Basic Electrical Laboratory

ESC110A

B.Tech. I / II Semester

Department: Electrical Engineering

Faculty of Engineering & Technology

Ramaiah University of Applied Sciences

Ramaiah University of Applied Sciences

Private University Established in Karnataka State by Act No. 15 of 2013

Faculty of Engineering & Technology Ramaiah University of Applied Sciences			
Department	**Electrical Engineering**		
B. Tech.	**Common to All**	**Sem**	**I/II**
Course Code	**ESC110A**		
Course Title	**Basic Electrical Laboratory**		

List of Experiments / Exercises

S No.	Title of Experiment / Exercise
1.	Verification of KVL & KCL for DC circuits
2.	Verification of Superposition theorem
3.	Maximum Power Transfer theorem
4.	Study of R-L-C- Series & Parallel circuit Characteristics
5.	Relationships between phase & line currents and voltages in a three phase system (star & delta)
6.	Power and phase measurement in three phase system by two wattmeter method
7.	O.C. and S.C. tests on a single phase transformer
8.	Load Characteristics of Single phase Induction Motor
9.	Calibration of Single phase Energy Meter
10.	Load test on D.C Shunt Motor
11.	Internal Test

Index Sheet

Name: **Semester /Year:**

Registration No: **Staff In-charge:**

Course: ESC110A (Basic Electrical Laboratory)

Sl. No.	**Name of the Experiment/**Exercise	**Experiment Write up (7)**	**Experiment Conduction (7)**	**VIVA (6)**	**Total (20)**
1	Verification of KVL & KCL for DC circuits				
2	Verification of Superposition theorems				
3	3 Maximum Power Transfer theorems (Thevenin's and Norton's)				
4	Study of R-L-C- Series & Parallel circuit Characteristics				
5	Relationships between phase & line currents and voltages in a three phase system (star & delta)				
6	Power and phase measurement in three phase system by two wattmeter method				
7	O.C. & S.C. tests on single phase transformer				
8	Load Characteristics of Single phase Induction Motor				
9	Calibration of Single phase Energy Meter				
10	Characteristics of DC Machines				
11	Internal Test				
				Average	

Component 1 = Lab Internal Marks = $\left(\frac{}{220}\right) \times 25 =$

Signature of the Staff In-charge

Experiment 1 Date:

Verification of KVL & KCL for DC circuits

1. Introduction and Purpose of Experiment
   KCL and KVL are used to solve the electrical network. Purpose of the KVL and KCL for circuits is to analyze and understand the fundamental principles.

2. Aim and Objectives
   I. To compute the voltage and current for each parameters in circuit
   II. To verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) concepts

3. Experimental Set Up

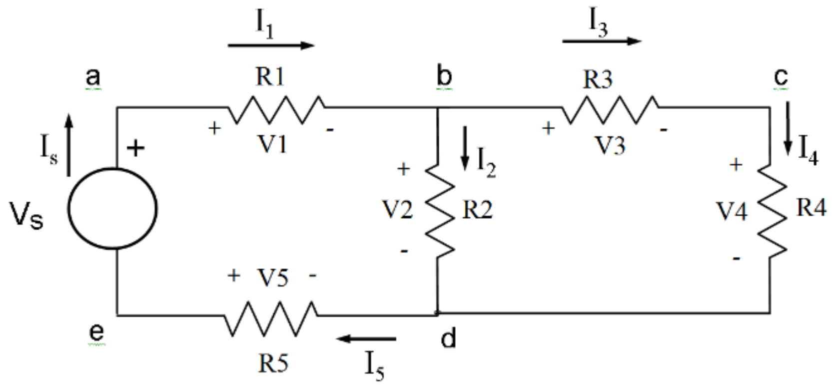


Figure 1. Experimental setup to verify KVL and KCL

R_1 = ________ Ω, R_2 = ________ Ω, R_3 = ________ Ω, R_4 = ________ Ω

R_5 = ________ Ω

4. Experimental Procedure
   1) Connect the circuit as per the circuit diagram
   2) Switch on the power supply
   3) Measure the voltage across each of resistor and find the current through them
   4) Calculate the voltage across each resistor and current through the each resistor theoretically
   5) Compare the theoretical results of KCL & KVL with practical one

5. Data Collection and Tabulation

Branch Voltage/Current	V (Volts)	I(A)	R (Ω)
V_1 , I_1			
V_2 , I_2			

V_3 , I_3			
V_4 , I_4			
V_5 , I_5			
V_S , I_S			

6. Calculations/Computations/Algorithms

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

   i. Limitations of Experiments

   ii. Limitations of Results

   iii. Learning happened

   iv. Recommendations

Experiment 2 Date:

Verification of Superposition Theorem

1. Introduction and Purpose of Experiment

The theorem is applicable to linear and bilateral networks consisting of independent sources, linear dependent sources, linear passive elements and linear transformers. The purpose of superposition theorem is to convert linear and bilateral circuits into its Norton equivalent or Thevenin'n equivalent.

2. Aim and Objectives
   I. To compute the voltage and current for each parameters in circuit
   II. To verify the superposition theorem

3. Experimental Set Up

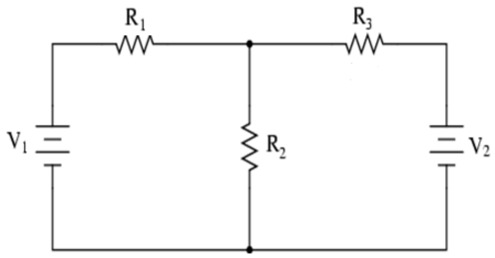


Figure 1. Experimental setup to verify Superposition Theorem

R_1 = ________ Ω, R_2 = ________ Ω, R_3 = ________ Ω, V1 = _______V,

V_2 = _______V

4. Experimental Procedure
   1) Connect the circuit as per circuit diagram.
   2) Apply both the voltages $V_1$and V_2 and note down the value read the current I in the Ammeter, through resistor R_2
   3) Connect the circuit as per circuit diagram by making one voltage source short circuited, record the current I_1 through resistance R_2
   4) Connect the circuit as per circuit diagram by short circuiting the other voltage source and ,record the current I_2 through the resistanceR_2
   5) Now observe that $I=I_1+I_2$

5. Data Collection and Tabulation

S.NO	V_1(V)	V_2 (V)	I_1(mA)	I_2(mA)	I_3(mA)
1					
2					

3					

6. Calculations/Computations/Algorithms

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

i. Limitations of Experiments

ii. Limitations of Results

iii. Learning happened

iv. Recommendations

Experiment 3 Date:

Maximum Power Transfer theorems

1. Introduction and Purpose of Experiment

Network theorems provide insight into the behaviour and properties of electrical circuits and define the behaviour of a linear circuit. Purpose of the experiment is to compute the maximum power transfer to utility from the source.

2. Aim and Objectives
   - I. To Verify Thevenin's Theorem
   - II. To compute Maximum power across the load

3. Experimental Set Up

To find Vth:

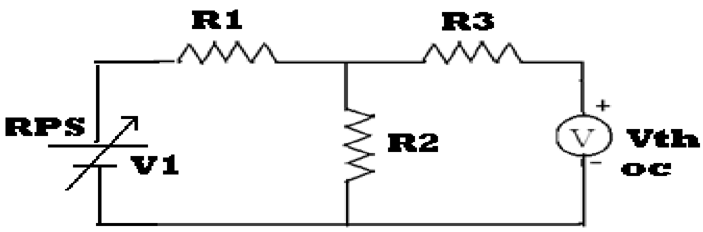


Figure 1. Circuit Diagram (1)

To find R_{th}:

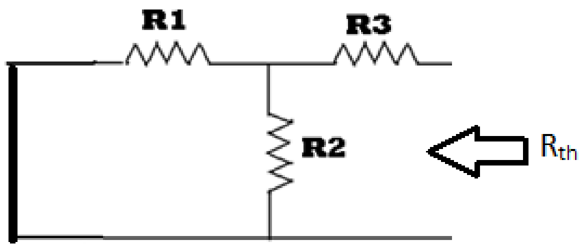


Figure 2. Circuit Diagram (2)

To find IL:

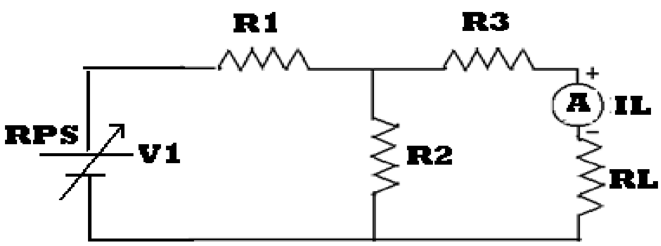


Figure 3. Circuit Diagram (3)

4. Experimental Procedure

1) Connections are made as per the circuit diagram (1)
2) For different voltages of V_1 record $V_{OC} = V_{th}$
3) Connections are made as per the circuit diagram (2)
4) For the same different voltages of V_1 record $R_{th.}$
5) Connections are made as per the circuit diagram (3)
6) For the same different voltages of $V_{1,}$ measure and record $I_{L.}$

5. Data Collection and Tabulation

Thevenin's theorem:

S.NO	**V_1(V)**	**V_2(V_{th})**	**R_{th}**	**I_L(Amp)**

CAMPARISION:

PARAMETER	**THEORETICAL VALUE**	**PRACTICAL VALUE**
R_{th}		
V_{th}		
I_L		

6. Calculations/Computations/Algorithms

EQUIVALENT CIRCUIT:

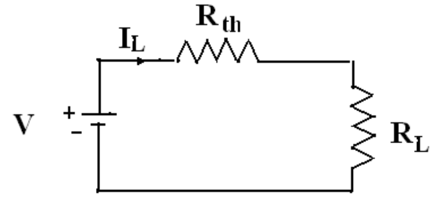


Figure 4. Equivalent Circuit

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

    i. Limitations of Experiments

    ii. Limitations of Results

    iii. Learning happened

    iv. Recommendations

Experiment 4 Date:

Study of R-L-C- Series & Parallel circuit Characteristics

1. Introduction and Purpose of Experiment
   Voltage through an RLC series circuit will be measured as a function of frequency for a fixed applied voltage. The frequency for which the RMS voltage attains a maximum value is the resonance frequency. Purpose of experiment is to compute the resonance frequency of circuit.

2. Aim and Objectives
   I. To find different characteristics of a series RLC circuit at resonance condition
   II. To find different characteristics of a parallel RLC circuit at resonance.

3. Experimental Set Up

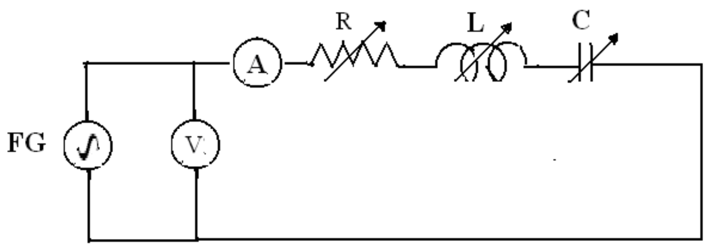


Figure 1. Experimental setup for series RLC circuit

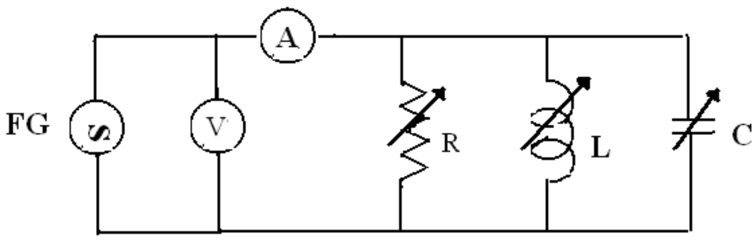


Figure 2. Experimental setup for Parallel RLC circuit

4. Experimental Procedure

For R-L-C- Series
1) Connect the circuit as per the circuit diagram
2) Fix the input voltage to ……V p-p
3) By varying the frequency of the function generator, note the readings of Ammeter

For R-L-C- Parallel
1) Connect the circuit as per the circuit diagram
2) Fix the input voltage to …...V p-p
3) By varying the frequency of function generator, note the readings of Ammeter

5. Data Collection and Tabulation

S.NO	FREQUENCY	I(mA)

S.NO	FREQUENCY	I(mA)

6. Calculations/Computations/Algorithms

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

i. Limitations of Experiments

ii. Limitations of Results

iii. Learning happened

iv. Recommendations

Experiment 5 Date:

Relationships between phase & line currents and voltages in a three phase system (star & delta)

1. Introduction and Purpose of Experiment
   Three-phase system is an integral component of power generation, transmission, and distribution. It is a type of poly-phase system used in electrical grids to transferring power from source to utility. The purpose of experiment is to verify the voltage and current relationship in star and delta connection

2. Aim and Objectives
   I. To find relationships between phase and line currents in a three phase system
   II. To find relationship between phase and line voltages in a three phase system

3. Experimental Set Up

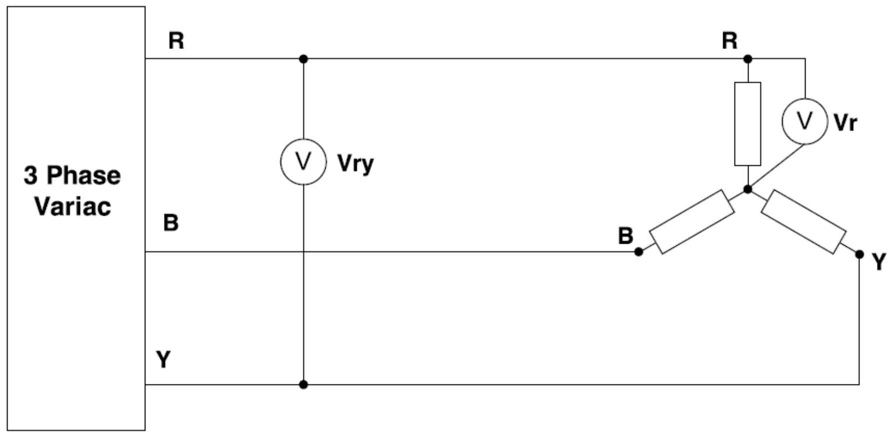


Figure 1. Three phase system with star connected load

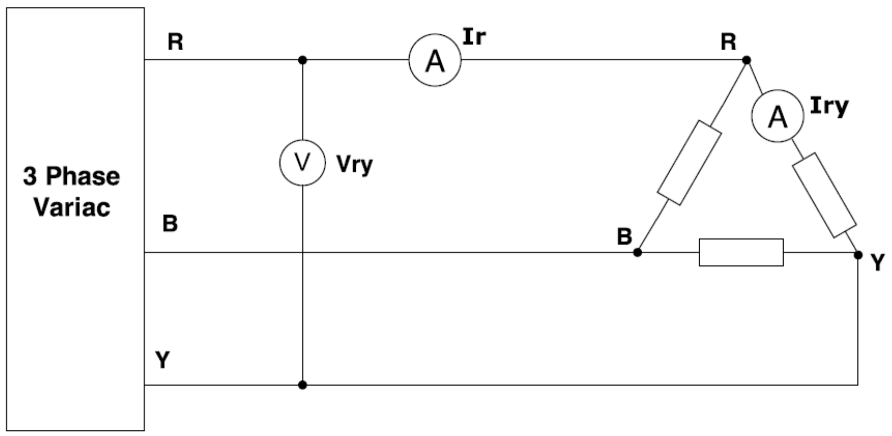


Figure 2. Three phase system with delta connected load

4. Experimental Procedure

For Star Connection

1) Connect the circuit as per the circuit diagram
2) Keep the auto-transformer in minimum position
3) Switch on the 3 phase power supply to the autotransformer and switch on the load
4) Slowly increase the voltage up to 400 V
5) Note down the readings of all the meters and switch off the load.
6) Slowly bring the auto-transformer to minimum position
7) Switch off the 3 phase supply.

For Delta Connection

1) Connect the circuit as per the circuit diagram
2) Keep the auto-transformer in minimum position
3) Switch on the 3 phase power supply to the autotransformer and switch on the load
4) Slowly increase the voltage up to 200 V
5) Note down the readings of all the meters and switch off the load.
6) Slowly bring the auto-transformer to minimum position
7) Switch off the 3 phase supply.

5. Data Collection and Tabulation

Particulars	V_{1L}	V_{2L}	V_{3L}	V_P	I_{1L}	I_{2L}	I_{3L}	I_P
Star								
Delta								

6. Calculations/Computations/Algorithms

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

    i. Limitations of Experiments

    ii. Limitations of Results

    iii. Learning happened

    iv. Recommendations

Experiment 6 Date:

Power and phase measurement in three phase system by two wattmeter method

1. Introduction and Purpose of Experiment

The two wattmeter method is commonly used on three-phase loads or circuits. The purpose of this experiment is to measure total three phase power at under balanced or unbalanced conditions with any power factor.

2. Aim and Objectives
   I. To measure power in a 3 Phase network using Two Wattmeter Method
   II. To compute power factor in a 3 Phase network using Two Wattmeter Method

3. Experimental Set Up

Resistances (3), inductors (3), ammeters (3), voltmeters (4), 3Phase auto-transformer and connecting wires

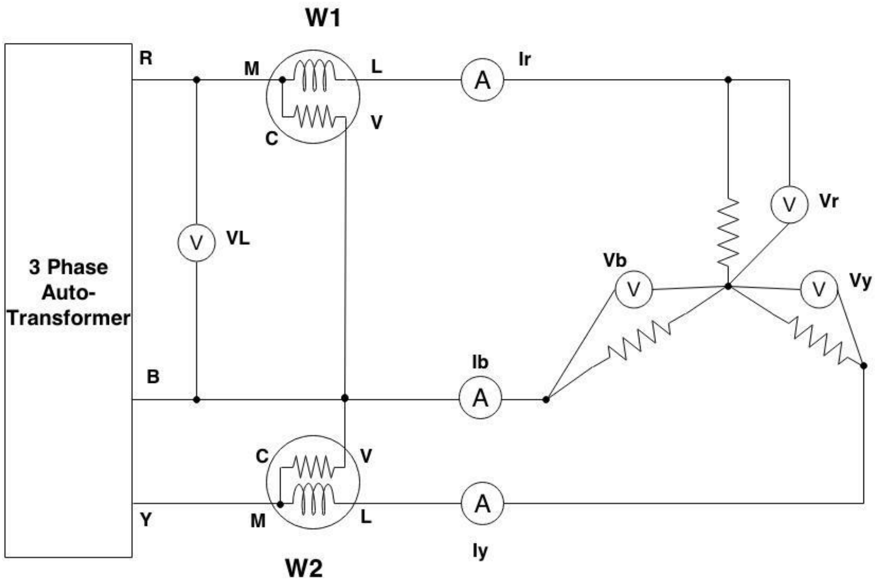


Figure 1. Power and phase measurement in three phase system by two wattmeter method

4. Experimental Procedure
   1) Connect the circuit as shown in figure
   2) Keep the auto-transformer in minimum position
   3) Switch on the 3 phase power supply to the autotransformer
   4) Slowly increase the voltage to 70V (V_L)
   5) Note down the readings of all the meter
   6) Slowly bring the auto-transformer to minimum position
   7) Switch off the 3 phase power supply to the autotransformer

5. Data Collection and Tabulation

R load

V_L	V_r	V_y	V_b	I_r	I_y	I_b	$P_1=V_r*I_r + V_y*I_y + V_b*I_b$	W_1	W_2	$P_2=W_1+W_2$	Error=$(P_1-P_2)/P_1$

6. Calculations/Computations/Algorithms

$$P_{Theoritica} = 3V_p I_p \cos\theta$$

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

i. Limitations of Experiments

ii. Limitations of Results

iii. Learning happened

iv. Recommendations

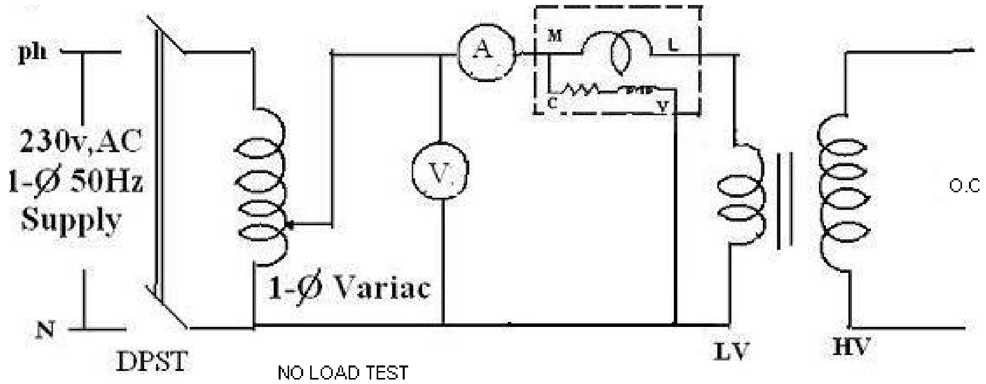
Experiment 7 Date:

O.C. & S.C. tests on single phase transformer

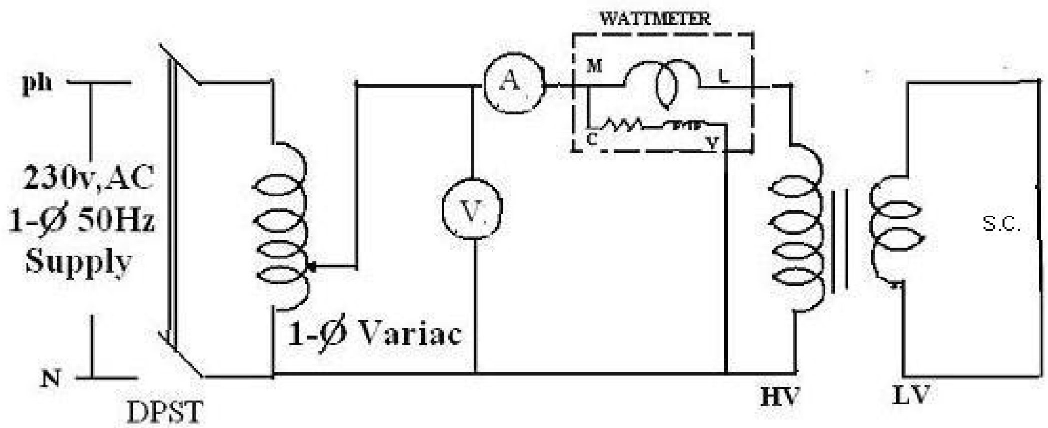
1. Introduction and Purpose of Experiment
   The equivalent circuit parameters of a transformer are determined by conducting two tests on a transformer. The purpose of this experiment is to determine the regulation and efficiency of a transformer at any load and power factor condition, without actual loading the transformer.

2. Aim and Objectives
   1) To conduct OC and SC tests on the given single phase transformer
   2) To determine equivalent circuits in terms of LV & HV
   3) To draw the voltage regulation & efficiency graphs
   4) To determine load corresponding to maximum efficiency and the value of maximum efficiency at UPF
   5) To determine power factor for maximum & zero regulations

3. Experimental Set Up



NO LOAD TEST



SHORT CIRCUIT TEST

4. Experimental Procedure

Open Circuit Test

1) Connections are made as per the circuit diagram.
2) Make sure that the secondary side of transformer is open.
3) Keep the auto-transformer (variac) in minimum position
4) Switch on A.C supply.
5) By varying the variac apply rated voltage to the primary of the transformer and note down the reading of voltmeter, wattmeter and ammeter.
6) Keep the variac at zero position and switch off the supply.

Short Circuit Test

1) Connections are made as per the circuit diagram
2) Make sure that the secondary side of transformer is shorted.
3) Keep the auto-transformer (variac) in minimum position.
4) Switch on A.C supply.
5) By varying the variac apply full load current to the transformer and note the reading of voltmeter, wattmeter and ammeter.
6) Keep the variac at zero position and switch off the supply.

5. Data Collection and Tabulation

OPEN CIRCUIT TEST

S.No	V_0	I_0	W_0

SHORT CIRCUIT TEST

S.No	Vsc	Isc	Wsc

6. Calculations/Computations/Algorithms

No Load Test (Conducted on LV side)

$$W_O = V_O I_O Cos\phi_o$$

No load power factor. $Cos\phi_o = W_o/V_oI_o$

Working component, $Iw = I_o.\ Cos\phi_o = W_o/V_o =$

Magnetizing component, $I_u = I_o Sin\phi_o =$

Core-loss resistance, $R_{eLV} = V_0/I_w$

Magnetising reactance, $X_{mLV} = V_0/I_u$

Short Circuit Test (conducted on HV side**)**

$Cos\phi_{sc} = W_{sc}/\ (I_{sc}V_{sc})$

$R_{H.V} = W_{sc}/I_{sc}^2$

$Z_{H.V} = V_{sc}/I_{sc}$

$X_{H.V} = SQRT(Z_{H.V}^2 - R_{H.V}^2)$

Efficiency

S.No	Fraction of full load (x)	Power factor(cos**ϕ**)	Output(xs cos **ϕ**)	Total losses = $P_i + x^2 P_c$	Input = output+losses	Efficiency(η) Output/input
1	¼	**1.0**				
2	½					
3	¾					
4	1					
5	$1_{1/4}$					
6	¼	**0.9**				
7	½					
8	¾					
9	1					
10	$1_{1/4}$					
11	¼	**0.8**				
12	½					
13	¾					
14	1					
15	$1_{1/411}$					

Voltage Regulation:

Full Load Regulation.

$Er = I_2 R_2 / V_2 =$

$Ex = I_2 X_2 / V_{2=}$

I_2=Full load secondary current

R_2=Total equivalent resistance in terms of secondary

X_2=Total equivalent leakage reactance in terms of secondary

S.NO	POWER FACTOR	$E_r\cos\phi$	$E_x\sin\phi$	Regulation for lagging p.f ($E_r\cos\phi+E_x\sin\Phi$)	Regulation for leading p.f ($E_r\cos\phi-E_x\sin\Phi$)
1	1.0				
2	0.8				
3	0.6				
4	0.4				
5	0.2				
6	0.0				

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

i. Limitations of Experiments

ii. Limitations of Results

iii. Learning happened

iv. Recommendations

Experiment 8 Date:

Load Characteristics of Single phase Induction Motor

1. Introduction and Purpose of Experiment

Single-phase induction motors are the most familiar of all electric motors because they are used in home appliances, businesses, and small industries. They are widely used in domestic appliances and for a very large number of low power drives in industry. The purpose of this experiment is to verify load characteristics of single phase induction motor.

2. Aim and Objectives
   1) To conduct No Load test on single phase induction motor
   2) To conduct Blocked rotor test on single phase induction motor

3. Experimental Set Up

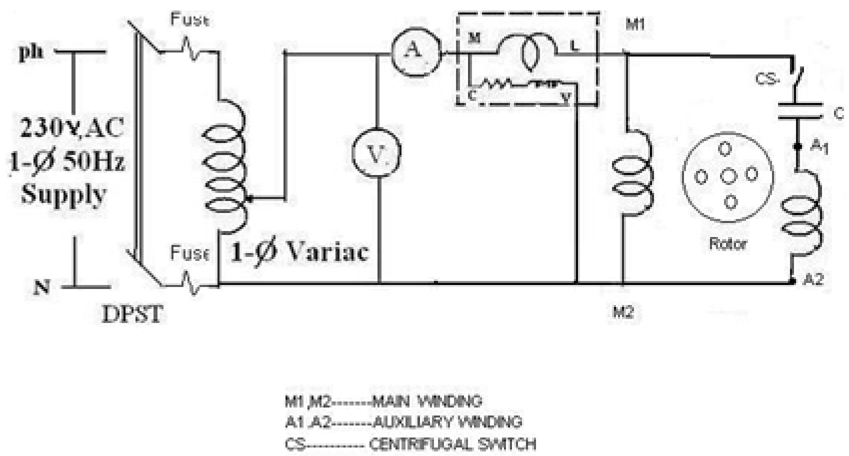


Figure 1. Load test on single phase induction motor

4. Experimental Procedure

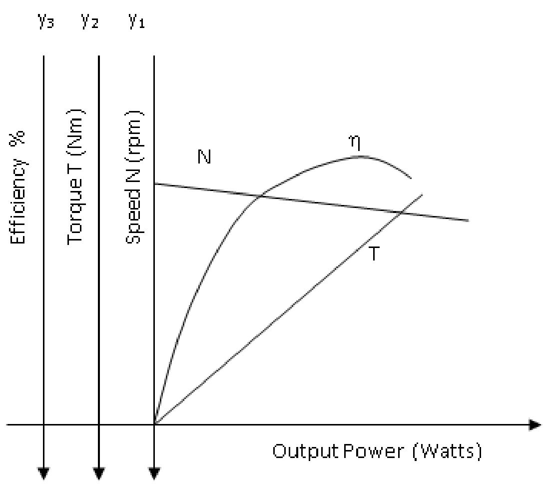
   1) Make the connections as per the circuit diagram
   2) Vary the applied voltage with the auto transformer so as to get rated voltage across stator terminals of the Induction motor
   3) Note down the readings of the watt meter, ammeter, volt meter and speed
   4) Now apply the load through brake drum arrangement in steps
   5) At every step note down the voltage, current, speed and spring balance readings
   6) Increase the load till rated load current is obtained and note down all the readings
   7) Remove the load and bring auto transformer to minimum position then switch off the supply

5. Data Collection and Tabulation

S.no	Speed N (rpm)	Voltage (V) V	Current (A) I_L	Readings of Spring balance (Kg)		Input VI_L	Torque (Nm) T	Output (Watts)	Efficiency (%)	Power factor	Slip
				S1	S2						

6. Calculations/Computations/Algorithms

i) Output Vs Torque ii) output Vs Efficiency iii) Output Vs Speed/Slip



7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

    i. Limitations of Experiments

    ii. Limitations of Results

    iii. Learning happened

    iv. Recommendations

Experiment 9 Date:

Calibration of Single phase Energy Meter

1. Introduction and Purpose of Experiment
   Electronic Energy Meter is a substitute for the mechanical energy meter at present for monitoring the consumption of electrical energy. The product is targeted at the Electricity Boards and mass consumers. The purpose of this experiment is to measure the % error at different load conditions.

2. Aim and Objectives
   1) To determine the error at 5%, 25% and 100% of full load current
   2) To determine percentage error at 5%, 25% and 100% of full load current

3. Experimental Set Up

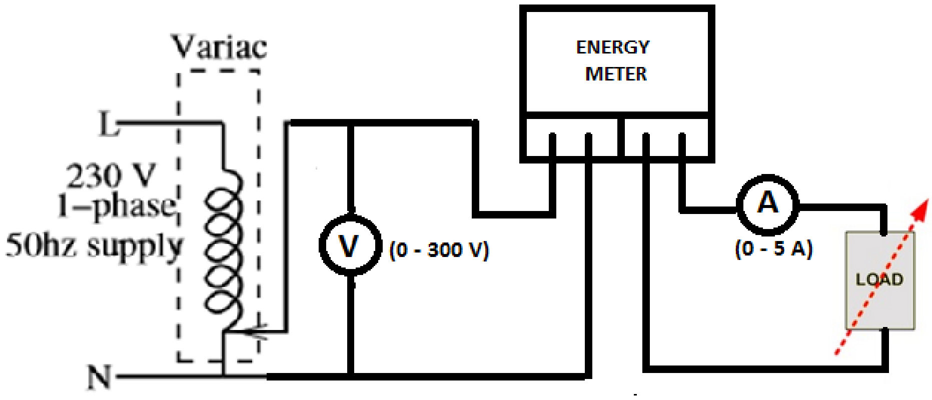


Figure 1. Single phase Energy Meter

4. Experimental Procedure

   1) Make the circuit as per the circuit diagram
   2) Keep the variac in minimum voltage position
   3) Keep the load in maximum position
   4) Take the readings of ammeter voltmeter and time taken for twenty blinks
   5) Calculate the energy and error in energy meter
   6) Repeat the above steps for different currents
   7) Remove the load and bring back the variac to minimum voltage position then switch off the supply

5. Data Collection and Tabulation

S.No	Voltage	Current	Time taken for revolutions (S)	No. of revolutions	Actual Energy W_a(W)	Energy registered by energy meter W_R (W)	Error W_R - W_a (W)	%Error

6. Calculations/Computations/Algorithms

Actual energy consumed during ‘n’ revolutions

Wa = V*I*t / 3600 watt-hour

where V= Voltage (V)

I= Current (A)

t = Time (S)

Energy registered by energy meter

WR = n / meter constant

Error = WR - Wa

% Error = [(WR - Wa) / Wa] * 100

7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

i. Limitations of Experiments

ii. Limitations of Results

iii. Learning happened

iv. Recommendations

Experiment 10 Date:

Characteristics of DC Machines

1. Introduction and Purpose of Experiment
   Motor characteristics vary considerably from type to type, and their performance characteristics can be altered by the supplied electrical power. DC machines have been frequently used in applications requiring a wide range of motor speeds or precise control of motor output.

2. Aim and Objectives
   1) To conduct a load test on the given dc machine
   2) To draw the performance curves.

3. Experimental Set Up

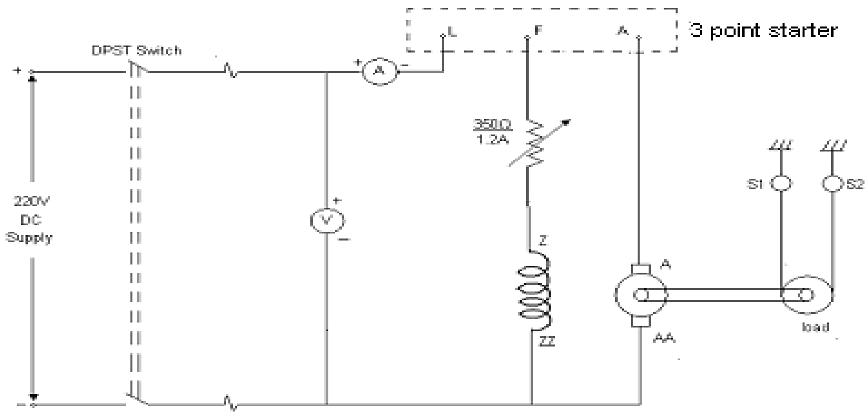


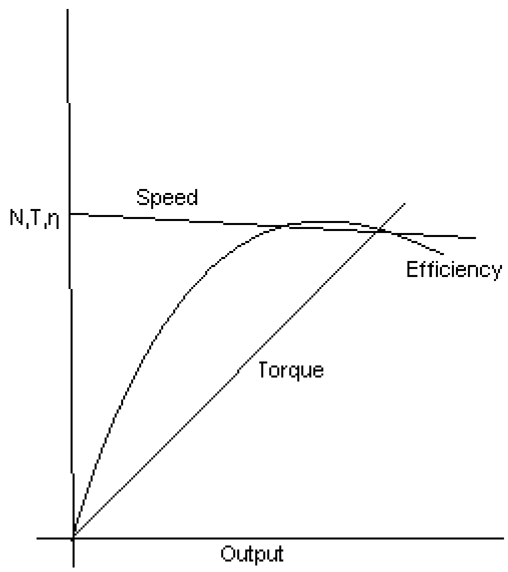
Figure 1. Load test on DC shunt motor

4. Experimental Procedure
   1) Connect the circuit as shown in the figure
   2) Keep the rheostat of motor field in minimum resistance position
   3) Give supply to the motor and start the motor with help of the 3 point starter
   4) Adjust no load speed to the rated value with the help of field rheostat
   5) Note down the voltmeter and ammeter readings
   6) Now apply the load through brake drum and rope arrangement in steps
   7) At every step, note down the voltage and current and speed and spring balance readings
   8) Increase the load till rated load current is obtained.

5. Data Collection and Tabulation

S.no	Speed (rpm)N	Voltage (V) V	Current (A) I_L	Readings of Spring balance (Kg)		Input VI_L	Torque (Nm) T	Output (Watts)	Efficiency (%)
				S1	S2				

6. Calculations/Computations/Algorithms:
i) Output Vs Torque ii) output Vs Efficiency iii) Output Vs Speed



7. Presentation of Results

8. Analysis and Discussions

9. Conclusions

10. Comments

    i. Limitations of Experiments

    ii. Limitations of Results

    iii. Learning happened

    iv. Recommendations