INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad – 500043

COURSE CONTENT

AC MACHINES LABORATORY								
IV Semester: EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AEEC13	**Core**	-	-	3	1.5	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: DC Machines and Transformers, ACM								

I. COURSE OVERVIEW:

This course is intended to train the students on alternating current machines. It provides hands-on experience by conducting various direct and indirect tests on transformers, synchronous and asynchronous machines to analyze the characteristics of AC machines and separate various losses. This course also enables to develop skills to select, install, operate, and maintain various types of AC machines and transformers

II. COURSES OBJECTIVES:

The students will try to learn

I. The elementary experimental and modeling skills for handling problems with electrical machines in industries and domestic applications.
II. The operation of AC machines and its role in power transmission and generating stations.
III. The automation concepts through programmable logic controllers to control the speed and starting current.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1	Select suitable testing strategies for evaluating the performance characteristics of Transformers
CO2	Determine the performance parameters of induction motor by conducting direct and indirect Tests
CO3	Explain the parallel operation of alternators for load sharing under various loading Conditions.
CO4	Calculate the synchronous impedance and ampere turns methods for the computation of Voltage regulation of an alternator
CO5	Estimate the voltage and current swings in salient pole alternator for determination of direct And quadrature axis reactance
CO6	Apply programmable logic controllers for limiting the starting current of poly phase induction Motors

DO's

1. Once the operation is completed pull the plug itself rather chord attached to it.
2. To repair the equipment switch-off the supply and go on.
3. To operate the equipment on supply, see that hands are dry, if that is not possibly hide the hand in the pockets.

4. If a person comes in contact with current unexpectedly don't touch the person with hands but immediately use any insulator material and shut down the power 5. If water is nozzles on the equipment, immediately shunt down the power using circuit breaker or pull out the plug.
6. Use the connecting wires of good continuity, short circuit of connecting wire leads damage of circuit parameters

DON'Ts

1. Do not wear loose clothing and do not hold any conducting materials in contact with skin when the power is on.
2. Do not pull out the connections until unless all the currents are dead.
3. Do not wait for switches to de-magnetize when there is a delay but pull out the plug.
4. Do not overload the circuit by plugging in too many appliances.
5. If you are mentally and physically stressed don't operate the power equipment.
6. Never operate the equipment under wet conditions.
7. Do not interconnect two or more wires, take appropriate length of wire.

SAFETY NORMS

1. The lab must be equipped with fire extinguisher.
2. See that the connections are made tight.
3. Use single plug for each equipment.
4. Cover the body completely to avoid arc effect.
5. To change the connections during the experiment, switch off the supply and carry on.
6. Used equipment may get heated, so take care handling the equipment after it is used.
7. Do the wiring, all set ups and check the circuit connections before the supply is on

IV. COURSE CONTENT:

EXERCISES FOR ELECTRICAL AC MACHINES LABORATORY

Note: Students are encouraged to bring their own laptops for laboratory practice session

1. OPEN AND SHORT CIRCUIT TEST ON A SINGLE-PHASE TRANSFORMER

Conduct the experiment to determine the circuit parameters at rated voltage and rated current.

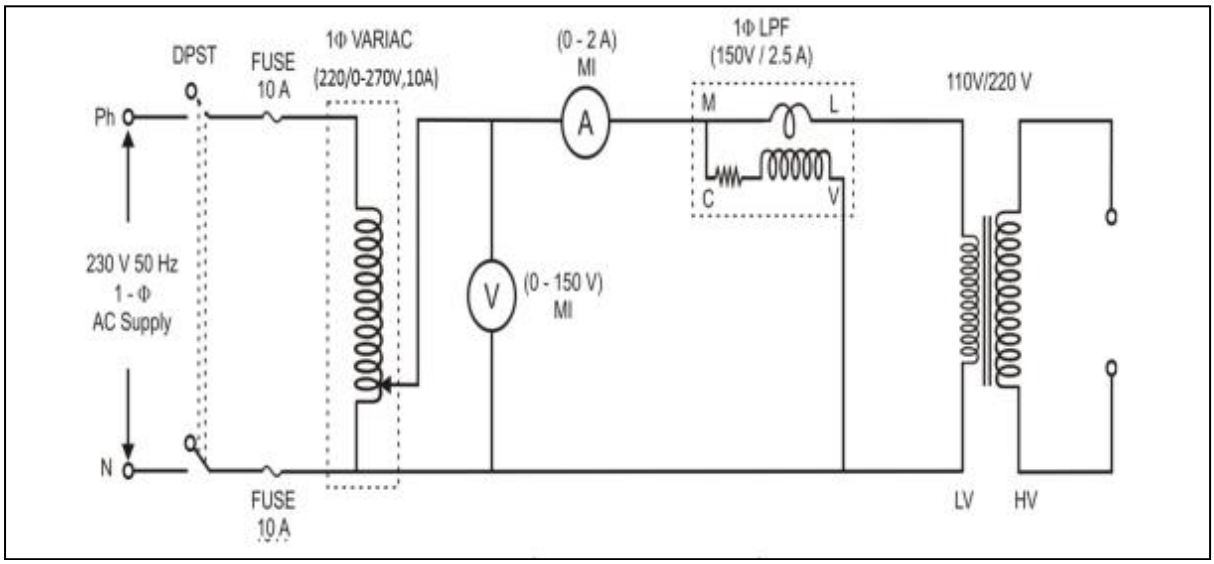

Figure 1 - Open circuit test Circuit

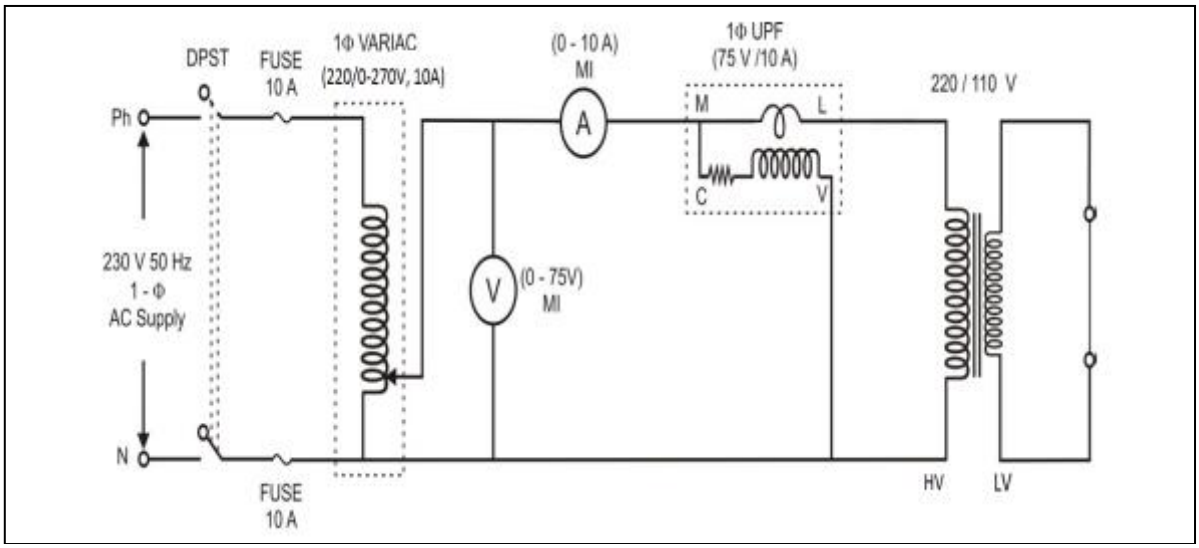

Figure 1.1 - Short circuit test Circuit

Try

1. From the Open circuit characteristics calculate the open circuit voltage and determine the performance using OCC from Figure 1.
2. Using short circuit characteristics calculate the short circuits current and determine the performance using SCC from Figure 2.

2. SUMPNERS TEST ON A PAIR OF SINGLE PHASE TRANSFORMERS

Conduct an experiment on pair of single phase transformers to determine the regulation and efficiency.

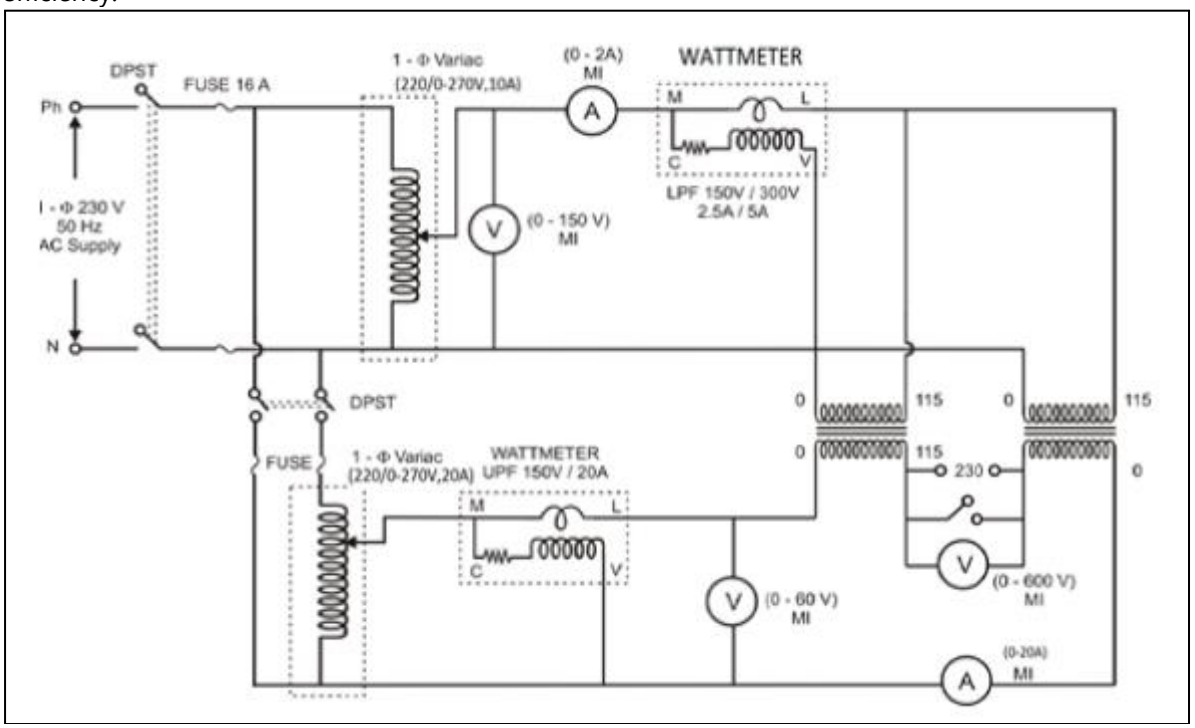

Figure 2 – Sumpner's test on a pair of single phase Transformers

Try

1. Calculate the circuit parameters like currents, voltages and power from Figure 2
2. Determine the regulation and efficiency by using the circuit parameters obtained.

3. LOAD TEST ON SINGLE PHASE TRANSFORMERS

Conduct an experiment to determine efficiency by performing load test on a single phase transformer

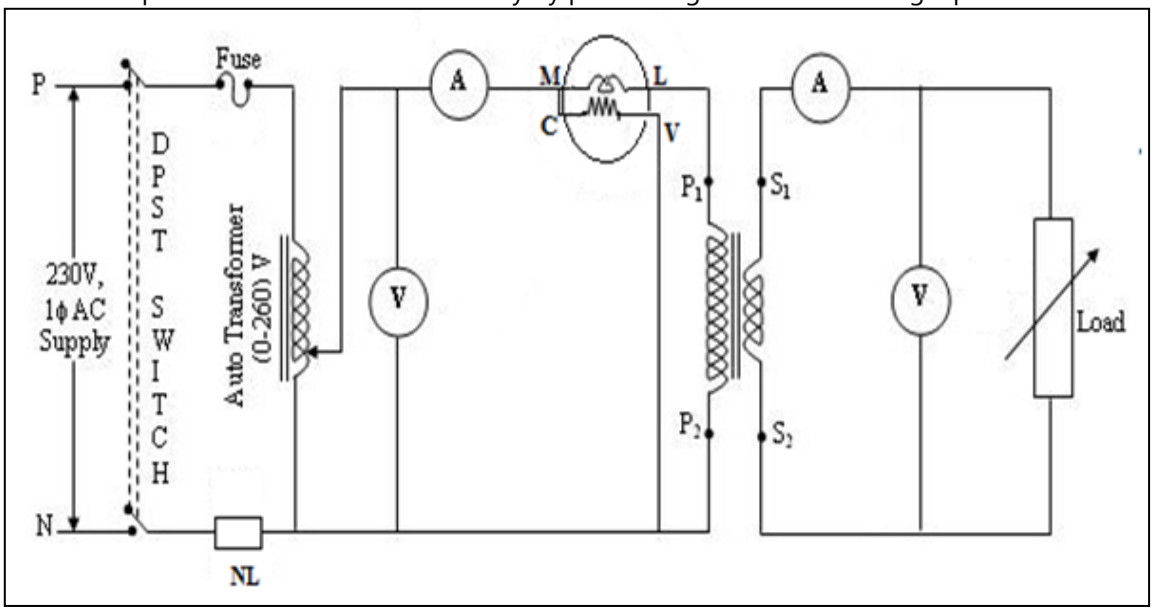

Figure 3 - LOAD TEST ON SINGLE PHASE TRANSFORMERS

Try

1. Calculate the different currents and voltages by using voltmeters and ammeters from Figure 3
2. Calculate the efficiency by performing the test on transformer

4. SCOTT CONNECTION OF TRANSFORMERS

Conduct an experiment to Convert three phase to two phase using single phase transformers

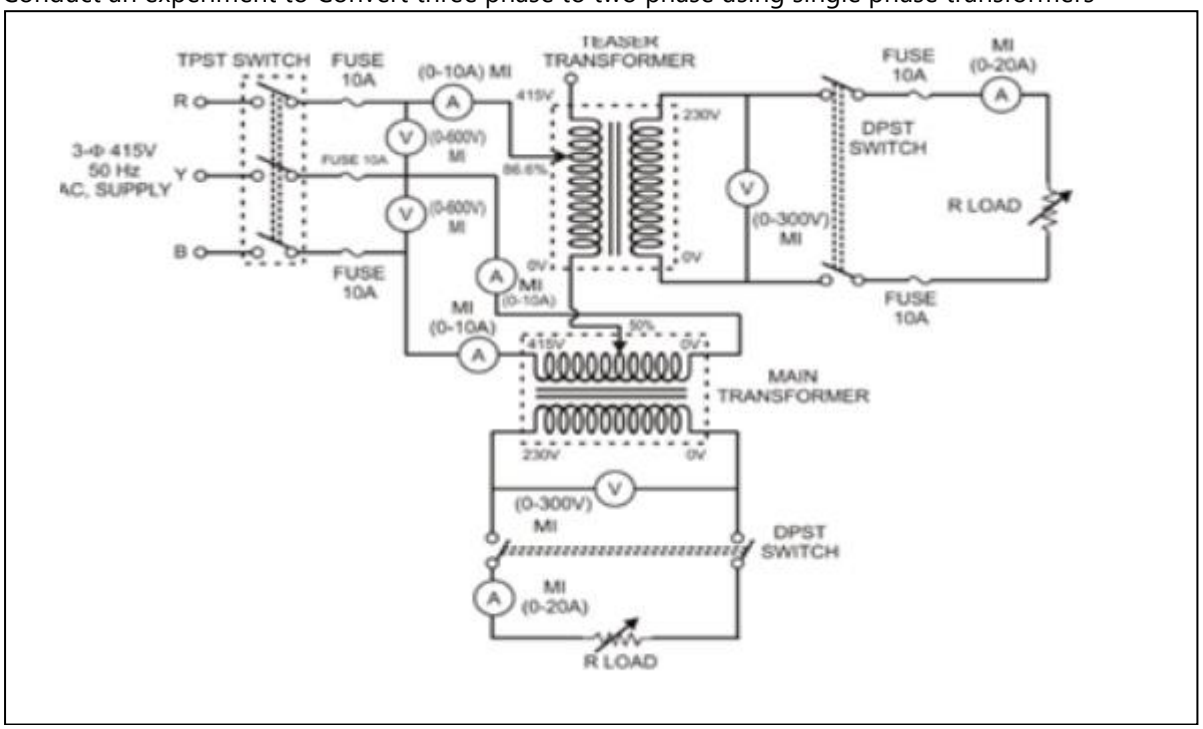

Figure 4 - SCOTT CONNECTION OF TRANSFORMERS

Try

1. Calculate the different currents and voltages by using voltmeters and ammeters from Figure 4
2. By increasing the load current on transformers, Calculate load currents and voltages.

5. SEPARATION OF CORE LOSSES IN SINGLE PHASE TRANSFORMER

Conduct an experiment to determine the eddy current losses and hysteresis losses in single phase transformer

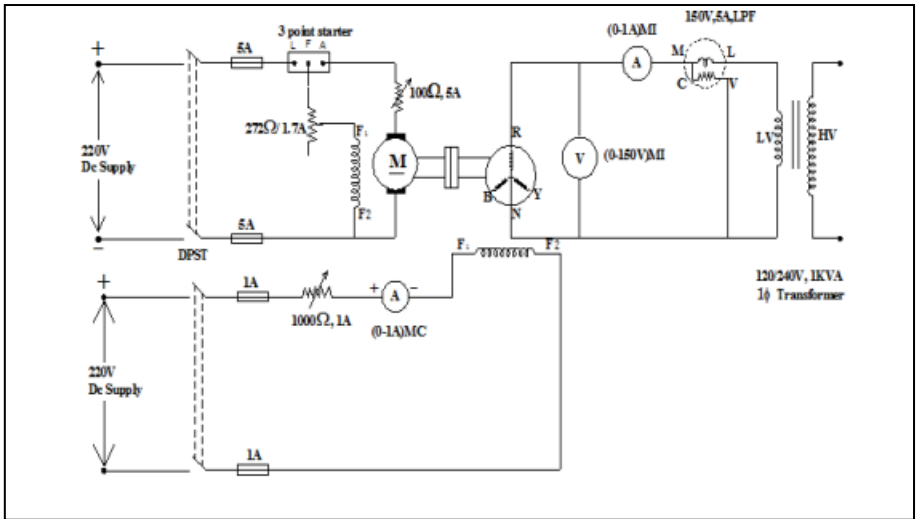

Figure 5 - SEPARATION OF CORE LOSSES IN SINGLE PHASE TRANSFORMER

Try

1. Calculate the value of eddy current losses with respect to current and voltage and power parameters' obtained at different frequencies by maintain V/F as constant from Figure 5.
2. Calculate the value of hysteresis losses with respect to current and voltage, power parameters' obtained at different frequencies by maintain V/F as constant.

6. HEAT RUN TEST ON SINGLE PHASE TRANSFORMERS

Conduct an experiment to check whether the oil and winding temperatures of the transformer meet the values specified in the standard and technical projects.

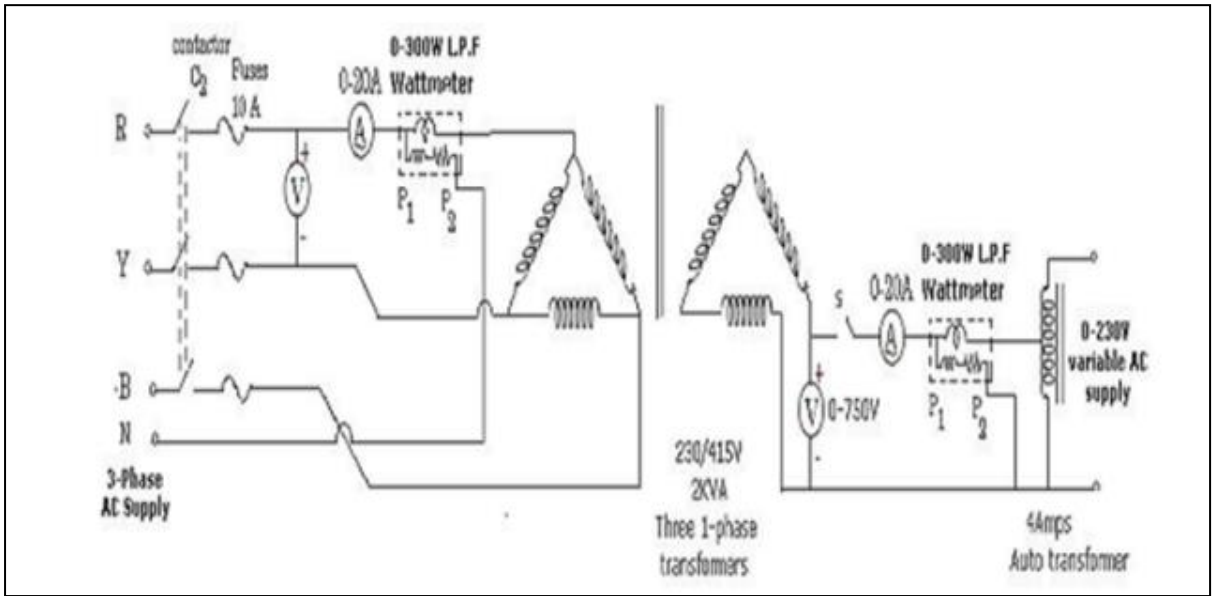

Figure 6 - HEAT RUN TEST ON SINGLE PHASE TRANSFORMERS

Try

1. Calculate the temperature rise by determining voltage, current and power from Figure 6.
2. Conduct the polarity test and connect them as per the dot Convention when voltmeter indicates high value.

7. BRAKE TEST ON THREE PHASE SQUIRREL CAGE INDUCTION MOTOR

Calculate the rotor and stator losses (mainly copper losses) by conducting blocked rotor test.

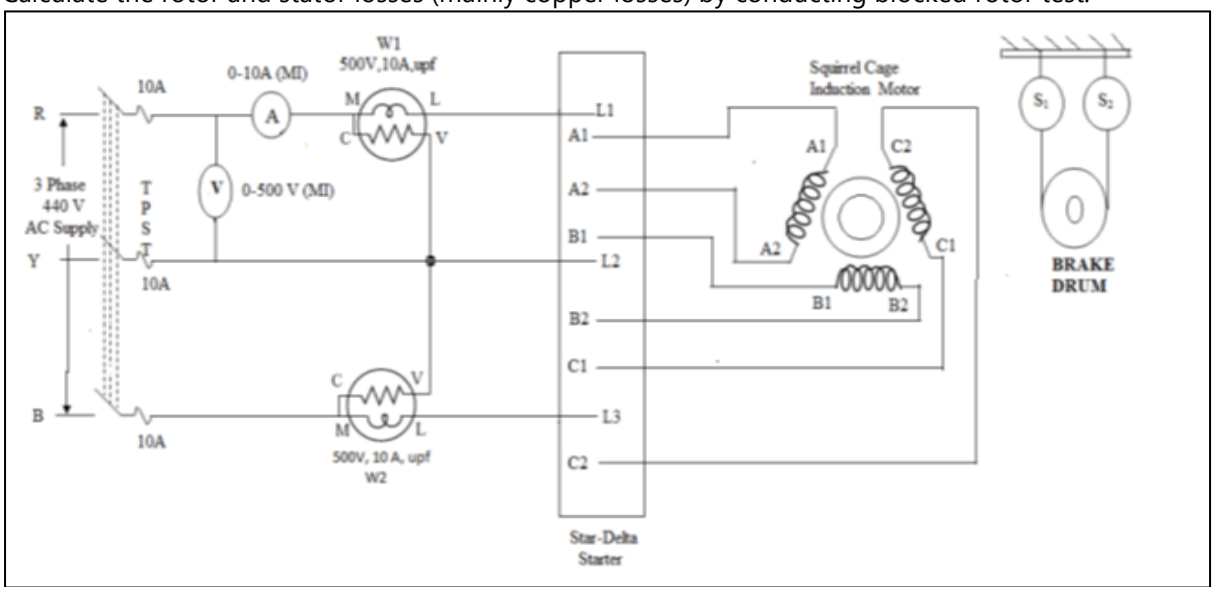

Figure 7 - BRAKE TEST ON THREE PHASE SQUIRREL CAGE INDUCTION MOTOR

Try

1. Calculate the voltage, current and power values at no-load condition from Figure 7
2. By applying mechanical load, calculate all meter readings including speed of induction motor.
3. Plot the performance characteristics of three phase induction motor

8. CIRCLE DIAGRAM OF THREE PHASE SQUIRREL CAGE INDUCTION MOTOR

Plot the circle diagram and predetermine the efficiency and losses of three phase squirrel cage induction motor.

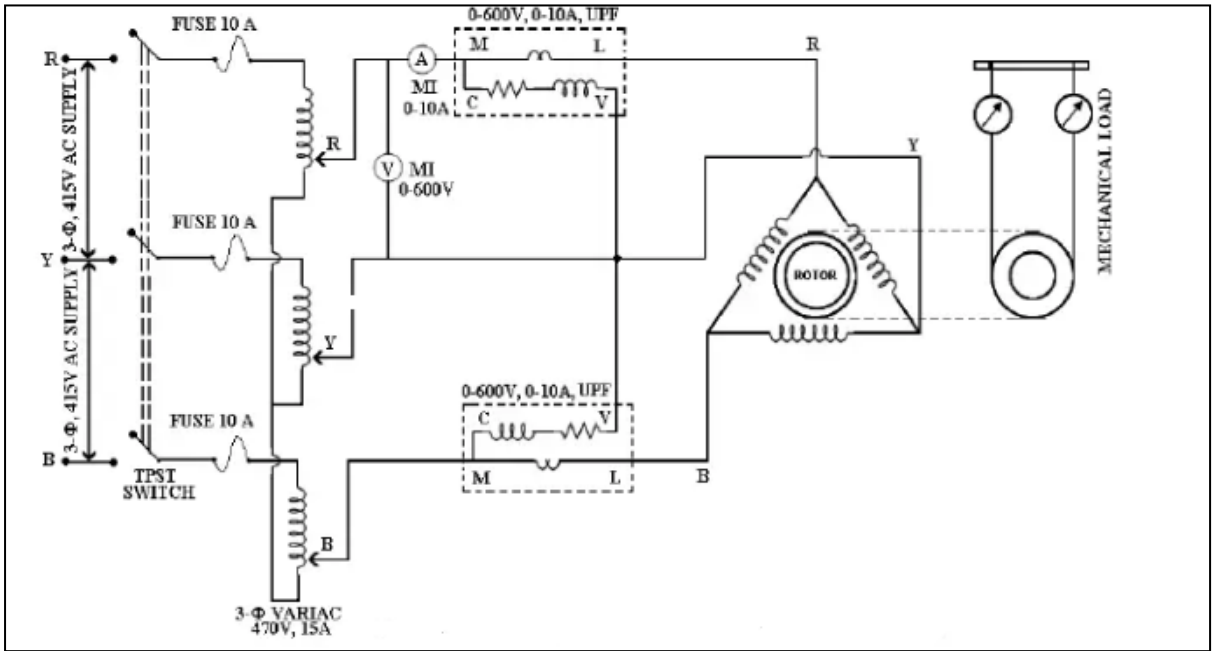

Figure 8 - CIRCLE DIAGRAM OF THREE PHASE SQUIRREL CAGE INDUCTION MOTOR

Try

1. Calculate the efficiency of Squirrel cage IM under different load conditions from Figure 8.
2. Plot the circle diagram by determining the currents and voltages connected in circuit.

9. REGULATION OF ALTERNATOR BY EMF METHOD

Determine the regulation of alternator using synchronous impedance method.

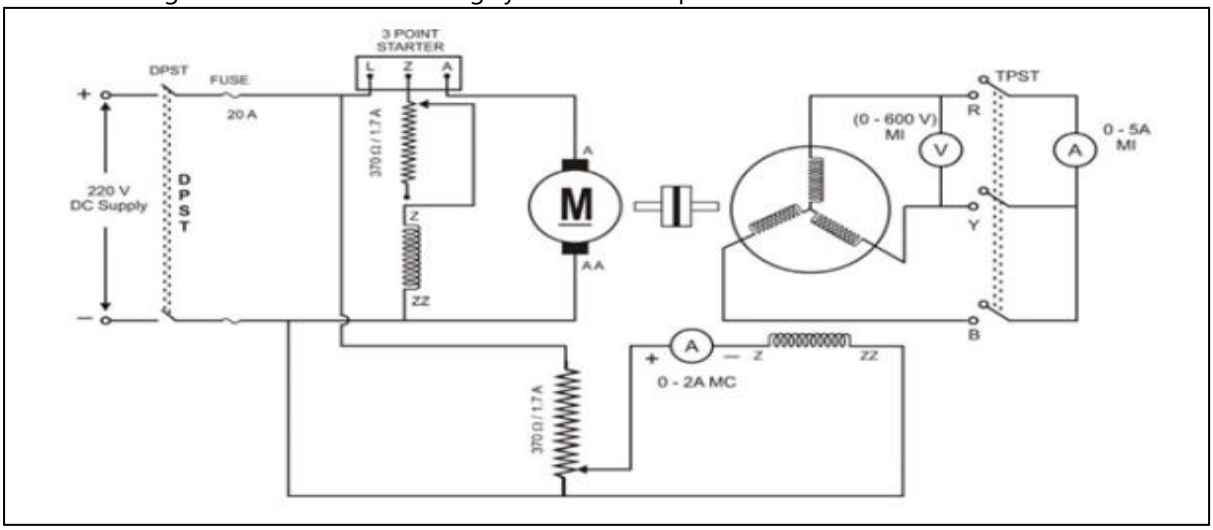

Figure 9 - REGULATION OF ALTERNATOR BY EMF METHOD

Try

1. Calculate the OCV from the circuit from Figure 9.
2. Draw the OCC curve.
3. Determine the voltage regulation by using EMF method.

10. REGULATION OF ALTERNATOR BY MMF METHOD

Determine the regulation of alternator using amperes turns method

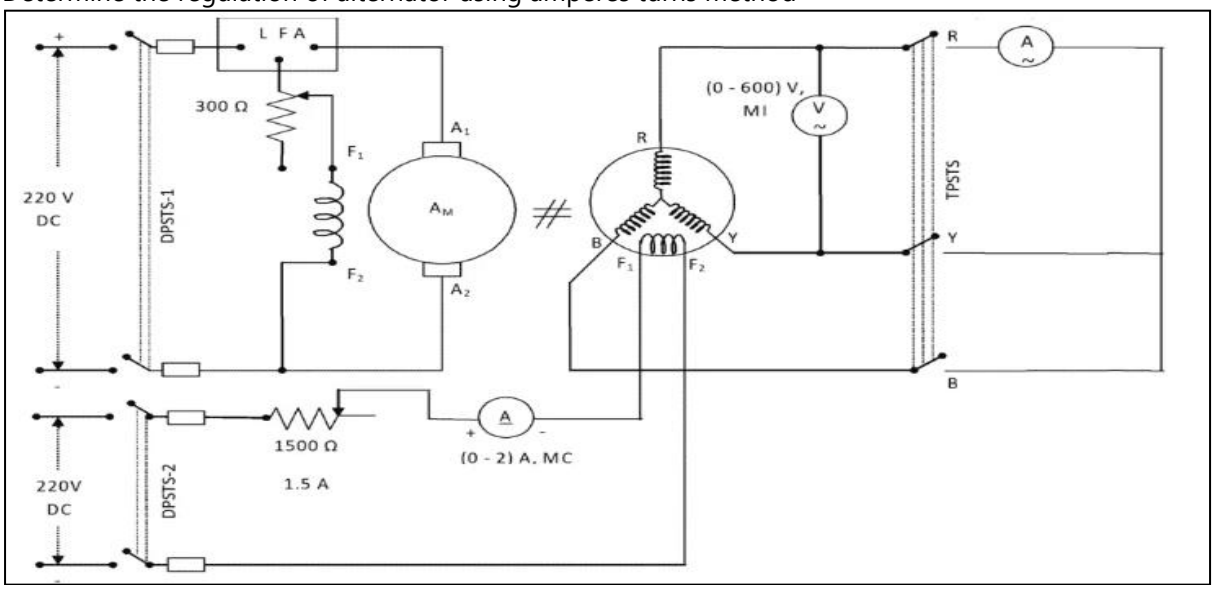

Figure 10 - REGULATION OF ALTERNATOR BY MMF METHOD

Try

1. Calculate the Short circuit current from the circuit in Figure 10.
2. Draw the SCC curve.
3. Determine the voltage regulation by using MMF method.

11. SLIP TEST ON THREE PHASE SALIENT POLE SYNCHRONOUS MOTOR

Determination of Xd and Xq in a three phase salient pole synchronous motor.

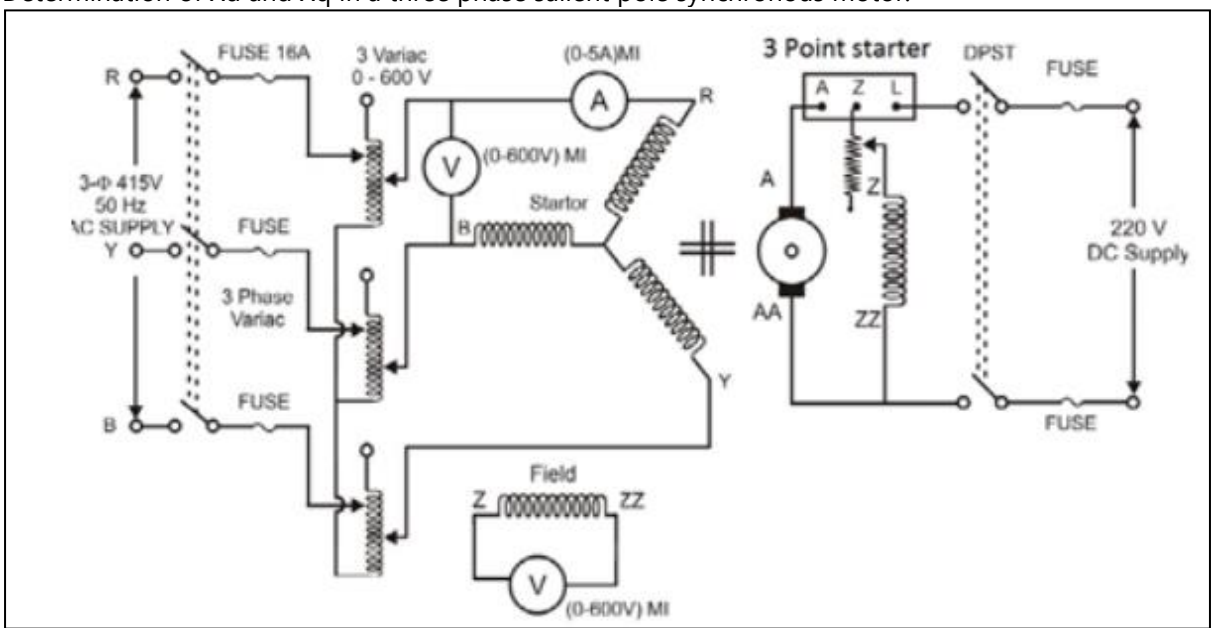

Figure 11 - SLIP TEST ON THREE PHASE SALIENT POLE SYNCHRONOUS MOTOR

Try

1. Calculate the direct axis reactance (Xd) by calculating min voltage and max current from Figure 11.
2. Calculate the quadrature axis reactance (Xq) by calculating max voltage and min current.

12. V AND INVERTED V CURVES OF SYNCHRONOUS MOTOR

Plot V and inverted V curves to study the effect of power factor in synchronous motor.

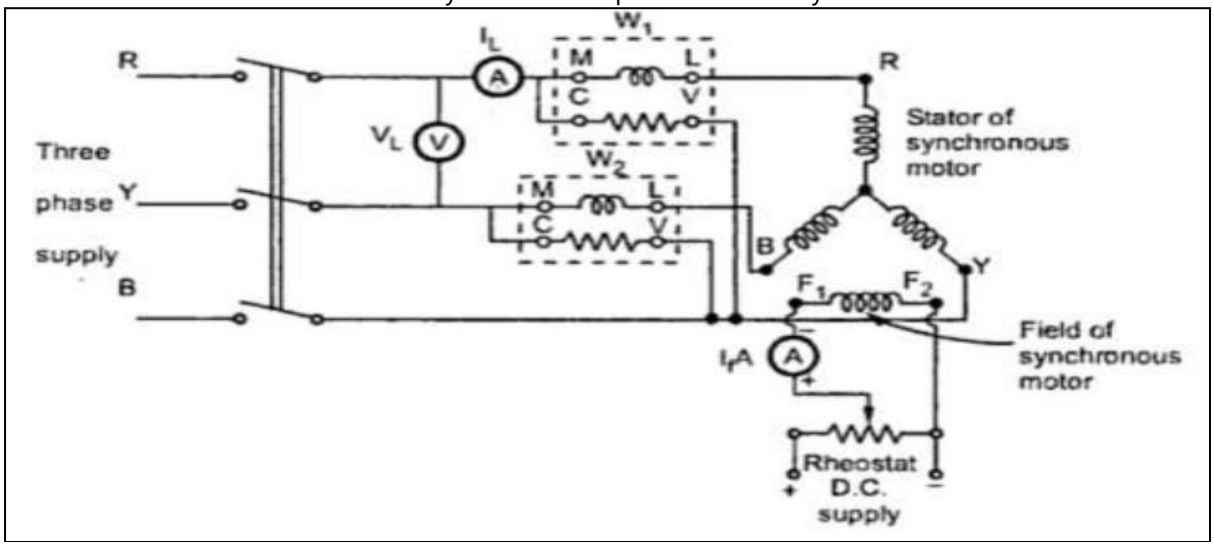

Figure – 12 V AND INVERTED V CURVES OF SYNCHRONOUS MOTOR

Try

1. For different Power factors plot the V curve and inverted V curves for lagging, leading and Unity PF from Figure 12.

13. EQUIVALENT CIRCUIT PARAMETERS OF SINGLE PHASE INDUCTION MOTOR

Determine the equivalent circuit parameters of a single phase induction motor

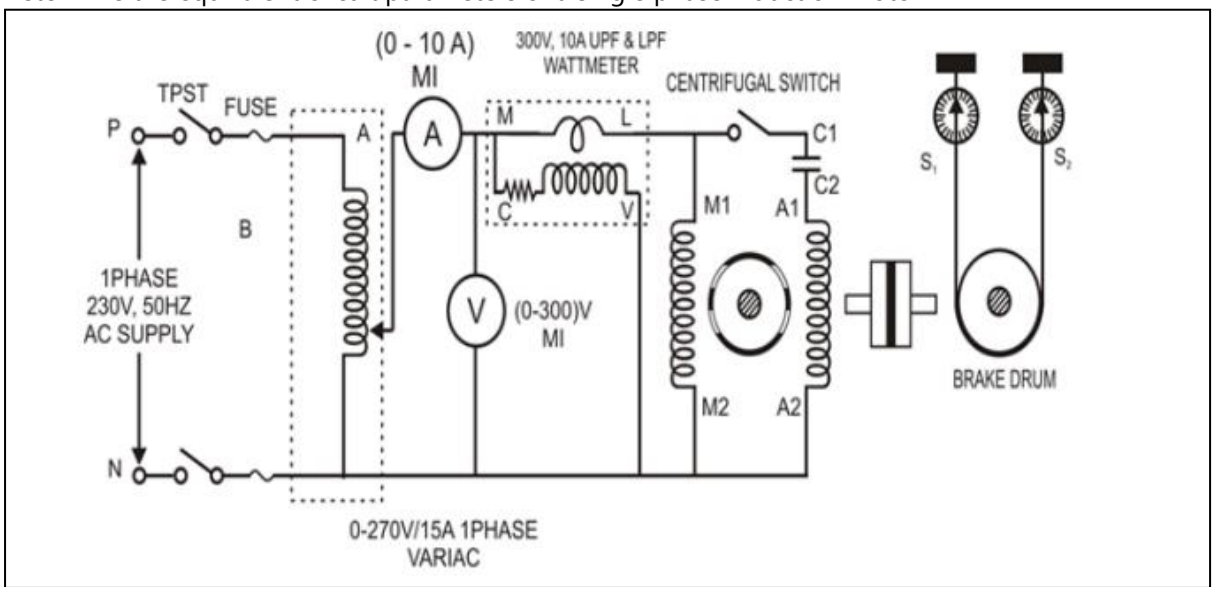

Figure – 13 EQUIVALENT CIRCUIT PARAMETERS OF SINGLE-PHASE INDUCTION MOTOR

Try

1. Calculate the equivalent circuit parameters like current, voltage and power under various loads from Figure – 13.
2. Draw the equivalent circuit diagram of induction motor.

14. STARTING AND SPEED CONTROL OF INDUCTION MOTOR USING PLC

Implementation of direct online (DOL) starter for three phase induction motor using Programmable Logic Controllers.

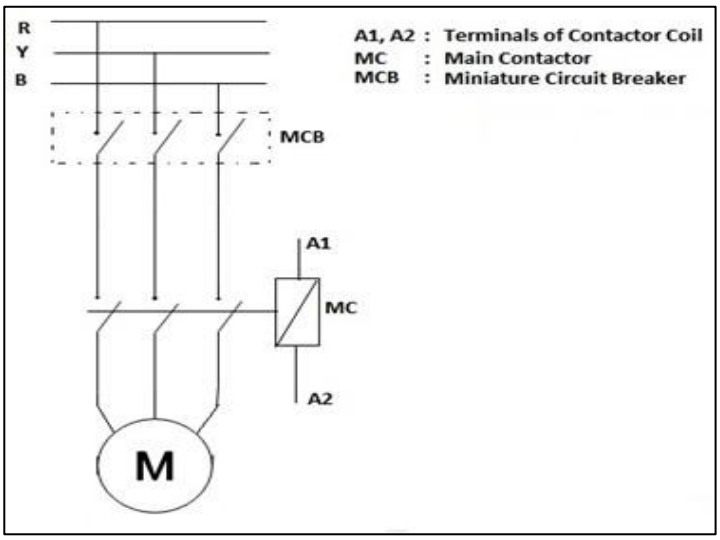

Figure – 14 STARTING OF INDUCTION MOTOR USING PLC

Try

1. Analyze about the components and operation of direct online starter using ladder diagram in terms of concepts.
2. Conclude the above obtained results with wiring the Programmable Logic Controller and Human Machine Interface.

14.1 Automatic Forward and Reverse Control of Motor

Implement automatic forward and reverse control of three phase squirrel cage induction motor for milling operation using PLC.

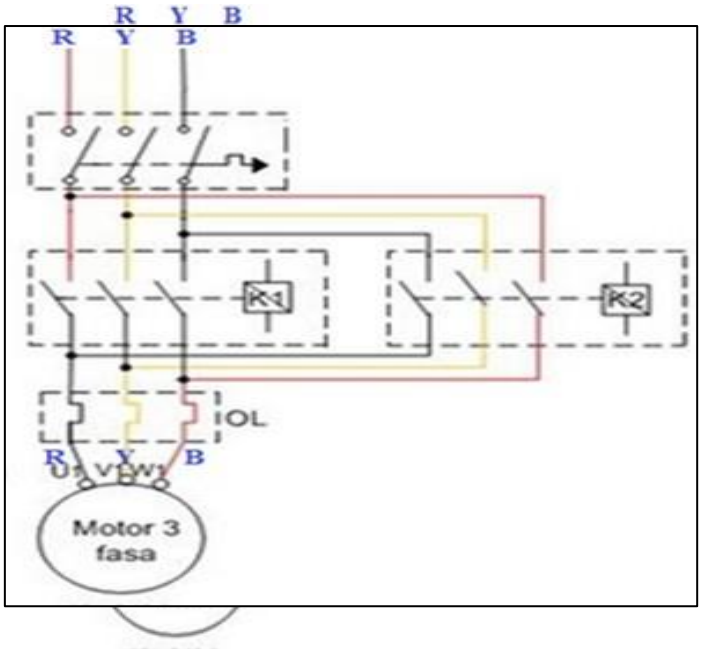

Figure – 14.1 SPEED CONTROL OF INDUCTION MOTOR USING PLC

Try

1. Analyze the forward and reverse control operation of three phase induction motor for Circuit using ladder diagram in terms of concepts.
2. Conclude the above obtained results with wiring the Programmable Logic Controller and Human Machine Interface.

V. TEXT BOOKS:

1. P S Bimbhra, "Electrical Machinery", Khanna Publishers, 1st edition, 2011.
2. I J Nagrath and D P Kothari, "Electric Machines", McGraw Hill Education, 1st edition, 2010.
3. J B Guptha "Theory and performance of Electrical machiines", S.K.Kataria & Sons Publishers 14th edition, 2009.

VI. REFERENCE BOOKS:

1. P S Bimbhra, "Electrical Machines", Khanna Publishers, 2nd edition, 2008.
2. M G Say, E O Taylor, "Direct Current Machines", Longman Higher Education, 1st edition, 1985.
3. Hughes, "Electrical Technology", Prentice Hall, 10th edition, 2015.
4. Nesimi Ertugrul, "LabVIEW for Electric Circuits, Machines, Drives, and Laboratories", Prentice Hall, 1st edition, 2002.
5. Gupta, Gupta & John, "Virtual Instrumentation Using LabVIEW", Tata McGraw-Hill, 1st edition, 2005.

VII. WEB REFERENCES:

1. https://www.ee.iitkgp.ac.in
2. https://www.citchennai.edu.in
3. https://www.iare.ac.in /

VIII. MATERIALS ONLINE

1. Course template
2. Lab manual