Three phase induction motor

An **electrical motor** is an electro-mechanical device which converts electrical energy into mechanical energy.

In the case of three phase **AC (Alternating Current)** operation, the most widely used motor is a **3 phase induction motor**.

A **3 phase induction motor** consists of **major parts like:**

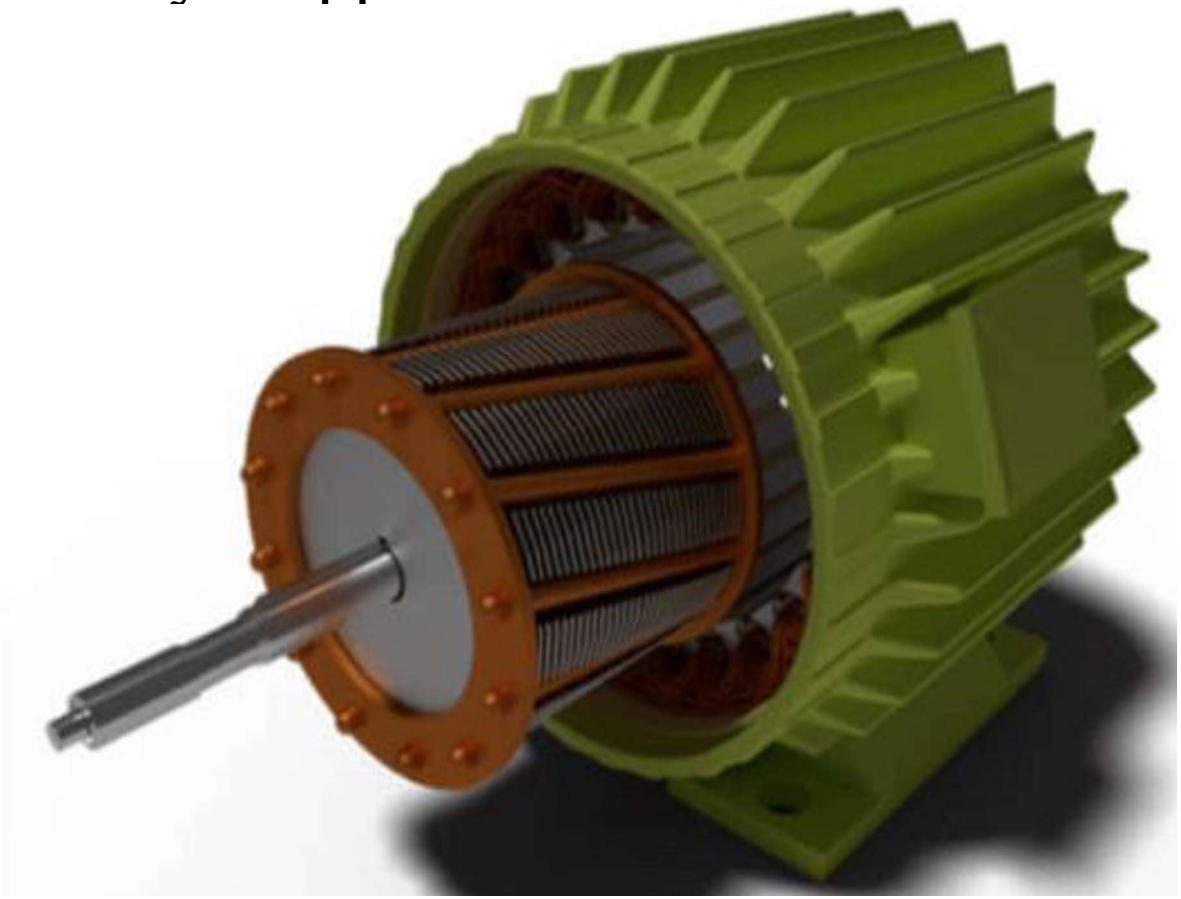
- A stator
- A rotor

The stator of three phase induction motor is made up of numbers of slots to construct a 3 phase winding circuit which we connect with 3 phase AC source.

Rotor of 3 Phase Induction Motor

The rotor of three phase induction motor consists of a cylindrical laminated core with parallel slots that can carry conductors.

The conductors are heavy copper or aluminum bars fitted in each slot.



Working of Three Phase Induction Motor

The stator of the motor consists of overlapping winding offset by an electrical angle of 120.

When we connect the primary winding, or the stator to a 3 phase AC source, it establishes rotating magnetic field.

Secrets Behind the Rotation

According to Faraday's law an emf induced in any circuit is due to the rate of change of magnetic flux linkage through the circuit.

As the rotor winding in an induction motor cut the stator rotating magnetic field, an emf is induced in the rotor copper bar and due to this emf a current flows through the rotor conductor.

Here due to the rotating flux, static rotor conductor experience current and hence as per Lenz's law, the rotor will rotate.

Single Phase induction motor

1. The single-phase system is required in most of the houses, shops, offices are small.

2. The single phase motors are simple in construction, cheap in cost, reliable and easy to repair and maintain.

3. Single phase motor finds its application in vacuum cleaners, fans, washing machines washing machines, etc.

Single phase induction motors or asynchronous motors.

Asynchronous motors also have two main parts namely rotor and stator.

STATOR

1.As its name indicates stator is a stationary part of induction motor.

2.A single phase **AC supply** is given to the stator of single phase induction motor.

ROTOR

1.The rotor is a rotating part of an induction motor.

- When we apply **a single phase AC** supply to the stator winding of single phase induction motor, the alternating current starts flowing through the stator or main winding.

- This alternating current produces an **alternating flux** called main flux.

- This main flux also links with the rotor conductors and hence **cut the rotor conductors**.

- **According to the Faraday's law of electromagnet induction**, **emf gets induced** in the rotor. As the rotor circuit is closed one so, **the current starts flowing** in the rotor. This current is called the rotor current.

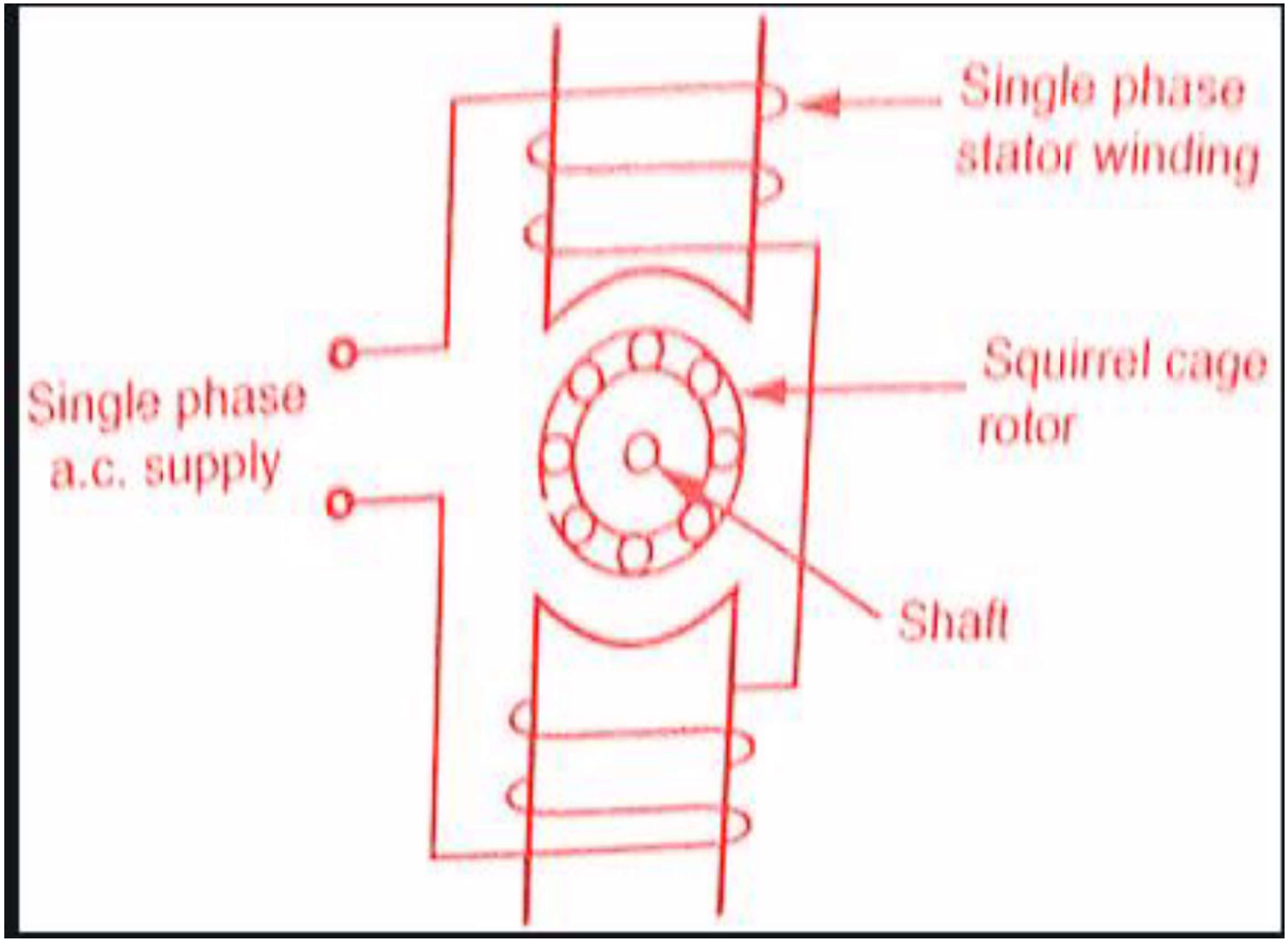
- This rotor current produces its flux called rotor flux. Since this flux is produced due to the induction principle so, the motor working on this principle got its name as an induction motor.

- Now there are two fluxes one is main flux, and another is called rotor flux. These two fluxes produce the desired torque which is required by the motor to rotate.

- **But single-phase induction motors are not self-starting** because the produced stator flux is alternating in nature the two components of this flux cancel each other and hence there is no net torque.

- **Solution:** if we make the stator flux rotating type which rotates in one particular direction only. Then the induction motor will become self-starting.

- Now for producing this rotating magnetic field, we require two alternating flux, having some phase difference angle between them. When these two fluxes interact with each other, they will produce a resultant flux. This resultant flux is rotating in nature and rotates in space in one particular direction only.


Single phase
stator winding
Squirrel cage
rotor
Single phase
a.c. supply
Shaft

Comparison between Single Phase and Three Phase Induction Motors

- Single Phase Induction Motors are simple in construction, reliable (dependable) and economical (cheap) for small power rating as compared to three phase induction motors.

- The efficiency of single phase induction motors is less compared to that of three phase induction motors.

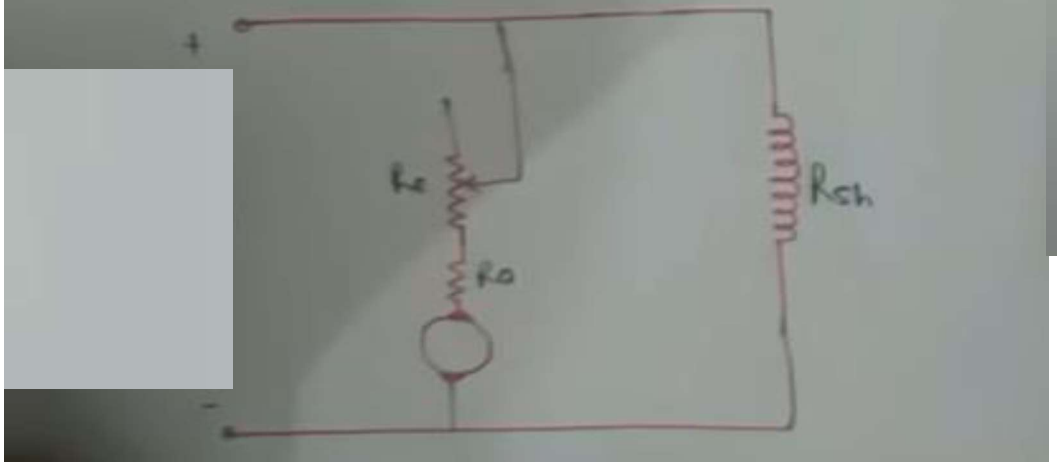
Speed Control of DC motor

The speed of dc motor is given by relationship :-

$$N = \frac{V - I_a R_a}{k\phi}$$

Numerator more- speed more

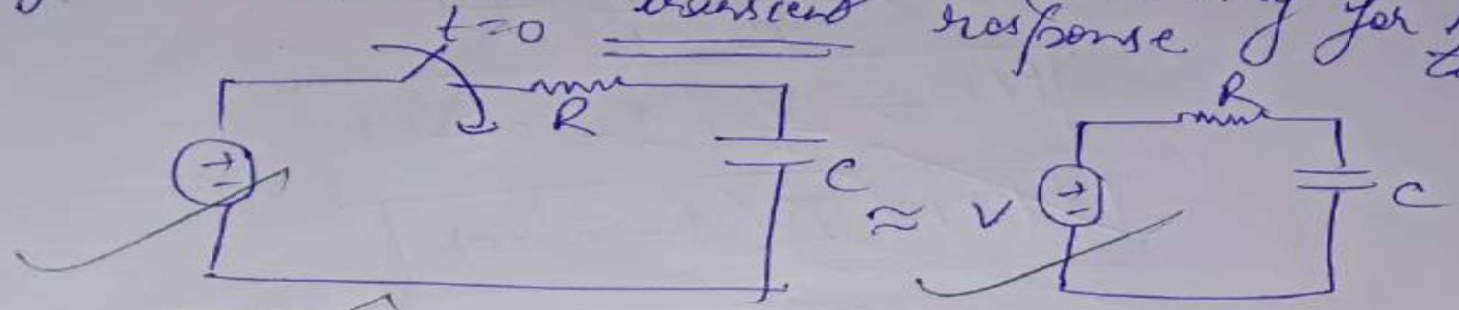
i) Armature resistance Control :-



$$N = \frac{V - I_a(R_a + R_e)}{k\phi}$$

Forced response of RC circuit
Capacitor charging

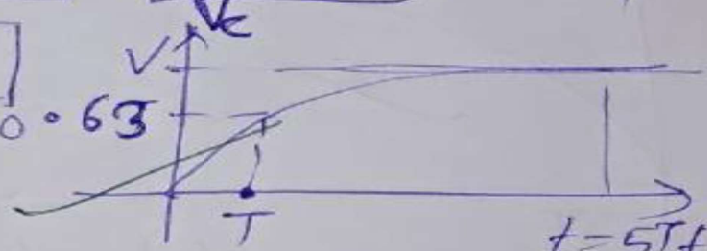
When the operation of circuit before they reach steady state condition, this is referred to as transient response (last only for short time)



$V_c = V - Ve^{-t/RC}$

$T = RC$

$V_c = V(1 - e^{-t/T})$



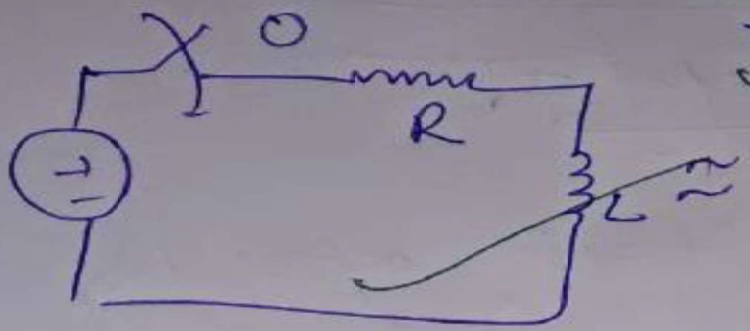
(1) for $t = 5T$ — 99.3% V

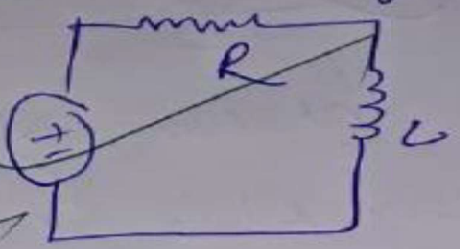
(2) for $T = 1T \Rightarrow 0.63V$

(almost equal to 99%)

Forced response RL circuit

Inductor energising



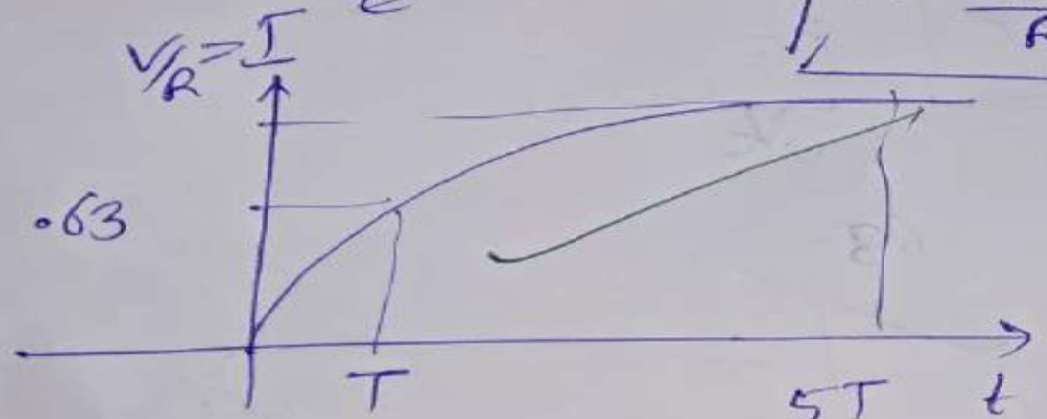


$$i(t) = \frac{V}{R} - \frac{V}{R} e^{-\frac{R}{L}t}$$

$$i(t) \Rightarrow \frac{V}{R}\left(1 - e^{-\frac{R}{L}t}\right)$$

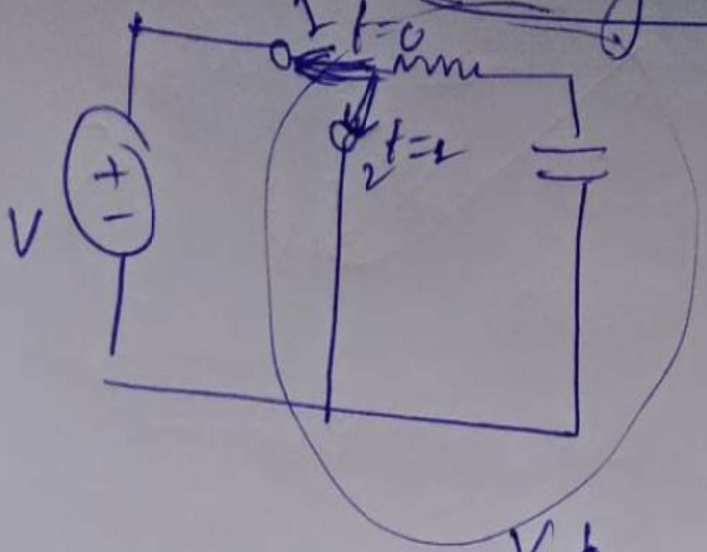
$$i(t) = I\left(1 - e^{-t/T}\right)$$

$$T = \frac{L}{R}$$



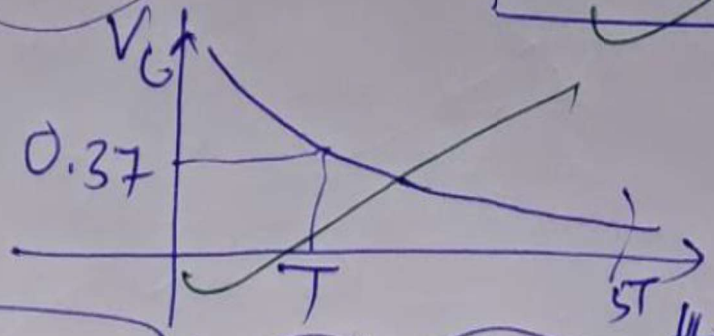
Source free response RC circuit

Capacitor discharging



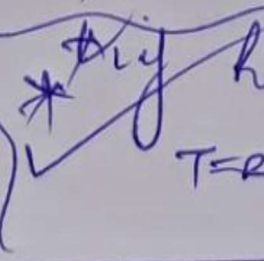
$$V_c = Ve^{-t/RC} \Rightarrow V_c = Ve^{-t/T}$$

T = RC time constant

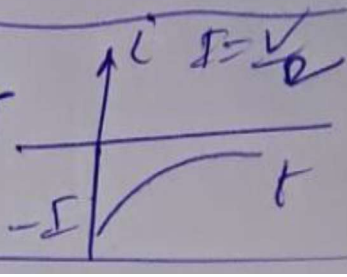


$t = 1T \Rightarrow .37V$

$t = 5T \Rightarrow \approx 0.V$

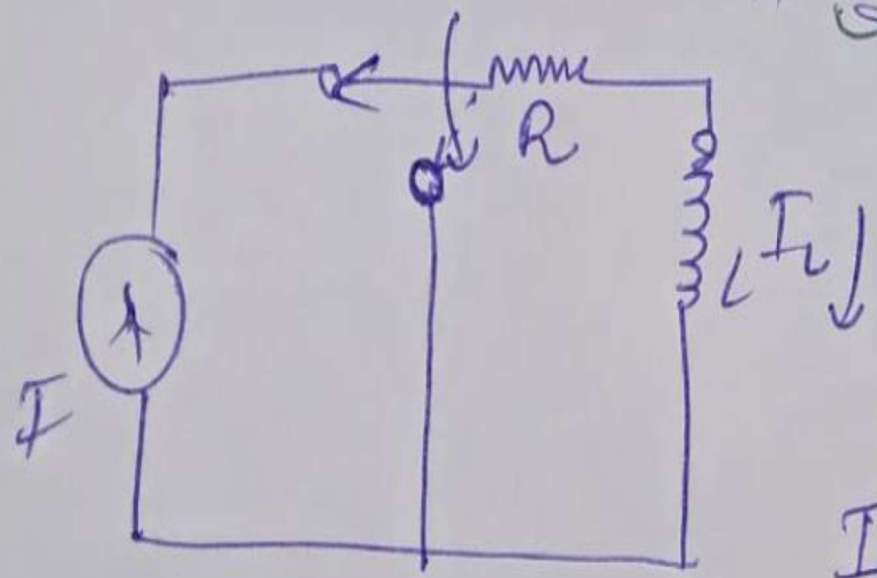


$$i = -Ie^{-t/T}$$



Source free response RL circuit

Inductor de-energized



$$i_L(t) = I e^{-\frac{R}{L}t}$$