18EE001

I/IV B.Tech (Regular) DEGREE EXAMINATION SCHEME OF EVALUATION

DECEMBER, 2018 **Mechanical Engineering**

First Semester **Basic Electrical And Electronics Engineering**

Time: Three Hours **Maximum :** 50 Marks

Answer Question No.1 compulsorily. (1X10 = 10 Marks)

Answer ONE question from each unit. (4X10=40 Marks)

1. Answer all questions (1X10=10 Marks)

a State two fundamental laws of circuit analysis.

LCK: Algebraic sum of currents at any node (junction) is equal to Zero.
KVL: Algebraic sum of potential drops at any loop is equal to Zero.

b A piece of resistive material has a length of 10 mm, a cross sectional area of 7 mm^2 and a resistivity of
4700 X 10^{-8} Ω -m. What is its resistance?

$$R = \frac{\Gamma l}{A} = \frac{4700X10^{-8}X0.01}{7X10^{-6}} = 4.7K\Omega$$

c Write expression for gain of non-inverting amplifier.

Gain of non –inverting amplifier $Af = 1 + \frac{R_f}{R_1}$

d Calculate the energy stored in a 22 μF capacitor when it is charged to 120 V.

$$\text{energy stored in capacitor} = \frac{1}{2}cv^2 = \frac{1}{2}X\ \ 2210^{-6}X120X120 = 158.4mJ$$

e FET is a <u>voltage</u> operated (controlled) device.

f Define slew rate.
The maximum rate at which an amplifier can respond to an abrupt change of input level.

g Maximum theoretical efficiency of half-wave rectifier is <u>40.6.</u>

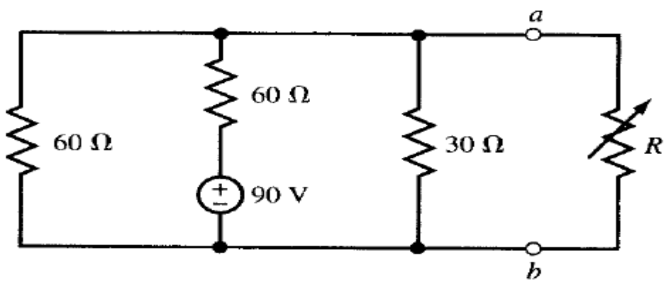
h All <u>Meshes</u> are loops but <u>All loops</u> are not meshes.

i Distinguish between statically induced EMF and dynamically induced EMF.
Static is stationary. so there is no relative motion between field nor coil. The source should be alternating in nature. Then only emf can be induced. In dynamically induced emf there is relative motion between conductor and field. Because relative speed is an important point to get the dynamically induced emf.

j What is the unit of admittance?
mho, and its symbol is ℧.

UNIT – I

2. a Obtain Norton’s equivalent for the fallowing circuit to the left of terminals ab. 5M



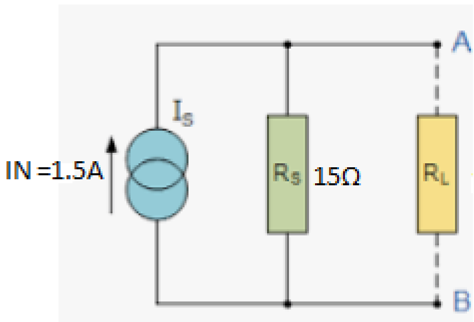
30Ω and 60 Ω are connected in parallel , so parallel equivalent resistance is =

$$\frac{60X30}{60+30} = \frac{1800}{90} = 20\ \Omega.$$

$$\text{Voltage at terminals ab is} V_{th} = \frac{90X20}{20+60} = 22.5V$$

$$\text{Thevenin equivalent resistance} = R_{Th} = \frac{60X20}{60+20} = \frac{1200}{80} = 15\Omega$$

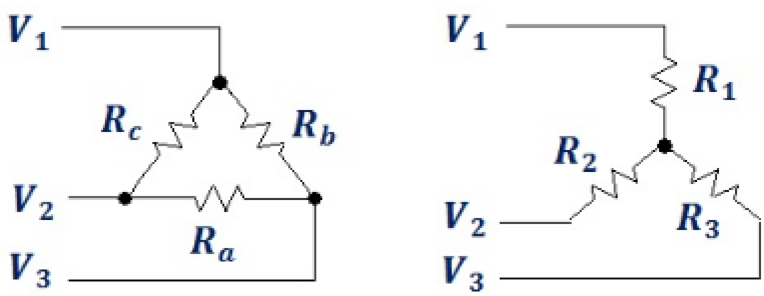
$$\text{Norton's current} = \frac{\text{Open circuit voltage}}{\text{thevenins resistance}} = \frac{22.5}{15} = 1.5A$$



Norton's equivalent circuit

2. b | Convert delta network of resistances 10Ω, 15Ω and 25Ω in to an equivalent star network. | 5M

Delta to Star (Δ to Y) Resistance Conversion Formula



$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_a R_c}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

Let Ra = 10Ω,Rb = 15Ω,Rc = 25Ω

Using these values and above formulae

R1=7.5Ω, R2=5Ω, R3=3Ω.

(OR)

3. a	Obtain the expressions for impedance of RLC series circuit and admittance of RLC parallel circuit along with resonant frequency.	4M

$Z=R+j\omega L+\frac{1}{j\omega C}$

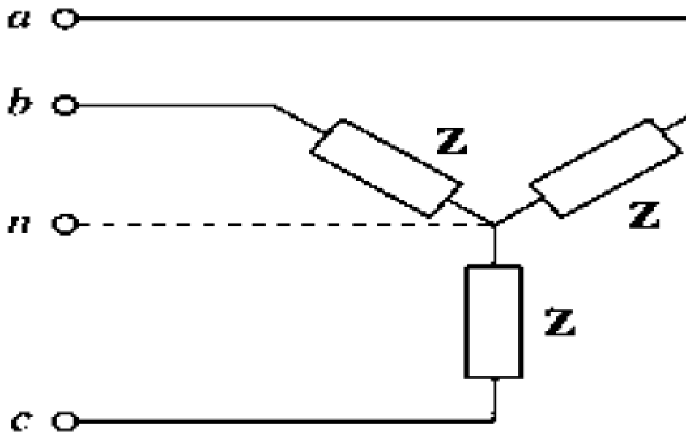
$Y=\frac{1}{R}+\frac{1}{j\omega L}+j\omega C$

At resonant frequency impedance Z becomes equal to R and imaginary frequency part becomes equal to Zero.

$j\omega L=\frac{j}{\omega C}$

$F=\frac{1}{2\pi\sqrt{LC}}$

3. b	Derive expressions for voltage and current relation in balanced 3 phase Y network?	6M



For star connection, phase voltage= Line voltage/($\sqrt{3}$)

For ABC sequence, the phase voltage is polar form are taken as

$$V_{AN}=V_{ph}\angle-90^0\ ;\ V_{CN}=V_{ph}\angle150^0\ ;\ V_{BN}=V_{ph}\angle30^0$$

For star connection line currents and phase currents are equal

$$I_A=\frac{V_{AN}}{Z}\ ;\ I_B=\frac{V_{BN}}{Z}\ ;\ I_C=\frac{V_{CN}}{Z}\ ;$$

To determine the current in the neutral wire apply KVL at star point

$$I_N+I_A+I_B+I_C=0$$

$$I_N=-(I_A+I_B+I_C)\quad\text{(since they are balanced)}$$

In a balanced system the neutral current is zero. Hence if the load is balanced, the current and voltage will be same whether neutral wire is connected or not. Hence for a balanced 3-phase star connected load, whether the supply is 3- phase 3 wire or 3-phase 4 wire, it is immaterial. In case of unbalanced load, there will be neutral current.

UNIT – II

4. a Elaborate the construction of DC Generator With neat diagram.(Diagrams-2 Explenation-3M) 7M

DC Generator

A dc generator is an electrical machine which converts mechanical energy into direct current electricity. This energy conversion is based on the principle of production of dynamically induced emf.

Construction of a DC machine:

Note: A DC generator can be used as a DC motor without any constructional changes and vice versa is also possible.

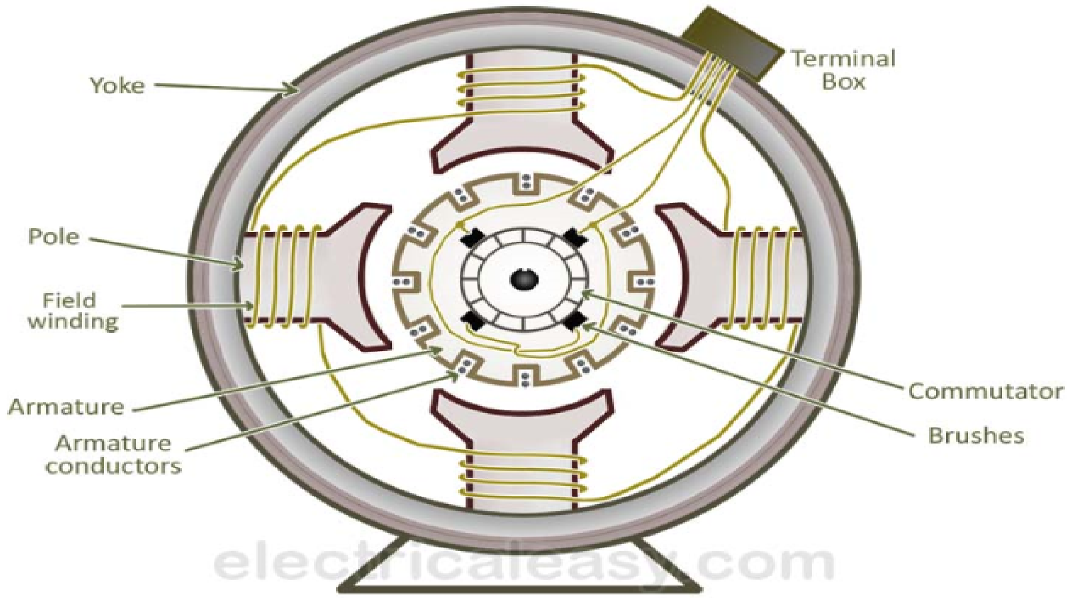
Thus, a DC generator or a DC motor can be broadly termed as a DC machine.

Yoke:

- The outer frame of a dc machine.
- Provides mechanical strength to the whole assembly
- Protects all component -Moisture, Air etc..
- Made up of cast iron or steel.
- carries the magnetic flux produced by the field winding.
- Provides low reluctance for the flux.
- Reluctance: property of magnetic circuit of opposing the passage of magnetic flux lines,
- Equal to ratio of the magnetomotive force to the magnetic flux

Poles and pole shoes:

- Poles are joined to the yoke with the help of bolts or welding.
- carry field winding and pole shoes are fastened to them.



Pole shoes serve two purposes-

1.Support field coils

2.Spread out the flux in air gap uniformly.

Thin shiets

Field winding:

- Carries current responsible for production of magnetic flux.
- Made of copper –Bend easily.
- Field coils are former wound and placed on each pole
- connected in series.
- They are wound in such a way that, when energized, they form alternate North and South poles.

- **Armature core:**

  Armature core is the rotor of a dc machine. It is cylindrical in shape with slots to carry armature winding. The armature is built up of thin laminated circular steel disks for reducing eddy current losses.

  It may be provided with air ducts for the axial air flow for cooling purposes. Armature is keyed to the shaft.

  Armature winding:

  It is usually a former wound copper coil which rests in armature slots. The armature conductors are insulated from each other and also from the armature core. Armature winding can be wound by one of the two methods; lap winding or wave winding. Double layer lap or wave windings are generally used. A double layer winding means that each armature slot will carry two different coils

1. **Commutator and brushes:** Physical connection to the armature winding is made through a commutator-brush arrangement. The function of a commutator, in a dc generator, is to collect the current generated in armature conductors. Whereas, in case of a dc motor, commutator helps in providing current to the armature conductors. A commutator consists of a set of copper segments which are insulated from each other. The number of segments is equal to the number of armature coils. Each segment is connected to an armature coil and the commutator is keyed to the shaft. Brushes are usually made from carbon or graphite. They rest on commutator segments and slide on the segments when the commutator rotates keeping the physical contact to collect or supply the current.

4. List various losses in transformer. 3M

b Mmainly transformer losses are classified in following category

- **core loss**(fixed for given frequency and given material of core)
- hysteresis loss
- eddy current loss
- **copper loss**(variable with load current)

  core loss occur due to the core of transformer .as core of transformer is made up of ferromagnetic material so these losses occur

1. **Hysteresis loss** :A transformer core is made up of ferromagnetic material and these materials are very sensitive to magnetisation.These materials behave as magnates when external magnetic field is applied these materials having number of domains in their structure .these domains are nothing but small permanent magnets whose axes are randomly oriented inside the material so net magnetization is zero. But when an external magnetic field is applied, the axes of domains (small magnets) get aligned to the axis of external applied magnetic field and when this external magnetic field is removed, maximum domains attain their original position but some of them do not attain their position means material do not demagnetize completely

and this is the reason of hysteresis loss. In transformer we give AC supply so after each half cycle reversal of external magnetic field, so reversal of domain, so an extra work has to done to completely reverse it and this extra work needs electrical energy which results in hysteresis loss.

2. **eddy current loss:**In transformer we provide alternating current in primary which produces alternating flux in core ,this flux links with secondary of transformer and induces emf in secondary , it may be possible that flux also links with some other conducting parts of transformer like ferromagnetic core or iron body and induces local emf i n these parts of transformer which will cause a circulating current to flow in these parts causing heat loss.these currents are called eddy current and this loss is called eddy current loss.

3. **copper loss: A**s pure inductive coil is not possible,it must have some resistance ,so due to resistances there are losses in each winding of transformer which are called copper loss.this loss varies as load current varies so it is called variable loss.

(OR)

5. a Describe generation of rotating magnetic field with example. 5M

The production of Rotating magnetic field in 3 phase supply is very interesting. When a 3-phase winding is energized from a 3-phase supply, a rotating magnetic field is produced. This field is such that its poles do no remain in a fixed position on the stator but go on shifting their positions around the stator. For this reason, it is called a rotating field. It can be shown that magnitude of this rotating field is constant and is equal to 1.5 fm where fm is the maximum flux due to any phase.
A three phase induction motor consists of three phase winding as its stationary part called stator. The three phase stator winding is connected in star or delta. The three phase windings are displaced from each other by 120°. The windings are supplied by a balanced three phase ac supply.
The three phase currents flow simultaneously through the windings and are displaced from each other by 120° electrical. Each alternating .phase current produces its own flux which is sinusoidal. So all three fluxes are sinusoidal and are separated from each other by 120°. If the phase sequence of the windings is R-Y-B, then mathematical equations for the instantaneous values of the three fluxes ΦR , ΦY ,ΦB can be written as,

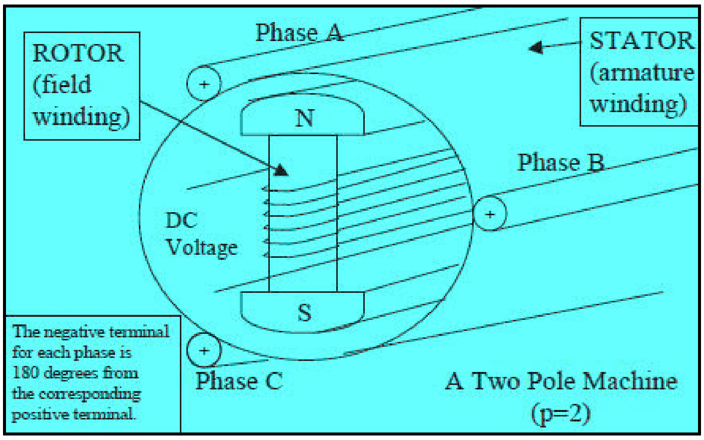
$$\Phi R = \Phi m \sin(\omega t)$$
$$\Phi Y = \Phi m \sin(\omega t - 120)$$
$$\Phi B = \Phi m \sin(\omega t - 240)$$

As windings are identical and supply is balanced, the magnitude of each flux is Φm
.

5. b Explain working principle of synchronous generator with neat diagram.(Diagrams-2 Explenation-3M) 5M

Construction of Synchronous Generator

In general, synchronous generator consists of two parts rotor and stator. The rotor part consists of field poles and stator part consists of armature conductors. The rotation of field poles in the presence of armature conductors induces an alternating voltage which results in electrical power generation.

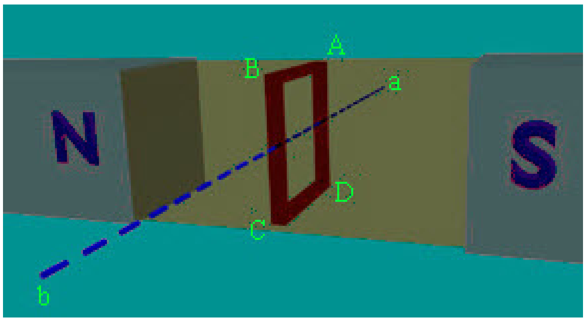


The speed of field poles is synchronous speed and is given by

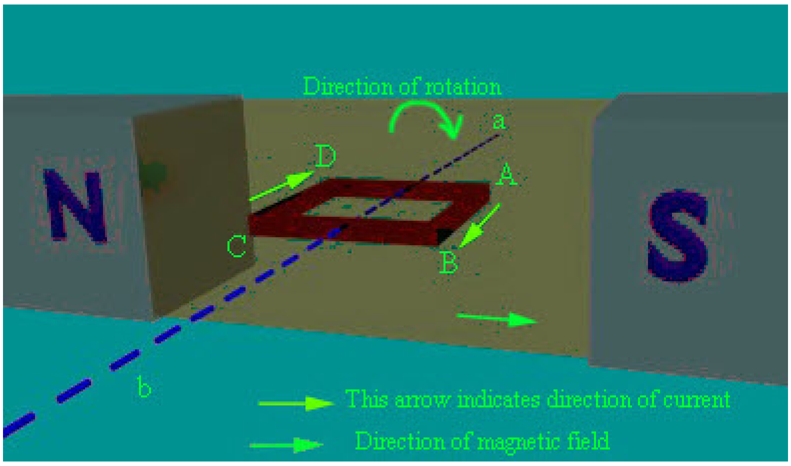
$$N_s = \frac{120f}{P}$$

Synchronous Generator Working Principle

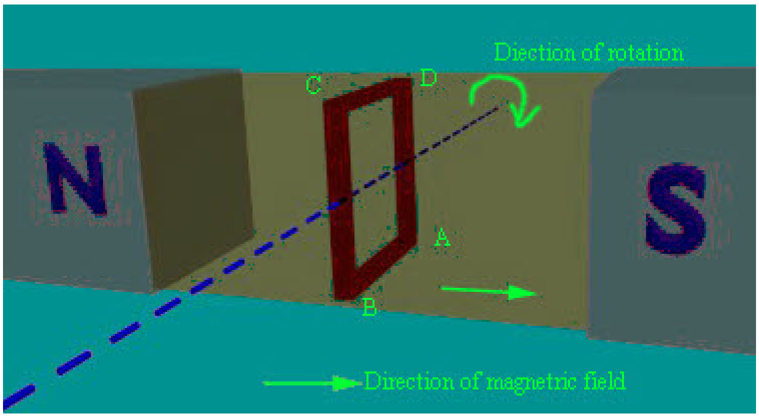
The principle of operation of synchronous generator is electromagnetic induction. If there exists a relative motion between the flux and conductors, then an emf is induced in the conductors. To understand the synchronous generator working principle, let us consider two opposite magnetic poles in between them a rectangular coil or turn is placed as shown in the below figure.



If the rectangular turn rotates in clockwise direction against axis a-b as shown in the below figure, then after completing 90 degrees rotation the conductor sides AB and CD comes in front of the S-pole and N-pole respectively. Thus, now we can say that the conductor tangential motion is perpendicular to magnetic flux lines from north to south pole.



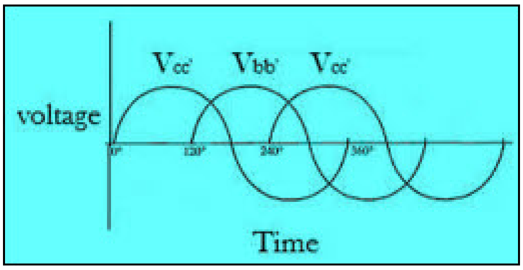
So, here rate of flux cutting by the conductor is maximum and induces current in the conductor, the direction of the induced current can be determined using [Fleming's right hand rule](). Thus, we can say that current will pass from A to B and from C to D. If the conductor is rotated in a clockwise direction for another 90 degrees, then it will come to a vertical position as shown in the below figure.



Now, the position of conductor and magnetic flux lines are parallel to each other and thus, no flux is cutting and no current will be induced in the conductor. Then, while the conductor rotates from clockwise for another 90 degrees, then rectangular turn comes to a horizontal position as shown in the below figure. Such that, the conductors AB and CD are under the N-pole and S-pole respectively. By applying Fleming's right hand rule, current induces in conductor AB from point B to A and current induces in a conductor CD from point D to C.

So, the direction of current can be indicated as A – D – C – B and direction of current for the previous horizontal position of rectangular turn is A – B – C – D. If the turn is again rotated towards vertical position, then the induced current again reduces to zero. Thus, for one complete revolution of rectangular turn the current in the conductor reaches to maximum & reduces to zero and then in the opposite direction it reaches to maximum & again reaches to zero. Hence, one complete revolution of rectangular turn produces one full sine wave of current induced in the conductor which can be termed as the generation of alternating current by rotating a turn inside a magnetic field.

Now, if we consider a practical synchronous generator, then field magnets rotate between the stationary armature conductors. The synchronous generator rotor and shaft or turbine blades are mechanically coupled to each other and rotates at synchronous speed. Thus, the magnetic flux cutting produces an induced emf which causes the current flow in armature conductors. Thus, for each winding the current flows in one direction for the first half cycle and current flows in the other direction for the second half cycle with a time lag of 120 degrees (as they displaced by 120 degrees). Hence, the output power of synchronous generator can be shown as below figure.



UNIT – III

6. Derive the expression for average, RMS and efficiency of Full wave rectifier. 5M

a **Average (DC) current**

$$I_{av} = I_{DC} = \frac{1}{\pi}\int_0^{\pi} i_L \, d(\omega t) = \frac{1}{\pi}\int_0^{\pi} I_m \sin\omega t \, d\omega t$$

$$\boxed{I_{DC} = \frac{2I_m}{\pi}}$$ for full wave rectifier

Average (DC) Voltage

$$E_{DC} = I_{DC}R_L = \frac{2I_mR_L}{\pi}$$

Substituting value of I_m,

$$E_{DC} = \frac{2\,E_{sm}\,R_L}{\pi\,[R_f + R_s + R_L]} = \frac{2\,E_{sm}}{\pi\left[1 + \frac{R_f + R_s}{R_L}\right]}$$

But as R_f and $R_s << R_L$ hence $\frac{R_f + R_s}{R_L} << 1$

$$\therefore \quad \boxed{E_{DC} = \frac{2E_{sm}}{\pi}}$$

DC Output Power

D.C. Power output $= E_{DC}I_{DC} = I_{DC}^2 R_L$

$$P_{DC} = I_{DC}^2R_L = \left(\frac{2I_m}{\pi}\right)^2 R_L$$

$$P_{DC} = \frac{4}{\pi^2} I_m^2 R_L$$

AC input power (Pac)

The a.c. power input is given by,

$$\therefore \quad \boxed{P_{AC} = I_{RMS}^2(R_f + R_s + R_L) = \left(\frac{I_m}{\sqrt{2}}\right)^2 (R_f + R_s + R_L)}$$

$$\therefore \quad P_{AC} = \frac{I_m^2(R_f + R_s + R_L)}{2}$$

Rectifier Efficiency (η)

$$\eta = \frac{P_{DC}\text{ output}}{P_{AC}\text{ input}} = \frac{\frac{4}{\pi^2} I_m^2 R_L}{\frac{I_m^2(R_f + R_s + R_L)}{2}} = \frac{8\,R_L}{\pi^2(R_f + R_s + R_L)}$$

But if $R_f + R_s << R_L$, neglecting it from denominator

$$\eta = \frac{8\,R_L}{\pi^2(R_L)} = \frac{8}{\pi^2}$$

$$\therefore \quad \boxed{\%\,\eta_{max} = \frac{8}{\pi^2} \times 100 = 81.2\ \%}$$

6. Explain Clipping and Clamping action With simple diagrams. (Diagrams-2 5M
b Explenation-3M)

CLIPPING CIRCUIT :

- Diode **Clipper** is a wave shaping circuit that takes an input waveform and ***clips*** or ***cuts*** off its top half, bottom half or both halves together. This clipping of the input signal produces an output waveform that resembles a ***flattened version*** of the input.
- It is also known as a **limiter**.
- Clippers are used to perform one of the following two functions:

Changing the shape of a waveform:

  - For example, a clipper can be used to convert a sine wave into rectangular wave, square wave etc.

Circuit Transient protection :

A transient is a sudden current or voltage rise that has an extremely short duration.

In such cases, a clipper diode can be used to prevent the transient from reaching that circuit.

Depending on the features of the diode, the positive or negative region of the input signal is "clipped" off and accordingly the diode clippers may be positive or negative clippers.

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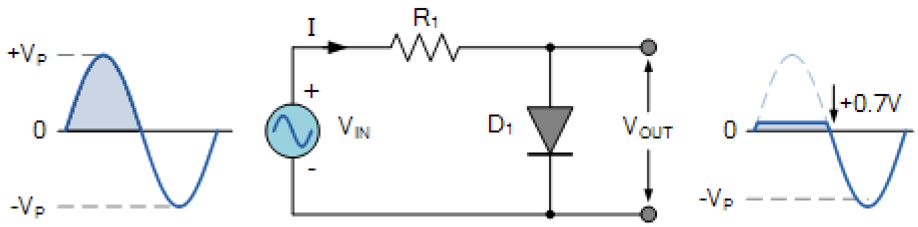
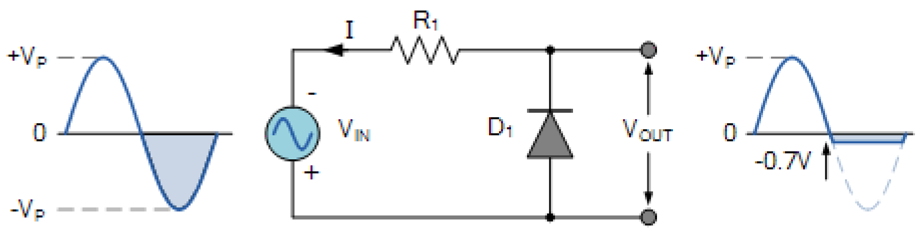


Positive Clipper



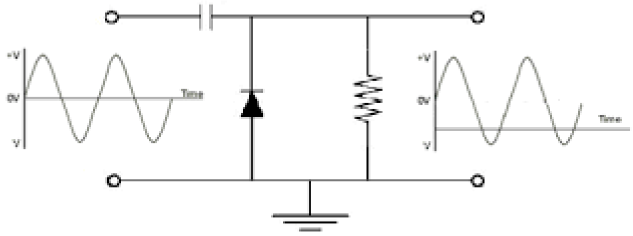
Negative Clipper

- Different levels of clipping can be obtained by varying the amount of voltage of the battery and also interchanging the positions of the diode and resistor.

CLAMPING CIRCUIT :

The Clamping circuit or clamper keeps the amplitude of the output signal same as that of the input signal except that the D.C. level (offset) has been changed.

Simply it is a circuit that places either the positive or negative peak of a signal at a desired d.c. level is known as a clamping circuit.



CLAMPING CIRCUIT

(OR)

7. a What are regions of operations of transistor? Explain Transistor characteristics with Common Emitter configuration. (Diagrams-2 Explenation-3M) 5M

Bipolar junction **transistors** has two junctions base emitter junction, base collector junction. Accordingly there are four different **regions** of operation in which either of the two junctions are forward biased reverse biased or both.

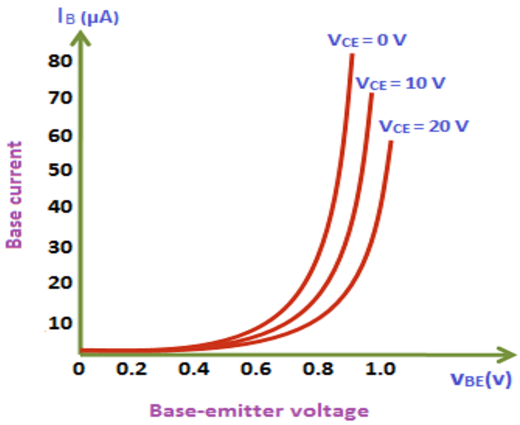
1.Active region 2. Saturation region 3.cutoff region

Input characteristics

The input characteristics describe the relationship between input current or base current (I_B) and input voltage or base-emitter voltage (V_{BE}).

First, draw a vertical line and a horizontal line. The vertical line represents y-axis and horizontal line represents x-axis. The input current or base current (I_B) is taken along y-axis (vertical line) and the input voltage (V_{BE}) is taken along x-axis (horizontal line).

To determine the input characteristics, the output voltage V_{CE} is kept constant at zero volts and the input voltage V_{BE} is increased from zero volts to different voltage levels. For each voltage level of input voltage (V_{BE}), the corresponding input current (I_B) is recorded.



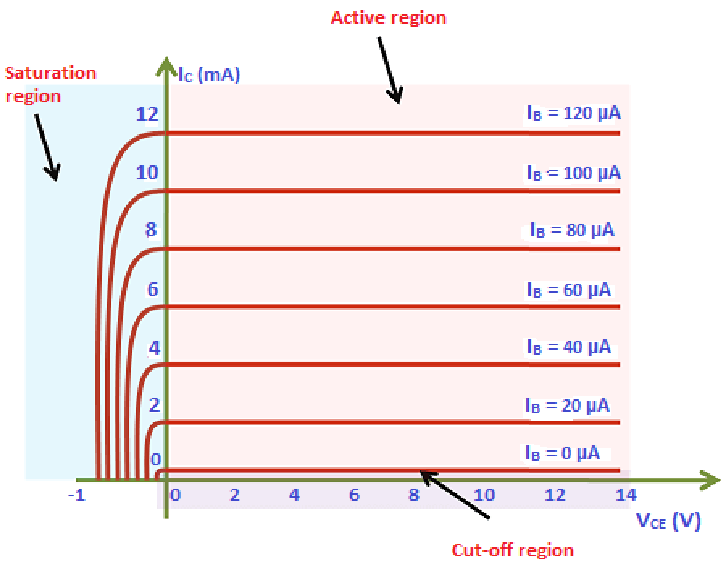
I/P characteristics CE configuration

Output characteristics

The output characteristics describe the relationship between output current (I_C) and output voltage (V_{CE}).

First, draw a vertical line and a horizontal line. The vertical line represents y-axis and horizontal line represents x-axis. The output current or collector current (I_C) is taken along y-axis (vertical line) and the output voltage (V_{CE}) is taken along x-axis (horizontal line).

To determine the output characteristics, the input current or base current I_B is kept constant at 0 μA and the output voltage V_{CE} is increased from zero volts to different voltage levels. For each level of output voltage, the corresponding output current (I_C) is recorded.



O/P Characteristics CE Configuration

7. b What is Q point? Explain voltage divider biasing of transistor with neat sketch. 5M

(Diagrams-2 Explenation-3M)

The operating **point** of a device, also known as bias point, quiescent point, or Q-point, is the DC voltage or current at a specified terminal of an active device (a transistor or vacuum tube) with no input signal applied.

Voltage Divider Transistor Biasing

The common emitter transistor is biased using a voltage divider network to increase stability. The name of this biasing configuration comes from the fact that the two resistors R_{B1} and R_{B2} form a voltage or potential divider network across the supply with their center point junction connected the transistors base terminal as shown.

This voltage divider biasing configuration is the most widely used transistor biasing method, as the emitter diode of the transistor is forward biased by the voltage dropped across resistor R_{B2}. Also, voltage divider network biasing makes the transistor circuit independent of changes in beta as the voltages at the transistors base, emitter, and collector are dependent on external circuit values.

To calculate the voltage developed across resistor R_{B2} and therefore the voltage applied to the base terminal we simply use the voltage divider formula for resistors in series.

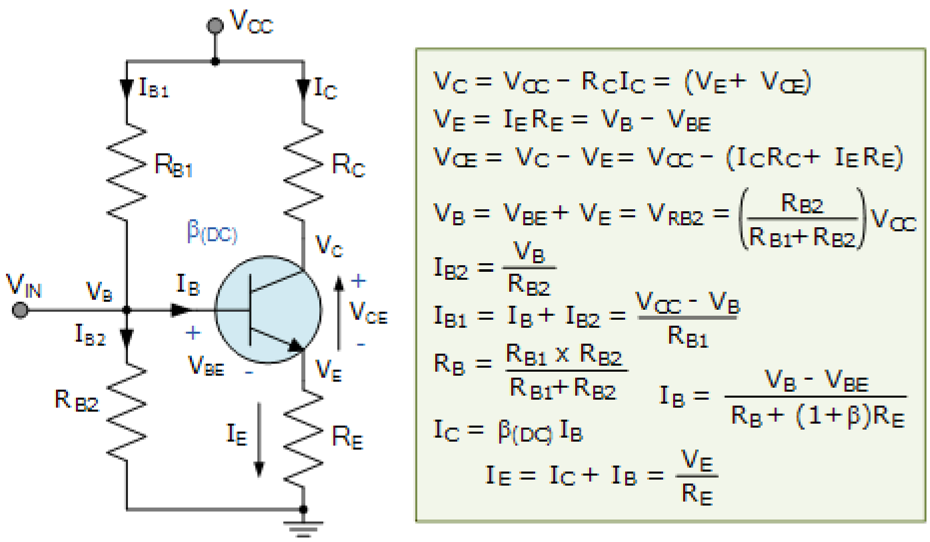
Generally the voltage drop across resistor R_{B2} is much less than for resistor R_{B1}. Then clearly the transistors base voltage V_B with respect to ground, will be equal to the voltage across R_{B2}.

The current flowing through resistor R_{B2} is generally set at 10 times the value of the required base current I_B so that it has no effect on the voltage divider current or changes in Beta.

The goal of Transistor Biasing is to establish a known Q-point in order for the transistor to work efficiently and produce an undistorted output signal. Correct biasing of the transistor also establishes its initial AC operating region with practical biasing circuits using either a two or four-resistor bias network.

In bipolar transistor circuits, the Q-point is represented by (VCE, I_C) for the NPN transistors or (VEC, I_C) for PNP transistors. The stability of the base bias network and therefore the Q-point is generally assessed by considering the collector current as a function of both Beta (β) and temperature.

Here we have looked briefly at five different configurations for "biasing a transistor" using resistive networks. But we can also bias a transistor using either silicon diodes, zener diodes or active networks all connected to the base terminal of the transistor or by biasing the transistor from a dual power supply.

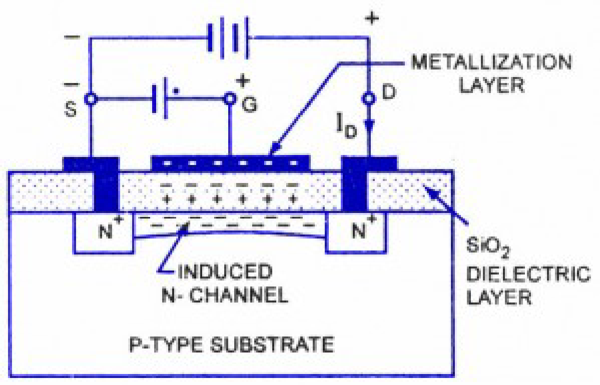


UNIT – IV

8. a Explain operational characteristics of Enhancement MOSFET. (Diagrams-3 Explenation-4M) 7M

Enhancement Mode Operating regions

Operation of an EMOSFET:



Operation of N-Channel E-MOSFET

Working of an EMOSFET

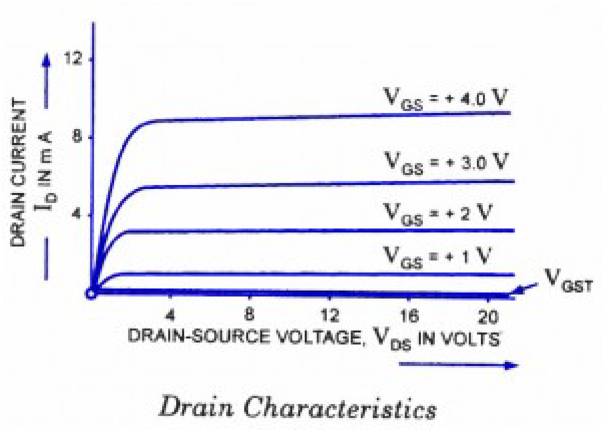
As its name indicates, this MOSFET operates only in the *enhancement mode* and has no depletion mode. It operates with large positive gate voltage only. It does not conduct when the gate-source voltage $V_{GS} = 0$. This is the reason that it is called normally-off MOSFET. In these MOSFET's drain current I_D flows only when V_{GS} exceeds V_{GST} [gate-to-source threshold voltage].

When drain is applied with positive voltage with respect to source and no potential is applied to the gate two N-regions and one P-substrate from two P-N junctions connected back to back with a resistance of the P-substrate. So a very small drain current that is, reverse leakage current flows. If the P-type substrate is now connected to the source terminal, there is zero voltage across the source substrate junction, and the drain-substrate junction remains reverse biased.

When the gate is made positive with respect to the source and the substrate, negative (i.e. minority) charge carriers within the substrate are attracted to the positive gate and accumulate close to the-surface of the substrate. As the gate voltage is increased, more and more electrons accumulate under the gate. Since these electrons cannot flow across the insulated layer of silicon dioxide to the gate, so they accumulate at the surface of the substrate just below the gate. These accumulated minority charge carriers N -type channel stretching from drain to source. When this occurs, a channel is induced by forming what is termed an *inversion layer* (N-type). Now a drain current start flowing. The strength of the drain current depends upon the channel resistance which, in turn, depends upon the number of charge carriers attracted to the positive gate. Thus drain current is controlled by the gate potential.

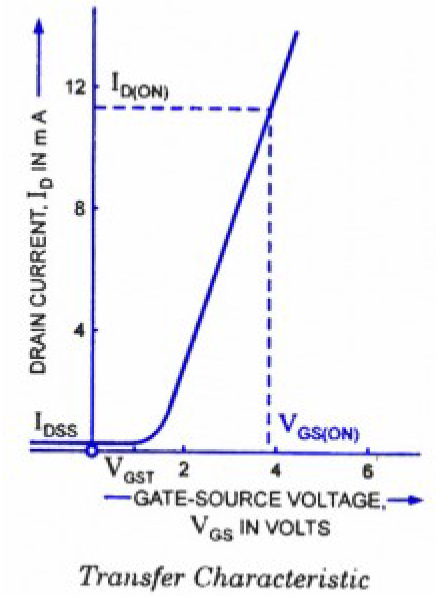
Since the conductivity of the channel is enhanced by the positive bias on the gate so this device is also called the *enhancement MOSFET* or E- MOSFET.

Characteristics of an EMOSFET.



Drain Characteristics-EMOSFET

Drain characteristics of an N-channel E-MOSFET are shown in figure. The lowest curve is the V_{GST} curve. When V_{GS} is lesser than V_{GST}, I_D is approximately zero. When V_{GS} is greater than V_{GST}, the device turns- on and the drain current I_D is controlled by the gate voltage. The characteristic curves have almost vertical and almost horizontal parts. The almost vertical components of the curves correspond to the ohmic region, and the horizontal components correspond to the constant current region. Thus E-MOSFET can be operated in either of these regions *i.e.* it can be used as a variable-voltage resistor (WR) or as a constant current source.



EMOSFET-Transfer Characteristics

Figure shows a typical transconductance curve. The current IDSS at VGS <=0 is very small, being of the order of a few nano-amperes. When the V_{GS} is made positive, the drain current I_D increases slowly at first, and then much more rapidly with an increase in V_{GS}. The manufacturer sometimes indicates the *gate-source threshold voltage* V_{GST} at which the drain current I_D attains some defined small value, say 10 u A. A current $I_{D\ (0N}$, corresponding approximately to the maximum value given on the drain characteristics and the values of V_{GS} required to give this current $V_{Gs\ QN}$ are also usually given on the manufacturers data sheet.

The equation for the transfer characteristic does not obey equation. However it does follow a similar “square law type” of relationship. The equation for the transfer characteristic of E-MOSFETs is given as:

$I_D=K(V_{GS}-V_{GST})^2$

8. b	How FET is voltage controlled device, Explain?	3M
	he most common type of FET is an "Insulated Gate" type. Since the Gate is insulated from the Drain and Source, no current can flow through it (or very little, in practice). So the FET has no choice: it can not be controlled by current so it must be controlled by the electrostatic field set up by the voltage on its Gate. (Hence its name: Field Effect Transistor.)	
	(OR)	
9. a	What is Op-Amp? List the characteristics of ideal Op-Amp.(Definition -2MCharacteristics-3M)	5M
	An **operational amplifier** (often **op-amp** or **opamp**) is a DC-coupled high-gain electronic voltage**amplifier** with a differential input and, usually, a single-ended output. The Ideal Op-amp The IC Op-amp comes so close to ideal performance that it is useful to state the characteristics of an ideal amplifier without regard to what is inside the package. 1.Infinite voltage gain 2.Infinite input impedance 3.Zero output impedance 4.Infinite bandwidth Zero input offset voltage (i.e., exactly zero out if zero in).	
9. b	Derive expression for Gain of noninverting amplifier. (Diagram -2M Derivation -3M)	5M

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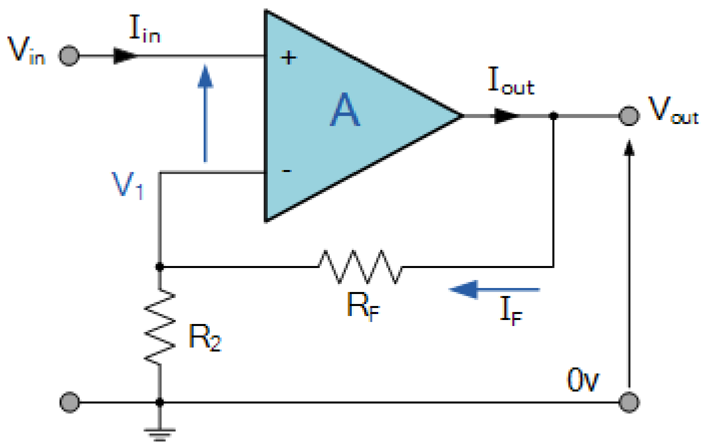
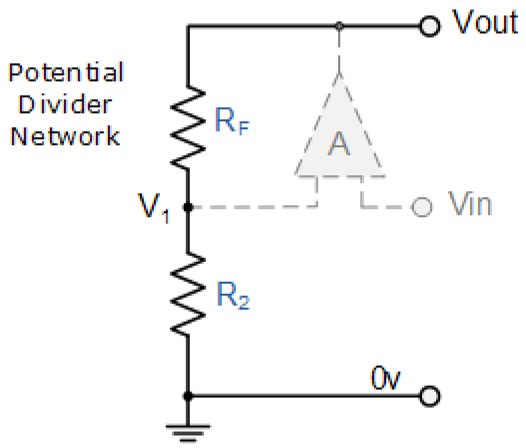


Equivalent Potential Divider Network



Then using the formula to calculate the output voltage of a potential divider network, we can calculate the closed-loop voltage gain (A_V) of the **Non-inverting Amplifier** as follows:

$$V_1 = \frac{R_2}{R_2 + R_F} \times V_{OUT}$$

$$\text{Ideal Summing Point: } V_1 = V_{IN}$$

$$\text{Voltage Gain, } A_{(V)} \text{ is equal to: } \frac{V_{OUT}}{V_{IN}}$$

$$\text{Then, } A_{(V)} = \frac{V_{OUT}}{V_{IN}} = \frac{R_2 + R_F}{R_2}$$

$$\text{Transpose to give: } A_{(V)} = \frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_F}{R_2}$$