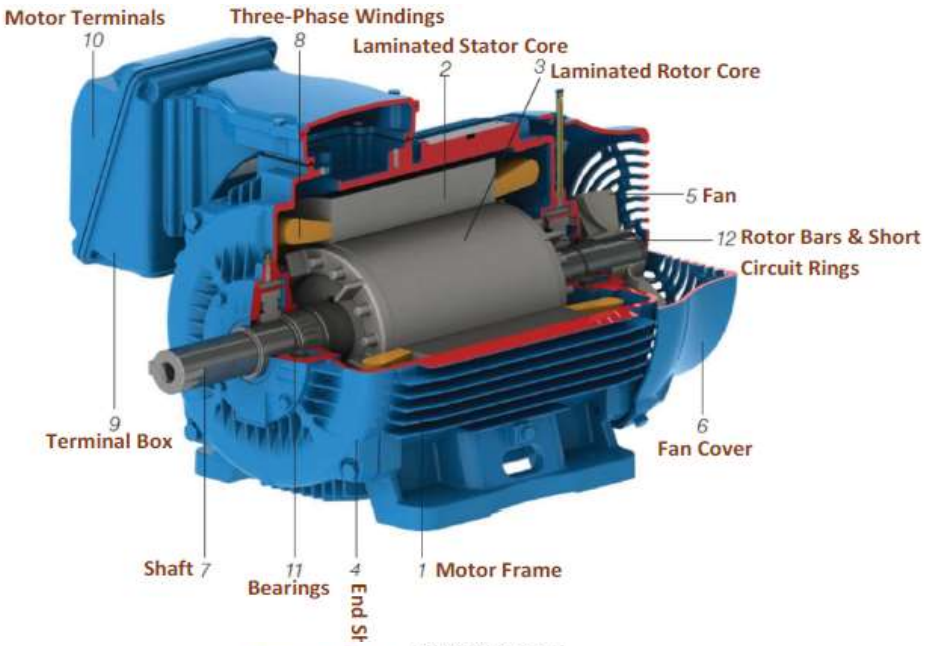
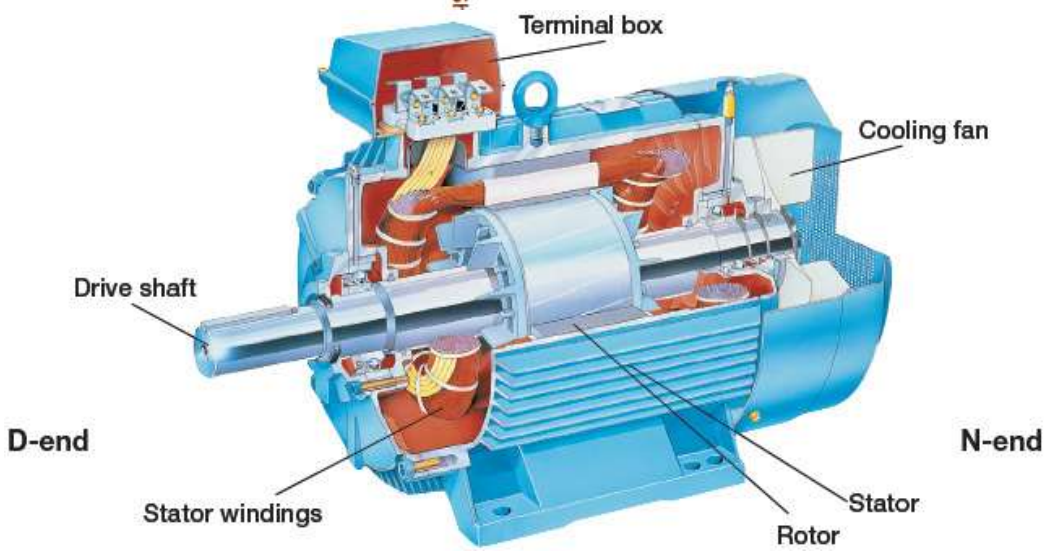
Pracs MTRN3026 Mechatronics Systesm Week#7 - Induction Motor

Activity 1:

- Open the Induction motor and examine the inside construction layout. Read the nameplate of the motor and explain its significance.
- Please select five important parts and briefly explain the significance of those parts (2-3 lines for each).
- Explain the operating principle of Induction Motor. Differentiate the principle of operation of DC Motor and Induction Motor.
- Please have a look at the links: https://www.youtube.com/watch?v=LAtPHANEfQo https://www.youtube.com/watch?v=AQqyGNOP_3o





Activity 2: Setup Demonstration

Schneider Electric motor drive system

- Switch on the drive system (Ensure *f* =50 Hz)
- Familiarize with the basic operations:

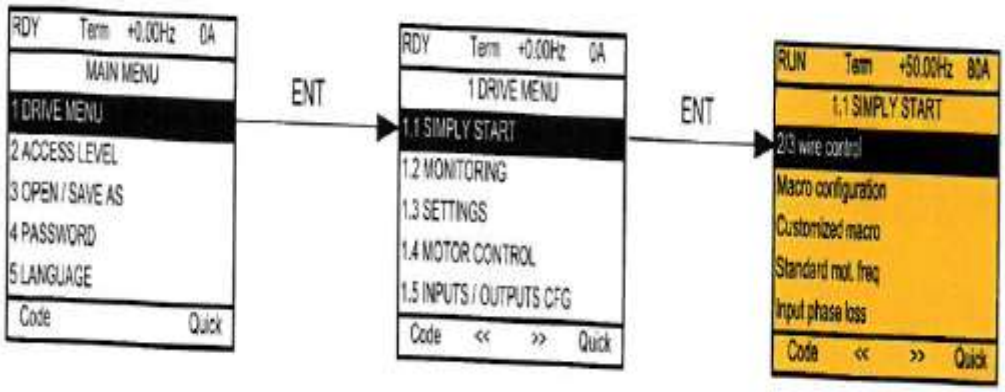
a) Control of Motors

b) Monitoring of parameters

c) Running mode of motor

d) Check for motor parameters Operations:

1.	Torque%	Drive menu→ Monitoring → Motor Torque
2.	Power	Drive menu→ Monitoring → Power
3.	Torque	Drive menu→ Monitoring → Torque
4.	Frequency	On the front panel
5.	RPM	Drive menu→ Monitoring → Speed
6.	Slip	Calculate theoretically
7.	Ramp	Drive menu→ Settings → Ramp increment
8.	Voltage	Drive menu→ Monitoring → Voltage



Activity 3: Study of Motor Characteristics (No-Load)

Study the loading arrangement of the motor. Keep the magnets as far as possible from the disk. Set the frequency to a minimum value (say 5Hz) and run the motor. Measure the running speed of the motor. Adjust the frequency with a step of 5 Hz and increase up to 50 Hz. Please note down the machine parameters.

Frequency (Hz)	Voltage (V)	Current(A)	Power (W)	Speed (rpm)
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				

Plot:

i. Speed vs Frequency
ii. Voltage vs Frequency
iii. Power vs Frequency
iv. Current vs Frequency

Please comment on the above characteristics.
What is the relationship between voltage and frequency when frequency is changed?

Activity 4: Study of Motor Characteristics (On Load)

By now you know very well the Schneider Electric motor drive system. Please note that the driver delivers a three-phase output though it is supplied from single-phase input.

You now need to load the motor.

#1: Set the slip compensation to ZERO (No compensation).

Set the operating frequency to 50 Hz. Run the motor.

Measure the no-load speed of the motor (**the magnets should be as far as possible).**

#2: Bring the magnets slowly close to the disk **(machine loading)** and measure all parameters such as voltage, current, power, torque, etc. Measure the running speed of the motor. Take at least 5 readings (from zero to full load).

***f* = 50Hz**					
Slip Compensation (%)	Torque (%N-m)	Speed (rpm)	Current (A)	Voltage (V)	Power (%W)
0					
25					
50					
100					

#3: Repeat the same process by setting the frequency to 30 Hz (no-load to full load) with slip compensation of: i. 25%, ii. 50%, and iii. 100%

#4: Comment on the above results. Plot the output power, torques, current, power factor, and efficiency as a slip function.

Activity 5: Determination of Motor Parameters

The equivalent circuit is given in Figure 1 for one phase of the induction motor.

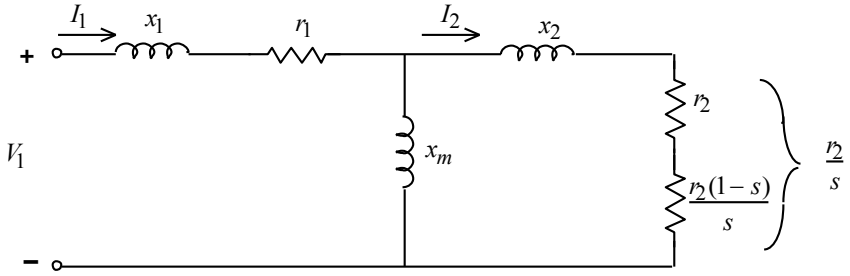


Figure 1. Per phase Equivalent Circuit of Induction Motor

The symbols used in Figure 1 are defined below:

V_1 = line-to-neutral terminal voltage. The phase windings are in a Y configuration.

r_1 = stator resistance per phase
x_1 = stator leakage reactance per phase
r_2 = rotor resistance referred to the stator, per phase
x_2 = rotor leakage reactance referred to the stator, per phase
x_m = a shunt reactance supplied to provide a path for the magnetizing component of the current flowing in the stator. It is this current which produces the revolving field in the motor.

In stead of conducting real test we are providing you test parameters.
The following test data were taken on a 7.5-hp, four-pole, 208-V, 60-Hz, design A, Y-connected IM having a rated current of 28 A.

DC Test:
V_{DC} = 13.6 V I_{DC} = 28.0 A

No-load Test:
V_l = 208 V f = 60 Hz
I = 8.17 A P_{in} = 420 W

Locked-rotor Test:
V_l = 25 V f = 15 Hz
I = 27.9 A P_{in} = 920 W

#5: Calculate the circuit parameters of the motor. Draw the equivalent circuit of the motor.

#6: Find the following parameters for a slips of 1, 0.75, 0.5, 0.25, 0.2, 0.15, 0.1, 0.05, 0.03, 0.02 and 0.01 for the above test data.
Input Current
Power factor
Power input
Air-gap power
Developed torque
Torque output
Power output
Efficiency

You may write a short MATLAB code for the above calculation.

Questions:

1. Define Slip and its importance for the operation of an Induction Motor.
2. Define Synchronous Speed.
3. What is the advantage of skewed stator slots in the rotor of an Induction motor?
4. What is meant by cogging in the Induction motor? How to prevent the cogging?

5. What are the various methods of speed control in three-phase induction motors?
6. What is meant by crawling in the induction motor?
7. What is the V/f control of an induction motor?
8. What are the different couplings by which an Induction motor should be coupled to a mechanical load?