Summer 2015 Examination

Subject Code: **17319** **Model Answer**

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.

1. A) Attempt any six: **12**

a. State any four applications of transistor.

Ans a. **Any four applications: 2M**

Four application of transistor are:

1. As a switch
2. As an amplifier
3. As a multivibrator
4. As an oscillator
5. As a timer circuit etc.

b. Define transistor. Explain why an ordinary junction transistor is called a bipolar device?

Ans b. **Any relevant correct definition: 1M, Explaination:1M**

The two pn - junction formed by sandwiching either p- type or n- type semiconductor between a pair of opposite types is known as transistor.

(OR)

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power.

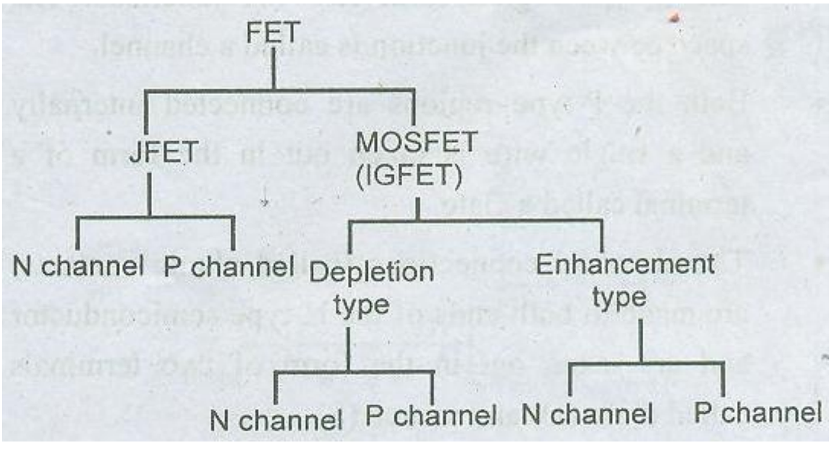
(OR)

An electronic device that can work as an amplifier, transforming weak electrical signals into strong ones. It is normally made from silicon or other semiconductors.

In ordinary transistor, the current conduction is done by both the electrons and holes so it is known as bipolar transistor.

c. Give the classification of FET.

Ans c. **Classification- 2M**



d. What are different types of amplifier coupling?

Ans d. **Different Types: 2M**

The different types of cascading (coupling) are as follows:

1. R-C coupled amplifier
2. Transformer coupled amplifier
3. Direct coupled amplifier

e. State the meaning of small signal amplifier. List two application of it.

Ans e. **Meaning:1M; Two application:1M**

- When the input signal is so weak so as to produce small fluctuation in the collector current as compared to its quiescent value, the amplifier is called small signal amplifier (also voltage amplifier).
- Such an amplifier is used as the first stage of the amplifier used in receivers (radio & TV), tape recorder, stereo and measuring instruments

f. What is the effect of negative feedback on the performance of amplifier?

Ans f. **Any four points:2M**

Negative feedback is used in an amplifier because of following reason:

1. Increased stability
2. Increased bandwidth
3. Decreased noise
4. Less phase distortion.

g. State the need of regulator.

Ans g. **Need of regulator: 2M**

- The expensive electronic instruments cannot use the unregulated dc power supply because the output contains ripples and its content in output will increase with increase in load current.
- Hence, the output voltage also does not remain constant.
- So to get a constant output voltage in spite of changes in input voltage, temperature, load current we need the voltage regulator.

h. State the function of comparator or error amplifier in series voltage regulator.

Ans h. **Correct answer:2M**

- In series of voltage regulator the transistor Q_1 also acts as comparator or error amplifier.
- The transistor acts as a variable resistance whose value is determined by the amount of base current. If load resistance increases the load current decreases and load voltage tends to increase.
- The increase in load voltage decreases V_{BE} which in turn increase V_{CE}.
- The base voltage of transistor Q_1 is held to a relatively constant voltage across the zener diode.

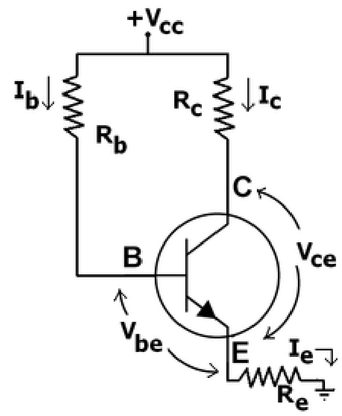
B) Attempt any TWO: 8

a. What are the requirements of transistor biasing? Draw the circuit diagram of base biased with emitter feedback.

Ans a. **Requirements: 2M; Diagram: 2M**

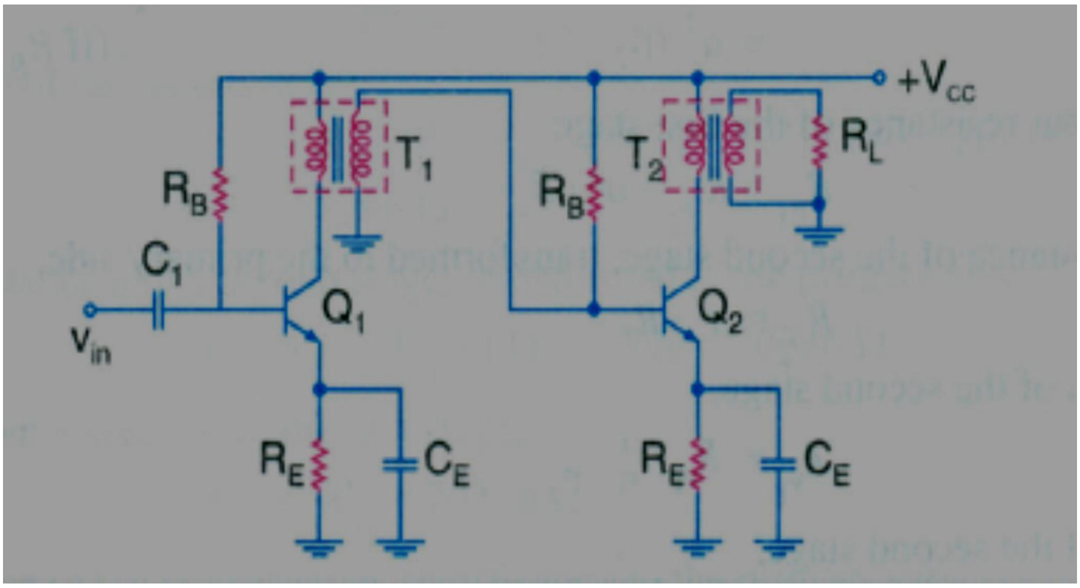
Requirements of transistor biasing:

- Position of a Q point
- Value of I_C at quiescent point(Q point)
- Value of every stability factor should be as low as possible.
- Transistor should be biased in the linear portion of transfer characteristics.
- Forward bias the B-E junction and reverse bias C-B junction to bias the transistor in active region.
- Maximum output swing without producing any distortion.



b. Draw the circuit diagram of two stage transformer coupled amplifier and explain function of each component.

Ans b. **Circuit Diagram:2M; Function:2M**



The circuit consists of two single stage common emitter transistor amplifiers. The function of transformer *(T1)* is to couple the a.c. output signal from the output of the first stage to the input of the second stage, while transformer *(T2)* couple output signal to the load. The input coupling capacitor is C1, while the emitter bypass capacitors C*E'*

The operation of the above circuit may be understood from the condition that when an a.c. input signal is applied to the base transistor Q_1' it appears in the amplified form across primary winding of the transformer *(T1).* The voltage developed across the primary winding is then transferred to input of the next stage by the secondary winding of the transformer *(T_1).* The second stage does amplification an exactly similar manner.

In actual practice. a bypass capacitor is used on the bottom of each primary winding to produce

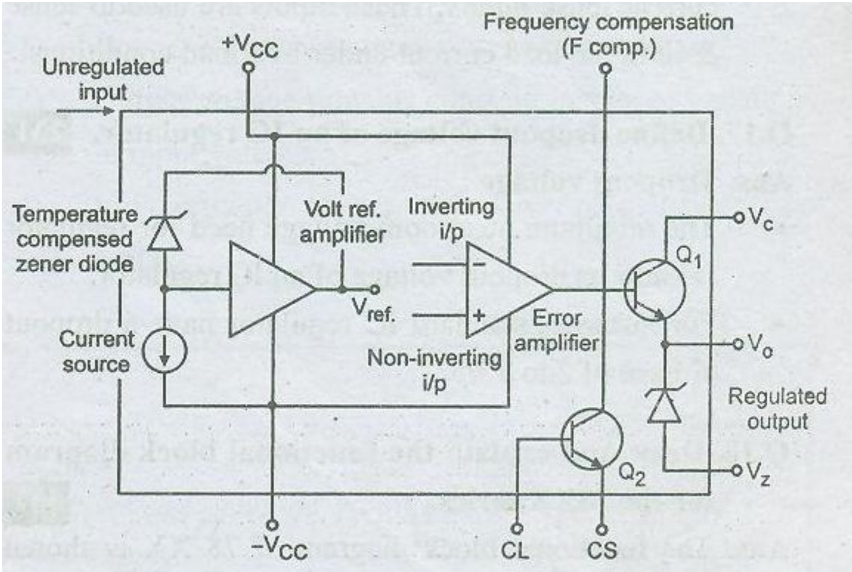
an a.c. ground. This avoids the load inductance of the connecting line that returns to the d.c. supply point.

Similarly, a bypass capacitor is used on the bottom of each secondary winding to get an a.c.

This prevents the signal power loss in the biasing resistors.

c. Draw the functional block diagram of IC 723. Give any four important features of IC 723.

Ans c. **Block Diagram:2M; Any four features:2M**



Features of IC 723 are as follows:

1. Unregulated dc supply
2. Maximum load current.
3. Built in short circuit protection
4. Very low temperature drift.
5. High ripple rejection.

2. Attempt any FOUR: 16

a. Compare the following biasing method of transistor in detail:

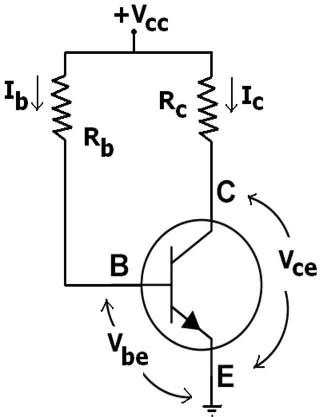
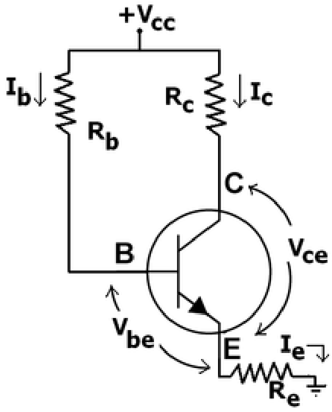
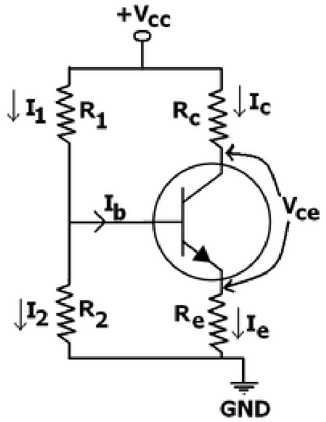
i. Base resistor method.

ii. Feedback resistor method.

iii. Voltage divider method.

on stability and circuit diagram.

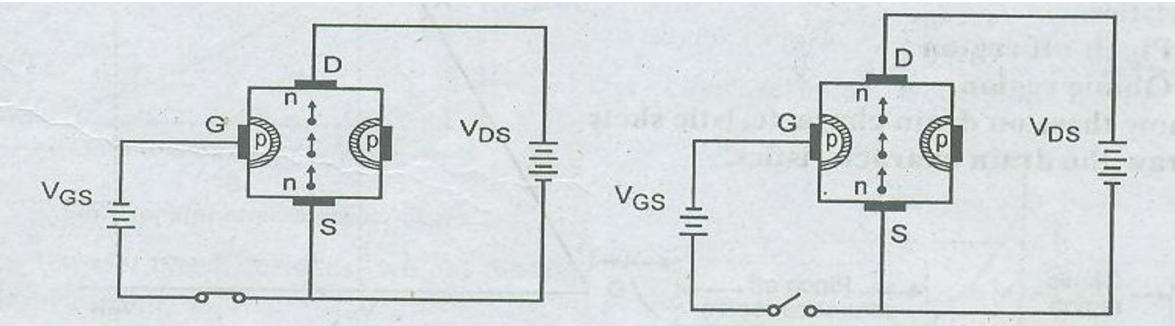
Ans a. **Both correct points: 2 Marks each**

Sr.No	Base resistor Method	Feedback resistor method	Voltage divider method
1	Stability factor is high	Stability factor is less than base resistor method	Stability factor is less
2			

b. Describe the working principle of n- channel JFET with diagram.

Ans b. **Working Principle: 2M; Diagram: 2M**

- When a voltage V_{DS} is applied between drain and source terminal and voltage on the gate is zero as shown in figure, the two pn- junction at the sides of the bar establish depletion layers.
- The electrons will flow from source to drain through a channel between the depletion layers. The size of these layers determines the width of the channel and hence the current conduction through the bar.
- When a reverse voltage V_{GS} is applied between the gate able source in figure (2) the width of the depletion layers is increased.
- This reduces the width of conducting channel thereby increasing the resistance of n type bar consequently the current from the source to drain is decreased.
- It is clear from the above discussion that current from source to drain can be controlled by the application of potential (i.e. electric field) on the gate for this reason the device is called as field effect transistor.



c. State the advantages and disadvantages of direct coupled amplifier.

Ans c. **Advantages:2M; Disadvantages:2M**

Advantages of direct coupled amplifier are:

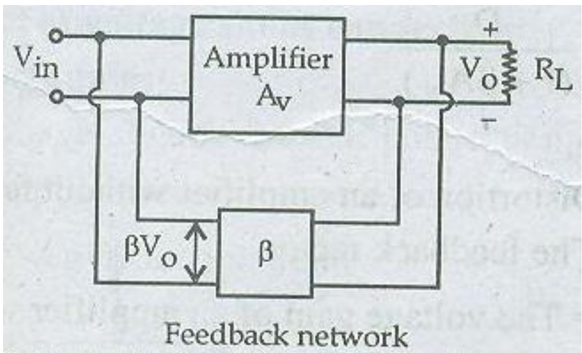
- The circuit cost is low.
- The circuit arrangement is very simple.
- It can amplify very low frequency signals down to zero frequency.

Disadvantages of direct coupled amplifier are:

- It has a poor temperature stability.
- It cannot amplify high frequency signal.

d. Draw the block diagram of voltage shunt negative feedback. Write its effect on voltage gain, bandwidth.

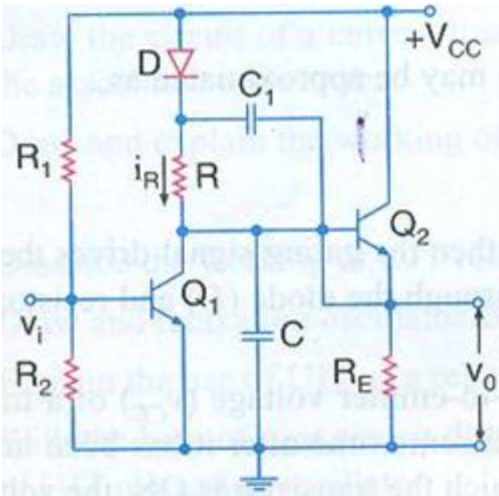
Ans d. **Block diagram:2M; Effect:2M**



- Voltage Gain decreases and bandwidth increases

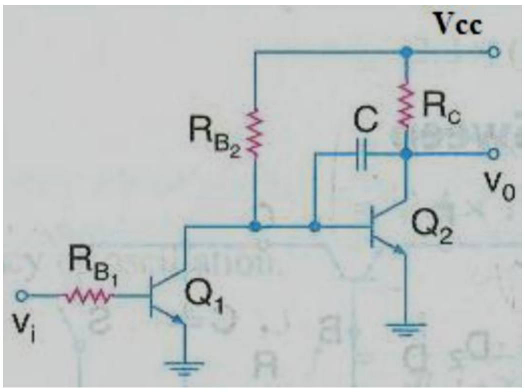
e. Draw the circuit diagram of voltage time base generator and describe its working.
Ans e. **Circuit diagram: 2M ; Working:2M**
Note: Voltage based time base generators are both Miller Weep and Bootstrap. Any one type diagram with explanation should be considered

Fig. (a) Below shows a practical form of bootstrap circuit. Here transistor Q1 acts as a switch and transistor Q2 acts as an emitter follower (i.e. a unit gain amplifier).



- Initially transistor Q1 is ON and Q2 is OFF. Therefore capacitor C1 is charged to VCC through the diode forward resistance (RF). At this instance output voltage is zero.
- When negative pulse is applied to the base of transistor Q1, it turns OFF. Since Q2 is an emitter follower, therefore the output voltage V0 is same as base voltage of Q2.
- Thus when Q1 turns OFF, the capacitor C1 starts charging this capacitor C through resistor (R). As a result of these both the base voltage of Q2 and output voltage begins to increase from zero.
- As the output voltage increases diode D becomes reverse biased, because of the fact that the output voltage is coupled through the capacitor (C1) to the diode.
- Since the value of capacitor (C1) is much larger than that of capacitor (C), therefore the voltage across capacitor (C1) practically remains constant.
- Thus voltage drop across resistor (R) and hence current (IR) remains constant, means capacitor C is charged with constant current.
- This causes voltage across capacitor C (and hence the output voltage) to increase linearly with time.
- The circuit pulls itself by its own bootstrap and hence it is known as bootstrap sweep circuit.

(OR)



A pulse of negative polarity is applied at the base of the transistor Q_1. As a result of this, the emitter base junction of the transistor Q_1 is reverse biased and it turns OFF. This causes the transistor Q_2 to turn ON. As the transistor Q_2 conducts, the output voltage begins to decrease towards zero. Since the capacitor is coupled to the base of the transistor Q_2 therefore the rate of decrease of the output voltage is controlled by the rate of discharge of capacitor. The time constant of the discharge is given by the relation.

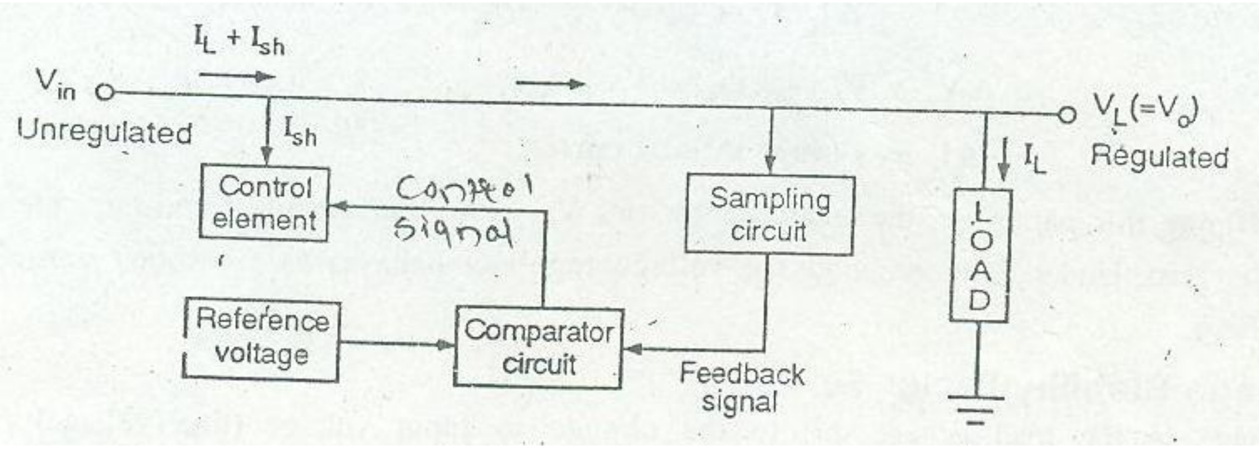
$\tau = R_B C$

Since the value of time constant is very large therefore the discharge current practically remains constant. As the result of this, the run-down of the collector voltage is linear. When the input pulse is removed the transistor Q_1 turn ON and Q_2 turns OFF. It will be interesting to know that as the transistor Q_1 turns OFF, the capacitor charges quickly, through resistor R_C to V_{CC} with a time constant equal to $R_C C$. The waveform of the generated sweep or the output voltage.

It may be noted from the circuit that we have shown only one stage of amplification. But in actual practice more than one stage of amplification is used. Usually, the amplifier stage uses emitter followers at the input and output to increase the low frequency input and output resistances. Sometimes the resistor R_C in the Miller sweep circuit is replaced by a diode. The diode forward resistance helps the capacitor to charge quickly from V_{CC}. This reduces the flyback time of generated sweep. The Miller sweep circuit provides an excellent sweep linearity as compared to other sweep circuits.

f. Draw block diagram of shunt voltage regulator and describe working of each block.

Ans f. **Block Diagram:2M; Working:2M**



The heart of any voltage regulator circuit is a control element. If such control element is connected in shunt with the load, the regulator circuit is called as shunt voltage regulator.

The regulated input voltage V_{in} tries to provide the load current. But part of the current is taken by the control element to maintain the constant voltage across the load. If there is any change in the load voltage the sampling circuit provides a feedback signal to the comparator circuit.

The comparator circuit compares the feedback signal with the reference voltage and generates a control signal which decides the amount of current required to be shunted to keep the load voltage constant.

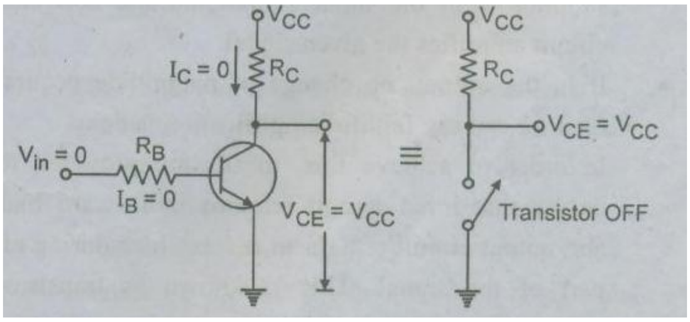
For example if load voltage increases then comparator circuit decides the control signal based on the feedback information, which draws increased shunt current I_{sh}. Due to this, the load current I_L decreases and hence the load voltage decreases to its normal value. Thus control element maintains the constant output voltage by shunting the current, hence the regulator circuit is called as voltage shunt regulator circuit.

3. Attempt any FOUR: **16**

a. Describe the working of transistor as a switch and give the application of it.

Ans a. **Working:2M; Application:2M**

Transistor as a switch:

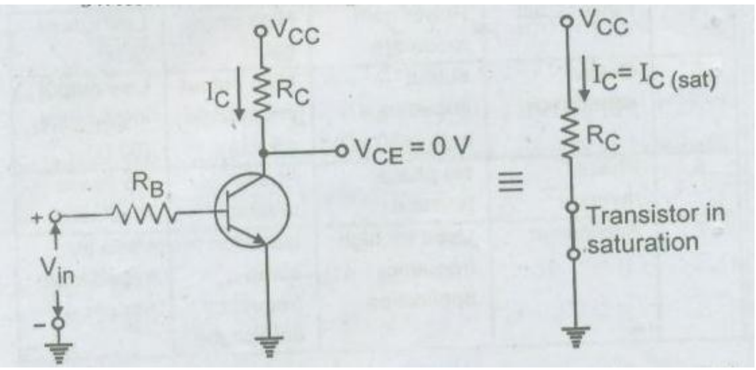


- The transistor can be used for two types of application viz. amplification and switching. For the amplification as a transistor is biased in its active region.
- Whereas for switching applications it is biased to operate in the saturation (full on) or cut off (full off) region.

a. Transistor in cut- off region (open switch):

- In the cut –off region both the junction of a transistor are reverse biased and very small reverse current flows through the transistors.
- The voltage drop across the transistor (V_{CE}) is high. Thus, in the cut off region the transistor is equivalent to an open switch as shown in figure.

Transistor in the saturation region:



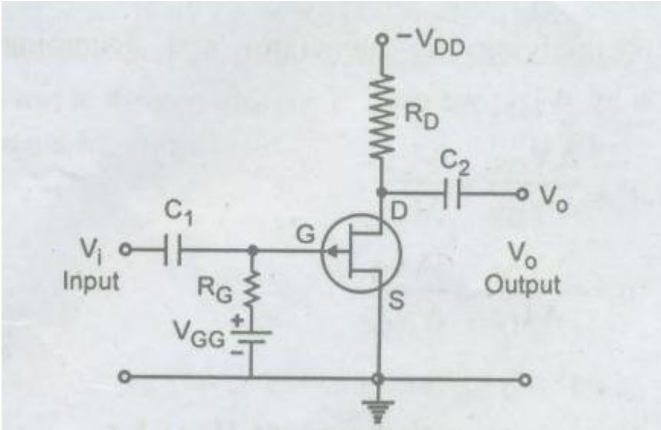
- When V_{in} is positive a large base current flows and transistor saturates.
- In the saturation region both the junctions of a transistor are forward biased. The voltage drop across the transistor (V_{CE}) is very small, of the order of 0.2 V to 1V depending on the type of transistor and collector current is very large.
- In saturation the transistor is equivalent to a closed switch.

Applications of transistor as a switch:

1. In the logic circuit.
2. Temperature control.
3. Chopper circuits used for dc motor speed control.
4. Inverters for ac motor control.
5. SMPS & UPS.

b. How P- channel JFET is used as an amplifier?

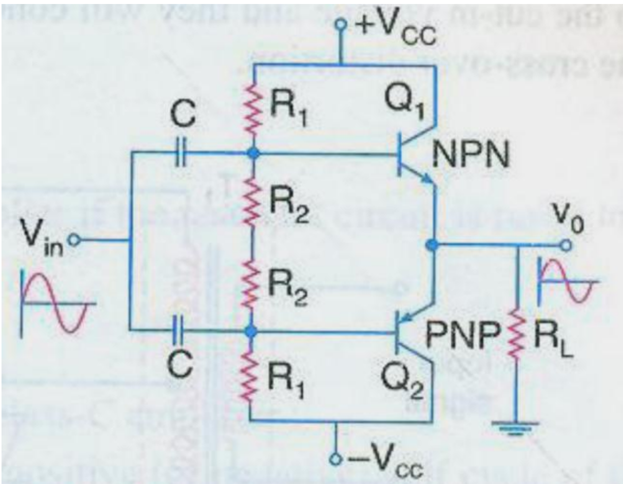
Ans b. **Diagram:2M; explaination:2M**



- Let an input ac signal is applied at the input of a CS JFET amplifier.
- During positive half cycle of the input signal, the reverse bias across the gate to source junction decreases.
- As a result of this, the gate current increases and hence the drain current also increases. This produces the larger voltage drop across the drain resistor R_D.
- During the negative half cycle of the input signal, the reverse bias across the gate to source voltage increases and makes the gate more negative.
- Due to this, the gate current decreases and hence the drain current also decreases. This decreased drain current produces the decreased output voltage across the resistor R_D in the opposite direction. Hence, an amplified output is obtained across the load R_D.
- It may be noted that a small ac signal at the input produces a large ac signal at the output. Thus, JFET acts as a basic voltage amplifier.

c. Draw the diagram of class B push pull amplifier and explain its working.

Ans c. **Diagram:2M; Working:2M**



- Figure shows the class – B push – pull amplifier which does not require an input transformer or an output transformer.
- This arrangement uses transistors having complementary symmetry in the emitter follower configuration.
- When the input signal is zero, none of the transistors conducts. Thus, the output voltage is zero.
- During the positive input half cycle, Q_1 conducts and Q_2 is OFF. Similarly, during the negative input half – cycle, Q_1 is OFF and Q_2 conducts.

- This amplifier has a unity gain because of the emitter follower configuration. Moreover, there is no phase inversion of the output signal.
- The split supply used in the circuit gives the advantage that the d.c. component of output voltage can be zero. Thus only ac component of the power is available across the load resistor (R_L).

d. In a single stage voltage amplifier, voltage gain without feedback is 80, input resistance (R_i) =800Ω and output resistance (R_o) is 8KΩ. If 20% output voltage is feedback in series with input, determine A_{vf}, R_{if} and R_{of} of the negative feedback amplifier.

Ans d. **Correct Solution:4M**

Ans:-

Given : $A_v = 80$, $R_i = 800\Omega$, $R_o = 8K\Omega$

To find : $A_{vf} = ?$, $R_{if} = ?$, $R_{of} = ?$

Sol^n: If 20% output voltage is feedback, then

$V_f = 0.2 V_o$

feedback factor $\beta = \frac{V_f}{V_o} = \frac{0.2 V_o}{V_o} = 0.2$

In voltage series, feedback amplifier gain reduces by factor $(1+\beta A_v)$

$\therefore A_{vf} = \frac{A_v}{(1+\beta A_v)} = \frac{80}{(1+\beta A_v)} = \frac{80}{(1+0.2\times 80)} = 4.7$

$\therefore A_{vf} = 4.7$

In voltage series feedback amplifier input resistance increases by factor $(1+\beta A_v)$

$R_{if} = R_i(1+\beta A_v)$

$= 800(1+0.2\times 80)$

$\therefore R_{if} = 13.6 K\Omega$

Output resistance will be decreased by factor $(1+\beta A_v)$

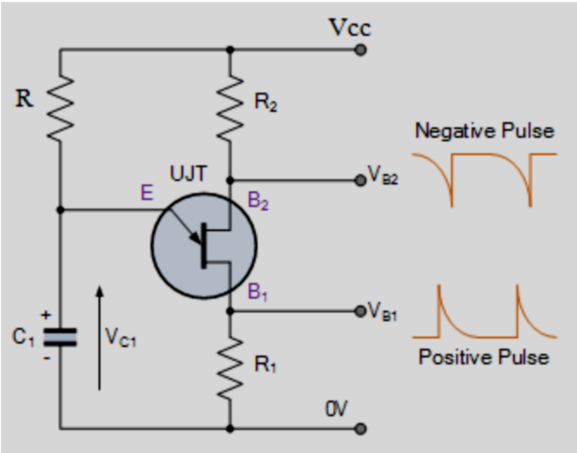
$\therefore R_{of} = \frac{R_o}{(1+\beta A_v)} = \frac{8\times 10^3}{(1+(0.2\times 80))}$

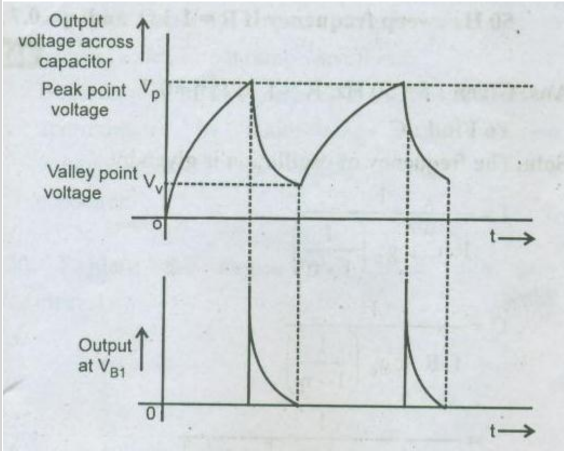
$\therefore R_{of} = 470.58\Omega$

e. Describe UJT as a relaxation oscillator with circuit diagram and waveform.

Ans e. **(circuit diagram – 2 marks, explanation – 1 mark, waveform – 1 mark)**

Diagram:





When the supply voltage (VCC) is switched ON, the capacitor charges through resistor (R), till the capacitor voltage reaches the voltage level (VP) which is called as peak point voltage. At this voltage the UJT turns ON.

As a result of this, the capacitor (C) discharges rapidly through resistor (R1). When that capacitor voltage drops to level Vv (called valley- point voltage) the uni-junction transistor switches OFF allowing the capacitor (C) to gain again.

In this way because of the charging and discharging of capacitor the exponential sweep voltage will be obtained at the emitter terminal of UJT. The voltage developed at base 1(V_{B1}) terminal is in the form of narrow pulses commonly known as trigger pulses.

The sweep period depends upon time constant (R.C.) and the sweep frequency can be varied by changing value of either resistance (R) or capacitor (C). Due to this fact, the resistor R is shown as a variable resistor.

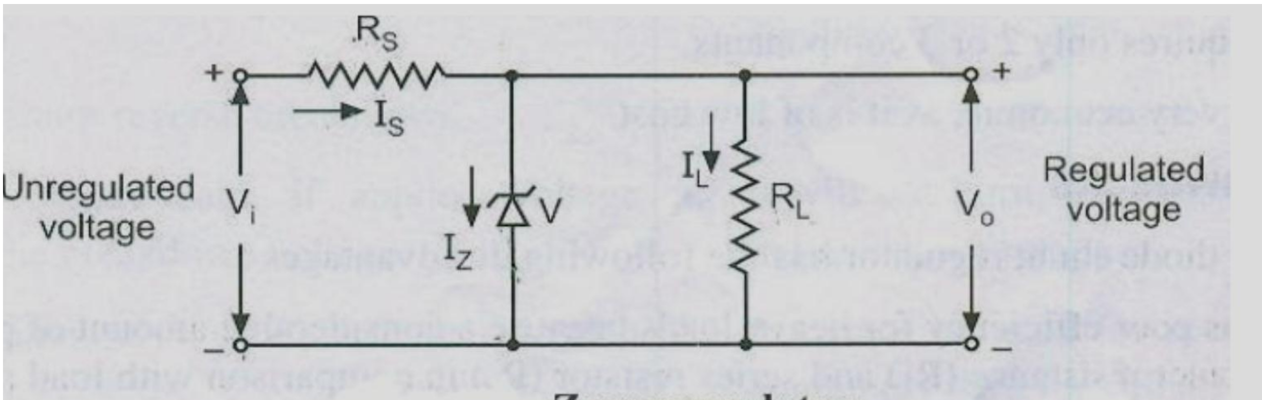
The sweep period is given by the relation

T= R.C. $\log_e$ (1/1-n)

T = 2/3 R.C. $\log_{10}$(1/1-n)

f. Draw and describe the working of zener diode as voltage regulator.

Ans f. **Diagram:2M; Working:2M**



Zener regulator

Working

- 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.
- Suppose this input voltage exceeds the Zener voltage. This voltage operates the Zener diode in reverse breakdown region and maintains a constant voltage, i.e. Vz = Vo across the load inspite of input AC voltage fluctuations or load current variations. The input current is given by, IS = Vi – Vz / Rs = Vi – Vo / Rs
- We know that the input current Is the sum of Zener current Iz and load current IL.

Therefore, $I_S = I_Z + I_L$

or $I_Z = I_S - I_L$

- As the load current increase, the Zener current decreases so that the input current remains constant. According to Kirchhoff's voltage law, the output voltage is given by,

$$Vo = Vi - Is.\ Rs$$

- As the input current is constant, the output voltage remains constant (i.e. unaltered or unchanged). The reverse would be true, if the load current decreases. This circuit is also correct for the changes in input voltage.
- As the input voltage increases, more Zener current will flow through the Zener diode. This increases the input voltage Is, and also the voltage drop across the resistor Rs, but the load voltage Vo would remain constant. The reverse would be true, if the decrease in input voltage is not below Zener voltage.
- Thus, a Zener diode acts as a voltage regulator and the fixed voltage is maintained across the load resistor RL.

4) Attempt any FOUR: 16

a. Define following terms related to transistor current amplification factor (α,β,γ)

Ans a. **(Correct definitions – 4 marks)**

Current amplification factor (α): The ratio of change in collector current to the change in emitter current at constant collector base voltage V_{CB} is known as current amplification factor in common base mode.

Base current amplification factor (β): The ratio of change in collector current (I_C) to the change in base current is known as base current amplification factor in common emitter mode.

Current amplification factor: The ratio of change in emitter current to the change in base current is known as current amplification factor in common collector mode.

b. What is thermal runaway and how it can be avoided?

Ans b. **(Thermal runaway – 2 marks, how it is avoided – 2 marks)**

1. The reverse saturation current in semiconductor devices changes with temperature. The reverse saturation current approximately doubles for every 100 c rise in temperature.

2. As the leakage current of transistor increases, collector current (Ic) increases

3. The increase in power dissipation at collector base junction.

4. This in turn increases the collector base junction causing the collector current to further increase.

5. This process becomes cumulative. & it is possible that the ratings of the transistor are exceeded. If it happens, the device gets burnt out. This process is known as 'Thermal Runaway'.

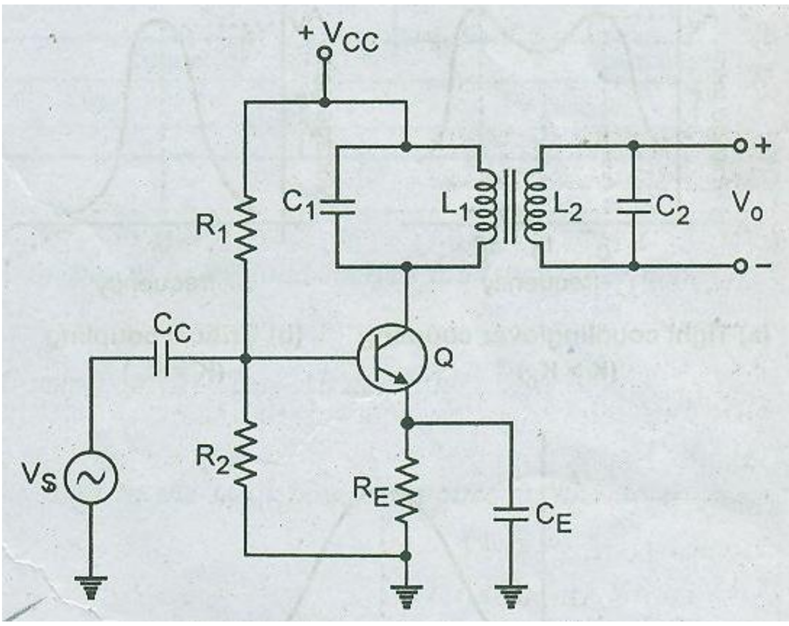
Thermal runaway can be avoided by

1) Using stabilization circuitry

2) Heat sink

c. Draw the circuit diagram of double tuned amplifier and describe its operating principle.

Ans c. **Diagram:2M; Operating Principle:2M**



Working:

- The signal to be amplified is applied at the input terminal through the coupling capacitor C_C
- The resonant frequency of the tuned circuit L_1 C_1 is made equal to that of the signal
- Under these conditions the tuned circuit offers a very high impedance to the input signal. As a result of this, a large output appears across the tuned circuit. The output from this tuned circuit is inductively coupled to the L_2C_2 tuned circuit.
- The double tuned voltage amplifiers are extensively used in intermediate frequency (IF) amplifiers in radio and TV receivers.

d. Compare Class A, Class B, Class AB, Class C power amplifiers on

i. efficiency ii. conduction angle.

Ans d. **correct comparison: 4M**

Sr.No	Parameters	Class A	Class B	Class AB	Class C
1	Efficiency	Lowest 25% to 50%	Higher (78.5%)	Between 50 to 78.5%	Very high 95%
2	Conduction angle	360^0 or full cycle	180^0 or half cycle	Between 180^0 and 360^0	Less than 180^0

e. Describe the Barkhausen criterion for sustained oscillations.

Ans e. **correct derivation: 4M**

Barkhausen criterion should be satisfied by an amplifier with positive feedback to ensure the sustained maintain oscillations.

– Expression for output voltage V_o is

$V_o = AV_i$ —(1)

But V_i is the sum of V_s & V_f

$\therefore V_i = V_s + V_f$ —(2)

Note that we have added V_s & V_f because in positive feedback V_s & V_f will be in phase in each other & hence, will get added.

The expression for feedback voltage is

$V_f = \beta V_o$ —(3)

Substitute the value of V_o from (1) into equation (3) we get.

$V_f = \beta A V_i$ —(4)

Substitute this equation (2) to get

$V_i = V_s + A\beta A V_i$

$\therefore (1 - A\beta) V_i = V_s$ —(5)

for oscillator the input voltage V_s is absent i.e $V_s = 0$ and feedback signal V_f is supposed to maintain the oscillations. Therefore, substitute $V_s = 0$ into equation (5) to get,

$V_i(1 - A\beta) = 0$.

or $\boxed{A\beta = 1}$.

With an inverting amplifier introducing a 180° phase shift between V_i & V_o the feedback network must introduce another 180° phase to ensure that V_i & V_f are in phase.

- There two conditions which are required to be satisfied to operate the circuit as an oscillator are called as the 'Barkhausen criterion' for sustained oscillations.

f) In UJT sweep circuit, calculate time period and frequency of oscillation if η= 0.62, R=5KΩ, C= 0.05μF.

Ans f. **Correct Solution:4M**

Given : $C = 0.05\ \mu f$, $\eta = 0.62$, $R = 5K\Omega$

To find : (a) T , (b) f

Solution.

(a) Period of oscillation,

We know that period of oscillation.

$$T = 2.3 R.C. \log_{10}\left(\frac{1}{1-\eta}\right)$$

$$= 2.3 \times (5\times 10^{3}) \times (0.05 \times 10^{-6}) \log_{10}\left(\frac{1}{1-0.62}\right)$$

$$= (5.75 \times 10^{-4}) \times \log_{10} 2.63$$

$$= 2.4 \times 10^{-4}\ sec$$

$\therefore$ $\boxed{T = 0.24\ msec}$ Ans.

(b) frequency of oscillation,

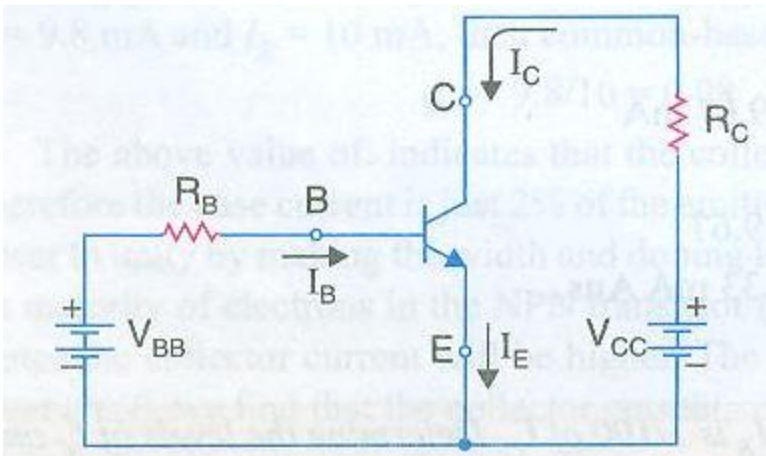
$$f = \frac{1}{T} = \frac{1}{2.4 \times 10^{-4}}$$

$\therefore$ $\boxed{f = 4140\ Hz}$ Ans.

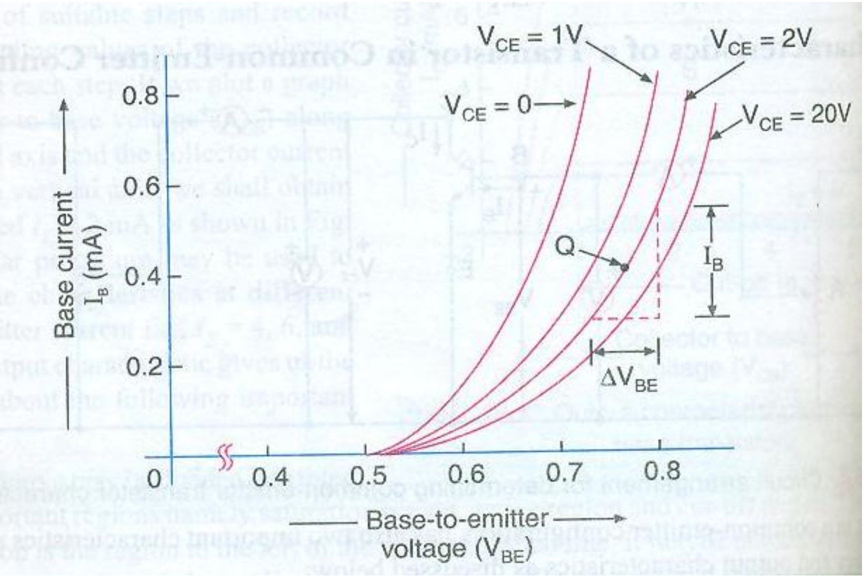
5) Attempt any FOUR: 16

a. Draw the circuit diagram of transistor in common emitter configuration and draw input and output characteristics.

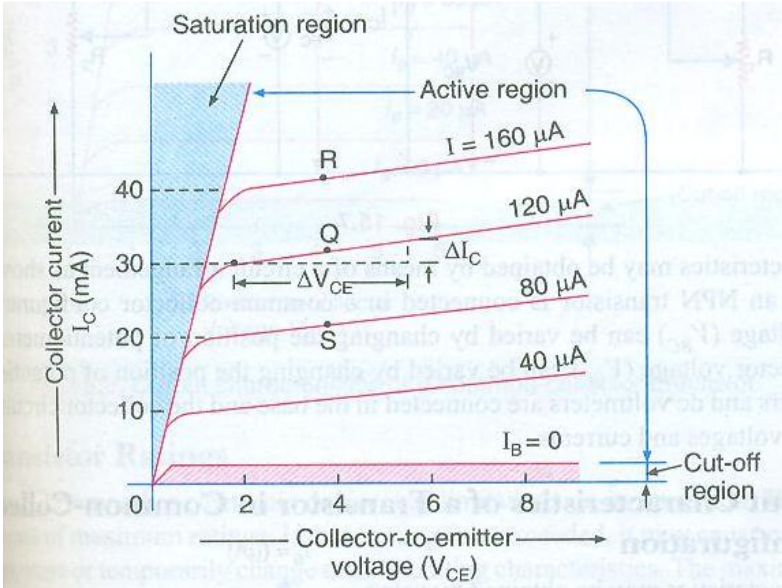
Ans **(circuit diagram – 2 marks, I/p & o/p characteristics – 1 mark each)**



Common emitter NPN transistor circuit



Input characteristics of common emitter transistor



Output characteristics of common emitter transistor

b. Describe the working of n- channel D MOSFET with diagram.

Ans b: **Working:2M; Diagram:2M**

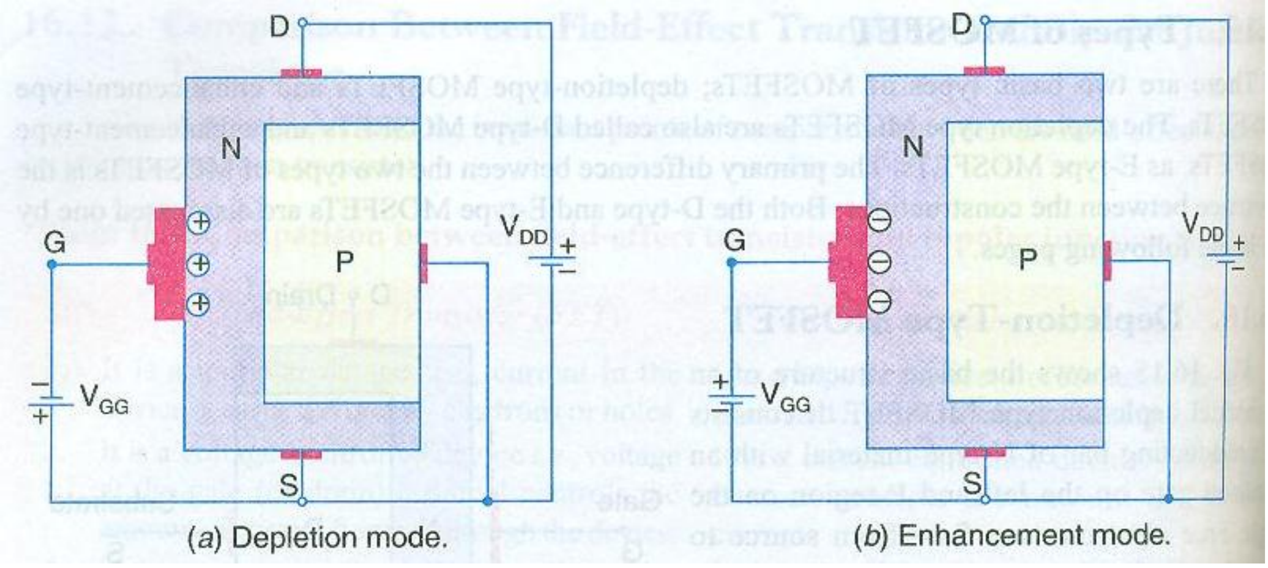
The depletion type MOSFET can be operated in two different modes as given below

Depletion mode: The device operates in this mode, when the gate voltage in negative.

2. *Enhancement mode.* The device operates in this mode, when the gate voltage is positive.

Depletion mode: MOSFET with a negative gate-to-source voltage.

The negative voltage, on the gate, induces a positive charge in the channel. Because of *this,* free electrons in the vicinity of positive charge are repelled away in the channel. As a result of this, the channel is depleted of free electrons. This reduces the number of free electrons (which constitute the drain current) passing through the channel. Thus as the value of negative gate-to-source voltage is increased the value of drain voltage, called *VGS(off)'* the channel is totally depleted of free electrons and therefore drain current reduces to zero. Thus with the negative gate voltage, the operation MOSFET is similar to that of a JFET.



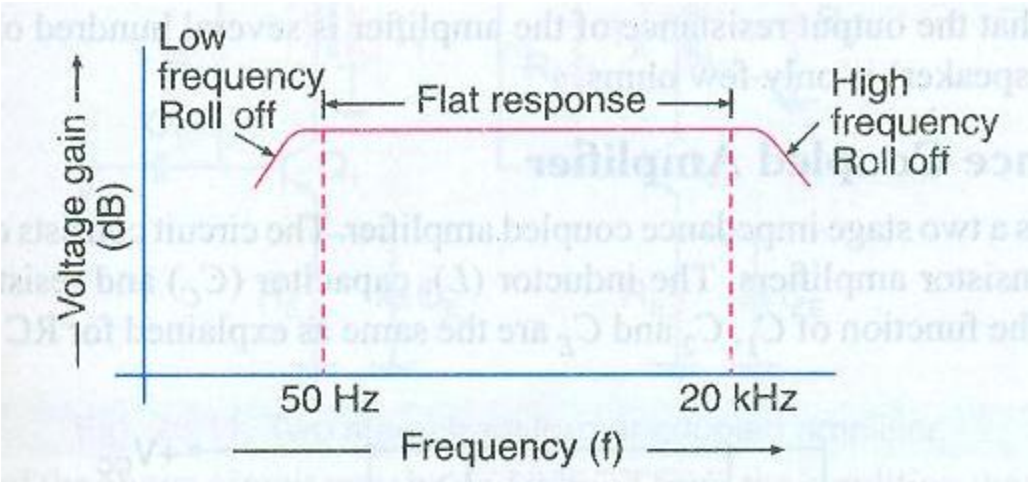
(*a*) Depletion mode. (*b*) Enhancement mode.

It is evident from the above discussion that negative gate voltage depletes the channel of free electrons. It is due to this fact that the working of a MOSFET with a negative gate voltage is called depletion mode.

Enhancement mode: MOSFET with a positive gate to source voltage . 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 increases enhances the conducting of the channel. Because of this fact, positive gate operation is called enhancement mode.

c. Draw the nature of frequency response of two stage RC coupled amplifier and describe it.

Ans c. **Diagram:2M; Explaination:2M**



At low frequencies: We know that the capacitive reactance X_C is inversely proportional to the frequency. Thus at low frequencies the reactance of the capacitor C_C is quite large. Therefore it will allow only a small part of the signal to pass from one stage to the next stage.

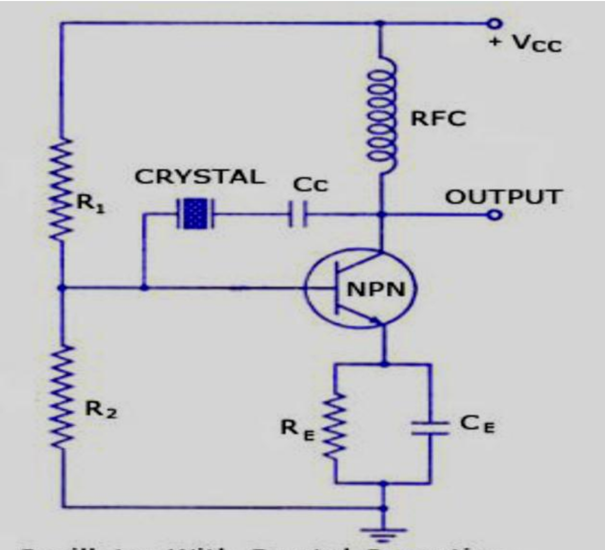
In addition to this the emitter bypass capacitor cannot shunt the emitter resistor effectively, because of its large reactance at low frequencies. As a result of these two factors, the voltage gain rolls off at low frequencies.

At high frequencies (above 20 kHz): In this frequencies range the reactance of capacitor become quite small, therefore it behaves like a short circuit. As a result of this, the loading effect of the next stage increases, which reduces the voltage gain. In addition to this, the capacitance of the emitter diode plays an important role at high frequencies. It increases the base current of transistor due to which the current gain reduces. Hence the voltage gain rolls off at high frequencies.

At mid frequencies (50Hz to 20kHz): The effect of coupling capacitor in this frequency range is such that it maintains a constant voltage gain. Thus as the frequency increases the reactance of capacitor decreases, which tends to increase the gain. However at the same time the lower capacitive reactance increases the loading effect of the next stage due to which the gain reduces. These two factors almost cancel each other. Thus a constant gain is maintained throughout this frequency range.

d. Describe the working of transistorized crystal oscillator with the help of circuit diagram.

Ans d. **Working:2M. Circuit Diagram:2M**

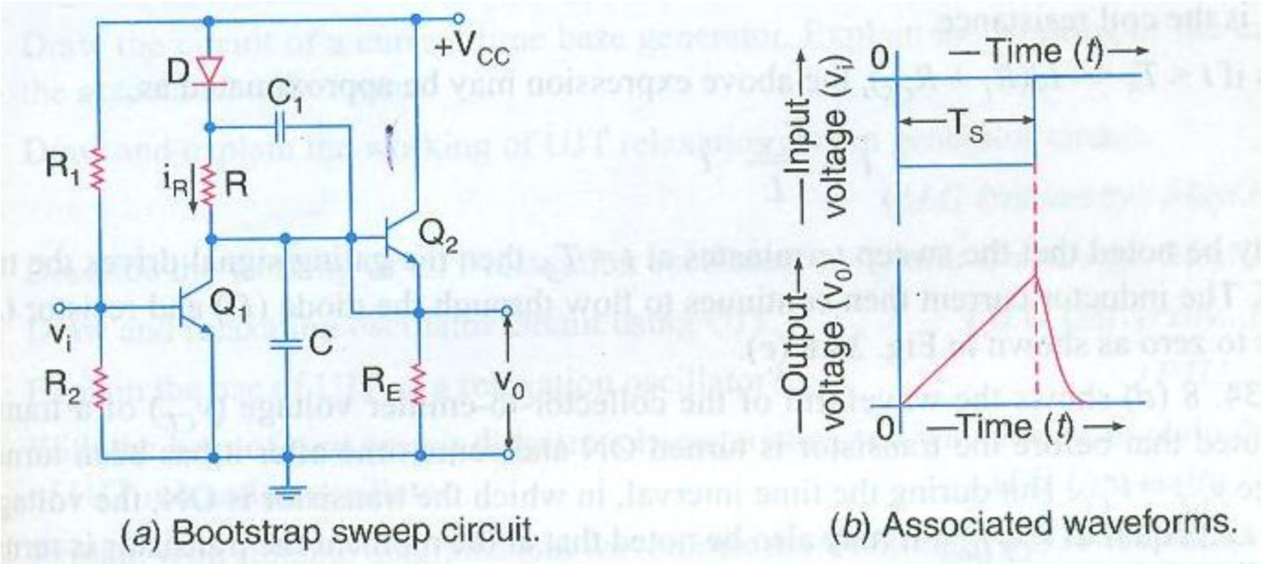


Oscillator With Crystal Operating in Series Resonance

- When the D.C power is switched on, the noise voltage of small amplitude appearing at the base gets amplified and appears at the output.
- This amplified noise now drives the feedback network consisting of a quartz crystal and a capacitor C. Thus the crystal is excited by a fraction of energy feedback from the output to the input.
- The crystal is made to operate as an inductor L so that the feedback network consists of series resonant LC circuit.
- This is possible only, if the frequency of oscillations f_o is in between the series resonant frequency f_s and the parallel resonant frequency f_p of an electrical equivalent circuit of a crystal, Thus, the frequency of oscillations is set by the series resonant frequency f_s of the crystal. This produces the undamped oscillations of stable frequency f_o.

e. Draw the bootstrap sweep circuit and describe its working with waveforms.

Ans e. **Circuit Diagram:2M; Working:1M, Waveform:1M**



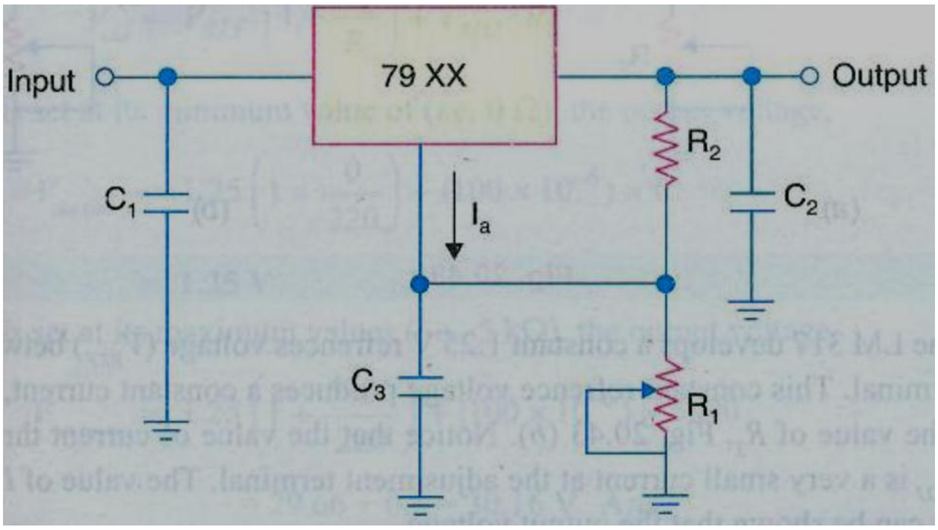
- Here transistor Q1 acts as a switch and transistor Q2 acts as an emitter follower (i.e. a unit gain amplifier).

Circuit Operation:

- Initially transistor Q1 is ON and Q2 is OFF. Therefore capacitor C1 is charged to VCC through the diode forward resistance (RF). At this instance output voltage is zero.
- When negative pulse is applied to the base of transistor Q1, it turns OFF. Since Q2 is an emitter follower, therefore the output voltage V0 is same as base voltage of Q2.
- Thus when Q1 turns OFF, the capacitor C1 starts charging this capacitor C through resistor (R). As a result of these both the base voltage of Q2 and output voltage begins to increase from zero.
- As the output voltage increases diode D becomes reverse biased, because of the fact that the output voltage is coupled through the capacitor (C1) to the diode.
- Since the value of capacitor (C1) is much larger than that of capacitor (C), therefore the voltage across capacitor (C1) practically remains constant.
- Thus voltage drop across resistor (R) and hence current (IR) remains constant, means capacitor C is charged with constant current.
- This causes voltage across capacitor C (and hence the output voltage) to increase linearly with time.
- The circuit pulls itself by its own bootstrap and hence it is known as bootstrap sweep circuit.

f) Describe the working of 79XX series voltage regulator.

Ans f. **Working:2M, Diagram:2M**



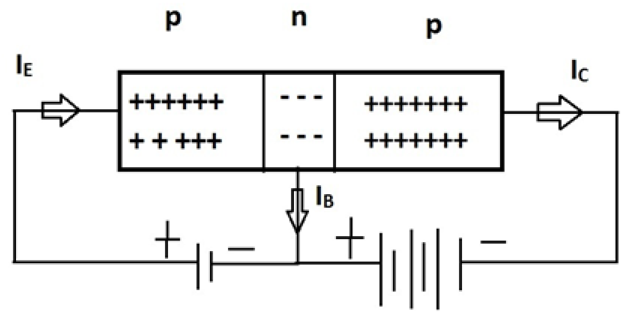
- The capacitor C_1 (typically 0.22µF) is required only if the power supply filter is located more than 3 inches away from the IC regulator.
- The capacitor C_2 (typically 1µF) is required for stability of the output voltage.
- Both the capacitors must be solid tantalum capacitors.
- Figure above shows the 79XX to produce an adjustable output voltage.
- The capacitor C_3 (typically 25µF) improves the transient response of output voltage. The output voltage is given by the equation,

$$V_{out} = V_{fixed} = \left(\frac{R_1 + R_2}{R_2}\right)$$

6. Attempt any FOUR: **16**

a. Explain the operation principle of PNP transistor.

Ans a. **Diagram:2M; Operating Principle:2M**



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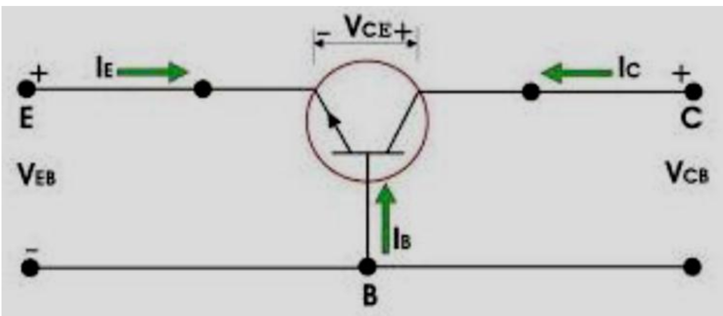
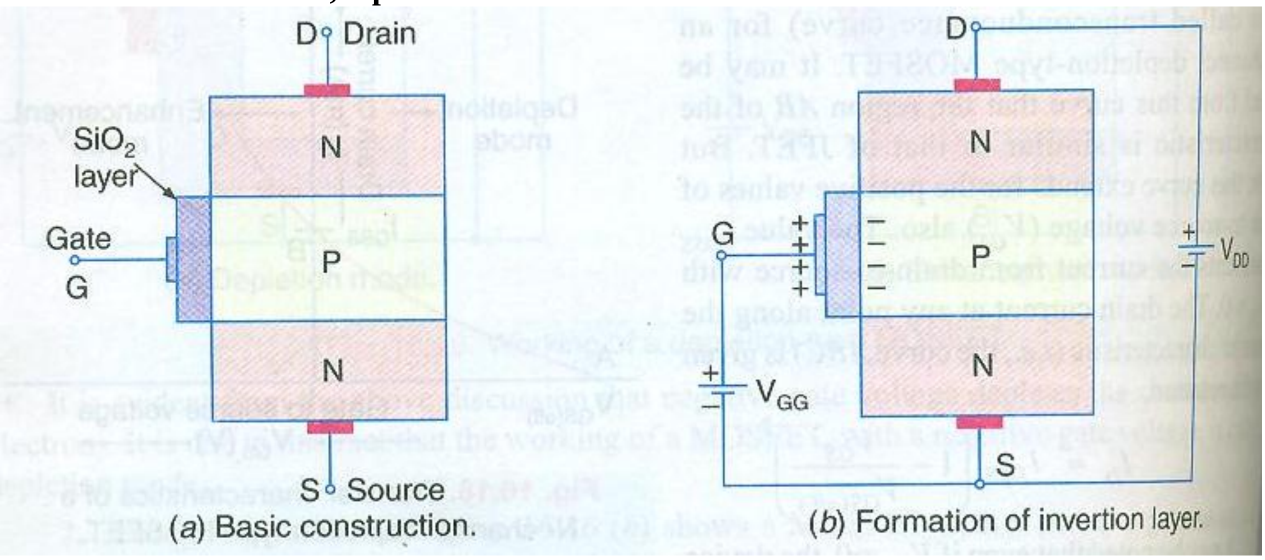


Operating Principle

1) Base emitter junction is forward biased and base collector is reverse biased.
2) The emitter is common and base is the input terminal, collector is the output terminal.
3) IE = IB + IC basic equation of transistor.
4) The holes from emitter are repelled and they move towards the base. Base is lightly doped and they get attracted by collector which is reverse biased.
5) The current gain for CE mode is β= Ic/Ib

b. Describe construction, operation of E-MOSFET

Ans b. **Construction:2M; Operation:2M**



(a) Basic construction. (b) Formation of invertion layer.

The enhancement type MOSFET has no depletion mode and it operates only in enhancement mode. It differs in construction from the depletion type MOSFET in the sense that it has no physical channel. It may be noted that the P- type substrate extends the silicon dioxide layer completely.

The normal biasing polarities for N channel enhancement type MOSFET.

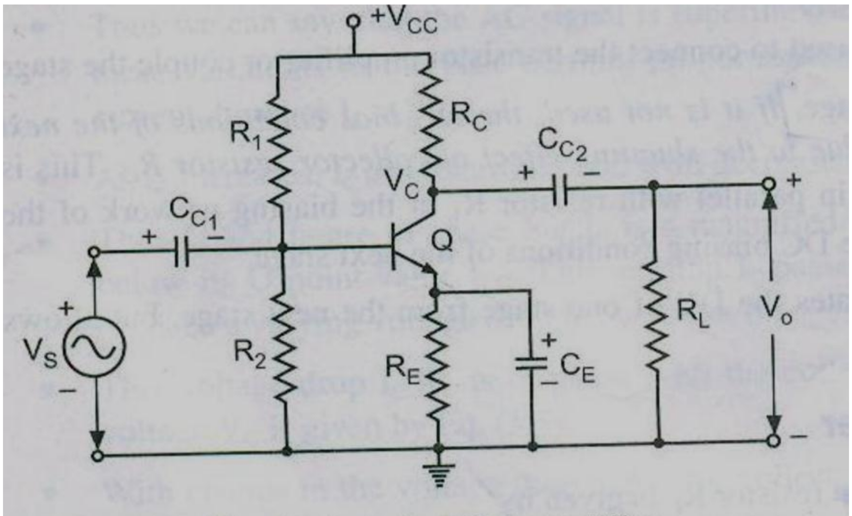
It must be remembered that this MOSFET is always operated with the positive gate to source voltage. When the gate to source voltage is zero, the V_{DD} supply tries to force free electrons from source to drain. But the presence of P- region does not permit the electrons to pass through it. Thus there is no drain current for V_{GS}= 0. Due to this fact, the enhancement type MOSFET is also called normally OFF MOSFET.

Now if some positive voltage is applied at the gate, it induces a negative charge in the P- type substrate just adjacent to the silicon dioxide layer. The induced negative charge is produced by attracting the free electrons from the source. When the gate is positive enough, it can attract a number of free electrons. This form a thin layer of electrons, which stretches from source to drain, This effect is equivalent to producing a thin layer of N- type channel in the P- type substrate. This layer of free electrons is called N- type inversion layer.

The minimum gate to source voltage which produces inversion layer, is called threshold voltage and is designated by the symbol. When the voltage V_{GS} is less than V_{GS} no current flows from drain to source. However when the voltage V_{GS} is greater than V_{GS} the inversion layer connects the drain and source and we get significant value of current.

c. Draw circuit diagram of practical single stage CE amplifier and state the function of each component.

Ans c. **Circuit Diagram:2M; Function:2M**



Single-stage led CE amplifier

- The circuit diagram of a voltage amplifier using single transistor in CE configuration is shown in figure. It is also known as a small-signal single-stage CE amplifier or RC coupled CE amplifier. It is also known as a voltage amplifier.
- The potential divider biasing is provided by resistors R1, R2 and RE.
- It provides good stabilization of the operating point. The capacitors CC1 and CC2 are called the coupling capacitors used to block the AC voltage signals at the input and the output sides.
- The capacitor CE works as a bypass capacitor. It bypasses all the AC currents from the emitter to the ground and avoids the negative current feedback. It increases the output AC voltage.
- The resistance RL represents the resistance of whatever is connected at the output. It may be load resistance or input resistance of the next stage.

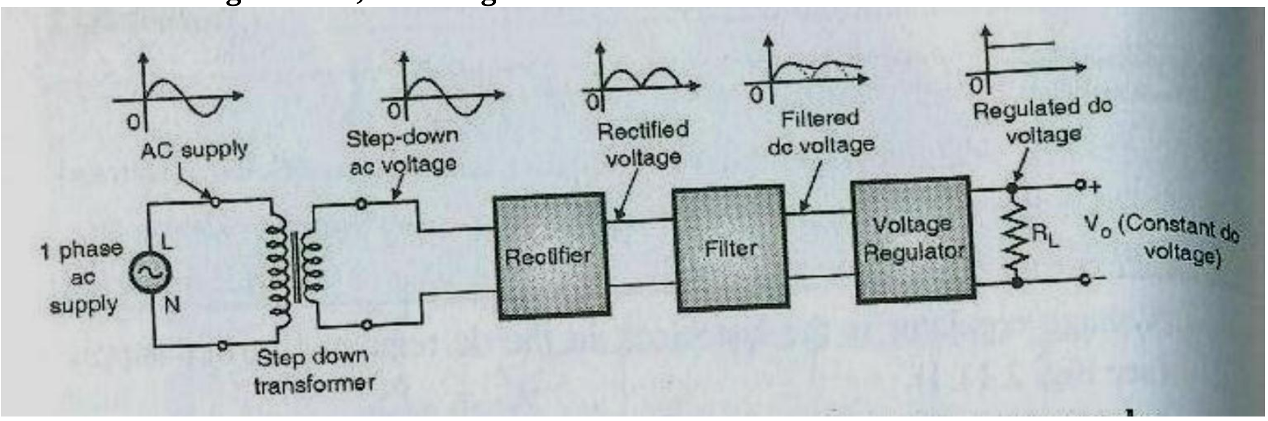
d. Compare amplifier and oscillator for:
   1. Feedback   2. Application

Ans d**. (Each correct point – 2 marks)**

Parameter	Amplifier	Oscillator
Feed back	Negative feedback	Positive feedback
Application **(Note: any relevant application should be considered)**	TV & Radio receivers, tape recorder, PA system	Digital watches, Function generators, AM & FM transmitters

e. Draw the block diagram of DC regulated power supply and describe the working of each block.

Ans e. **Block Diagram:2M; Working:2M**



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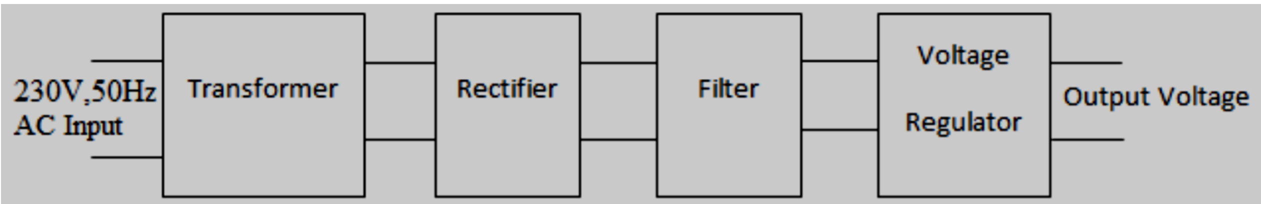


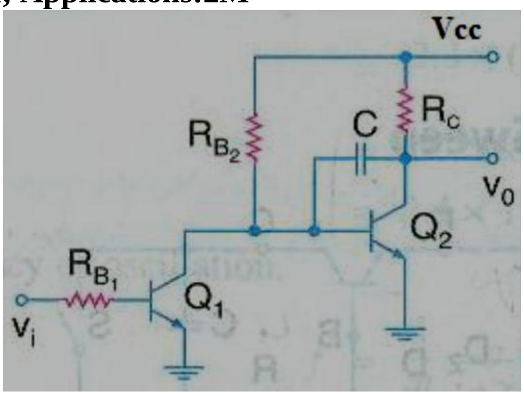
There are four basic blocks of a D.C. regulated power supply. They are 1) Step down transformer 2) Rectifier 3) Filter 4) Voltage Regulator.

Functions of each block are as follows:

- **Step down transformer:** Reduces 230 volts 50Hz ac voltage to required ac voltage level.
- **Rectifier:** Rectifier converts ac voltage to dc voltage. Typically bridge full wave rectifier is widely used.
- **Filter:** Filter is a circuit used to remove fluctuations (ripple or ac) present in dc output.
- **Voltage Regulator:** Voltage regulator is a circuit which provides constant dc output voltage irrespective of changes in load current or changes in input voltage.
- **Voltage divider** is a passive circuit used for providing different dc voltages required by different electronic circuits.

f. Draw the circuit diagram of Miller's sweep generator and state its application.

Ans f. **Circuit Diagram:2M; Applications:2M**



Applications of Miller Sweep Generator: (any two)

1. Applications where linear output is expected.
2. In Television (TV)
3. In CRO
4. To convert step waveform into ramp waveform.