back to the base through the crystal.

e) Define current gain and voltage gain. What is the need for multistage amplifiers? (Definitions: 1M each; Need:2M)

Ans.

Current gain: It is the ratio of collector current (i_c) to the base current (i_b). Mathematically, the current gain,

$$A_I = \frac{i_c}{i_b} = \beta$$

Voltage gain: It is the ratio of output voltage ($v_{0)}$ to the input voltage ($v_{in)}$. Since the output voltage is the same as collector voltage and input voltage is the same as base voltage, therefore it is also known as voltage gain from base to collector. Mathematically the voltage gain.

$$A_v = \frac{v_o}{v_{in}}$$

Need of multistage amplifiers:

The output of single stage amplifier is usually insufficient to drive the output device, Gain of the amplifier depends on the device parameters and the circuit components. Hence, there exists an upper limit for gain obtainable from one stage. The gain of single stage is not sufficient for practical applications. The voltage level of a signal can be raised to the desired level by using more than one stages.

f) A transistor has $\beta = 100$. If its collector current $(I_c) = 50$ mA. What is the value of I_B and I_E ?
(Calculation of I_B : 2M; Calculation of I_E : 2M)

Ans. Given; $\beta = 100$; I_C=50mA, I_B=?, I_E=?

Now,

For I_B

$\beta = I_C / I_B$

I_B =50mA /100

I_B = 0.5 mA

We know that,

$I_E = I_B + I_C$

$= 0.5 + 50$

I_E = 50.5 mA

Q.4) Attempt any FOUR of the following: 16

a) Draw and explain V - I characteristics of P – N junction diode.
(Diagram :2M; Explanation:2M)

Ans.

V-I characteristics is a graph between the voltage applied across the terminals of a device and the current that flows through it. This can be divided into two parts namely forward characteristic and reverse characteristic.

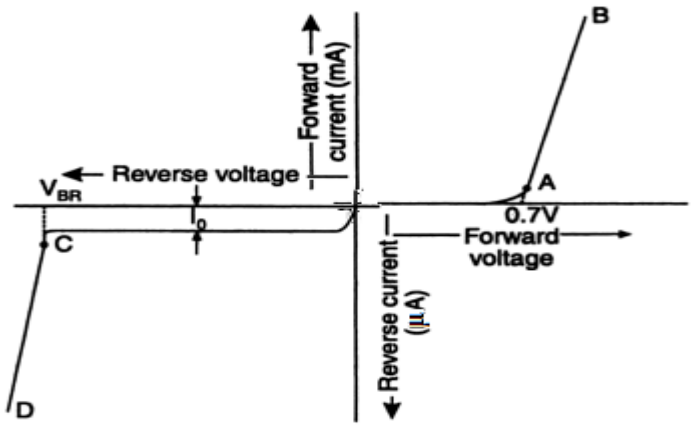


Fig: VI characteristics of PN Junction diode

Forward Characteristics:

There is no diode current till the point A is reached. It is because of the fact, that the external applied voltage is being opposed by the junction voltage, whose value is 0.7 V for silicon and 0.3 V for germanium. However, as the voltage is increased above that of the point A, the diode current increases rapidly.

Reverse Characteristics:

When the applied reverse voltage is below the breakdown voltage(V_{BR}), the diode current is small and remains constant. This value of current is called reverse saturation current (I_oWhen the reverse voltage is increased to a sufficiently large value, the diode reverse current increases as rapidly as shown by the curve *CD* in the figure. The applied reverse voltage, at which this happens, is known as break down voltage (V_{BR}) of a diode.

b) Differentiate between half wave rectifier and centre tapped full wave rectifier. (Four points)
(Any four points – 1M each)

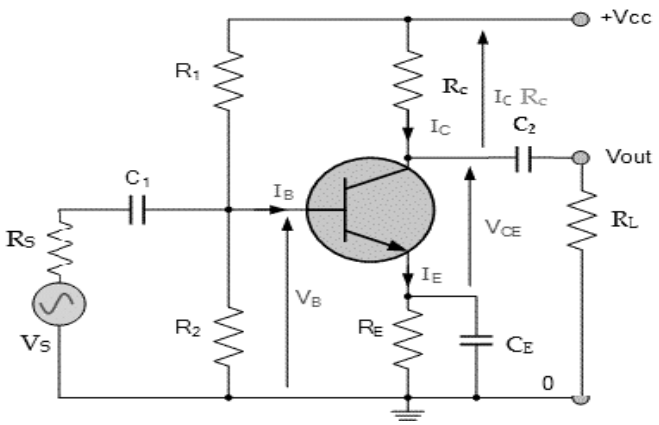
Ans:

Sr.No.	Half wave rectifier	Centre tapped full wave rectifier
1.	It uses only one diode	It uses Two diodes.
2.	Simple transformer is used	Centre tapped transformer is used
3.	It has high ripple factor	It has low ripple factor
4.	It has low rectification	Efficiency is twice that of HWR

	efficiency	
5.	Has less PIV rating for diode (PIV = V_m)	The PIV of a diode is twice that of diodes in HWR. (PIV = 2 V_m)

c) Draw the circuit diagram of single stage CE amplifier.
State functions of each component.
(Diagram:2M; Functions of any four components - ½ M each)

Ans. Single stage CE amplifier



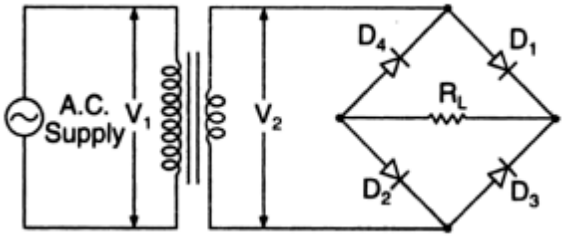
Circuit diagram

- The capacitors C_1 and C_2 are called as coupling capacitors. A coupling capacitor passes ac signal from one side to the other and blocks DC. The capacitor C_1 blocks DC from the input signal Vs. The capacitor C_2 blocks DC from the output of the transistor. These capacitors are used to couple or cascade further stages of amplifier if required.
- The capacitor C_E is called bypass capacitor. It bypasses all ac current from emitter to ground. If this capacitor is not connected, the ac voltage developed across R_E will affect the input ac voltage. Such a feedback of ac signal is reduced by putting capacitor C_E so that gain is not reduced.
- R_L represents the resistance connected at the output as load.
- Resistor R_E provides stabilization to the transistor.
- Resistors R_1 and R_2 are used for proper biasing of the transistor.

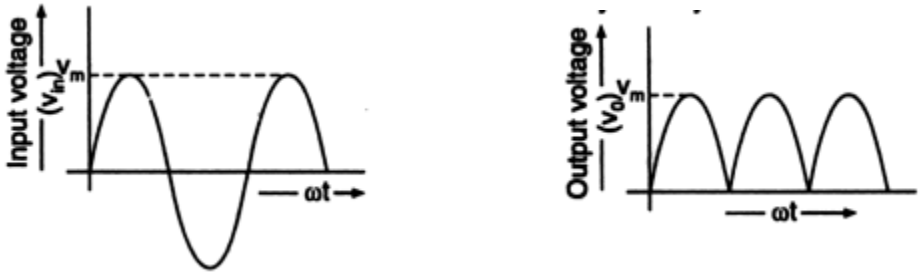
d) Draw circuit diagram of bridge rectifier along with its input and output waveforms.
(Circuit Diagram:2M; Waveforms:2M)

Ans. Bridge Rectifier:

Circuit Diagram:



Waveforms:

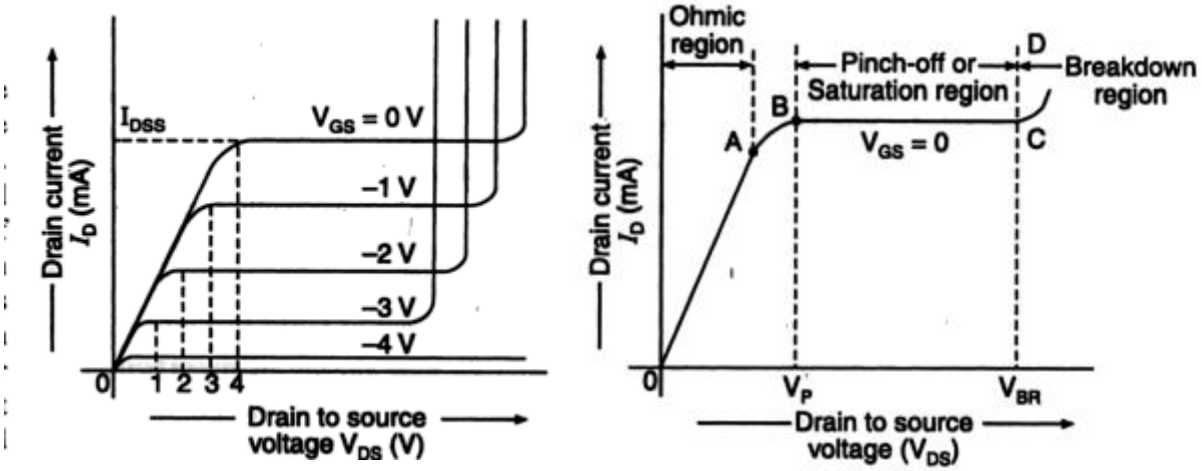


e) Explain drain characteristics of JFET with neat diagram.
(Diagram: 2M; Explanation:2M)

Ans:

Drain characteristics of JFET are shown in fig (a)

These curves give relationship between drain current I_D and drain to source voltage V_{DS} for different values of gate to source voltage (V_{GS})



1. **Ohmic Region:** Shown by curve OA in fig (b). In this region the drain current increases linearly with the increase in drain to source voltage V_{DS}. JFET acts as a simple resistor.
2. **Curve AB:** In this region the drain current increases slowly as compared to that in the Ohmic Region. This is because with increase in drain to source voltage, the drain current increases. This in turn increases the reverse bias voltage across the gate source junction. As a result of this the depletion region grows in size, thereby reducing the effective width of the channel.
3. **Pinch-off Region:** This region shown by BC curve. It is also called saturation Region or constant current region. In this region, the drain current remains constant at its maximum value. The pinch-off region is the normal operating region of JFET, when it is used in an amplifier circuit.
4. **Break down Region:** This region shown by curve CD. In this region the drain current increases rapidly as the drain to source voltage increases. This happens because of break down of gate to source junction due to avalanche breakdown. The drain to source voltage corresponding to point C is called breakdown voltage V_{BR}.

f) Define drain resistance, transconductance, amplification factor and input resistance.
(Each definition -1M)
(Either DC or AC drain resistance can be considered)

Ans. DC Drain Resistance (R_{DS})

It is also called as static or ohmic resistance of the channel. It can be expressed as:

$$R_{DS} = \frac{Vds}{Id}$$

AC Drain Resistance (r_d):

It is also known as the dynamic resistance of the channel. It is the ac resistance between drain to source terminal when JFET is operating in the pinch-off or saturation region.

$$\mathbf{r_d} = \frac{\boldsymbol{\Delta V_{DS}}}{\boldsymbol{\Delta I_D}}$$

Transconductance (g_m) :

It is also known as the forward transconductance (g_m) It is the ratio of small change in drain current to the corresponding change in gate to source voltage.

$g_m = \frac{\Delta I_D}{\Delta V_{GS}}$ keeping V_{DS} constant.

Amplification factor:

Ratio of small change in drain voltage to small change in gate voltage at constant drain current.

$\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}}$ I_D = constant

Input Resistance:
It is the ratio of reverse gate to source V_{GS} to a resulting reverse gate current when the drain to source voltage is zero.

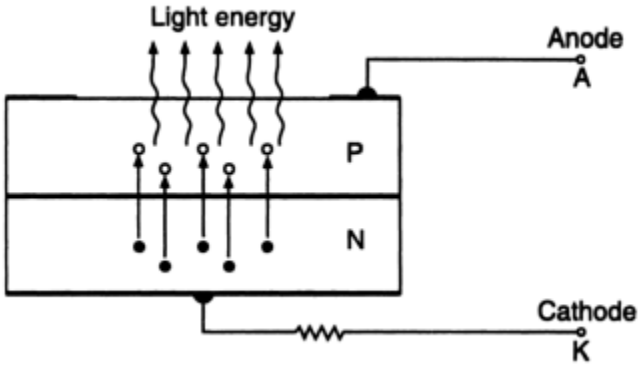
$$Ri = \frac{V_{GS}}{I_{GSS}}$$

Q.5) Attempt any FOUR of the following: 16

a) Explain the operating principle of LED. State any two applications of LED. (Diagram: 1M; Operating Principle:2M; Application (Any two) – 1M)

Ans.

LED:
A PN junction diode, which emits light when forward biased, is known as a Light Emitting Diode (LED). The emitted light may be visible or invisible. The amount of light output is directly proportional to the forward current. Thus, higher the forward current, higher is the light output.



When the LED is forward biased, the electrons and holes move towards the junction and the recombination takes place. After recombination, the electrons, lying in the conduction bands of N region, fall into the holes lying in the valence band of a P region. The difference of energy between the conduction band and valence band of a P region is radiated in the form of light energy. The semiconducting materials used for manufacturing of Light Emitting Diodes are Gallium Phosphide and gallium Arsenide Phosphide. These materials decide the colour of the light emitted by the diode.

Applications of LED :

- In 7 Segment and 16-segment and dot matrix displays, which are used to indicate characters and symbols in various systems like digital clock, ovens etc.
- For indicating ON/OFF conditions in various equipment.
- In optical switching applications
- For video displays
- In Optical communications
- For image sensing circuits
- In burglar alarm systems (sensors)
- White LEDs are used in backlighting in automobile, mobiles and path making lights.
- Used for traffic signal management.
- Used in Fax machines

b) Explain the working of centre tapped full wave rectifier with neat diagram and also draw its input and output waveform.
(Circuit Diagram:1M; Working – 2M; Waveforms -1M)
(Note: Circuit diagram showing operation is optional)

Ans.

Working of Centre tapped Full wave rectifier:

The diagram of centre tapped Full Wave rectifier uses two diodes, which are connected to the center tapped secondary winding of the transformer. The input signal is applied to the primary winding of the transformer. The center tap on the secondary winding is taken as zero voltage reference point. The voltage between the center tap and either end of the secondary winding is half of the secondary voltage.

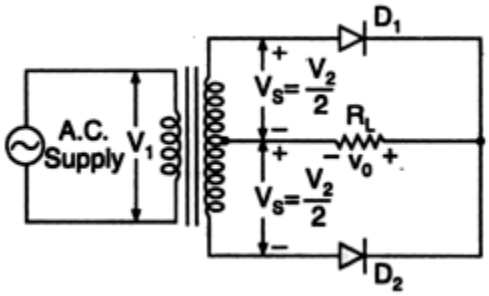


Fig: Centre tapped Full wave rectifier

During the positive input half cycle, the polarities of the secondary voltage as shown in the circuit diagram. This forward biases the Diode D1 and reverse biases D2. Thus Diode D1 conducts whereas, diode D2 is OFF. The current flows through the resistor $R_{L.}$

During the negative input half cycle, the polarities of the secondary voltage as shown in the circuit diagram. This reverse biases the Diode D1 and forward biases D2. Thus Diode D1 is OFF whereas, diode D2 conducts. The current again flows through the resistor R_L in the same direction.

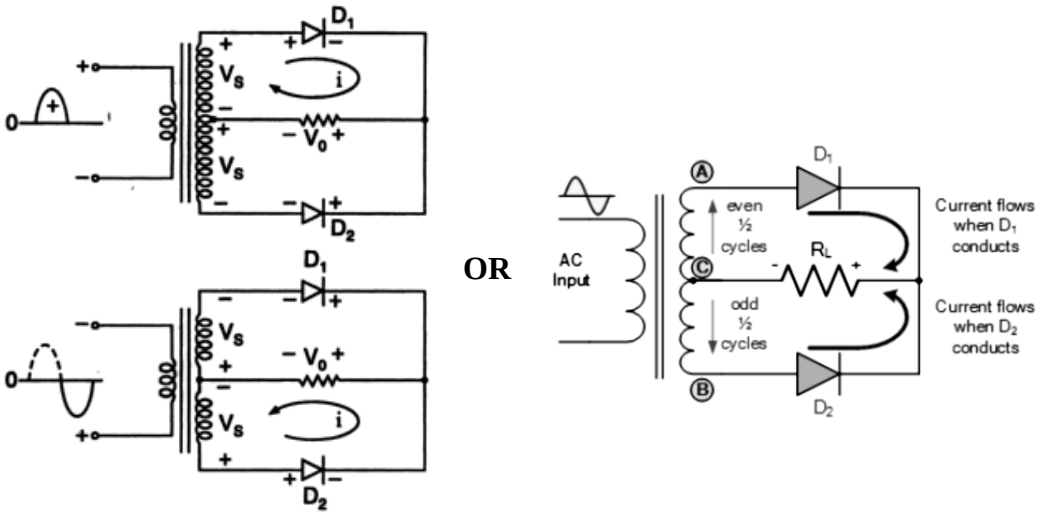
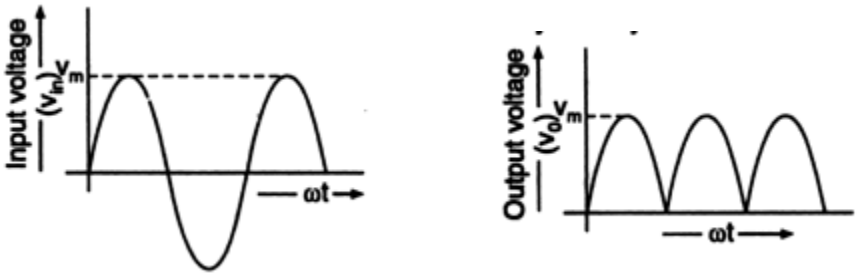


Fig: Circuit operation of Centre tapped Full wave rectifier

Thus during both the half cycles, the current through R_L is in the same direction. Thus the voltage developed at the resistor R_L as output is full-wave rectified as shown in the waveforms given below.

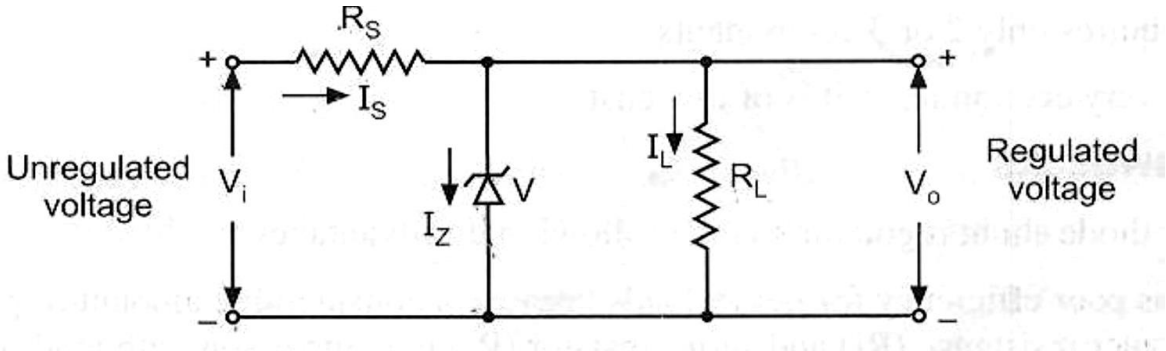
Input and Output Waveforms



c) Explain the working of zener diode as voltage regulator.
(Diagram – 1M; Description 3M)

Ans. Zener diode as voltage regulator

A reverse biased Zener diode is used to provide a constant voltage across the load resister R_L. The voltage regulator circuit diagram showing the Zener diode is as given below.



For proper operation, the input voltage Vi must be greater than the Zener voltage Vz. This ensures that the Zener diode operates in the reverse breakdown condition. The unregulated input voltage Vi is applied to the Zener diode.

Regulation with varying input voltage:

As the input voltage increases, the input current (I_S) increases. This increases the current through Zener Diode, without affecting the load current (I_L). The increase in input current will also increase the voltage drop across R_S and keeps V_L as constant. If the input voltage is deceased, the input current also decreases. As a result, the current through zener will also

decrease. Hence voltage drop across series resistance will be reduced. Thus V_L and I_L remains constant.

Regulation with varying load resistance:

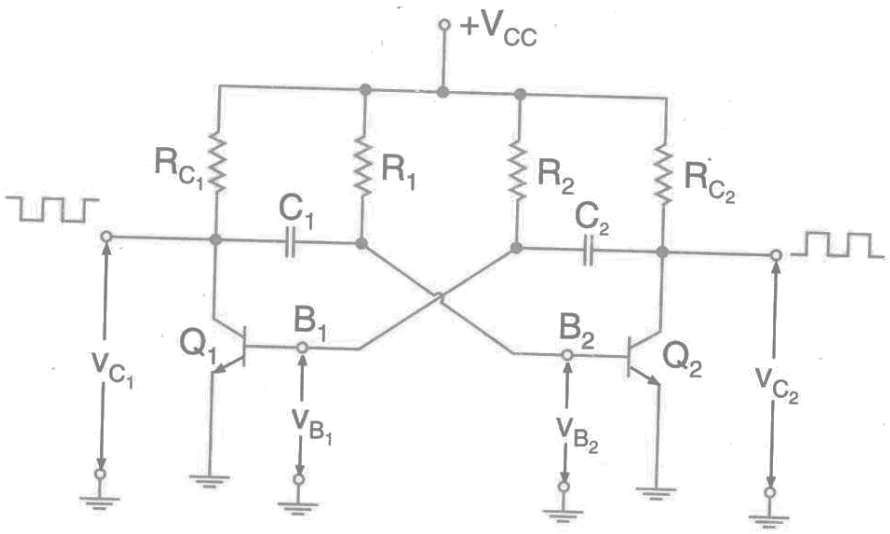
The variation in the load resistance R_L changes I_L, thereby changing V_L. When load resistance decreases, the load current increases. This causes zener current to decrease. As a result, the input current and voltage drop across R_S remains constant. Thus, the load voltage V_L is also kept constant.

On the other hand, When load resistance increases, the load current decreases. This causes zener current to increase. This again keeps the input current and voltage drop across R_S constant. Thus, the load voltage V_L is also kept constant.

Thus, a Zener diode acts as a voltage regulator and the fixed voltage is maintained across the load resistor R_L.

d) Draw the circuit of astable multivibrator using transistor. State its two applications. (Diagram – 2M; Applications (Any two) – 2M)

Ans. Circuit diagram of Astable Multivibrator using transistor:



Applications:

1. Square wave generators
2. Voltage to frequency converters
3. Pulse Synchronization
4. As clock for binary logic signals

e) Draw and explain V- I charactristics of schotkky diode.
(V-I characteristics diagram- 2M; Description – 2M)

Ans. Schottky diode VI characteristics:

The fig. below shows the characteristics of Schottky diode. When forward biased, it has a lower forward voltage drop of about 0.25 V (V_F) when compared to PN junction diode. Under reverse biased condition, it has lower reverse breakdown voltage (V_{BR}) than PN junction diode (around -50V). This diode is used in higher frequencies and for higher switching time requirements.

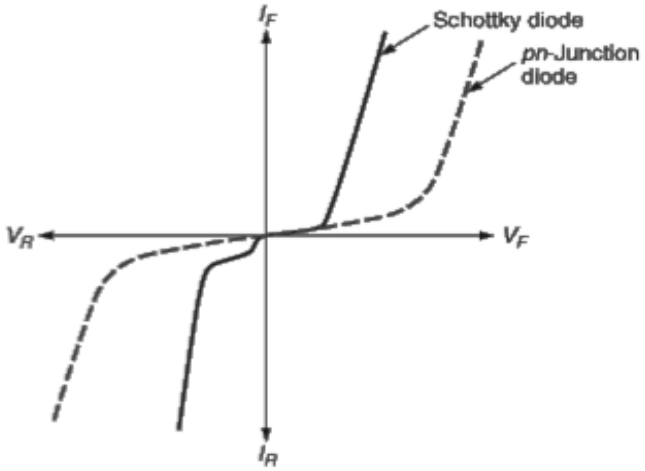


Fig: Schottky Diode Characteristics

f) Draw and explain transformer coupled amplifier with its frequency response.
(Circuit Diagram: 1M; explanation: 2M; frequency response: 1M)

Ans. Transformer coupled amplifier:

The figure below shows the circuit diagram of two-stage transformer coupled amplifier. Here, The transformer T_1 is used to couple the ac output signal from the output of the first stage to the input of the second stage, while the transformer T_2 is used to couple the output signal to the load. The AC signal developed across the primary winding induces the AC signal in the secondary winding which couples this AC signal to the base of the next stage. C_1 and C_E are used as coupling and bypass capacitors.

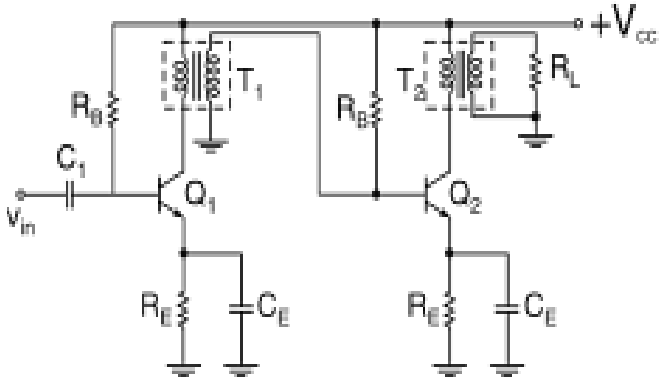


Fig: Transformer coupled amplifier

OR

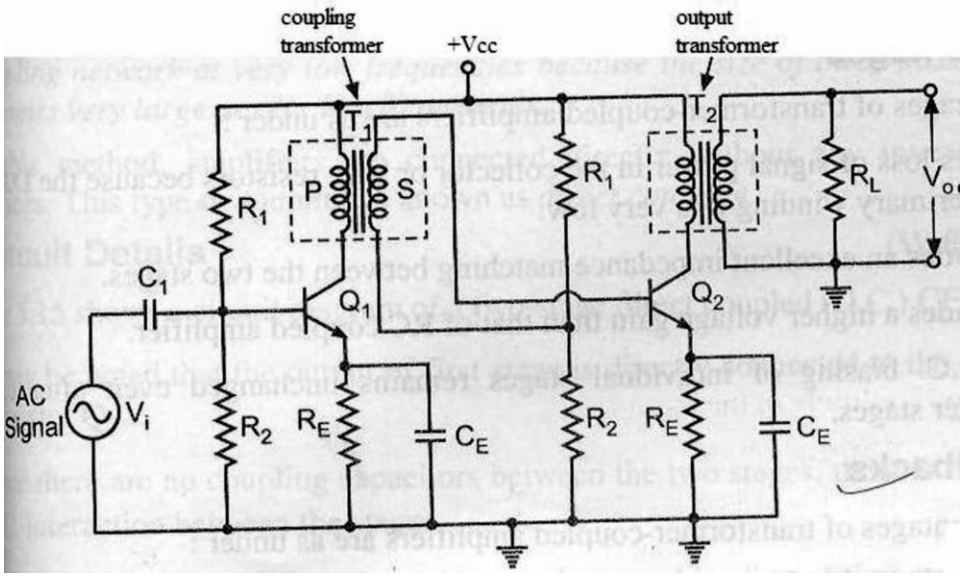


Fig: Transformer coupled amplifier

Frequency Response:

The voltage gain drops off at low as well as at high frequencies whereas it remains constant in mid frequency range. And at one particular frequency f_0, the voltage gain increases and then rolls off continuously.

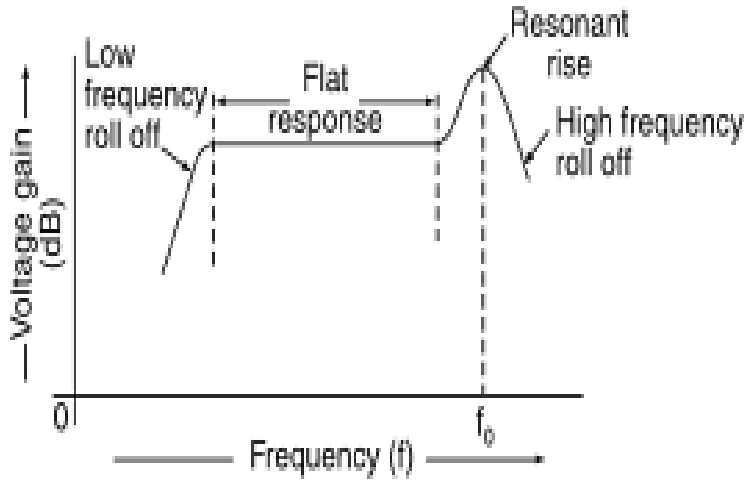


Fig. Frequency Response

Q.6) Attempt any FOUR of the following: 16

a) Differentiate between P – N junction diode and zener diode. (Any fouir points)
(Any four points – 1M each)

Ans.

Sr. No.	PN Junction Diode	Zener Diode
1	It is not properly doped to control reverse breakdown.	It is properly doped to control reverse breakdown.
2	It conducts only in one direction	It conducts in both directions
3	It is always operated in forward-bias condition.	It is always operated in reverse-bias condition.
4	It has no sharp reverse breakdown.	It has quite sharp reverse breakdown.
5	It burns immediately, if applied voltage exceeds the breakdown voltage.	It will not burn, but functions properly in breakdown region.
6	It is commonly used for rectification purpose.	It cannot be used for rectification, but commonly used for voltage regulation

b) Draw block diagram of regulated power supply. Draw output voltage waveforms at each block.
(Block diagram- 2M; Voltage waveforms – 2M)
(Note: Waveforms at the output of each stage separately can also be considered)

Ans. Block diagram of Regulated Power Supply with voltage waveforms:

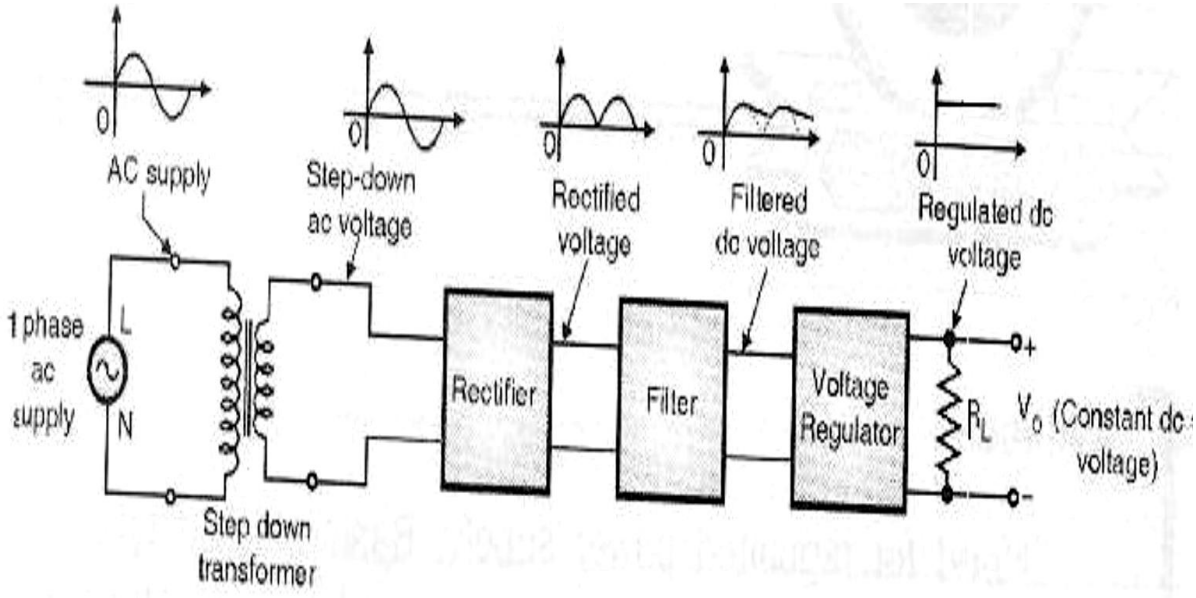


Fig: Regulated Supply with waveforms

c) Draw circuit diagram of voltage divider biasing circuit and state its two advantages.
(Circuit Diagram: 2M; Advantages (any two): 2M)

Ans. Voltage Divider bias (Self Bias):

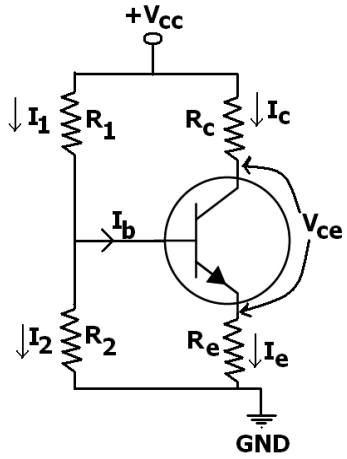


Fig: Circuit Diagram of Voltage Divider Bias

Advantages:

- The circuit operation is independent of the transistor current gain β.
- The resistors help to give complete control over the voltage and current.
- The emitter resistor, R_e, allows for stability of the gain of the transistor, despite fluctuations in the β values.
- Operating point stabilized against shift in temperature.
- Operating point is almost independent of β variation.

d) State and explain Barkhausen's criteria for oscillator.
(Two criteria statements –1M each; Explanation 2M)

Ans.

Barkhausen's criteria:

1. Loop gain (β.Av) should be ≥ 1.
2. Phase shift between the input and output signal must be equal to 360^0 or 0^0.

Explanation:

In a feedback amplifier, a part of the output is fed back to the input in proper phase and magnitude such that the effect of feedback increases the input signal. This is called Positive feedback.

Considering such an amplifier with positive feedback the overall voltage gain can be defined as

$$A'_v = \frac{Av}{1-\beta Av}$$

Where,

A_v = Gain of an amplifier without feedback (open loop gain)

βA_v = loop gain (product of feedback fraction and open loop gain.

First Condition:

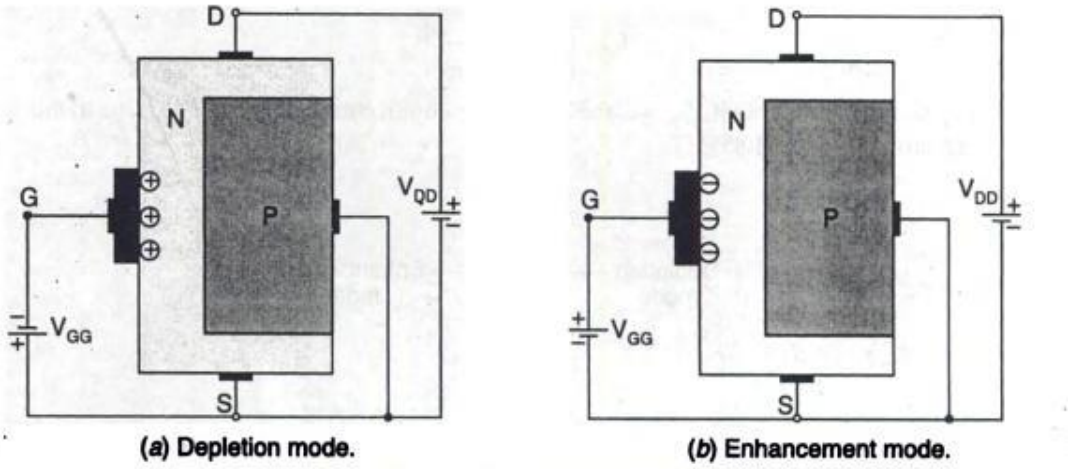
If $\beta . A_v = 1$, Then denominator becomes zero, which indicates that the gain is infinity. But, the output of the feedback amplifier cannot be infinite. Therefore the condition ($1 - \beta A_V = 0$) represents that there will be an output voltage, whose frequency is completely different from the input signal. Thus the circuit will start oscillating and not amplifying.

Second Condition:

An amplifier reverses the phase of an input signal at its output. Thus the amplifier causes a phase shift of 180^0 between the input and output signals. In order to provide positive feedback, the feedback network should provide a phase shift of 180^0, so as to provide a signal with a phase shift of 360^0 or 0^0 at the amplifier input.

e) Explain the working principle and MOSFET with a suitable diagram.
(Diagram – 2M; Explanation:2M)
(Note: Depletion type or Enhancement type can be considered; also N-channel or P-channel can be considered)

Ans. N-CHANNEL DEPLETION TYPE MOSFET



Basic Operation

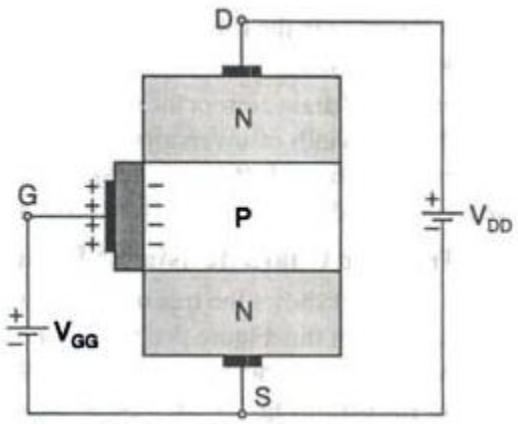
This MOSFET can be operated in two different modes, namely, Depletion Mode and Enhancement Mode.

In depletion Mode, MOSFET is with negative gate to source voltage. The negative voltage on the gate induces a positive charge in the channel. Due to this, free electrons in the vicinity of positive charge are repelled away in the channel. Thus, the channel is depleted of free electrons, reducing the number of free electrons that are passing through the channel. Thus, negative gate to source voltage is increased and the value of drain voltage V_{GS} is totally depleted of free electrons and hence drain current reduces to zero.

In Enhancement mode, a positive gate to source voltage is applied. The positive gate voltage increases the number of free electrons passing through the channel. The greater the gate voltage, greater is the number of free electrons passing through the channel. This enhances the conducting of the channel.

OR

N-CHANNEL ENHANCEMENT- TYPE MOSFET



Working:

When V_{GS} is set at 0V and a voltage is applied between the drain and source, no current flows due to the absence of an N-channel. By keeping V_{DS} at some positive voltage and when V_{GS} is increased, the positive potential at the gate will push the holes (since like charges repel) in the P-substrate along the edge of the SiO_2 layer. The result is a depletion region near the SiO_2 insulating layer void of holes.

However, the electrons in the P-substrate (the minority carriers of the material) will be attracted to the positive gate and accumulate in the region near the surface of the SiO_2 layer. This is called Inversion layer.

As V_{GS} increases in magnitude, the concentration of electrons near the SiO_2 surface increases, until eventually, the induced N-type region can support a measurable flow between drain and source.

f) An ac supply of 230 V is applied to half wave rectifier circuit through transformer of turns ratio 2:1.
Calculate:
(i) DC output voltage and
(ii) PIV of a diode.
(DC output voltage -3M; PIV of a Diode – 1M)

Ans.

Given :

$V_{in} = V_1 = 230V$

Transformer ratio =2:1 = $\frac{N_2}{N_1} = \frac{1}{2}$

Dc output voltage:

We know that secondary voltage

$V_2 = \frac{N_2}{N_1}$ X V1

$= \frac{1}{2}$ X 230 = 115V

Maximum value of secondary voltage

$V_m = \sqrt{2}$ x V_2

$= \sqrt{2}$ x 115V

= 162.6 volts

Therefore, DC voltage **[Note: $V_{dc} = 0.318$ X V_m may also be considered]**

$\mathbf{V_{dc}} = \frac{V_M}{\pi} = \frac{162.6}{3.14}$ = **51.8 volts**

PIV of diode:

For half Wave rectifier,

PIV of diode = Vm= **162.6 volts**