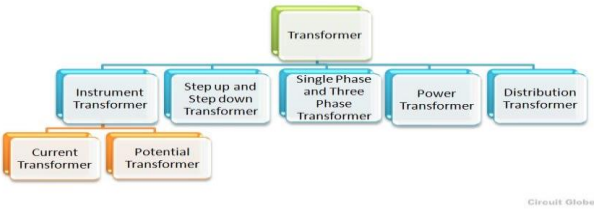
Mechatronics Engineering Lectures

Subject: electromechanical system **Class: second**

Lecture Contents:	**Name:myasar alattar**		**Lecture Number:**	**1**

Topics: single phase transformer
1-introduction to single phase transformer
2- construction of single phase transformer
3- operation principle of single phase transformer
4- equivalent circuit of single phase transformer (approximate and exact)
5- losses and efficiency
6- test of single phase transformer (open and short test)

Contents:
1- An A.C. device used to change high voltage low current A.C. into low voltage high current A.C. and vice-versa without changing the frequency
1. Transfers electric power from one circuit to another
2. It does so without a change of frequency
3. It accomplishes this by electromagnetic induction
4. Where the two electric circuits are in mutual inductive influence of each other



2 - working principle of transformer depends upon Faraday's law of electromagnetic induction. Actually, mutual induction between two or more winding

Lecture Contents:	**Name:myasar alattar**		**Lecture Number:**	**2**
	Topics: single phase transformer **1- equivalent circuit of single phase transformer (approximate and exact)** **2 - losses and efficiency** **3- test of single phase transformer (open and short test)**			
	Contents: **1- the magnetization current Im, is required to generate the magnetic field (or the flux in the iron core, Φc). This flux which is a time-varying flux links both the primary and secondary windings. Accordingly, voltages (emfs) are induced in both windings , when the iron core is connected to AC current, the source should also supply a component of current called the core loss component, Ic, to account for hysteresis and eddy current losses. ,Total No-load current, Io=Im+Ic** **2- It is the ratio of the output power to the input power of a transformer** **Input = Output + Total losses** **= Output + Iron loss + Copper loss** **3- Two tests - no-load test (or open circuit test) and short circuit test will provide information for determining the parameters of the equivalent circuit. Of Single Phase Transformer**			

Lecture Contents:	Name:myasar alattar		Lecture Number:	3

Topics: universal motor
1-introduction to universal motor
2- construction of universal motor
3- operation principle of universal motor
4- losses and efficiency torque speed charctaristic
6- test of single phase transformer (open and short test)

Contents:

1- A universal motor is a special type of motor which is designed to run on either DC or single phase AC supply these motors are generally series wound

2. Construction of a universal motor consists of two parts a- stator :on which field poles are mounted. Field coils are wound on the field poles.

b- rotor :armature is of wound type having straight or skewed slots and commutator with brushes resting on it. The commutation on AC is poorer than that for DC. because of the current induced in the armature coils. For that reason brushes used are having high resistance

All parts made of lamination material to minimize the eddy currents which induce while operating on AC.

3. When the universal motor connected to a DC supply, it works as a DC series motor current flows in the field winding, it produces an electromagnetic field. The same current also flows from the armature conductors generating field .then mechanical force, or torque, the rotor starts to rotate. The direction of this force is given by Fleming's left hand rule

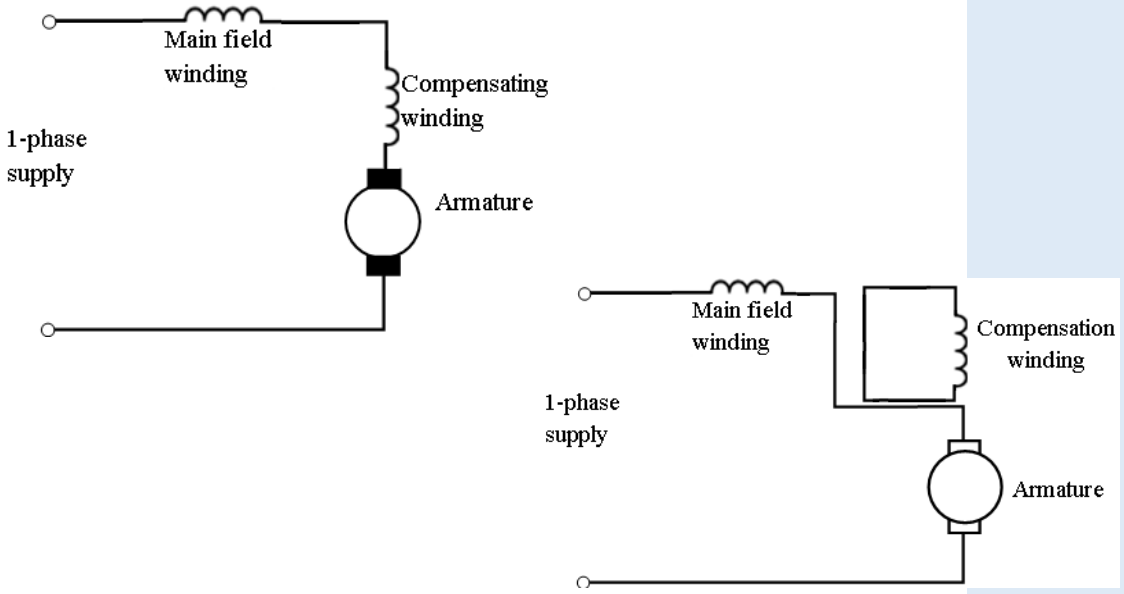
4.

1-material of motor made of low hysteresis losses and laminated to reduce the eddy current

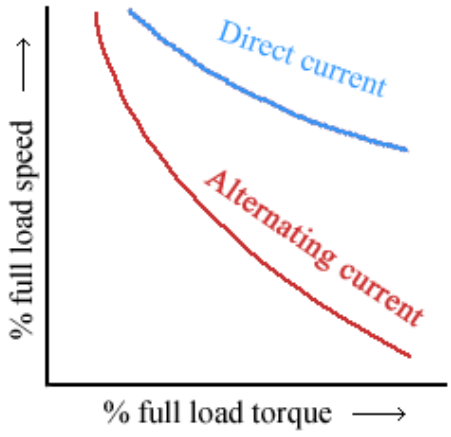
2 reduced the number of turns

3- increase number of conductor to generate a require torque

-to reduce the effect of armature reaction, for improving commutation and reducing armature reactance, a compensating winding is used. The compensating winding is put in the stator slots. The axis of the compensating winding is 90 (electrical) with the main field axis. It may be connected in series with both the armature and field as shown in fig.1 In such a case the motor is conductively compensated.



Like DC series motor. The speed of a universal motor is low at full load and very high at no load. Usually, gears trains are used to get the required speed on required load



	Name:myasar alattar		**Lecture Number:**	**4**

Topics: single phase induction motor
1-introduction to induction motor
2- construction of induction motor
3- operation principle of single induction motor
4- equivalent circuit of single phase transformer (approximate and exact)
5- losses and efficiency
6- test of single phase transformer (open and short test)

Lecture Contents:

Contents:
1- The single-phase induction machine is the most frequently used motor for refrigerators, washing machines, drills, compressors, pumps,

- **Simple design**
- **Inexpensive**
- **High power to weight ratio**
- **Easy to maintain**
- **Direct connection to AC power source**

single phase induction motor has no starting torque and some special arrangement have to be made to make it as self-starting
Single-phase induction motors types

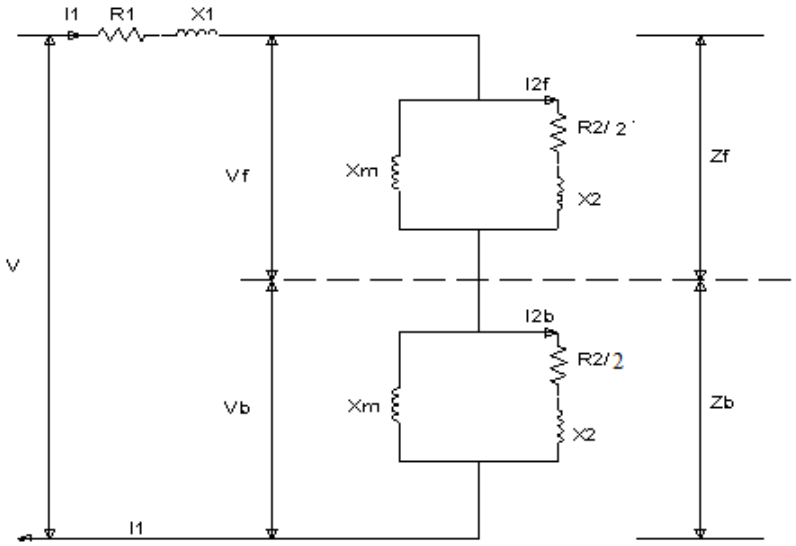
- **(i) split-phase type**
- **(ii) capacitor start type**
- **(iii) capacitor start capacitor run type**
- **(iv) shaded-pole type**

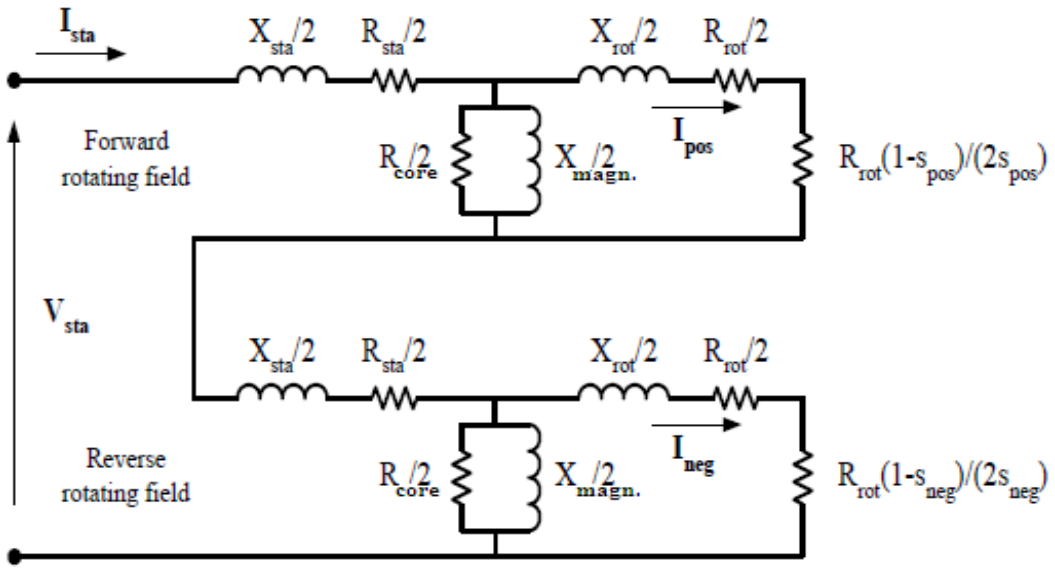
2. The single-phase motor stator has a laminated iron core with two windings arranged perpendicularly, One is the main and the other is the auxiliary winding or starting winding. It comprises of a steel outline which encases an empty, cylindrical core made up of thin laminations of silicon steel to reduce hysteresis and eddy current losses.
The rotor, mounted on a shaft, is a hollow laminated core having slots on its outer periphery. The winding placed in these slots (called rotor winding) may be one of the following two types:
(i) Squirrel cage rotor: (ii) wound rotor

3. When stator winding is energized from a.c. supply, a rotating magnetic field (RMF) is set up which rotates round the stator at synchronous speed Ns (= 120 f/P), when f = frequency and P No. of poles

The rotating field passes through the air gap and cuts the rotor conductors, which are stationary . Due to the relative speed between the rotating flux and the stationary rotor, electrical motive force (EMF) are induced in the rotor conductors. Since the rotor circuit is short-circuited, currents start flowing in the rotor conductorsThe flux from the stator will cut the coil in the rotor and since the rotor coils are short circuited, according to Faraday's law of electromagnetic induction, current will start flowing in the coil of the rotor
The current-carrying rotor conductors are placed in the magnetic field produced by the stator. Consequently, mechanical force acts on the rotor conductors. The sum of the mechanical forces on all the rotor conductors produces a torque which tends to move the rotor in the same direction as the rotating field with speed N =Ns (1-S) when S= slip and N = rotor speed

4. *Double revolving field theory*
When ac voltage connected to the main winding a sinusoidal space distributed mmf, whose peak or maximum value pulsates (alternates) with time s produced in the air gap. This sinusoidal varying flux (φ) is the sum of two rotating fluxes or fields, the magnitude of which is equal to half the value of the alternating flux (φ /2)
both the fluxes rotating at synchronous speed, in opposite directions
5 - The auxiliary wending and main winding connect in parallel together and with supply.
When the rotor move with speed until the synchronous speed the auxiliary wending will open from connection after few seconds.
if an external torque moves the motor in any direction, the motor will begin to rotate
6- We represent the equivalent circuit of single phase induction motor depending on double-field revolving theory . Where there are two fluxes induces by currents in the rotor circuit and creating induction motor action .
There fore this motor can be imagine as two motors, having a common stator winding but with their common rotors revolving in opposite directions. Each rotor has resistance and reactance half the actual rotor values





7- How to make motor self starting ?

At the beginning of lecture we classify motor in to many type according to their circuit connection

- **To make a single-phase induction motor self-starting , we need to convert motor from single phase to two phase by adding winding .**
- **When the motor reaches the certain speed, the starting means may be removed depending upon the type of the motor**

1-Split-Phase Induction 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. The starting winding is located 90° electrical from the

main winding its operates only during the brief period when the motor starts up.
The two windings are so resigned that the starting winding S has a high resistance and relatively small reactance while the main winding M has relatively low resistance and large reactance
Capacitor start motor
This motor is same as split-phase motor except that the starting winding has as many turns as the main winding. a capacitor C (3-20 μF) is connected in series with the starting winding .The value of capacitor must chose to make Is leads Im by about 80° which is considerably greater than 25° found in split-phase motor
(i) If the two stator windings are supplied from a supply, a current Im flow through main winding while Is flow through the starting winding.
(ii) Capacitance create phase angle a (80°) between current Im and Is
(iii) if starting torque become much more than that of a split-phase motor .the starting winding is disconnect by opening the centrifugal switch so the motor reaches 80% of synchronous speed. The motor then operates as a single-phase induction motor and continues to accelerate till it reaches the normal speed.
starting characteristics of a capacitor-start motor are better than those of a split-phase motor
due the main windings are identical. both type of motors have the same running characteristics
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 less quickly so it is well suited to applications has long or frequent starting periods
These motors are used for high starting torque application drive: (a) compressors (b) large fans (c) pumps (d) high inertia loads
3- Capacitor start Capacitor run induction motors
This motor is same as capacitor-start motor except that starting winding is not opened after starting so that both the windings remain connected to the supply when running as well as at starting .there is a design have 2 cap in starting winding which eliminates the need of a centrifugal switch and at the same time improves the power factor and efficiency of the motor. In the other design, two capacitors C1 and C2 are used in the starting winding.the value of capacitor is must chose to make Is leads Im by about 80° .
