COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

FUNDAMENTALS OF SINGLE PHASE INDUCTION MOTOR

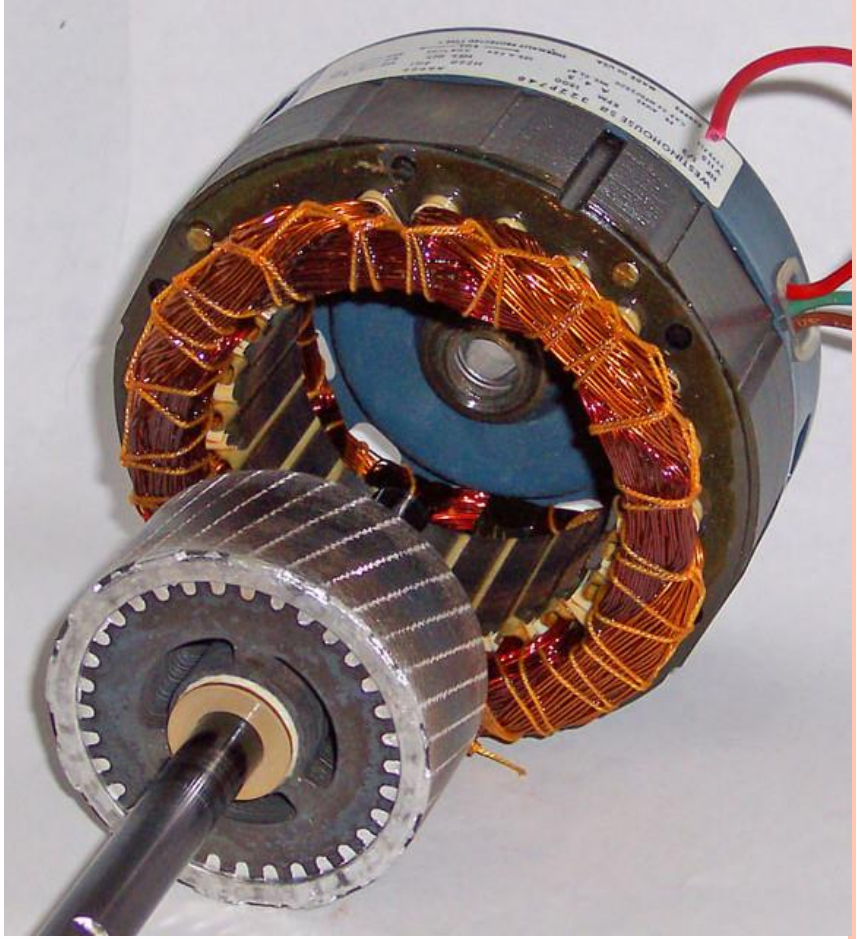
By

Prof. Avinash S. Welankiwar

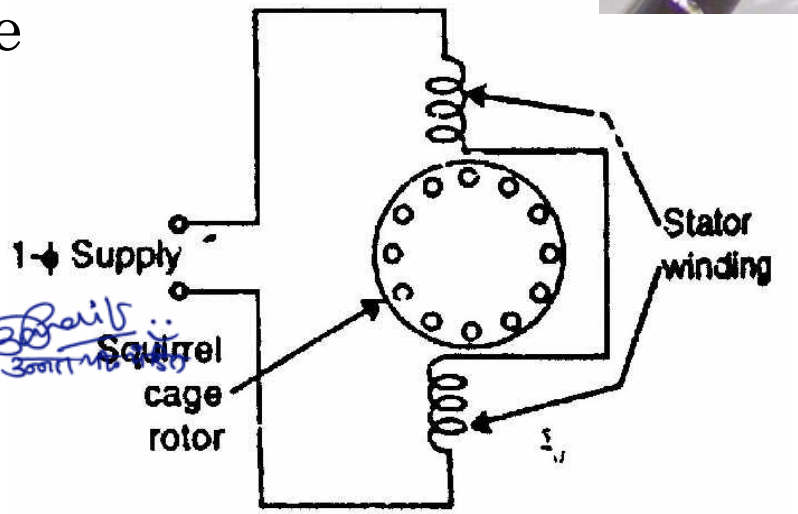
Assistant Professor, Dept. of Electrical Engg.
GHRCEM, Nagpur

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

STATOR & ROTOR



- Stator core is Laminated and slotted to facilitate stator winding
- Rotor is a squirrel cage structure



COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

WHY 1PH IM ARE NOT SELF STARTING

- It have a squirrel cage rotor and a single phase distributed stator winding.
- Such a motor inherently does not develop any starting torque and, therefore, will not start to rotate if the stator winding is connected to single phase a.c. Supply
- However, if the rotor is started by auxiliary means, the motor will quickly attain final speed.

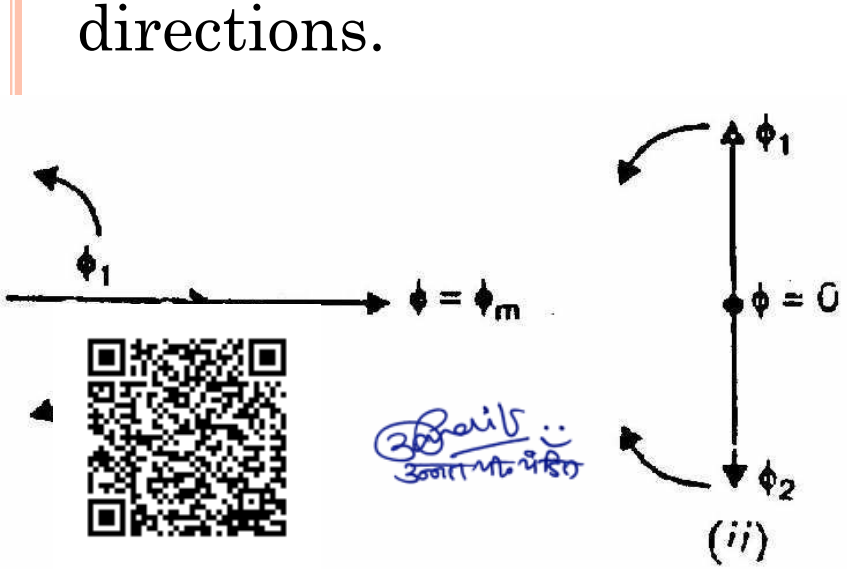
ehaviour of single-phase induction motor can ter explained on the basis of double-field ing theory.

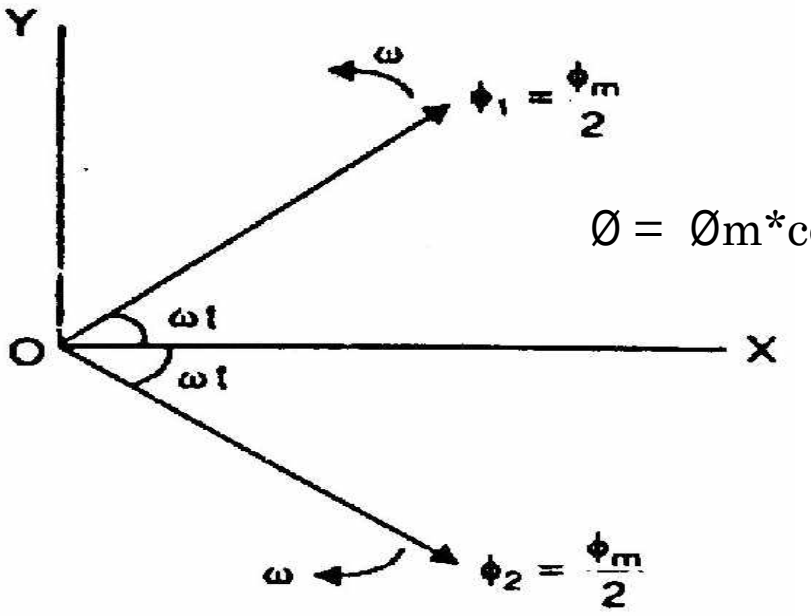
COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

DOUBLE FIELD REVOLVING THEORY

- The double-field revolving theory is proposed to explain this dilemma of no torque at start and net torque once rotated

- an alternating sinusoidal flux can be represented by two revolving fluxes $Ø_1$ and $Ø_2$, each equal to half of the maximum value of alternating flux (i.e., Øm/2) and each rotating at synchronous speed ($N_s = 120*f/P$, $W = 2\pi f$) in opposite directions.





COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161238/2025
Date-24/8/2025

ROTOR AT STANDSTILL

- Consider the case that the rotor is stationary and the stator winding is connected to a single-phase supply.
- Let the flux Ø1 rotate in anti clockwise direction and flux Ø2 in clockwise direction.
- The flux Ø1 will result in the production of torque T1 in the anti clockwise direction and flux Ø2 will result in the production of torque T2 In the clockwise direction.
- lstill, these two torques are equal and opposite and orque developed is zero

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-16123/2025
Date 24/02/2025

ROTOR RUNNING

- Now assume that the rotor is started by spinning the rotor or by using auxiliary circuit, in say clockwise direction

- The flux rotating in the clockwise direction is the forward rotating flux (Øf)

$$s_f = \frac{N_s - N}{N_s} = s$$

- The flux rotating in the anticlockwise direction is the backward rotating flux (Øb)

$$= \frac{N_s - (-N)}{N_s} = \frac{N_s + N}{N_s} = \frac{2N_s - N_s + N}{N_s}$$

$$= \frac{(N_s - N)}{N_s} = 2 - s$$

$$s_b = 2 - s$$

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

WAVEFORM

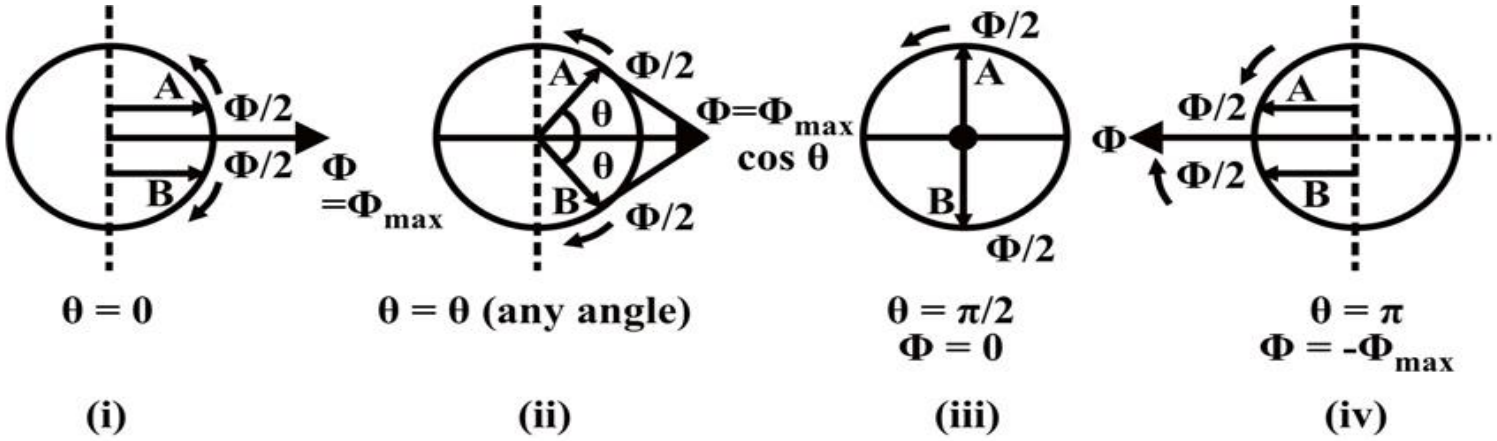
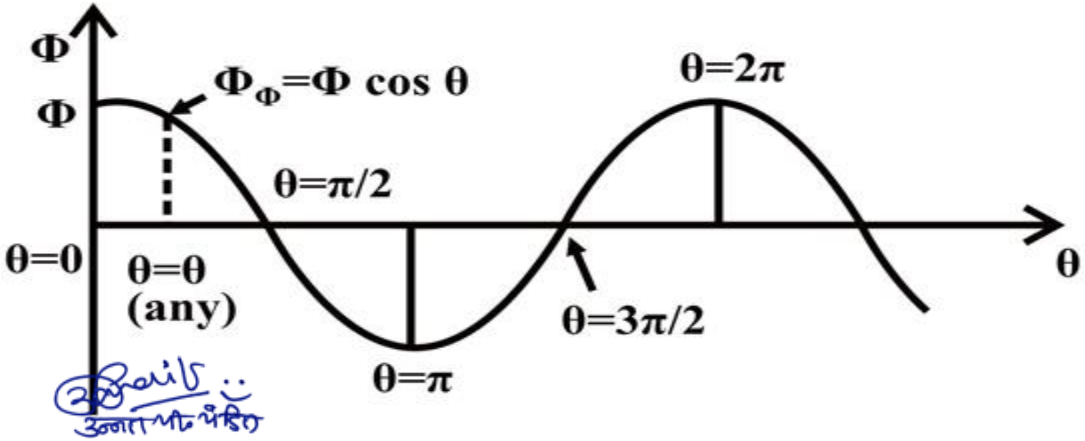


Fig. 34.2(a): Position of the pulsating and rotating in fluxes with change in angle (θ)



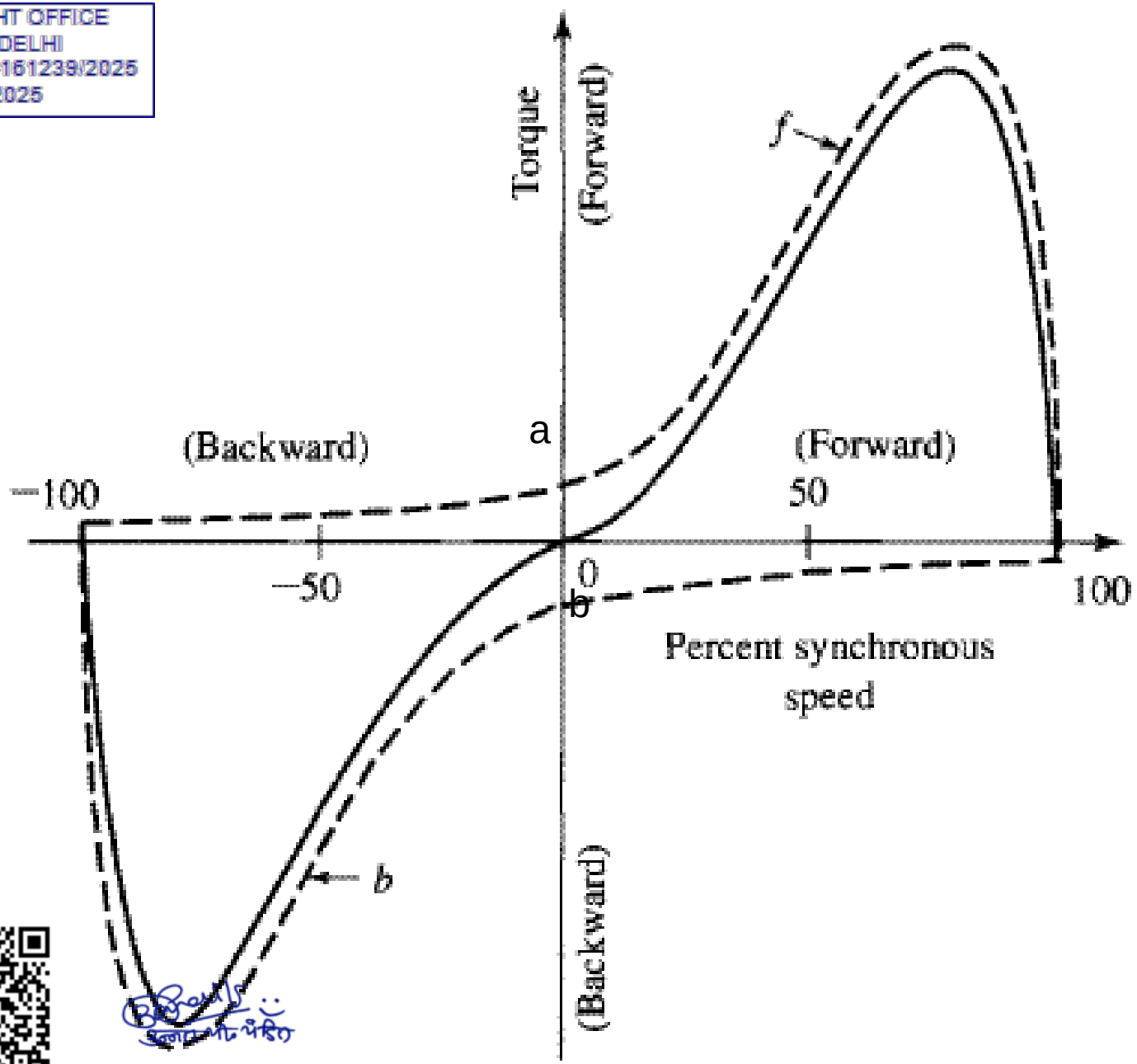
b): Pulsating (sinusoidal) flux as a function of space angle (θ)

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

Torque speed Characteristics of Single phase motor



COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025



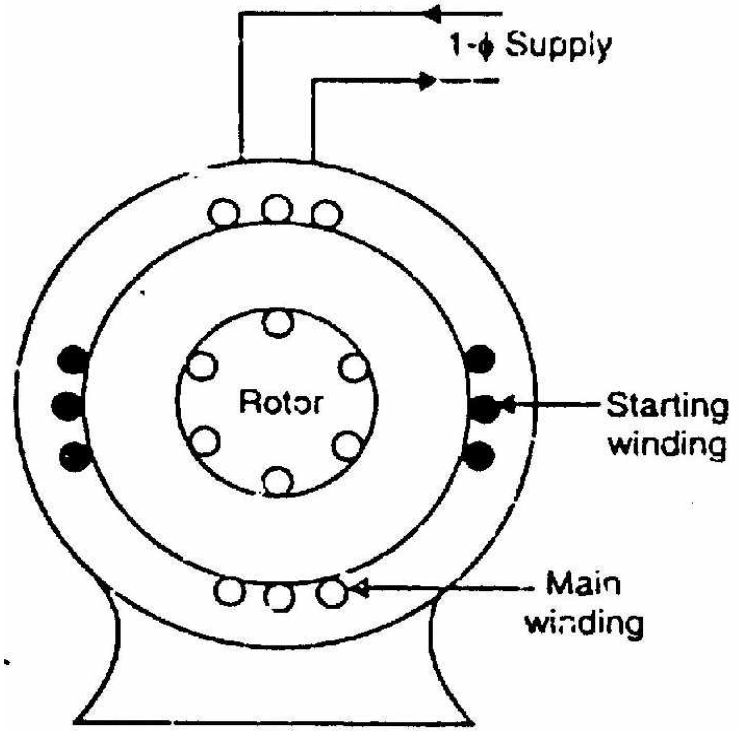
(b)

How to make 1 ph induction motor self starting

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-151239/2025
Date 24/02/2025

- This may be achieved by converting a single-phase supply into two-phase supply through the use of an additional winding

- When the motor attains sufficient speed, the starting means (i.e., additional winding) may be removed depending upon the type of the motor.



COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

- single-phase induction motors are classified and named according to the method employed to make them self-starting

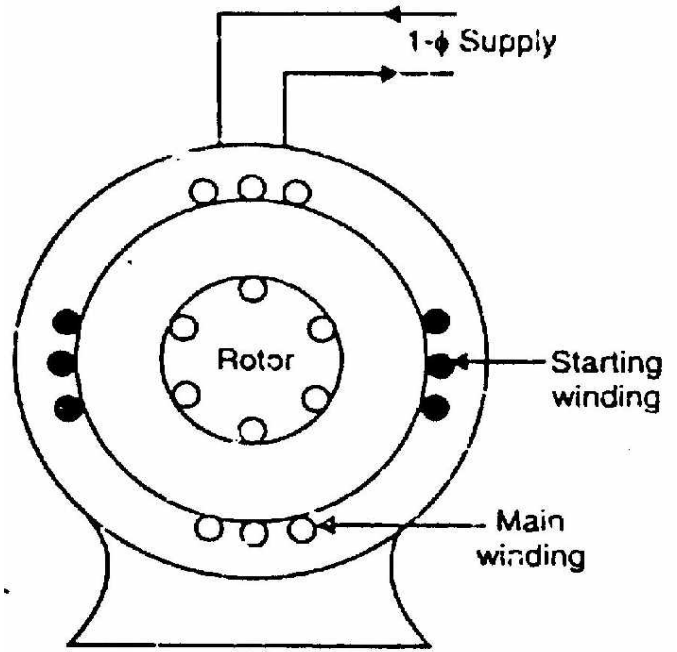
- (i) **Split-phase motors-started by two phase motor action through the use of an auxiliary or starting winding.**

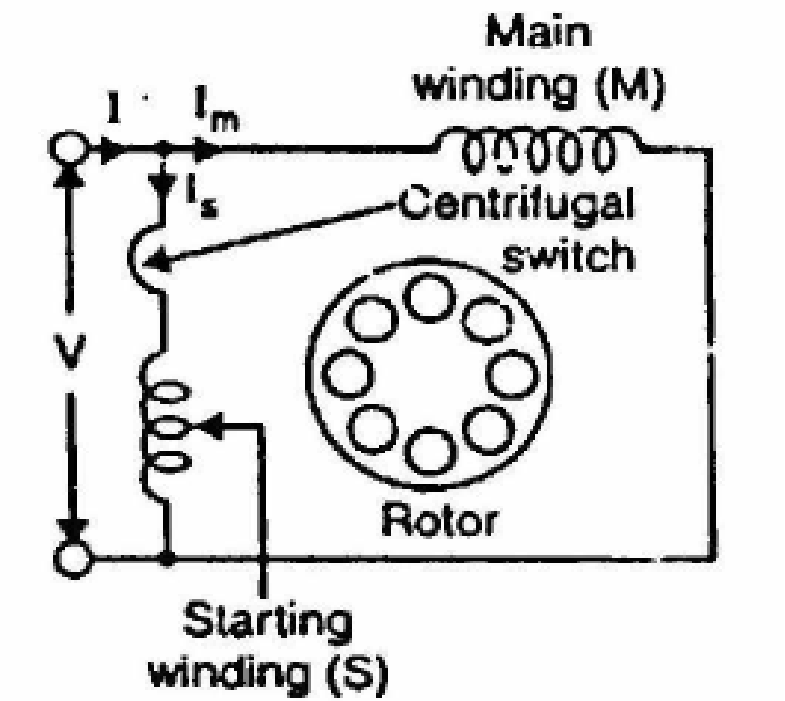
- **ii) Capacitor motors-started by two-phase motor action through the use of an auxiliary winding and a capacitor**

- **ıded-pole motors-started by the motion of the ic field produced by means of a shading coil a portion of the pole structure.**

COPYRIGHT OFFICE
NEW DELHI
Regn No. - L-16123/2025
Date 24/02/2025

SPLIT PHASE MOTOR





- The stator of a split-phase induction motor is provided with an auxiliary or starting winding S in addition to the main or running winding M

- ting winding is located 90° (approx.) electrical from n winding operates only during the brief period when the motor starts up.

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

- The two windings are so designed that the starting winding S has a high resistance and relatively small reactance

- the main winding M has relatively low resistance and large reactance
- Consequently, the currents flowing in the two windings have reasonable phase difference as shown in the phasor diagram



COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date-24/02/2025

- When the two stator windings are energized from a single-phase supply, the main winding carries current Im while the starting winding carries current Is

- Since main winding is made highly inductive while the starting winding highly resistive, the currents Im and Is have a reasonable phase angle between them

- Consequently revolving field approximating to that of a 2-phase machine is produced which starts the motor.

- When the motor reaches about 75% of rated speed, the centrifugal switch opens the circuit of the starting
  ıg.
  otor then operates as a single-phase induction and continues to accelerate till it reaches the normal speed.

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

- These motors are suitable where a moderate starting torque is required and where starting periods are infrequent e.g., to drive:

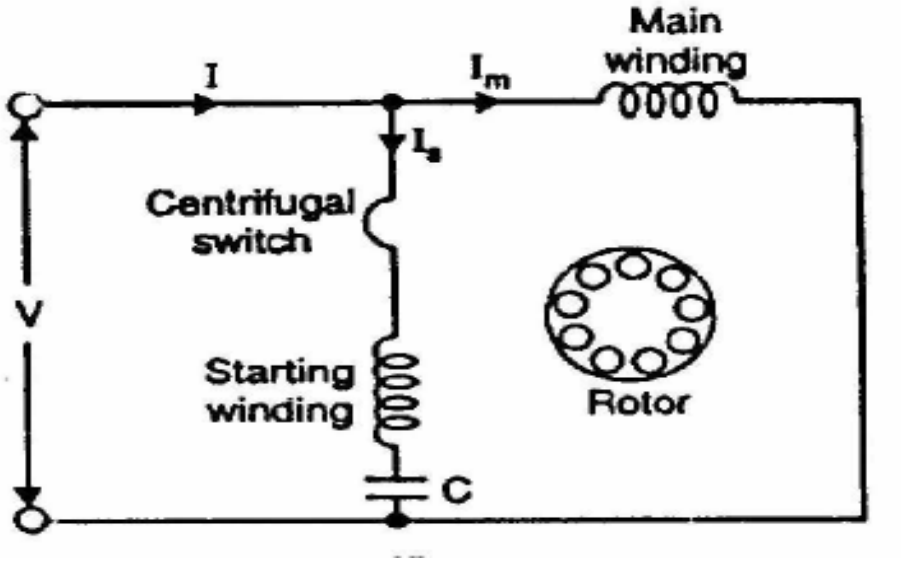
  (a)mixer grinder (b) washing machines

  (c) small machine tools etc.

- The power rating of such motors generally lies between 60 W and 250 W. Hence these motors are called as Fractional Horse power Motors (FHP)

COPYRIGHT OFFICE
NEW DELHI
Reg. No. -L-16012/9/2025
Date 24/02/2025

Capacitor-Start Motor

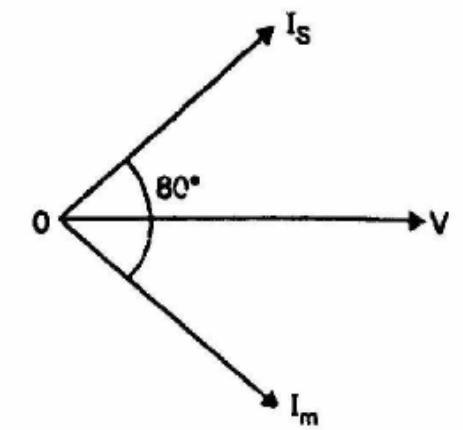


- The capacitor-start motor is identical to a split-phase motor except that the starting winding has as many turns as the main winding

er, a capacitor C is connected in series with the
g winding

COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

- The value of capacitor is so chosen that Is leads Im by about 80°
- Consequently, starting torque (Ts = k*Im*Is*sin α) is much more than that of a split-phase motor
- Again, the starting winding is opened by the centrifugal switch when the motor attains about 75% of rated speed.



COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

- both machines possess the same running characteristics because the main windings are identical

- Capacitor-start motors are used where high starting torque is required and where the starting period may be long e.g., to drive:

- Applications are

(a) compressors

(b)celing fans

(c) pumps

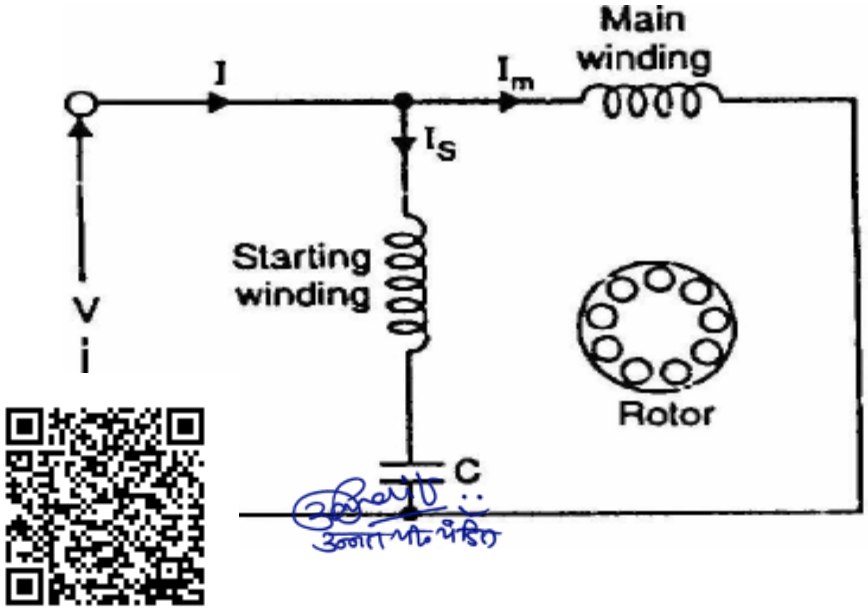


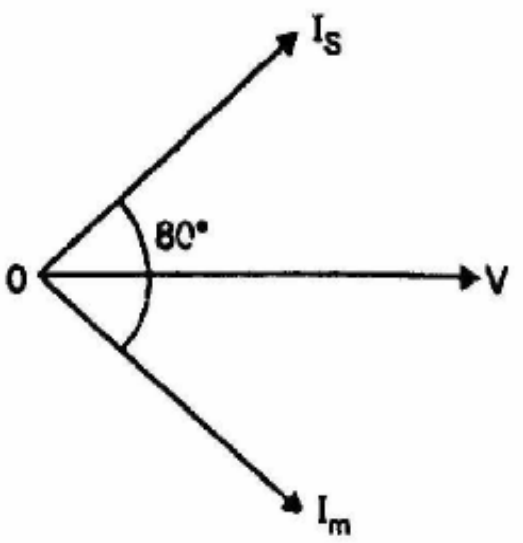
COPYRIGHT OFFICE
NEW DELHI
Reg. No. L-16123/2025
Date 24/02/2025

Capacitor-Start Capacitor-Run Motor

- This motor is identical to a capacitor-start motor except that starting winding is not opened after starting

- both the windings remain connected to the supply when running as well as at starting





COPYRIGHT OFFICE
NEW DELHI
Reg. No. - L-161239/2025
Date 24/02/2025

THANK YOU



