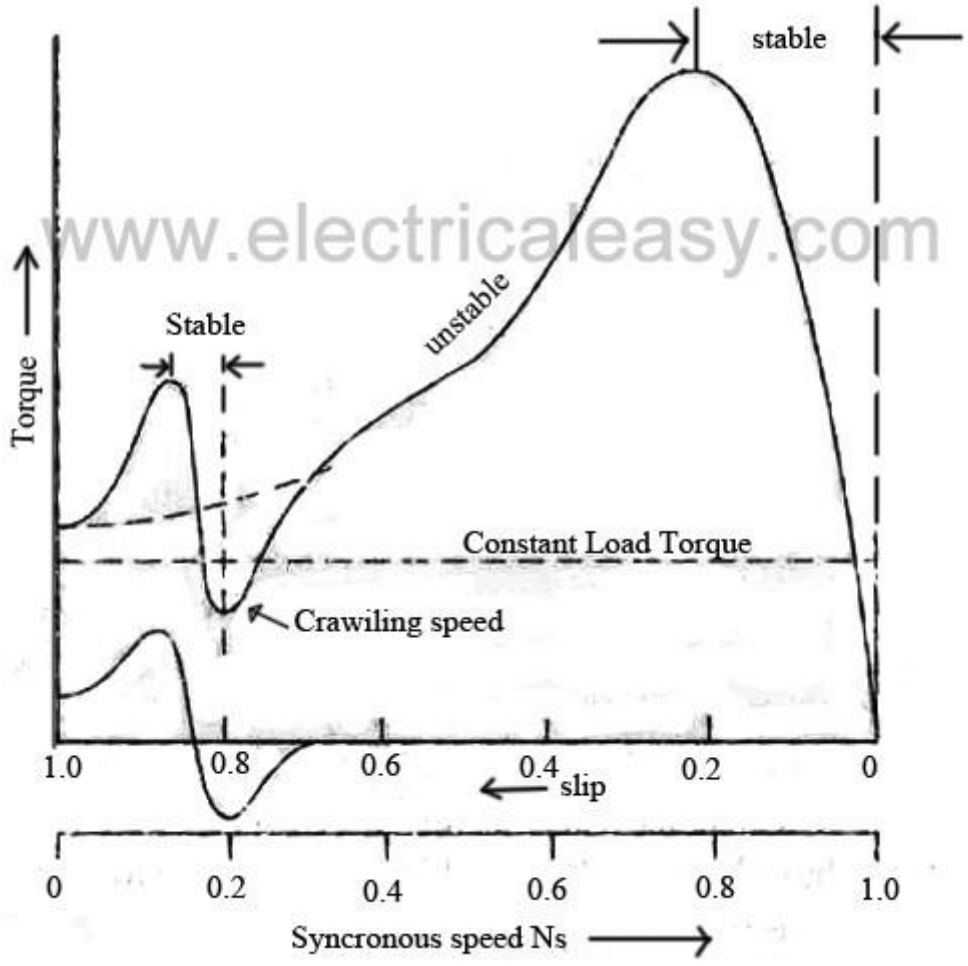
Cogging and Crawling

Crawling of Induction Motor

It has been observed that squirrel cage type induction motor has a tendency to run at very low speed compared to its synchronous speed, this phenomenon is known as crawling. The resultant speed is nearly $1/7^{th}$ of its synchronous speed. Now the question arises why this happens? This action is due to the fact that harmonics fluxes produced in the gap of the stator winding of odd harmonics like 3^{rd}, 5^{th}, 7^{th} etc. These harmonics create additional torque fields in addition to the synchronous torque.

The torque produced by these harmonics rotates in the forward or backward direction at $N_s/3$, $N_s/5$, $N_s/7$ speed respectively. Here we consider only 5^{th} and 7^{th} harmonics and rest are neglected. The torque produced by the 5^{th} harmonic rotates in the backward direction. This torque produced by fifth harmonic which works as a braking action is small in quantity, so it can be neglected. Now the seventh harmonic produces a forward rotating torque at synchronous speed $N_s/7$. Hence, the net forward torque is equal to the sum of the torque produced by 7^{th} harmonic and fundamental torque. The torque produced by 7^{th} harmonic reaches its maximum positive value just below 1/7 of N_s and at this point slip is high. At this stage motor does not reach up to its normal speed and continue to rotate at a speed which is much lower than its normal speed. This causes crawling of the motor at just below 1/7 synchronous speed and creates the racket. The other speed at which motor crawls is 1/13 of synchronous speed.



Cogging of Induction Motor

This characteristic of induction motor comes into picture when motor refuses to start at all. Sometimes it happens because of low supply voltage. But the main reason for starting problem in the motor is because of cogging in which the slots of the stator get locked up with the rotor slots. As we know that there is series of slots in the stator and rotor of the induction motor. When the slots of the rotor are equal in number with slots in the stator, they align themselves in such way that both face to each other and at this stage the reluctance of the magnetic path is minimum and motor refuse to start.

This characteristic of the induction motor is called cogging. Apart from this, there is one more reason for cogging. If the harmonic frequencies coincide with the slot frequency due to the harmonics present in the supply voltage then it causes torque modulation. As a result, of it cogging occurs. This characteristic is also known as magnetic teeth locking of the induction motor.

Sometimes, the rotor of a squirrel cage induction motor refuses to start at all, particularly if the supply voltage is low. This happens especially when number of rotor teeth is equal to number of stator teeth, because of magnetic locking between the stator teeth and the rotor teeth. When the rotor teeth and stator teeth face each other, the reluctance of the magnetic path is minimum, that is why the rotor tends to remain fixed. This phenomenon is called cogging or magnetic locking of induction motor.