TEMPLECITY INSTITUTE OF TECHNOLOGY & ENGG.
(DIPLOMA)
Internal Assessment Test-W-2021

Sub: - EC-II **FM – 20**
Branch: - EE **5th Sem** **Time: - 1 Hour**

(Figures in the right-hand margin indicate marks)

1. **Answer All the Question.** **(3 x 2 marks)**
   - **(a)** What is the procedure of starting a synchronous motor?
   - **(b)** Derive slip and rotor current frequency?
   - **(c)** What do you mean by synchronous speed of a three phase induction motor?
2. **Answer Any Two.** **(2 x 3.5 marks)**
   - **(a)** A 6 pole alternator running at 1000 r.p.m supplies an 8 pole induction motor. Find the actual speed of the motor .if the slip is 2.5 percentages?
   - **(b)** Derive stepper motor? Different types of stepper motor and its operation?
   - **(c)** Derive universal motor and capacitor start motor?
3. **Answer any One.** **(1 x 07 marks)**
   - **(a)** Explain working principle, torque speed characteristics of capacitor start, capacitor run motor?
   - **(b)** Explain the principle of induction generator and its application?
   - **(c)** Calculate the step angle of a single stack 4 phase 8/6 pole VR stepper motor .and draw neat sketch diagram of single phase series motor and repulsion start motor ?

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INTERNAL ANSWER

Sub- Energy Conversion-II
Branch- Electrical Engineering
Semester - 5th

1/(a) Synchronous motors are equipped with dampers or squirrel cage windings of cu bars embedded in the pole shoe and short circuited both ends. Such a motor starts readily acting as an induction motor during the starting period.

Procedure are

The line voltage is applied to the armature (stator) terminals and the field circuit is left unexcited. motor starts as an induction motor and while it reaches nearly 95% of its synchronous speed, the d.c field is excited.

At that moment the stator and rotor poles get engaged or interlocked with each other. and hence pull the motor in to synchronism.

At begining, when voltage is applied, the rotor is stationary. The rotating field induces a very large emf goes on decreasing as the rotor gathers speed.

When full line voltage is switched on to the armature at rest a very large current usually 5 to 7 times the full load armature current is drawn by the motor.

First main field winding is short circuited.

Reduced the voltage with the help of auto transformers is applied across the stator terminals. The motor starts up.

(b) **Slip**

The difference between the synchronous speed (N_S) of the rotating stator field and the actual rotor speed (N) is called slip. It is usually expressed as percentage of synchronous speed.

$$\%age\ of\ slip\ S = \frac{N_S - N}{N_S} \times 100$$

Rotor current frequency

The frequency of a voltage or current induced due to relative speed between a winding and a magnetic field is given by the formula.

$$frequency = \frac{NP}{120}$$

For rotor speed N the relative speed between the rotating flux and the rotor is $(N_S - N)$

the rotor current frequency (f')

$$f' = \frac{N_S - N\ P}{120}$$

$$= \frac{S\ N_S\ P}{120}$$

$$= Sf$$

Rotor current frequency

= fractional slip x supply frequency.

(c) **Synchronous speed of a 3ϕ Induction motor.**

In an induction motor, the speed at which the rotating magnetic field rotates is known as synchronous speed (N_S)

The value of a synchronous speed depends upon the number of stator poles in the motor and the supply frequency

So for a given motor of P-poles the Synchronous speed is

Synchronous speed N_S

$= \frac{120f}{P}$ RPM

2/(a) Let N = actual motor speed

$f = \frac{6 \times 1000}{120}$

$= \frac{6000}{120}$

$= 50Hz$

Synchronous speed $N_S = \frac{120 \times 50}{8}$

$= 750$ rpm

% slip $= \frac{N_S - N}{N} \times 100$

$2.5 = \frac{750 - N}{750} \times 100$

$= 726.5$ rpm

since slip is 2.5%, actual speed N is less than N_S by 2.5% $2.5 \times \frac{750}{100} = 18.75$ RPM

(b) Stepper motor

These motors are also called stepping motors or step motors.

The name stepper is used because this motor rotates through a fixed angular step in response to each input current pulse received by its controller.

Different types of stepper motor

(a) variable reluctance stepper motor
(b) permanent magnet stepper motor
(c) Hybrid stepper motor

Variable reluctance steppermotor

It has wound stator poles but the rotor poles are made of a ferromagnetic material.

It can be of the single stack type or multi stack type which gives smaller step angles.

Direction of a motor rotation independent of the polarity of the stator current. It is called variable reluctance steppermotor.

Permanent magnet steppermotor

It is also wound stator poles are permanently magnetized. It has a cylindrical rotor. Its direction of rotation ~~of~~ depends on the polarity of the stator current.

HYBRID

It has wound stator poles and permanently magnetized rotor poles. It is best suited when small step angles of 1.8°, 2.5° are required.

(c) Universal motor

It is a type of electric motor that can operate on either A.C or D.C. and uses an electromagnet as its stator to create its magnetic field.

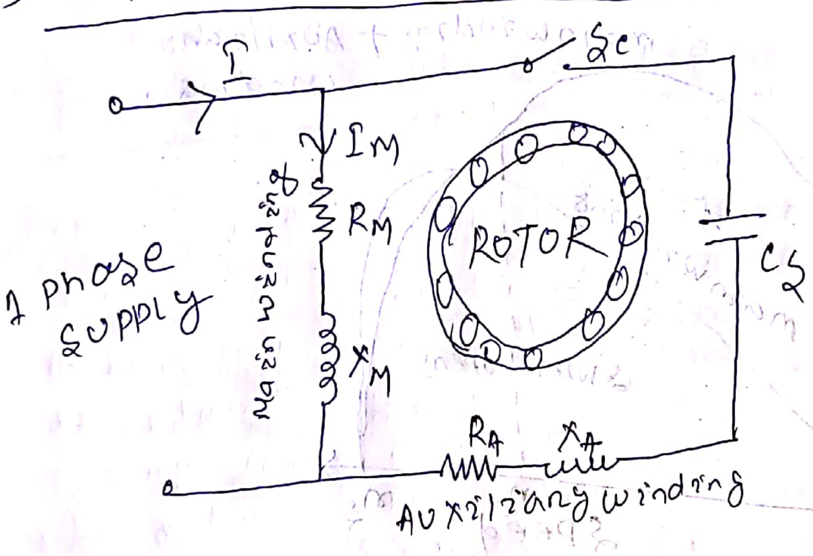
It is a commutated series wound motor where the stator's field coils are connected in series with the rotor windings through a commutator.

Capacitor start motor

A capacitor start motor is a single phase induction motor that employs a capacitor in the auxiliary winding circuit to produce a greater phase difference between the current in the main and the auxiliary winding.

The capacitor start motor has a cage rotor and two windings on the stator. they are known as main winding and auxiliary winding. The two windings are placed 90° apart. A capacitor CS is connected in series with the starting winding. A centrifugal switch SC is also connected to the circuit.

3/(a) capacitor start motor



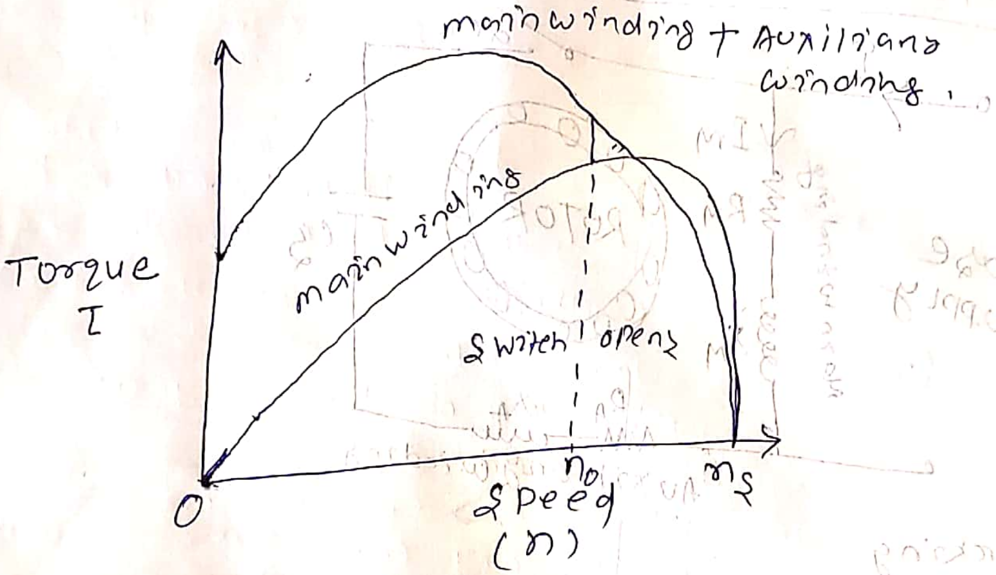
working

when the stator windings are energized from a 1ϕ supply the main winding and starting winding carry two different currents. There is a 90° time phase difference and 90° space difference between the two currents. these two currents produce a rotating magnetic field that starts the motor.

The main and auxiliary windings are connect in parallel during motor starting. A start capacitor stays in the circuit long enough to rapidly bring the motor upto a predeter speed which is usually about 70to 80% of full load.

Then the Auxiliary winding is disconnected from the supply often by a centrifugal switch and the motor remains powered by a single winding creating a pulsating magnetic field.

Torque speed characteristics

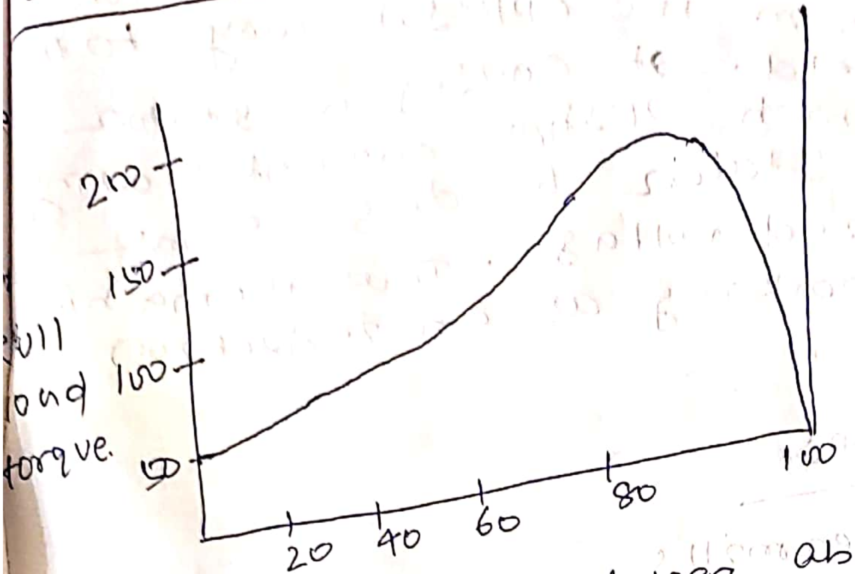


Capacitor run motor

Capacitor run motor is the same as the capacitor start motor except for the absence of centrifugal switch.

The capacitor is of paper type. The capacitor is permanently connected to the stating winding. In case of paper capacitor the value of the capacitance is small, since it is difficult andbecomes uneconomical to manufacture paper capacitor of higher value.

characteristics



Starting torque is lower about 50% of full load torque. power factor is improved. Efficiency is improved to about 75%

(b) Principle of induction generator

An induction generator or synchronous generator is a type of alternating current electrical generator that uses the principles of induction motors to produce electrical power.

An A.C supply is connected to the stator terminals of an induction machine the rotating magnetic field produced in the stator pulls the rotor to run behind.

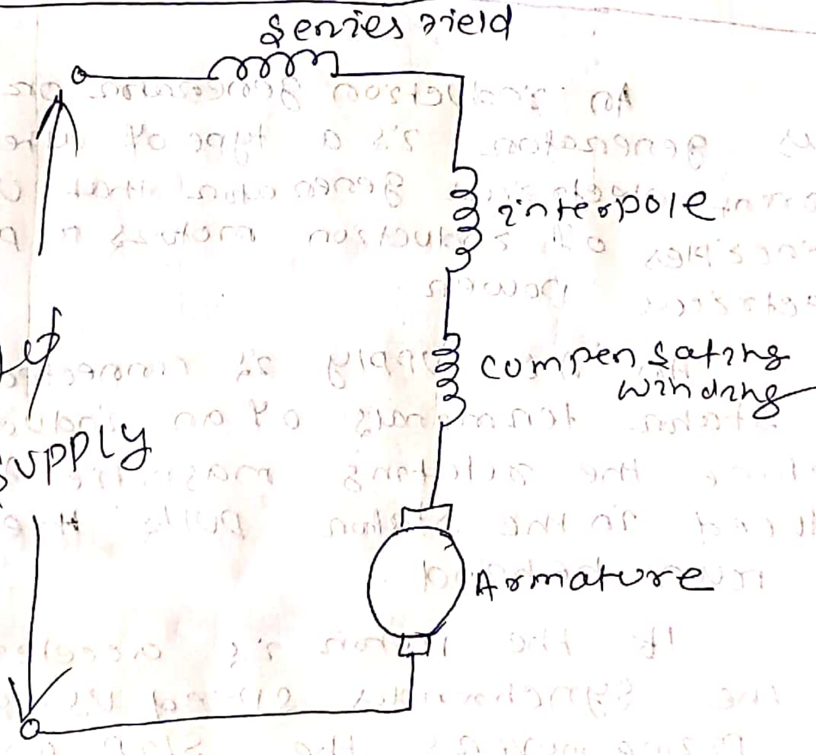
If the rotor is accelereated to the synchronous speed using one of the prime movers. the slip will be zero hence the net torque will be zero. The rotor current will become zero when the rotor is running at synchronous speed.

The generated rotor current produces a rotating magnetic field in the rotor that forces in the opposite way to the stator field. It causes a stator voltage which pushes current flowing out of the stator winding against the applied voltage. Thus the machine is now working as an induction generator.

Applications

1) Paper mills
2) wind mills
3) water companies

(c) Single phase series motor



$$\text{Step Angle } \beta = \frac{360}{m N_{re}}$$

$$= \frac{360}{4 \times 6}$$

$$= \frac{360'}{24} \quad 215^{\circ}$$

Writing Space

Re pulsion start motor