MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

Summer 2016 EXAMINATIONS

Subject Code: **17213** **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 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 judgment 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.

17213 - BEL **Summer 16**

1. **Answer any ten.** 20

(a) Define inductance and capacitance.

Ans:- (Each definition 1 mks)

Inductance: In electronics inductance is the property of a coil by which a change in current through it induces an electromotive force in the conductor, the unit of inductance is Henry .

Capacitance: Capacitor ability to store charge on its plates is known as Capacitance. The unit of capacitance is Farad.

(b) State any four applications of BJT.

Ans:- (Any 4 applications – 1mks each)

1.Amplifiers
2, Switching
3.Oscillators
4.Waveshapping circuits
5.Radio Transmitter and receivers
6.Output amplifiers

(c) State the majority and minority carriers in p-type and n-type of extrinsic semiconductor.

Ans: The majority carriers in p-type of extrinsic semiconductor is holes and minority carriers are electrons. (1 mks)

The majority carriers in n-type of extrinsic semiconductor is electrons and minority carriers in n-type is holes. (1mks)

(d) Draw the block diagram of multi-stage amplifier.

Ans:-

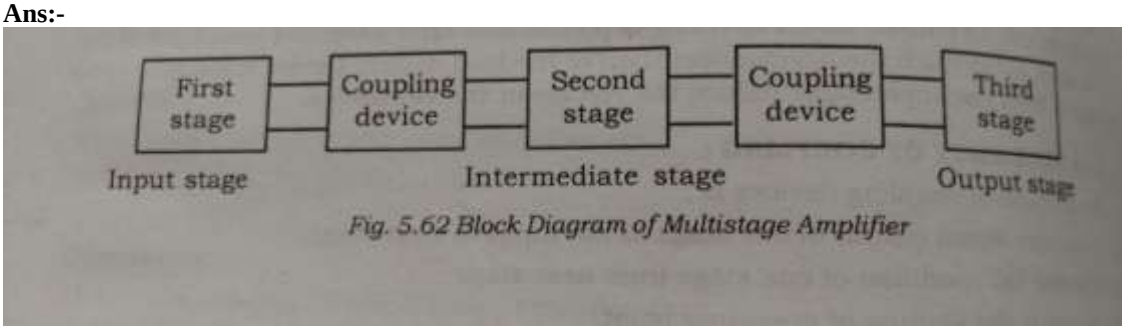


Fig. 5.62 Block Diagram of Multistage Amplifier

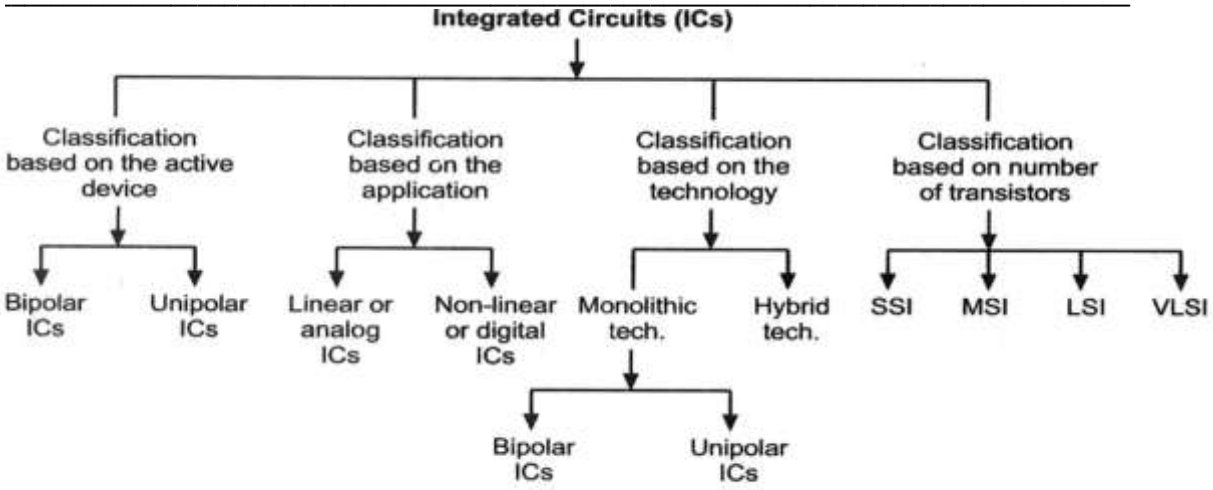
(e) State the effect of forward biased and reverse biased on depletion width of PN junction diode.

Ans:-In forward biased PN junction the majority carriers i.e. holes in P region and electrons in N region moves towards the PN junction so the width of depletion region is decreases and the current in the circuit is increases. As the forward voltage increases the current is also increases .
(1 mks)

In reverse biased PN junction the majority carrier i.e. holes in P region and electrons in N region moves towards the battery terminals so the width of depletion region is increases, and there is no current in the circuit due to majority carriers. (1 mks)

(f) Give classification of ICs.

Ans:-(Proper classification- 2 mks)



Classification of integrated circuits (ICs)

(g) State the need of rectification.

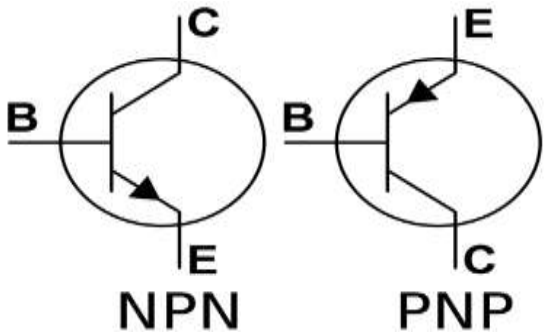
Ans: In many applications, we need DC power supply for amplifiers, oscillators in order to provide biasing. Hence, the main AC supply is rectified by using semiconductor diode as rectifier circuit.

(2mks)

(h) Define transistor and draw the symbol of PNP and NPN transistor.

Ans:"Transistor" means transfer of resistor, the main purpose of transistor is to amplify weak signals applied at forward biased junction having low resistance and transfer it to reverse bias junction having high resistance. It is a three terminal device COLLECTOR, BASE, EMITTER having two PN junctions.

(1 MKS)



(½ MKS EACH)

(i) What is meant by avalanche breakdown?

Ans: Avalanche breakdown- (2mks for concept)

This mechanism is occur in those diodes which have lightly doped and wide depletion layer. As the reverse external voltage goes on increasing, velocity of minority carriers also increases and they collide with covalent bonds 'thus produce electron-hole pair s and this process goes on as a chain reaction by increasing reverse voltage and finally at the breakdown voltage all the covalent bonds and also the depletion layer breaks, and there is a sudden rise in the current due to this chain reaction of minority carriers.

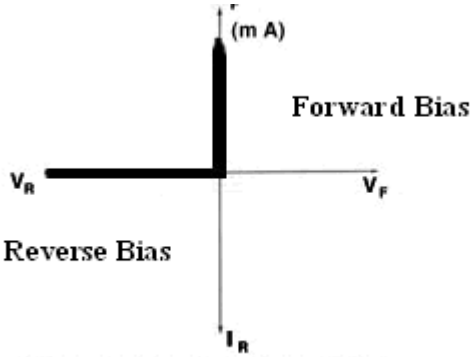
(j) List any four advantages of ICs.

Ans:- (any 4 advantages- 2 mks)

1. The physical size of an IC is extremely small (generally thousand times smaller) than that of discrete circuits.
2. The weight of an IC is very less as compared to that of equivalent discrete circuits.
3. The reduction in power consumption is achieved due to extremely small size of IC.
4. Interconnection errors are non-existent in practice.
5. Temperature differences between components of a circuit are small.
6. Close matching of components and temperature coefficients is possible.
7. In case of circuit failure, it is very easy to replace an IC by a new one.
8. Active devices can be generously used as they are cheaper than passive components.

(k) Draw the ideal V-I characteristics of PN junction diode.

Ans:(1mks each for forward and reverse characteristics)



V-I characteristics of an ideal diode

(l) List the application areas of electronics.

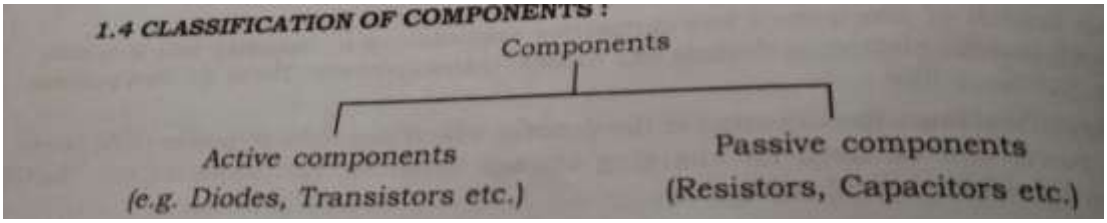
Ans: (any 4 applications-1/2 mks each)

1) Electro cardiograph
2) X-Ray machines
3) Ultra sound scanner
4) cathode ray oscilloscope
5) frequency counter
6) function generator
7) instrumentation
8) defense

2. Attempt any FOUR. **16**

(a) Give the classification of electronic components of each.

Ans:- (Classification- 2 mks)



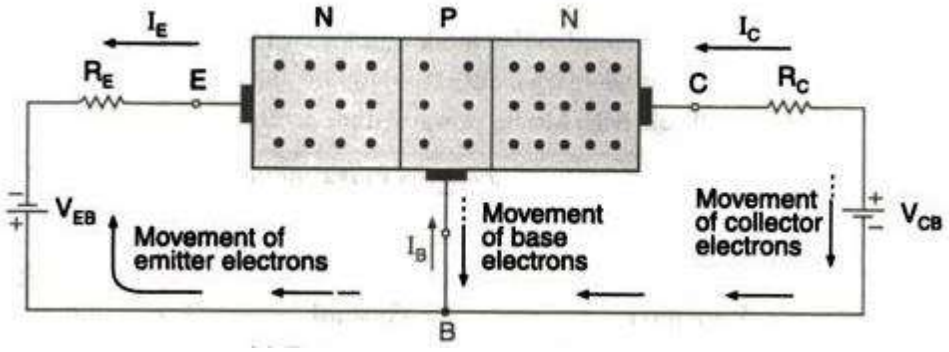
(b) List the four specifications of PN junction diode.

Ans:The specifications of PN Junction Diode are: (any 4- 4 mks)

1. Maximum reverse voltage (V)
2. Repetitive peak voltage (V)
3. Maximum forward current (mA)
4. Power dissipation.
5. Repetitive peak forward current.
6. Average forward current (A)
7. Surge current (A)
8. Operating ambient temperature (0C)
9. Maximum junction temperature (0C)
10. Forward voltage (V)

(c) Explain the working principle of npn transistor with the help of diagram.

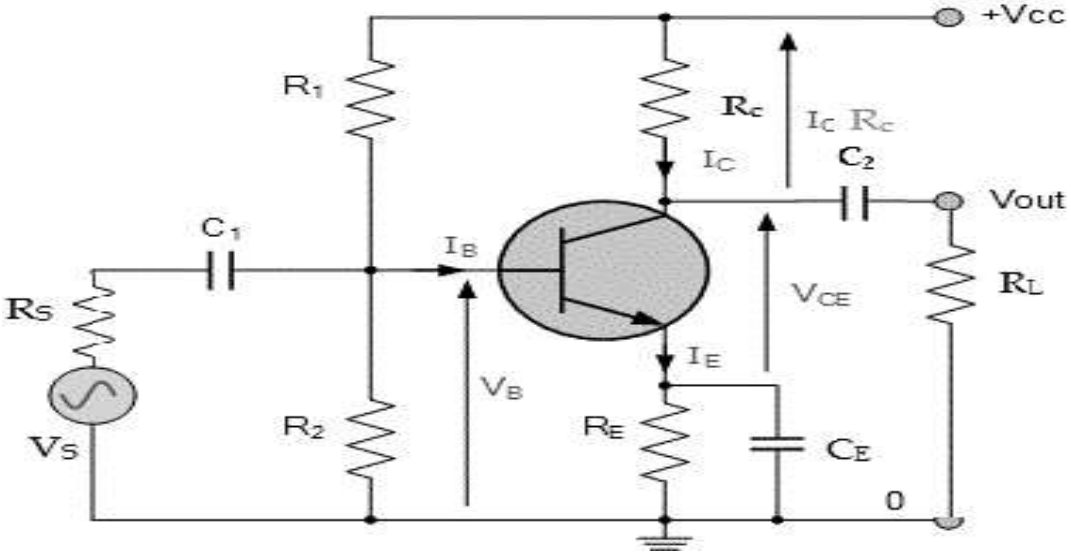
Ans:(Diagram- 2 mks, principle- 2mks)



Working principle- 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 IE.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 IB. The remaining electrons (98%) cross over in to the collector region to constitute collector current IC. 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.

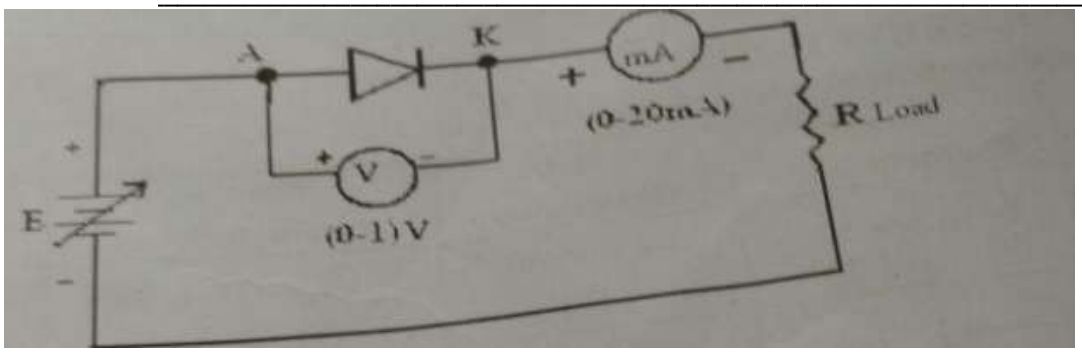
IE = IB + IC

(d) Write the function of each component used in single stage CE amplifier.
(Diagram:2M; Functions of any four components - ½ M each)
Ans. Single stage CE amplifier

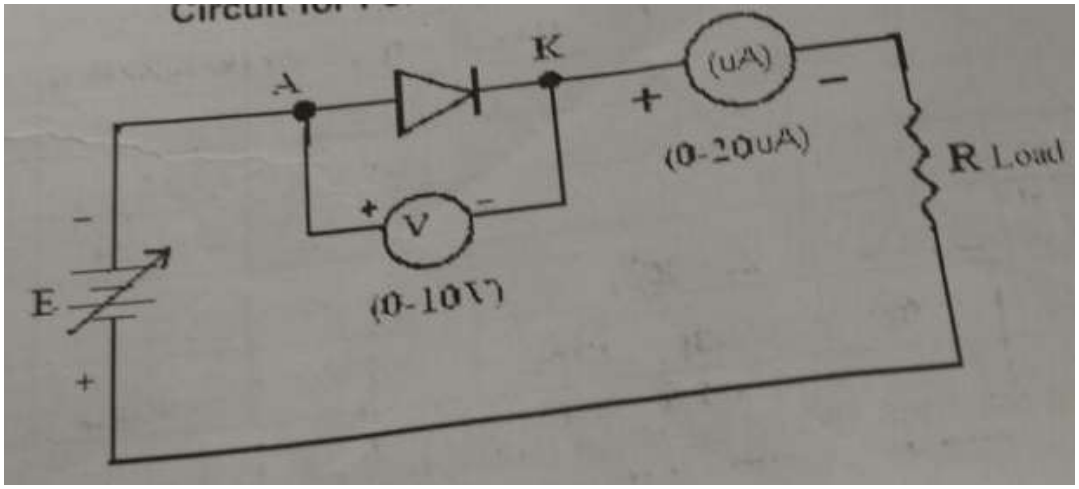


Circuit diagram :- The capacitors C1 and C2 are called as coupling capacitors. A coupling capacitor passes ac signal from one side to the other and blocks DC. The capacitor C1 blocks DC from the input signal Vs. The capacitor C2 blocks DC from the output of the transistor. These capacitors are used to couple or cascade further stages of amplifier if required. The capacitor CE is called bypass capacitor. It bypasses all ac current from emitter to ground. If this capacitor is not connected, the ac voltage developed across RE will affect the input ac voltage. Such a feedback of ac signal is reduced by putting capacitor CE so that gain is not reduced. RL represents the resistance connected at the output as load. Resistor RE provides stabilization to the transistor. Resistors R1 and R2 are used for proper biasing of the transistor.

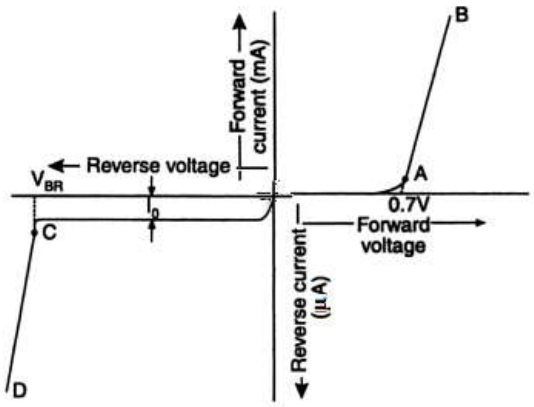
(e) Explain the V-I characteristics of PN junction diode with the help of circuit diagram.
Ans:-(V-I graph- 1 mks, Fwd characteristics circuit – 1 mks,reverse characteristics circuit – 1 mks, explanation – 1 mks)



Forward Characteristics



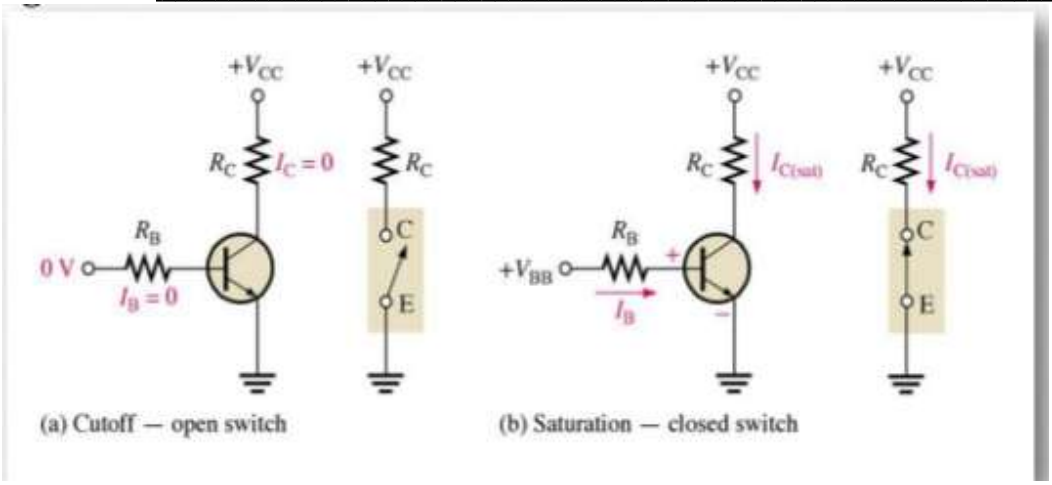
Reverse Characteristics



(f) With neat circuit diagram, explain how transistor works as a switch.

Ans:- (diagram- 2 mks, explanation- 2 mks)

The transistor is act as a switch meaning that we operate it at either saturation or cut-off but not in active.When transistor is saturated ,it is like closed switch from C to E and when transistor is cut-off it is like open switch.When there is negative voltage BE and CB both are reverse biased.when transistor is OFF ,no current exist in the circuit output voltage is equal to Vcc.

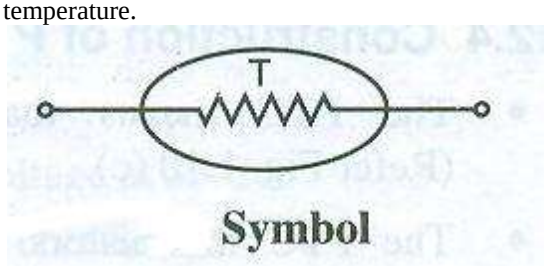


When the input voltage is positive both BE and CB junction are forward bias, therefore transistor is ON. Current I_c increases and the output voltage decreases.
So when input is low output is high and when input is high ouput is low so transistor switch is also known as inverter.

3. Attempt any four. **16**

(a) Explain working of thermistor.

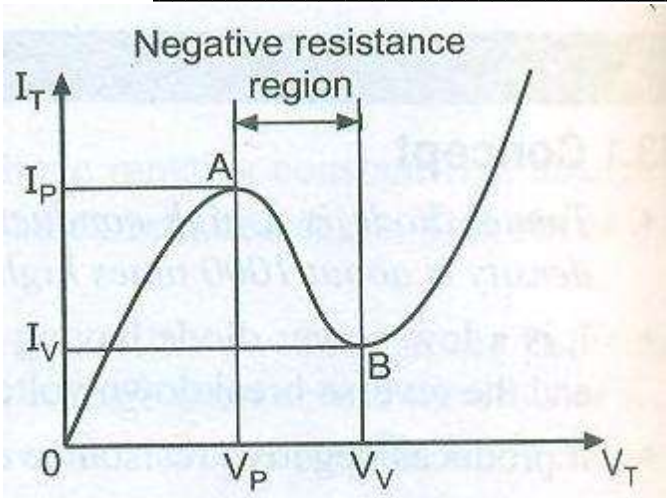
Ans:- (diagram- 2 mks, operation- 2 mks)
Thermistor means thermally sensitive resistor. These are the resistors whose resistance varries rapidly with temperature. The primary function of these resistors in circuit is to change their electrical resistance with a change in body temperature.



The device is manufactured from materials like sintered mixtures of oxides of metals such as manganese, nickel, cobalt, and iron. Their resistances range from 0.4 ohms to 75 mega-ohms and they may be fabricated in wide variety of shapes and sizes. Smaller thermistors are in the form of beads of diameter from 0.15 millimeters to 1.5 millimeters. Such a bead may be sealed in the tip of solid glass rod to form probe which is easier to mount than bead. Alternatively thermistor may be in the form of disks and washers made by pressing thermistor material under high pressure into flat cylindrical shapes with diameter from 3 millimeters to 25 millimeters.

(b) Draw V-I characteristics of tunnel diode and show different regions on the characteristic curve.

Ans:-(V-I graph – 2mks, regions 2 mks)



V-I characteristics of a tunnel diode

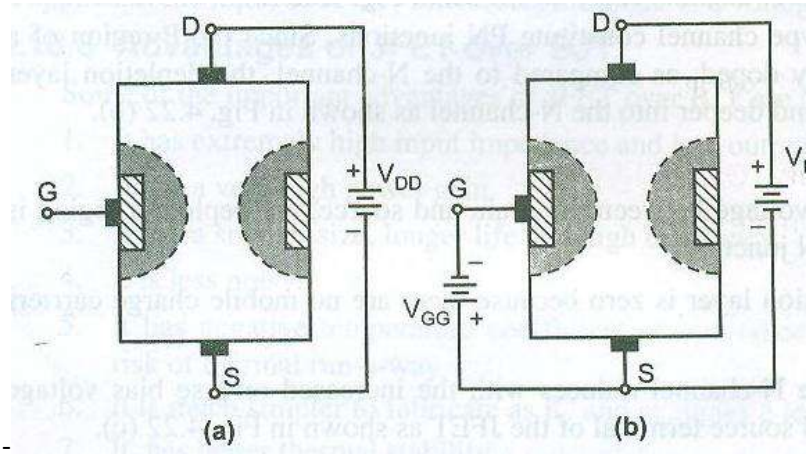
(c) Define alpha and beta of a transistor and give the relation between them.
(Defination - 2M ,Relation -2M}

Ans:-Current amplification Factor(alpha): The ratio of change in collector current I_c to the change in emitter current I_E at constant collector to base voltage(V_{CB}) is known as current amplification factor.

Amplification Factor(beta): The ratio of change in collector current to the change in base current at constant collector to emitter voltage is called as amplification factor Beta

$$\beta=\alpha\div(1-\alpha)$$

(d) Sketch the construction of N-Channel JFET and explain its working principle.
{ construction-2M and working Principle -2M}
Ans:-



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When there is no applied voltage between the drain and source, the depletion region is symmetrical around the PN junction. The conductivity of depletion layer is zero because there are no mobile charge carriers in this layer. The effective width of the N- channel reduces with the increased reverse bias voltage applied across the gate and source terminal of JFET.

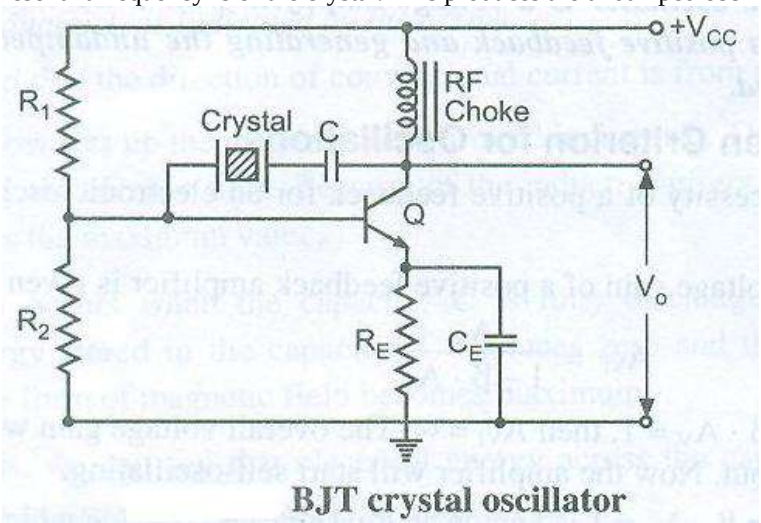
In presence of voltage VDS: When the voltage is applied between the drain and source with a battery VDD and the gate is kept open, the electrons flow from source to drain through the narrow channel existing between the depletion layer. This constitutes the drain current ID and its conventional direction is indicated from drain to source. When the gate to source voltage VGS is applied by a battery VGG and increased above zero, the reverse bias voltage across the gate source junction is now increased. As a result the depletion layers are widened. This reduces the effective width of the conducting channel, thereby increasing the resistance N type bar. Consequently the flow of electrons from source to drain decreases, thereby decreasing the drain current. On the other hand, if the reverse voltage on the gate is decreases, the width of the depletion layer also decreases. This increases the width of the conducting channel and hence the drain current increases. When the reverse voltage on the gate VGS is increased further, a stage is reached at which two depletion layers touch each other.

At this gate voltage, the conducting channel is completely blocked and the drain current is reduced to zero. It is clear from above discussion that the drain current can be controlled by the application of potential (i.e. electric field) on the gate.

(e) Compare FET and BJT (any 4 points).
{1M for each point}
Ans:-

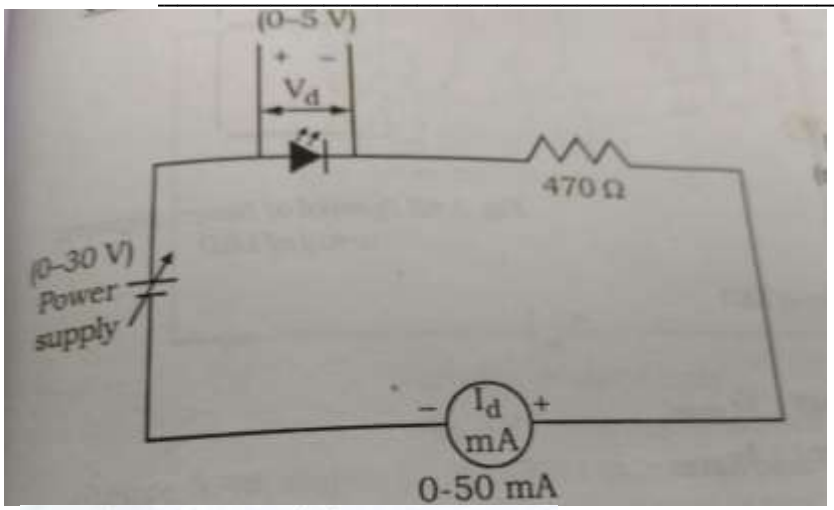
BJT	FET
It is Bipolar device	It is unipolar device
It is current controlled device	It is voltage controlled device.
It's input circuit is forward biased so it has low input impedence.	Input circuit of FET is reversed biased so it has high input impedence.
Collector and emitter cannot be interchanged due to dopping level	Source and drain can be interchanged because both terminals are taken from same channel
Frequency response is moderate and have low bandwidth	Frequency response is excellent and have large bandwidth
Depending on material of used for outer layer transistor is NPN or PNP	Depending on the material of channel FET is P type or N type.
BJT cannot be used as voltage variable resistor.	FET can be used as voltage variable resistor.

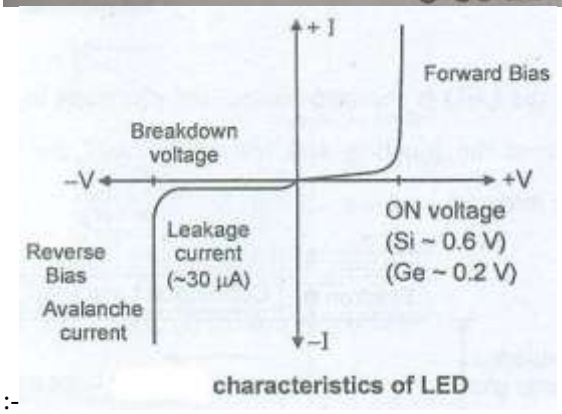
(f) Give the operating principle of crystal oscillator with its circuit diagram.
{2M for diagram and 2M for operating Principle}
Ans:-
When the D.C power is switched on, the noise voltage of small amplitude appearing at the base gets amplified and appears at the output. This amplified noise now drives 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 fo is in between the series resonant frequency fs and the parallel resonant frequency fp of an electrical equivalent circuit of a crystal, Thus, the frequency of oscillations is set by the series resonant frequency fs of the crystal. This produces the undamped oscillations of stable frequency fo.



BJT crystal oscillator

4. Attempt any FOUR. 16M
(a) Draw experimental setup to plot the V-I characteristics of LED.
{ 2M for diagram and 2M for V-I characterstics}





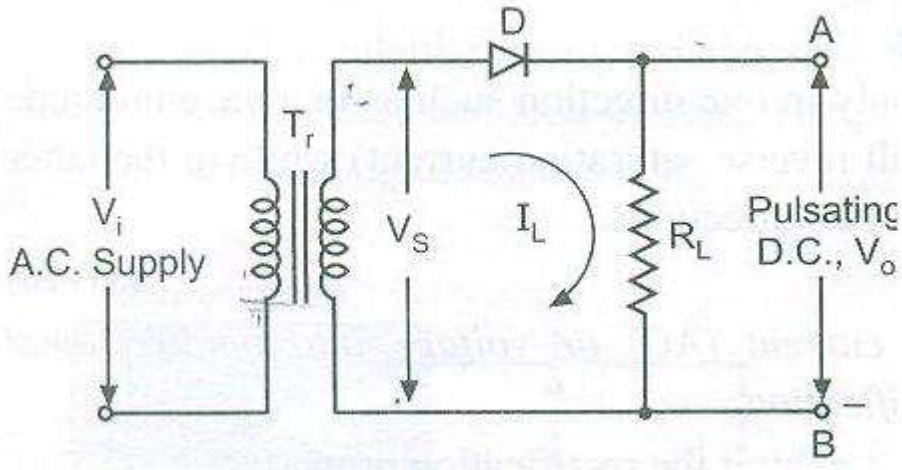
characteristics of LED

:-

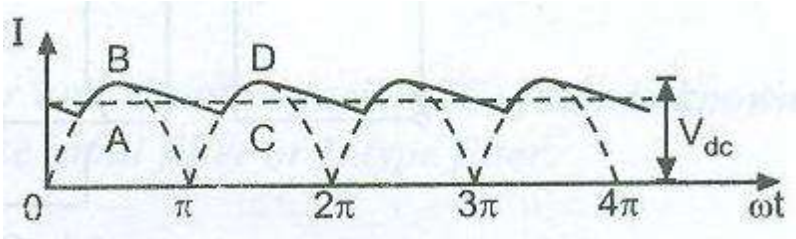
(b) Draw the circuit diagram of half wave rectifier and explain its working with input output waveforms.
{ 2M for circuit Diagram and 1M for working ,1M for waveforms}

Ans:-Explanation – As shown

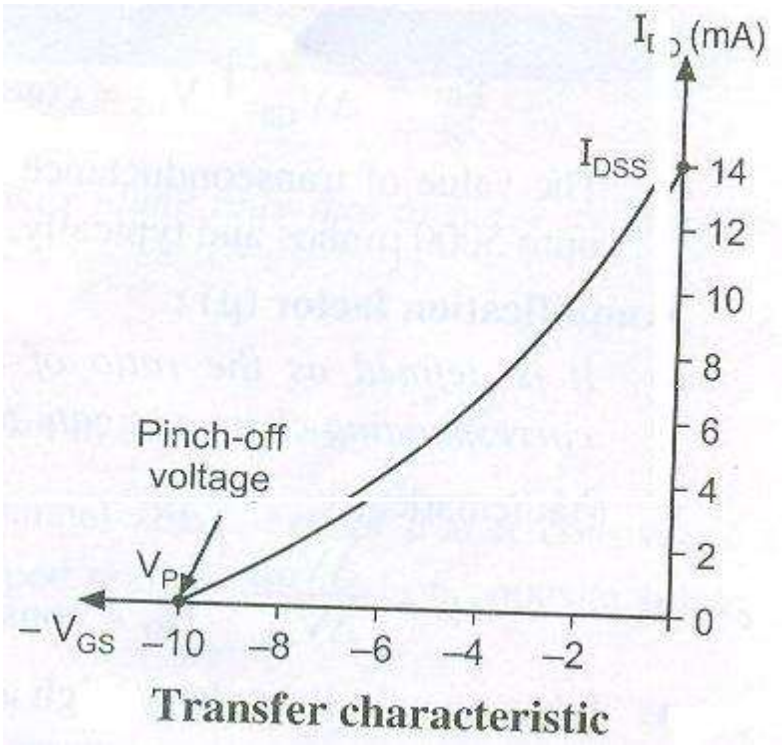
Circuit diagram-



Waveforms-



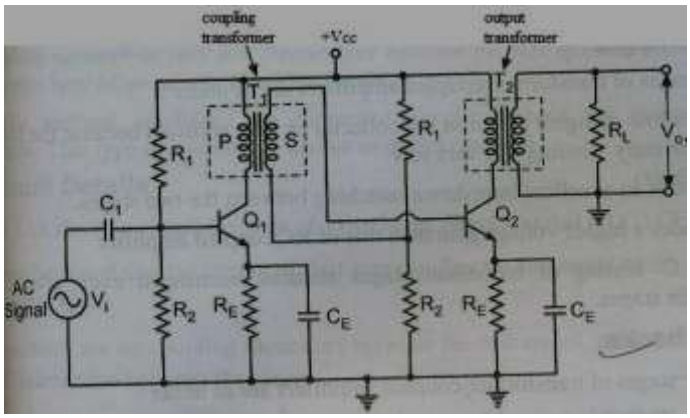
(c) Draw the transfer characteristic N-Channel J-FET and give the meaning of Idss and VGSoff.
{2M for Transfer characterstics and 2 M for definition}



I_{dss}(Shorted Gate Drain Current): It is the drain current with source shorted to gate,i.e. Vgs=0 and drain voltage is equal to pinch off voltage.

Vgsoff: The gate to source voltage at which drain current is reduced to zero is called as pinch Off voltage or Vgs off.

(d) Draw two stage transformer coupled amplifier and define bandwidth of an amplifier.
{ 3M for Diagram, 1M for Defination}
Ans:-

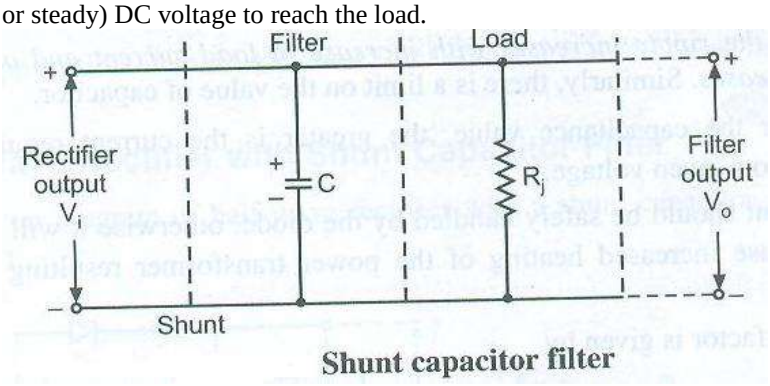


Bandwidth -The range of frequency over which the voltage gain of an amplifier remains constant is known as bandwidth of an amplifier.

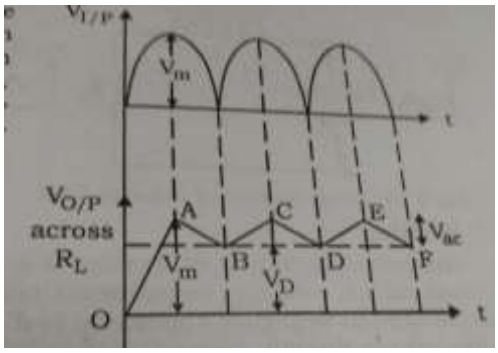
(e) State the need of filter and explain in 'C' type filter with diagrams and waveforms.
{1M need,1M for diagram,1M for explanation,1M for waveform}

Ans:-Need : The rectifiers provide a pulsating output DC voltage across the load containing some ripple and hence these circuits do not provide ripple free (i.e. pure or steady) DC voltage.

The presence of ripple (i.e. AC component) is most undesirable in many electronic circuits and systems because it may affect their normal operation. So ripple must be kept away from the load and it should be removed from the rectified (i.e. pulsating) output.
Therefore, there is a necessity of filter circuit for removing, i.e., smoothing or filtering the ripple and allowing the (pure or steady) DC voltage to reach the load.



Shunt capacitor filter

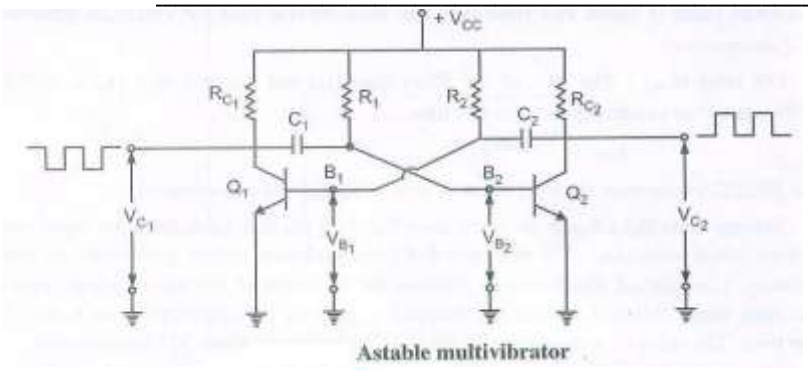


(f) Explain the operation of transistor astable multivibrator with waveforms.
{1M for diagram, Operation - 2M,I mks for waveform}
Ans:-Operation-

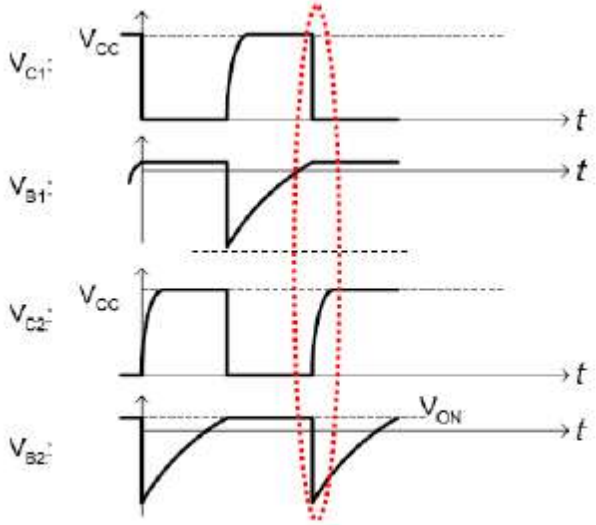
The astable circuit has no stable state. With no external signal applied, the transistors alternately switch from cutoff to saturation at a frequency determined by the RC time constants of the coupling circuits. Astable multivibrator circuit consist of two cross coupled RC amplifiers. 3 Consists of two amplifying devices cross-coupled by resistors and capacitors. Typically, R2 = R3, R1 = R4, C1 = C2 and R2 >> R1. The circuit has two states

State 1: VC1 LOW, VC2 HIGH, Q1 ON (saturation) and Q2 OFF.
State 2: VC1 HIGH, VC2 LOW, Q1 OFF and Q2 ON (saturation).

It continuously oscillates from one state to the other. Astable Multivibrators When the circuit is first powered up, neither transistor is ON. Both VB1 and VB2 rise via base resistor R 3 and R 2 respectively.. Since Q1 conducts and Q2 off hence Vc1 = 0V and Vc2 = VCC. - state1.4Since Q1 conducts and Q2 off hence Vc1 = 0V and Vc2 = VCC. Due to higher voltage at Vc2, capacitor C 2 will be charged via R 4 (low resistance path because R 4 R1). Time taken to discharge C1(T1 = R 2 C1) > time taken to charge C 2 (T 2 =R 4 C 2) When C 2 is fully charged then left plate of C 2 will be at –Vcc which switch off the Q1. When C1 is fully discharged then left plate of C1 will be at +Vcc which switch on the Q2. – State 2 When VB2 reaches Von, the circuit enters in state 1 again, and the process repeats.

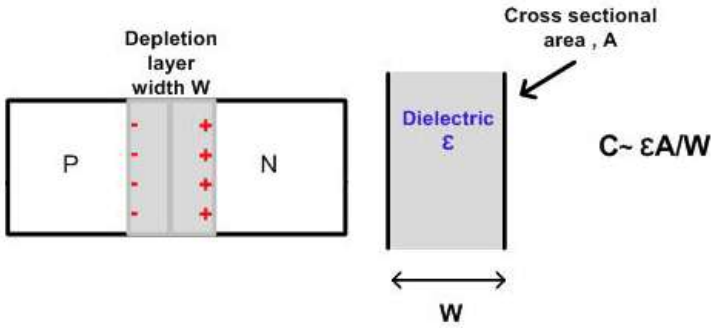


Astable multivibrator



5. Attempt any four **16M**

(a) Explain the operating principle of varactor diode.
{2M Diagram and 2M working Principle}
Ans:-



Working principle:
The varactor or varicap is a diode that exhibits the characteristics of a variable capacitor. The depletion region at the *p-n* junction acts as the dielectric and plates of a common capacitor and is caused to expand and contract by the voltage applied to the diode. This action increases and decreases the capacitance. The schematic symbol for the varactor is shown beside. Varactor diodes are used in tuning circuits and can be used as high-frequency amplifiers.

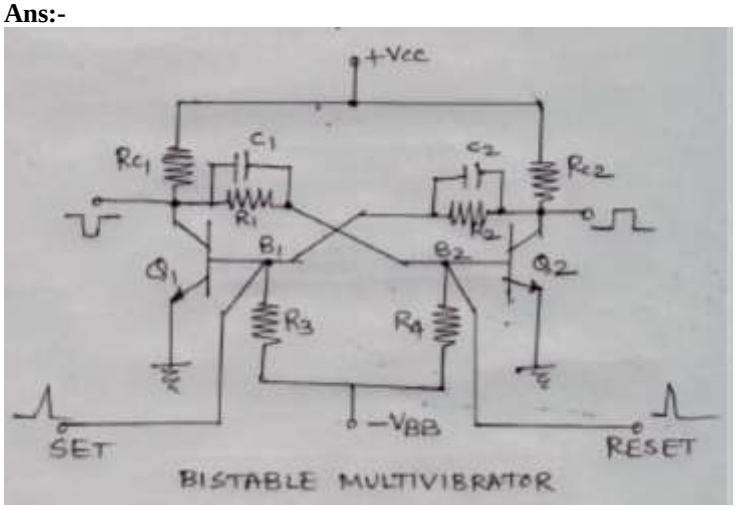
(b) Distinguish between Bridge Rectifier and Centre-tap Full wave Rectifier (any four points).
{4M: 1M for each Point}
Ans:-

Parameters	Bridge rectifiers	Centre Tap Rectifiers
No. of diodes	4	2
PIV	$V_m/2$	$2V_m$

Ripple Factor	0.482	0.482
TUF	0.812	0.693
Ripple Frequency	2f	2f

(b) Explain the working of transistor Bistable multivibrator using circuit diagram.
{2M for working,2M for circuit Dagram}

Ans:-



Working

1. When Vcc supply is switched ON one of the transistor will start conducting more than the other then because of feedback action, this transistor will be driven into saturation and the other to cut-off.
2. Assume that Q1 is ON and Q2 is OFF. It is a stable state of circuit.
3. A negative pulse applied to set input will turn OFF the transistor Q1 and Q2 switches ON.
4. Suppose positive pulse is applied at the reset input. It will cause Q2 to conduct. As Q2 conducts its collector voltage falls and it cut-offs Q1. This Q1 is OFF and Q2 is ON.
5. Now if positive pulse is applied at the set input, it will switch the circuit back to its original stable state i.e. Q1 is ON and Q2 is OFF.

(d) Define the following terms:
{1M for each term}

(i) PIV of diode-The maximum value of reverse voltage that a diode can withstand without destroying its PN junction during the non-conduction period is called peak inverse voltage.

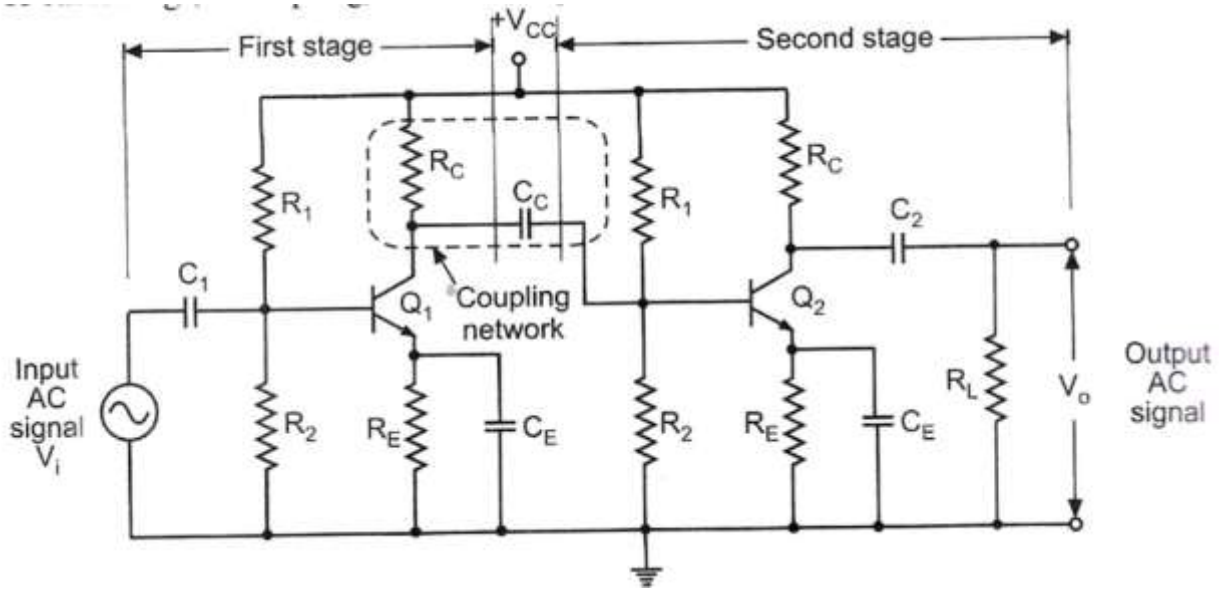
(ii) Efficiency of rectifier -It is the ratio of D.C. powerdelievered to the load to the A.C. input power from secondary transformer secondary.

(iii) Rectification -It is the process in which A.C. is converted the D.C.

(iv) Ripple Factor-It is the ratio of the rms value of a.c. components present in the output of the rectifier to the value of the d.c. component present.

e) Explain the working of two stage RC coupled amplifier with neat circuit diagram.
{2M for circuit Diagram and 2M for working}

Ans:-

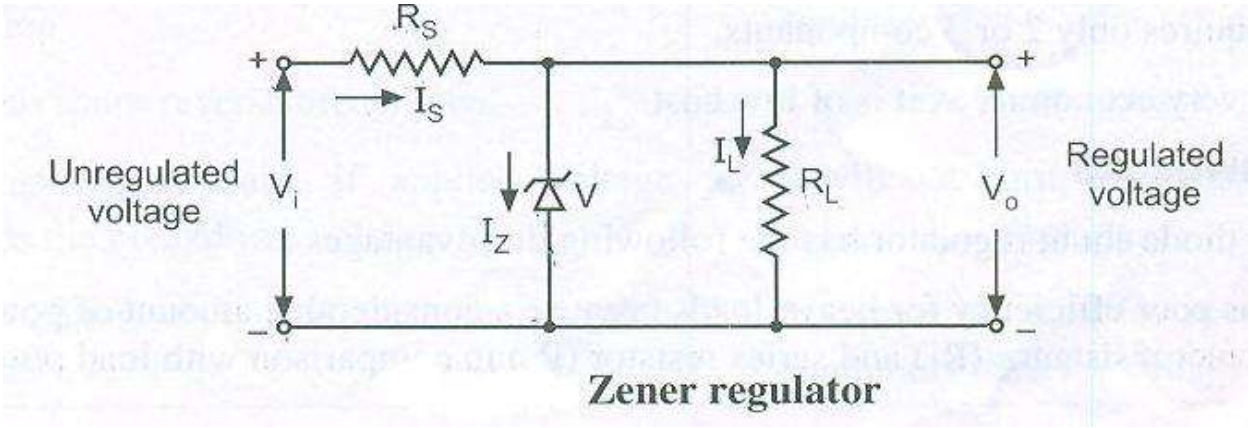


The circuit diagram of a voltage amplifier using single transistor in CE configuration is shown in figure. It is also known as a small-signal single-stage CE amplifier or RC coupled CE amplifier. It is also known as a voltage amplifier. . The potential divider biasing is provided by resistors R1, R2 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.

(f) Explain the working of Zener as voltage regulator .

{2 Mks diagram, 2 mks explanation)

Ans:-



Operating Principle

For proper operation, the input voltage Vimust 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 is the sum of Zener current Izand load current IL.

Therefore, IS = Iz+ IL

orIz= Is - IL

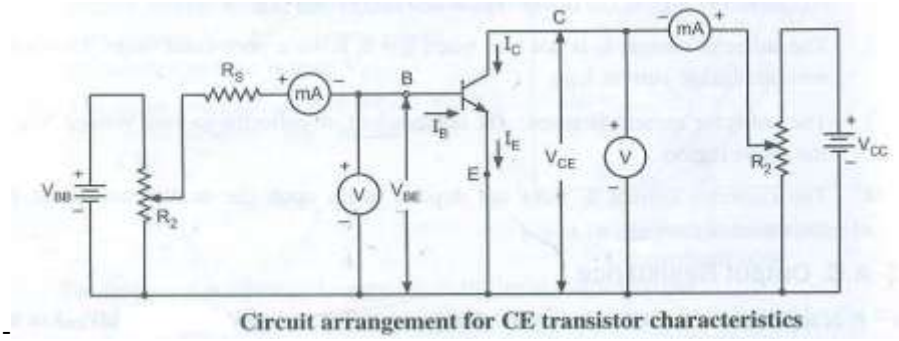
As the load current increase, the Zener current decreases so that the input current remains constant.

According to Kirchhoff's voltage law, the output voltage is given by,

Vo = Vi – Is .Rs

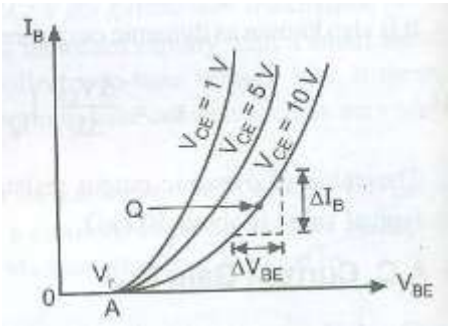
As the input current is constant, the output voltage remains constant (i.e. unaltered or unchanged). The reverse would be true, if the load current decreases. This circuit is also correct for the changes in input voltage.
As the input voltage increases, more Zener current will flow through the Zener 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.

g) Draw the experimental set-up to plot input and output characteristics of CE configuration.
{2M for circuit and 1M for each characterstics}
Ans:-

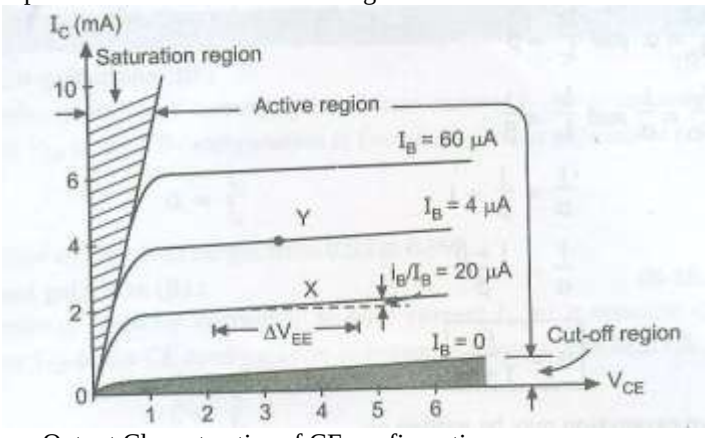


Circuit arrangement for CE transistor characteristics

-



Input Characteristics for CE configuration



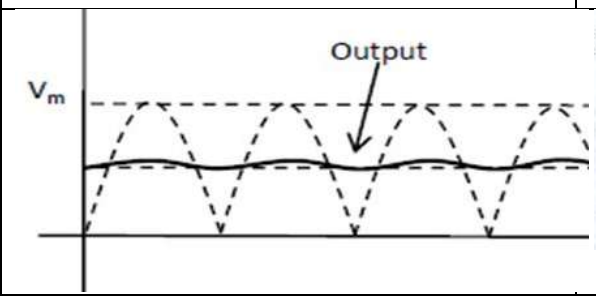
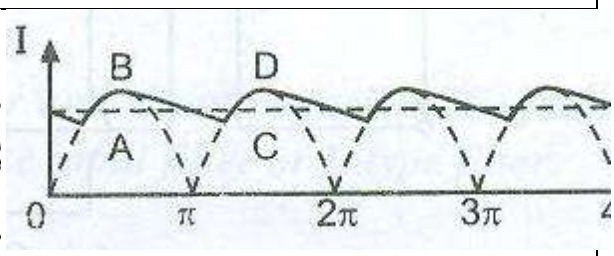
Output Characterstics of CE configuration

6. Attempt any four
(a) Compare PN junction diode and zener diode (any four points)
{4M for each point}
Ans:-

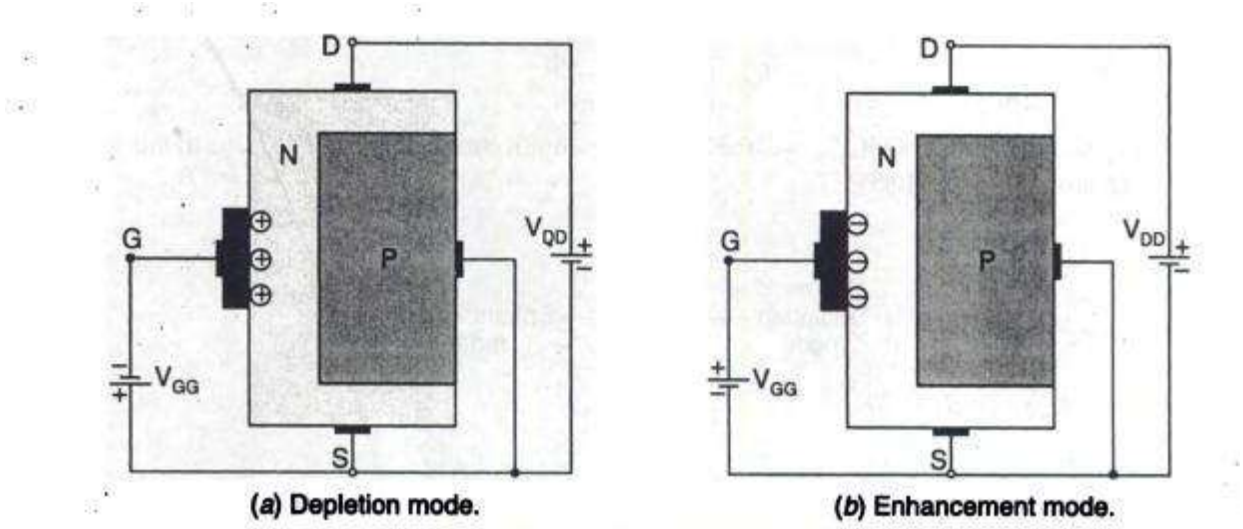
Sr. No.	PN junction Diode	Zener Diode
1	It is not properly doped to control reverse breakdown.	It is properly doped to control reverse breakdown.
2	It conducts only in one direction.	It conducts in both directions.
3	It is always operated in forward-bias condition.	It is always operated in reverse-bias

		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) Compare LC and CLC filter for components used, Ripple factor, waveforms.
{1M for each point}
Ans:-

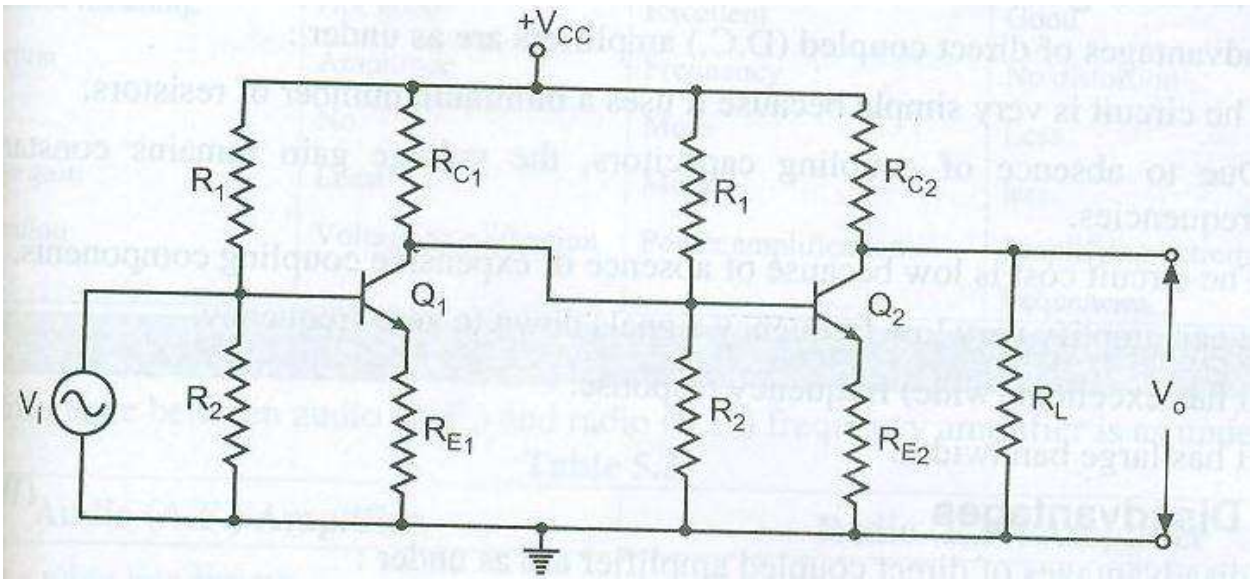
Specification	LC	CLC
Components	1 Inductor and 1 capacito	1 inductor and 2 Capacitors
Ripple Factor	0.83/LC	$3330/C_1C_2R_l$
Waveforms		

(c) Explain the working principle of N-Channel depletion type MOSFET.
{2M for working and 2M for diagram)
Ans:-



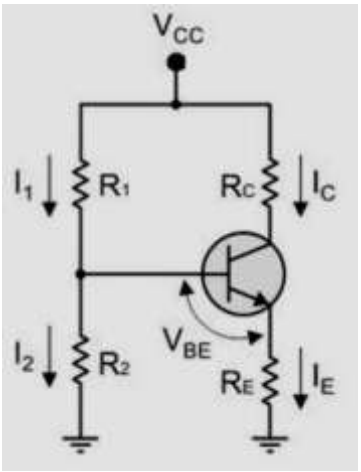
Basic Operation
This MOSFET can be operated in two different modes, namely, Depletion Mode and Enhancement Mode.
In depletion Mode, MOSFET is with negative gate to source voltage. The negative voltage on the gate induces a positive charge in the channel. Due to this, free electrons in the vicinity of 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 VGS is totally depleted of free electrons and hence drain current reduces to zero.

(d)Explain the working of direct coupled amplifier with circuit diagram.
{2M for circuit and 2M for working}
Ans:-



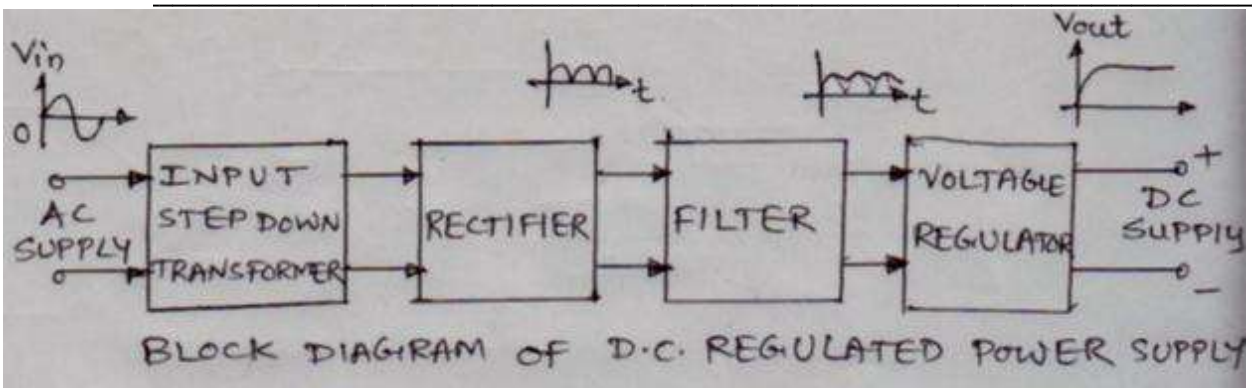
There is no capacitor used for coupling one stage to the other. Q1 and Q2 are the transistors, Vcc is the dc supply, R1, R2, Rc1, Rc2, RE1, RE2 are the biasing elements. i.e. o/p of Q1 i.e., collector of Q1 is connected to base of Q2. The input AC signal is applied to base of Q1, o/p at collector of 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.

(e) Explain the working of voltage divider biasing technique of transistor.
{ 2 mks diagram, 2 mks explanation}
Ans:-



Applying kvl and thevenin's theorem in input and output side we get,
VTH = IB RTH + VBE + IE RE
IC = βIB
Ic = VTH / RE
It is evident from the above equations that the increase in collector current (due to rise in temperature or current gain) will cause voltage drop across the emitter resistor RE to increase.
This in turn decreases the voltage VBE which causes the decrease in base current and hence the collector current decreases to restore its original value.
Thus good stabilization of operating point is ensured for D.C bias.

(f) Draw the block diagram of regulated power supply and explain the working of each block.
{2M for block diagram and 2M for explanation}
Ans:-



Explanation-Transformer- Step downs the 230 v AC into low voltage AC Vm
Rectifier- Converts AC into DC.
Filter-Converts pulsating DC into pure DC.
Voltage regulator- It converts fluctuating DC into Constant DC across the load.