Chapter-5

# Generator characteristic

## Voltage induced in the armature:

The voltage induced in a conductor can be expressed as,

$$e_c = \frac{\varphi}{t} \times 10^{-8} \text{ volts.} \quad \text{--- (I)}$$

where $\varphi$ = flux from one pole, lines
$t$ = time to cut flux of one pole, second.

The time t may be determined by the time for one revolution from the following formula:

$$T = \frac{1}{(r/min)/60} = \frac{60}{r/min}$$

Therefore, the time t is,

$$t = \frac{T}{P} = \frac{60}{P(r/min)}$$

where P = number of poles.

from (I),

$$e_c = \frac{\varphi}{\frac{60}{P(r/min)}} \times 10^{-8} = \frac{\varphi P(r/min)}{60} \times 10^{-8} \text{ volts.} \quad \text{--- (II)}$$

Since the number of conductors in series is equal to the total number of conductors on the armature (Z) divided by the number of parallel paths (a). Then eqn (II) need only be multiplied by $Z/a$ to give the total generated voltage between brushes.

If $E_g$ be the voltage induced per path in armature, then

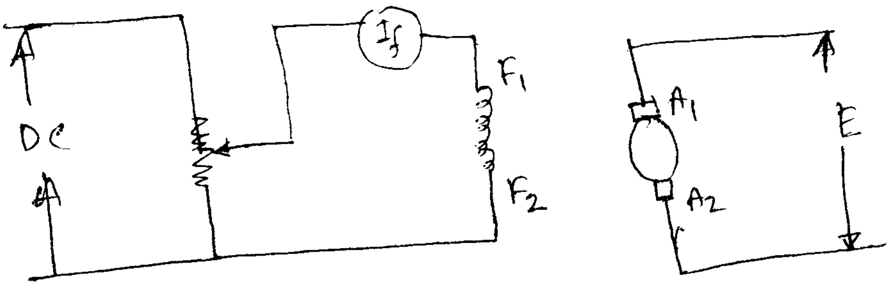
$$\boxed{E_g = \frac{Z}{a} \times \frac{\varphi P(r/min)}{60} \times 10^{-8} \text{ volts.}}$$

If $\varphi$ = flux per pole in webers then,

$$\boxed{E_g = \frac{Z}{a} \times \frac{\varphi P(r/min)}{60} \text{ volts.}}$$

# ~~Ho~~ What types of variation occurs ~~the~~ ~~when~~ when the factors of inducing voltage varied?

Ans- The ~~induced~~ voltage ~~depends~~ ~~in~~ voltage induced in a generator depends upon the flux and the speed, all other factors being fixed. If the speed of the driving machine is maintained at a constant value and the generator connected as follows, the flux in the generator may be varied to obtain different values of induced voltage.




Fig, circuit to obtain no-load magnetisation curve.

# Describe no-load magnetisation curve.

Ans- When current through the field coil ~~a~~ is zero, there is some ~~flux~~ flux from the field pole due to the residual magnetism and a small induced voltage is obtained. It is pointed as 1 in the following figure:

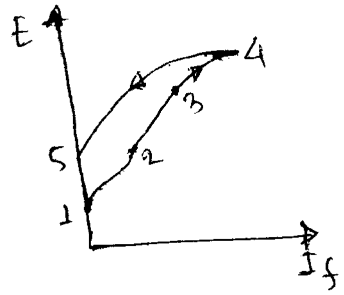



Fig: No-load magnetisation ~~fig~~ curve

At position 1-2 when field ~~curren~~ current increases, ~~the~~ the ~~flu~~ flux also increases, thus the voltage also increases.

At position 2-3 ~~as~~ ~~further increase in~~ the induced voltage increases directly proportional to the field current.

Again, at position 3-4 further increases in the field current produce smaller increases in the induced voltage.

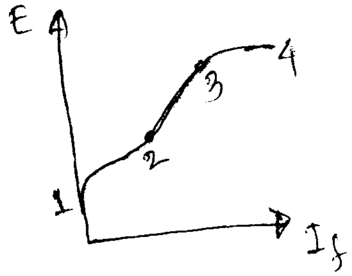
If the magnetomotive force is increased the flux will increase until saturation begins. After saturation begins, smaller increases in voltage occur.

Now, if the field current were decreased the path of decreasing voltage would not be the same as the rising path but would decrease from point 4 to 5.

Hence, by first increasing and then decreasing the field current, a hysteresis loop is formed.

Q- What is the straight line portion of magnetization curve, knee of the curve and above the knee of the curve?

Ans- Consider the following magnetisation curve:




The straight line portion: The curve from point 2 to point 3 is practically a straight line and is called straight line portion of the magnetisation curve.

Knee of the curve: Point 3, at which saturation of magnetic circuit begins, is known as the knee of the curve.

Above the knee of the curve: The portion of the curve from point 3 to point 4 is described as above the knee of the curve.

# Describe field- resistance line.

Ans- Some control of the field current is necessary to obtain the desired voltage. In the following figure the rheostat is connected in series with the field coils. The resistance value of the rheostat is approximately equal to the resistance of field coils. This permits a wide range of control of the field current and therefore a wide range of control of the induced voltage.

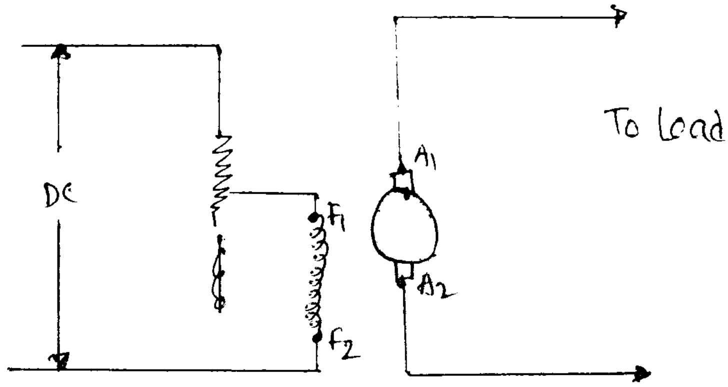



Fig: connections for seperately excited generator.

For any one setting of the field rheostat a line may be drawn which shows the relationship of the current in the field coils to the voltage across the circuit. If the setting of the field ~~ret~~ rheostat is changed to a higher resistance value, a new line indicates less field current for a given voltage. Again, if the setting of the field rheostat is changed to lower resistance value, a new line indicates higher field current through the field coils. The matter can be shown in the following diagram:-

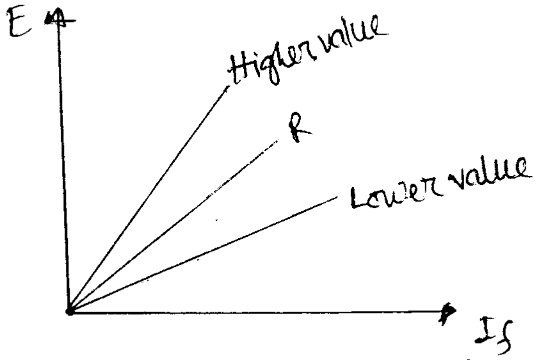



Fig: current in the field for various value of field resistance.

# Describ the build up process in a dc generator.

Build up process: The induced voltage depends upon the current in the field coils and the current in the field coils depends upon the induced voltage i.e they are dependent to each other and the generator undergoes a process ~~which is known~~ through which the voltage build up is known as build up process. The build up process can be described ~~by~~ from the following figure:-

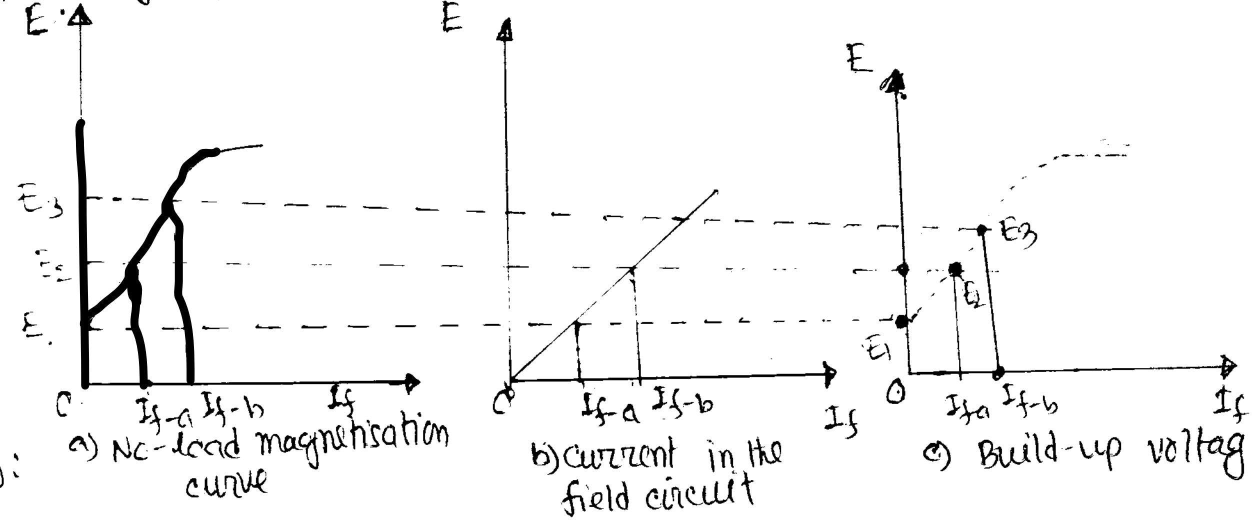



fig:

(i) After the generator has been brought upto speed, ~~a~~ voltage will be induced without any current in the field due to the residual magnetism. This is $E_1$ and is shown in fig (c) ~~for~~ at a field current 0 amp.

(ii) From fig (b) it is seen that when a voltage of $E_1$ is impressed across the field a current of $I_{f-a}$ will flow through the field.

(iii) From fig (a) the current $I_{f-a}$ will produce larger voltage $E_2$. This voltage is indicated in fig (c)

(iv) Now, if the voltage $E_2$ impressed across the field ~~coil~~ a current $I_{f-b}$ will flow through the field.

(v) From fig (a) the current $I_{f-b}$ will produce larger voltage $E_3$. This voltage is indicated in fig (c).

This process continues until the induced voltage is of such magnitude that, when impressed across the field circuit, a current ~~is~~ that produce the same magnitude of induced voltage.

# Critical resistance: The ~~maxim~~ minimum value of field resistance for which the induced voltage will build-up is called critical resistance.

# Failure of generator to build up: Generator is failed to build-up for the following reasons:-

(i) No residual magnetism: If there is no residual magnetism because of in-activity or jarring in shipment, no voltage will be generated that can produce field current.

To overcome this problem, a seperate source of direct current is applied to the field for a short period of time and then removed.

(ii) Field connections reversed: If the field connections are reversed, the lines of flux will oppose the residual flux so that the generated voltage will decrease rather than increase.

To overcome this problem it is necessary to reverse the field connections with respect to the armature.

(iii) Field circuit resistance too high: If the ~~the~~ field circuit resistance greater than the critical value, ~~will preven~~ then this prevent voltage build up.

To overcome this problem, the value of field resistance must be less than critical resistance.

(iv) Dirty commutator: A dirty commutator permits poor contact between the brush and commutator and shows up as a high resistance to flow of current in the field circuit.

# Voltage regulation: It is the change in terminal voltage from full load to no load taken as a percentage of terminal voltage at full load.

$$\text{Percencent voltage regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$