SINGLE PHASE INDUCTION MOTOR
UNIT- V

Vinod Kumar
HOD- ECE
DGI, Greater Noida

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Single Phase Induction Motor

Starting methods

Lecture No. 6 & 7

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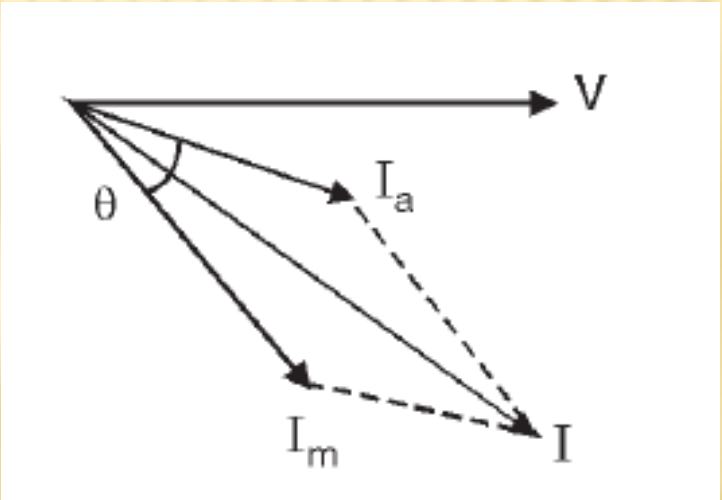
The auxiliary winding is made of thin wire so that it has a high R/X ratio as compared to the main winding which has thick super enamel copper wire. When the two stator windings are energized from a single – phase supply, the current Im and Ia in the main winding and auxiliary winding lag behind the supply voltage V, and Ia leading the current Im as shown in figure:



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This means the current through auxiliary winding reaches maximum value first and the mmf or flux due to Ia lies along the axis of the auxiliary winding and after some time the current Im reaches maximum value and the mmf due to Im lies along the main winding axis. Thus the motor becomes a 2 – phase unbalanced motor. Because of these two fields a starting torque is developed and the motor becomes a self starting motor. After the motor starts, the auxiliary winding is disconnected usually by means of centrifugal switch that operates at about 75% of synchronous speed. Finally the motor runs because the main winding. Since this being single phase some level of humming noise is always associated with the motor during running.

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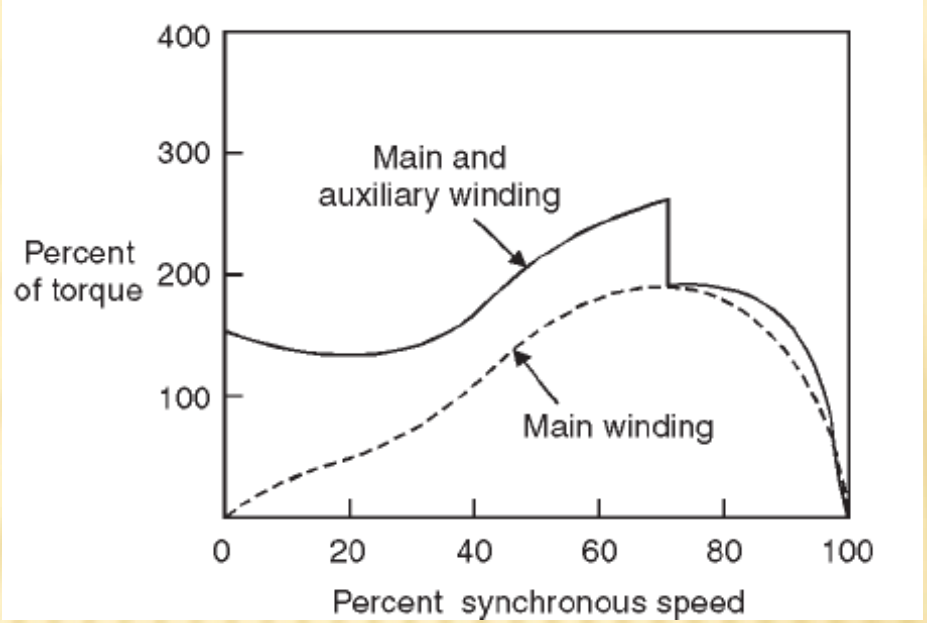
The typical torque – speed characteristic is shown in the given fig.



Characteristics

1. Due to their low cost, split – phase induction motors are most popular single – phase motors in the market
2. Since the starting winding is made of thin wire, the current density is high and the winding heats up quickly. If the starting period exceeds 5 seconds, the winding may burn out unless the motor is protected by built – in thermal relay. This motor is, therefore, suitable where starting periods are not frequent.

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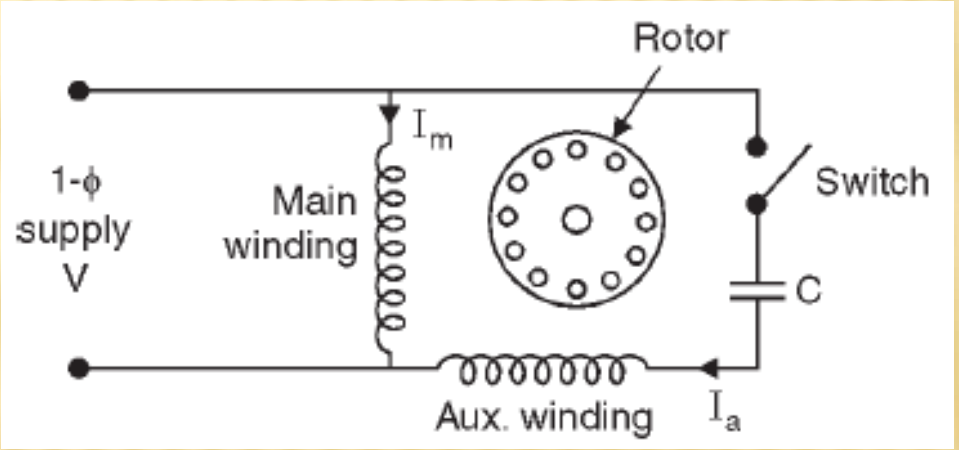
2. Capacitor – Start Motor: Capacitors are used to improve the starting and running performance of the single phase inductions motors. The capacitor – start motor is identical to a split – phase motor except that the starting winding has as many turns as the main winding. Moreover, a capacitor C is connected in series with the starting winding as shown in figure:



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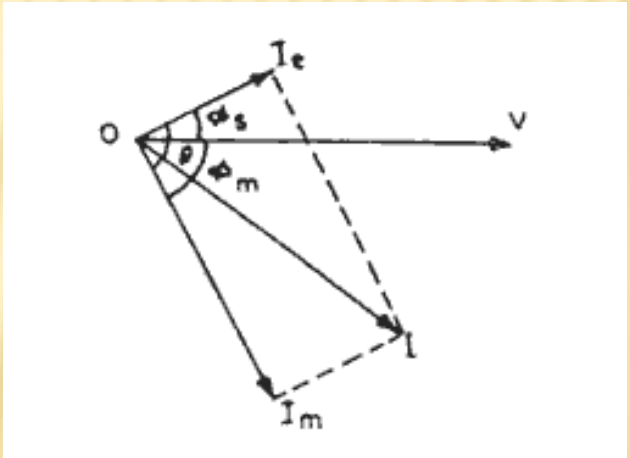
The value of capacitor is so chosen that Ia leads Im by about 90°, so that the starting torque is maximum for certain values of Ia and Im. Again, the starting winding is opened by the centrifugal switch when the motor attains about 75% of synchronous speed. The motor then operates as a single – phase induction motor and continues to accelerate till it reaches the normal speed.



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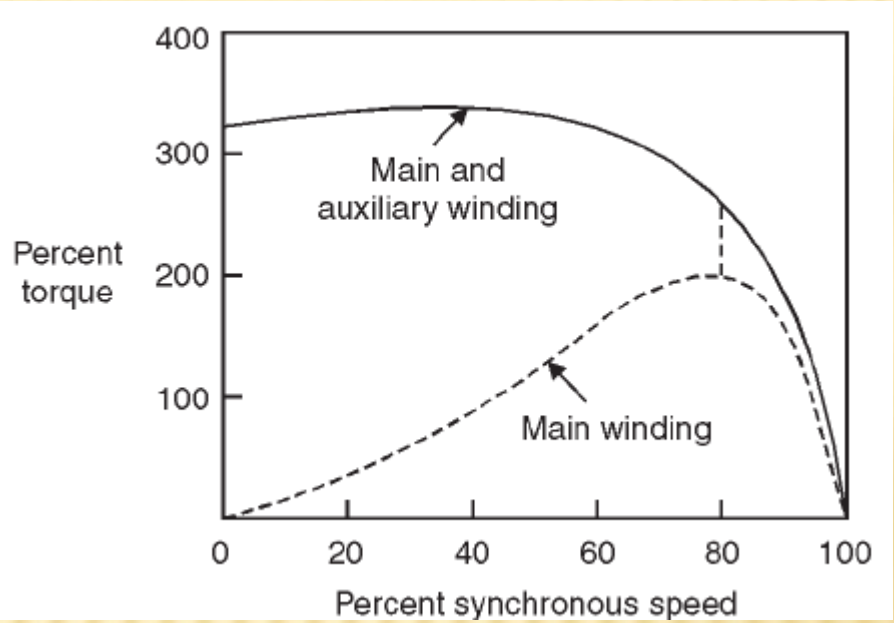
The typical torque – speed characteristic is shown in fig.



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Characteristics:

1. Although starting characteristics of a capacitor – start motor are better than those of a split – phase motor, both machines possess the same running characteristics because the main windings are identical.

2. The phase angle between the two currents is about 90° compared to about 25° in a split – phase motor. Consequently, for the same starting torque, the current in the starting winding is only about half that in a split – phase motor. Therefore, the starting winding of a capacitor start motor heats up less quickly and is well suited to applications involving either frequent or prolonged starting periods.

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3. Permanent – Split Capacitor Motor: In this motor, as shown in fig. the capacitor that is connected in series with the auxiliary winding is not cut out after starting and is left in the circuit all the time. This simplifies the construction and decreases the cost because the centrifugal switch is not needed. The power factor, torque pulsation, and efficiency are also improved because the motor runs as a two – phase motor. The motor will run more quietly. The capacitor value is of the order of 20 – 50 F and because it operates continuously, it is an ac paper oil type. The capacitor is compromise between the best starting and running value and therefore starting torque is sacrificed. The typical torque – speed characteristic is shown in fig .

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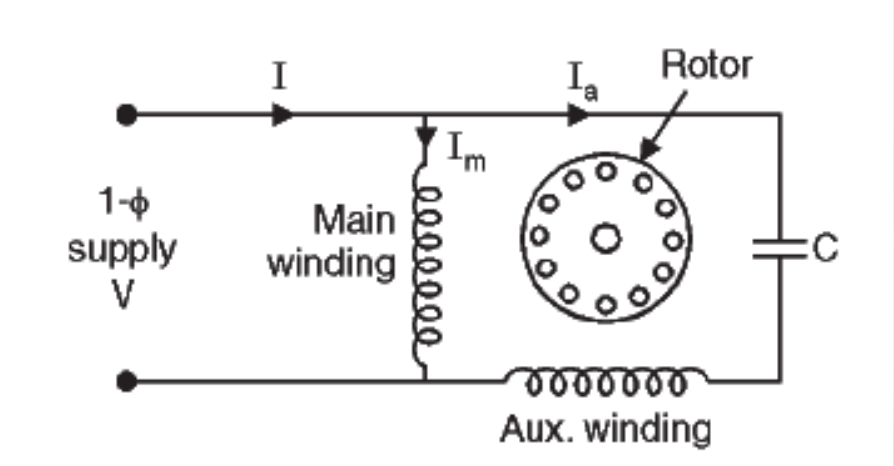

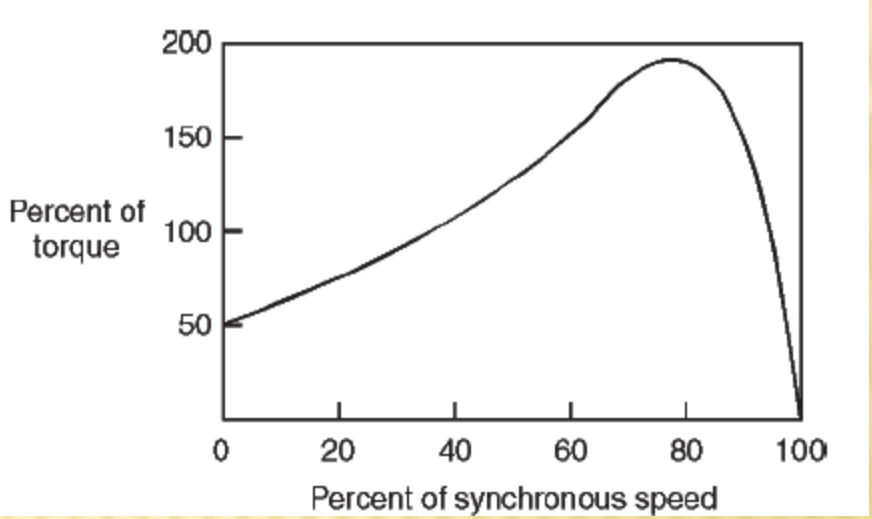

Characteristic

These motor are used where the required starting torque is low such as air – moving equipment i.e. fans, blowers and voltage regulators and also oil burners where quite operation is particularly desirable.

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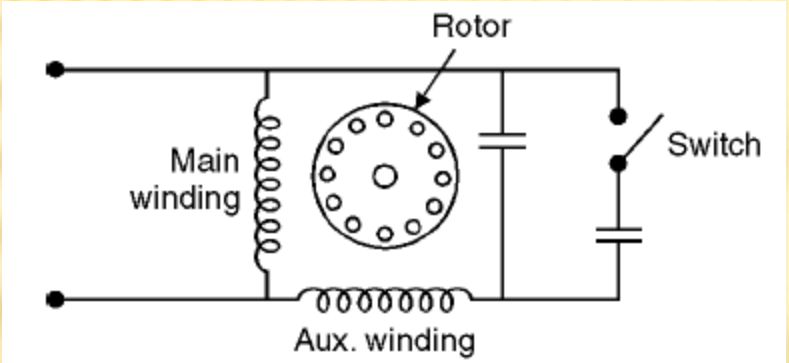
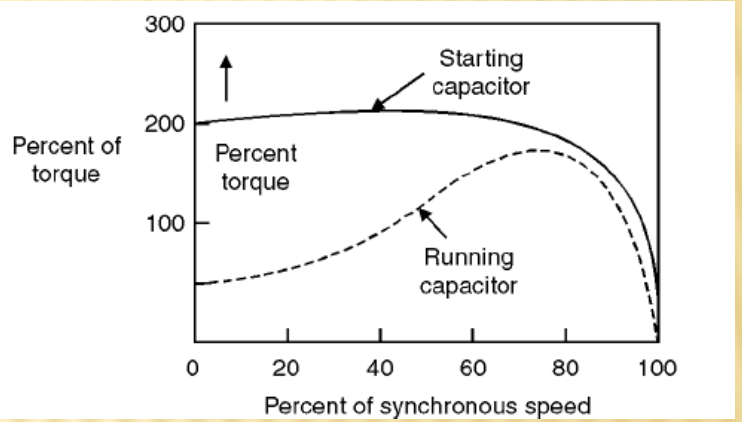
4.Capacitor - Start Capacitor – Run: Two capacitor, one for starting and one for running, can be used, as shown in fig:





Theoretically, optimum starting and running performance can be achieved by having two capacitors. The starting capacitor is larger in value and is of the ac electrolytic type. The running capacitor permanently connected in series with the starting winding, is of smaller value and is of the paper oil type. Typical values of these capacitors for a 0.5 hp are Cs =300 F, Cr =40 F. The typical torque – speed characteristic is shown in fig.

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Characteristic

1. Ability to start heavy loads
2. Extremely quiet operation
3. Higher efficiency and power factor
4. Ability to develop 25 per cent overload capacity. Hence, such motors are ideally suited where load requirements are severe as in the case of compressors and conveyors etc.

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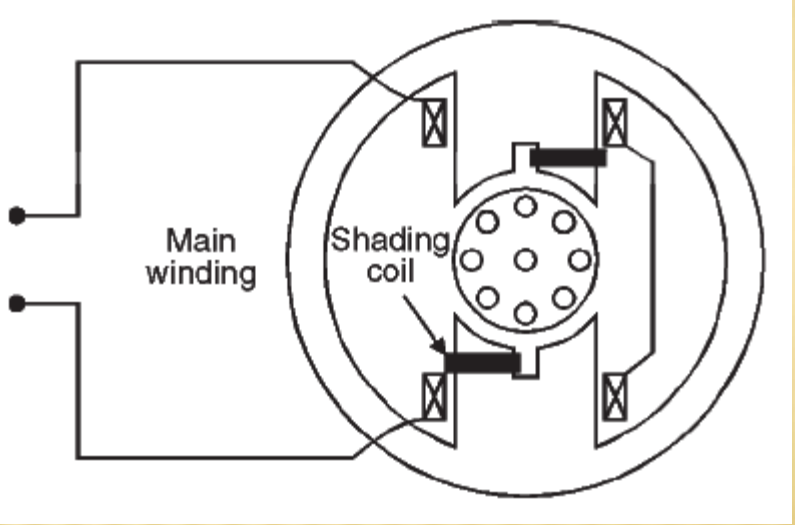
5. Shaded Pole Induction Motor: These motors have a salient pole construction. A shaded band consisting of a short – circuited copper turn, known as a shading coil, is used on one portion of each pole, as shown in fig:



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When alternating current flow in the field winding, an alternating flux is produced in the field core. A portion of this flux links with the shading coil, which behaves as short – circuited secondary of a transformer. A voltage is induced in the shading coil, and this voltage circulates a current in it. The induced current produces a flux called the induced flux which opposes the main core flux. The shading coil, thus, causes the flux in the shaded portion to lag behind the flux in the unshaded portion of the pole. At the same time, the main flux and the shaded pole flux are displaced in space. This displacement is less than 90o. Since there is time and space displacement between the two fluxes, the conditions for setting up a rotating magnetic field are produced. Under the action of the rotating flux a starting torque is developed on the cage rotor. The direction of this rotating field (flux) is from the unshaded to the shaded portion of the pole.

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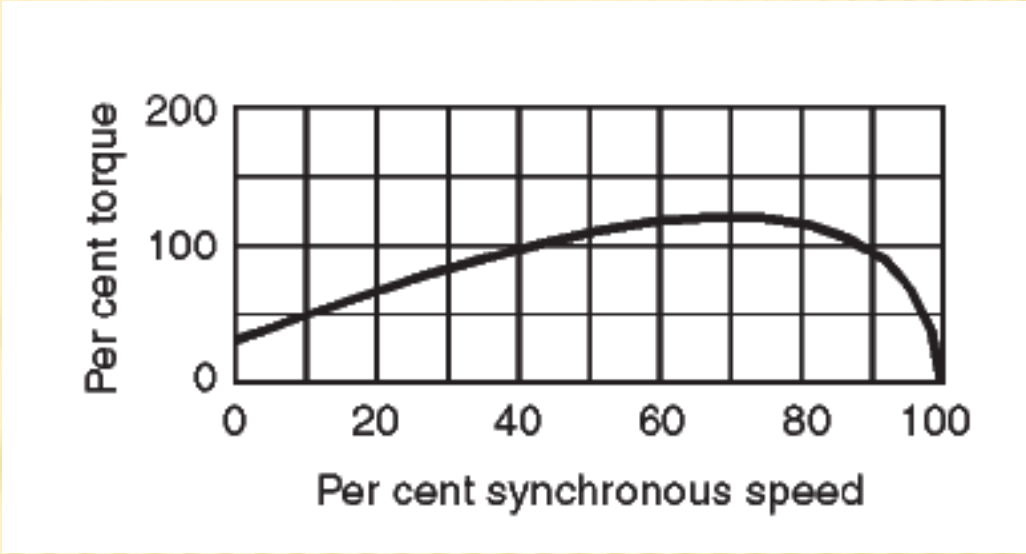
The typical torque-speed characteristic is shown in fig.:



Characteristic

1. The salient features of this motor are extremely simple construction and absence of centrifugal switch.
2. Since starting torque, efficiency and power factor are very low, these motors are only suitable for low power applications e.g. to drive: Small fans b) toys c) hair driers. The power rating of such motors is up to about 30 W.