NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE

(Accredited by NAAC, Approved by AICTE New Delhi, Affiliated to APJKTU)

Pampady, Thiruvilwamala(PO), Thrissur(DT), Kerala 680 588

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

EE335-ELECTRICAL & ELECTRONICS LABORATORY

VISION OF THE INSTITUTION

To mould our youngsters into Millennium Leaders not only in Technological and Scientific Fields but also to nurture and strengthen the innate goodness and human nature in them, to equip them to face the future challenges in technological break troughs and information explosions and deliver the bounties of frontier knowledge for the benefit of humankind in general and the down-trodden and underprivileged in particular as envisaged by our great Prime Minister Panduit Jawaharlal Nehru

MISSION OF THE INSTITUTION

To build a strong Centre of Excellence in Learning and Research in Engineering and Frontier Technology, to facilitate students to learn and imbibe discipline, culture and spirituality, besides encouraging them to assimilate the latest technological knowhow and to render a helping hand to the under privileged, thereby acquiring happiness and imparting the same to others without any reservation whatsoever and to facilitate the College to emerge into a magnificent and mighty launching pad to turn out technological giants, dedicated research scientists and intellectual leaders of the society who could prepare the country for a quantum jump in all fields of Science and Technology

Vision of the Department of Mechanical Engineering

Producing internationally competitive Mechanical Engineers with social responsibilities and sustainable employability through viable strategies as well as competent exposure oriented quality education.

Mission of the Department of Mechanical Engineering

M1: Imparting high impact education by providing conductive teaching learning environment.

M2: Fostering effective modes of continuous learning process with moral and ethical values.

M3: Enhancing leadership qualities with social commitment, professional attitude, unity, team spirit and communication skill.

M4: Introducing present scenario in research and development through collaborative efforts blended with industry and institution.

Program Educational Objectives of the Department of Mechanical Engineering

PEO1: Graduates shall have strong practical and technical exposures in the field of Mechanical Engineering and will contribute to the society through Innovation and Enterprise.

PEO2: Graduates will have the demonstrated ability to analyze, formulate and solve design engineering/thermal engineering/materials and manufacturing/design issues and real life problems.

PEO3: Graduates will be capable of pursuing Mechanical Engineering profession with good communication skills, leadership qualities, team spirit and professional ethics.

PEO4: Graduates will sustain an appetite for continuous learning by pursuing higher education and research in the allied areas of technology

PREPARATION FOR THE LABORATORY SESSION

GENERAL INSTRUCTIONS TO STUDENTS

1. Read carefully and understand the description of the experiment in the lab manual. You may go to the lab at an earlier date to look at the experimental facility and understand it better. Consult the appropriate references to be completely familiar with the concepts and hardware.

2. Make sure that your observation for previous week experiment is evaluated by the faculty member and your have transferred all the contents to your record before entering to the lab/workshop.

3. At the beginning of the class, if the faculty or the instructor finds that a student is not adequately prepared, they will be marked as absent and not be allowed to perform the experiment.

4. Bring necessary material needed (writing materials, graphs, calculators, etc.) to perform the required preliminary analysis. It is a good idea to do sample calculations and as much of the analysis as possible during the session. Faculty help will be available. Errors in the procedure may thus be easily detected and rectified.

5. Please actively participate in class and don't hesitate to ask questions. Please utilize the teaching assistants fully. To encourage you to be prepared and to read the lab manual before coming to the laboratory, unannounced questions may be asked at any time during the lab.

6. Carelessness in personal conduct or in handling equipment may result in serious injury to the individual or the equipment. Do not run near moving machinery/equipment's. Always be on the alert for strange sounds. Guard against entangling clothes in moving parts of machinery.

7. Students must follow the proper dress code inside the laboratory. To protect clothing from dirt, wear a lab coat. Long hair should be tied back. Shoes covering the whole foot will have to be worn.

8. In performing the experiments, please proceed carefully to minimize any water spills, especially on the electric circuits and wire.

9. Maintain silence, order and discipline inside the lab. Don't use cell phones inside the laboratory.

10. Any injury no matter how small must be reported to the instructor immediately.

11. Check with faculty members one week before the experiment to make sure that you have the handout for that experiment and all the apparatus.

AFTER THE LABORATORY SESSION

1. Clean up your work area.

2. Check with the technician before you leave.

3. Make sure you understand what kind of report is to be prepared and due submission of record is next lab class.

4. Do sample calculations and some preliminary work to verify that the experiment was successful

MAKE-UPS AND LATE WORK

Students must participate in all laboratory exercises as scheduled. They must obtain permissionfrom the faculty member for absence, which would be gran ted only under justifiablecircumstances. In such an event, a student must make arrangements for a make-up laboratory, which will be scheduled when the time is available after completing one cycle. Late submission will be awarded less mark for record and internals and zero in worst cases.

LABORATORY POLICIES

1. Food, beverages & mobile phones are not allowed in the laboratory at any time.

2. Do not sit or place anything on instrument benches.

3. Organizing laboratory experiments requires the help of laboratory technicians and staff. Be punctual.

Course code	Course Name	L-T-P-Credits	Year of Introduction
EE335	**ELECTRICAL AND ELECTRONICS LAB**	**0-0-3-1**	**2016**

Course Objectives: The main objectives of this course are

- To give a practical knowledge on the working of electrical machines including dc machines, induction motors and synchronous motors.
- To impart the basics about design and implementation of small electronic circuits.

Syllabus

List of experiments:

1. OCC on a dc shunt generator, determination of critical resistance, critical speed, additional resistance required in the field circuit
2. Load characteristics of DC Shunt generator
3. Load characteristics of DC Compound generator
4. Load test on DC Series motor
5. Load test on DC Shunt motor
6. Load test on single phase transformer
7. Starting of three phase squirrel cage induction motor by star delta switch, load test on three phase squirrel cage induction motor
8. Load test on three phase slip ring induction motor
9. Load test on single phase induction motor.
10. OC and SC test on single phase transformer
11. V-I Characteristics of diodes and Zener diodes
12. Input and output characteristics of CE configuration of BJT S. Determination of β, input resistance and output resistance.
13. Half wave and full wave rectifiers with and without filters- Observe the waveforms on CRO.

Expected outcome:

The students will be able to

i. Test and validate various types of electrical motors
ii. Acquire knowledge on working of semiconductor devices.

1. OPEN CIRCUIT CHARACTERISTICS OF A DC SHUNTGENERATOR

AIM

To predetermine the Open Circuit Characteristics (OCC) of the dc shunt generatorat rated speed and also to determine the critical field resistance at the rated speed.

APPARATUS REQUIRED

Sl. No.	Name of the instrument	Specification	Quantity
1	Ammeter	(0-1)A MC (0-2)A MC	1 No. 1 No.
2	Voltmeter	(0-30)V MC (0-300)V MC	1 No. 1 No.
3	Rheostat	300Ω, 1.7A 570Ω, 1.2 50Ω, 5A	1 No. 1 No. 1 No.
4	SPST Switch		1 No.

MACHINE DETAILS

Take down the name plate ratings of motor and generator

Name plate Details		
S.No		
1.		
2.		
3.		
4.		
5.		

PRINCIPLE

The O.C.C is a curve showing the relationship between the no load emf generated and the shunt field current (Eo and If). Even when the field current is zero there is some residual magnetism present in the poles. Hence there is a small voltage generated even at zero field current, which is called the residual voltage. As the field current is increased, Eo also increases and the curve traced is almost a straightline. As If is further increased the poles start getting saturated, the straight linerelation no longer holds good and the curve bends and becomes almost horizontal.

Critical resistance

It is that value of resistance in the field circuit at which the generator will justexcite (or voltage build up begins). If the resistance is higher, the machine will fail to build up voltage. It is given by the slope of the tangent drawn to the linear portion of the magnetization curve from the origin.

Conditions for voltage build up in a d.c shunt generator

1. There should be some residual magnetism in the poles.
2. For the given direction of rotation, the shunt field coils should be properly connected. That is, the coils should be so connected that the flux generated by the field current aids the residual flux.
3. When excited at no load, the shunt field circuit resistance should be less than the critical resistance.

Critical speed

It is that value of speed at which the given shunt field resistance represents thecritical resistance.

It is determined as follows. For the same value of If determine E1 and E2 from thefield resistance lines. Then

$$\frac{E_1}{E_2} = \frac{N_1}{N_C} \Rightarrow N_C = \frac{E_2}{E_1} N_1$$

N_1 is the rated speed – 1500rpm.

PROCEDURE

1. Connections are made as shown in the diagram. The motor field rheostat (Rh1) is kept in minimum position, the generator field rheostat (Rh2) in maximum position and switch 'S' is kept open at starting.
2. Supply is switched on. The starter handle is gradually moved to cut off the starter resistance.
3. The rheostat Rh1 is varied till the speed equals the rated speed of the machine.
4. With 'S' open, the residual voltage is measured using the smaller rangevoltmeter.
5. Switch 'S' is then closed. Rheostat Rh2 is then decreased in steps, each timenoting down the voltmeter and ammeter readings.

To find Rsh

1. Connections were made as per the circuit diagram.
2. Voltmeter and ammeter readings were noted down.

RESULT

Residual voltage =

Critical resistance, Rc =

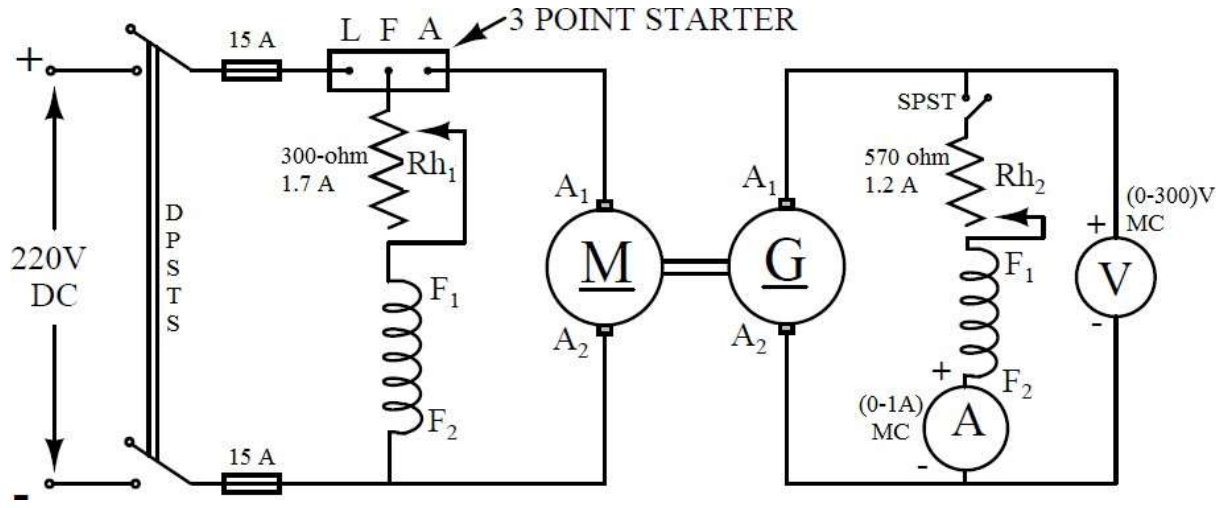
Critical Speed, Nc =

CONCLUSION AND DISCUSSION

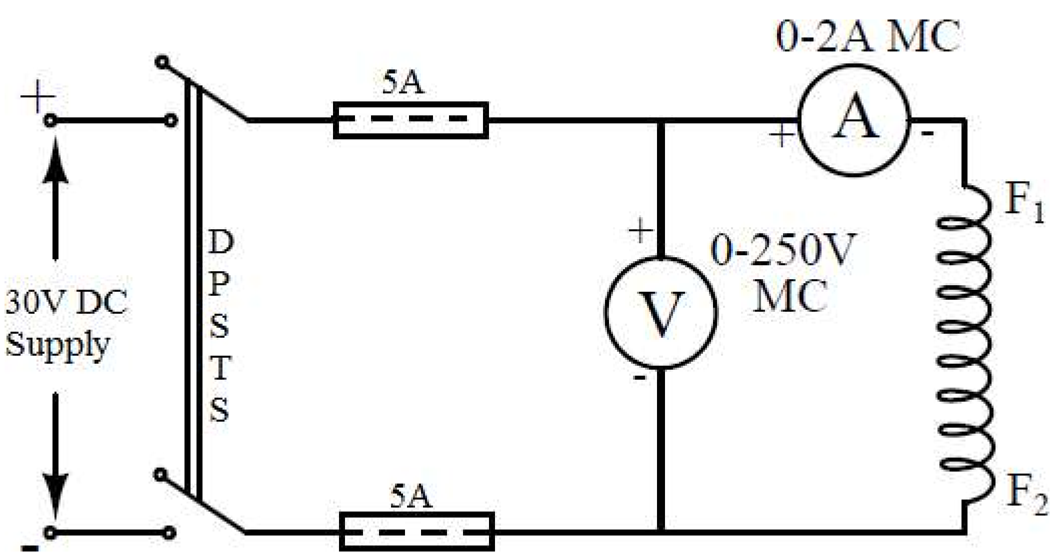
VIVA QUESTIONS

1. What is the need for starter in a d.c motor?2.How does a 3-point starter function?
3. What is residual voltage? How is it measured?
4. What is critical resistance? How can it be determined?
5. What are the conditions necessary for voltage build up in a d.c shuntgenerator?

CONNECTION DIAGRAM



Circuit diagram to determine OCC of DC shunt Generator



Circuit diagram to determine Rsh

OBSERVATIONS

Sl. No.	E1(V)	If(A)

Sl. No.	Voltage(V)	Current (A)	Rsh=V/I

2. LOAD TEST ON D.C SHUNT GENERATOR

AIM

To conduct load test on the given D.C shunt generator and plot the external andinternal characteristics.

APPARATUS REQUIRED

Sl. No.	Name of the instrument	Specification	Quantity
1	Voltmeter	(0-300V) MC, (0-10V) MC	1,1
2	Ammeter	(0-2A)MC, (0-5A)MC	1,1
3	Rheostat	600Ω, 2A	1
4	Tachometer		1

THEORY

Load characteristics of the machine can be broadly classified into:-

1) External characteristics
2) Internal Characteristics

External Characteristics(V *vs* I_L)

It is a curve showing the variation in terminal voltage of the generator as the loadon the generator is increased. The characteristics are as shown in the figure.

At no load, the terminal voltage of the generator is at its rated value. As the load current is increased the terminal voltage drops. The drop in terminal voltageis due to the following reasons:-

1. For a generator $V = E_g - I_a R_a$, as the load current increases, I_a increases, $I_a R_a$ drop increases, thus decreasing the terminal voltage V.
2. As the load current increases, I_a increases, armature reaction effect also increases. Due to demagnetizing effect of armature reaction, the induced *emf* E_g decreases, thereby decreasing V.
3. Due to reasons (1) and (2), the terminal voltage decreases, which in turn reduces the field current I_{sh}, thereby decreasing E_g causing further decrease in V.

Internal Characteristics [E_g vs I_a]

It is a plot of the internally generated *emf* (E_g) and armature current (I_a). It is acurve similar to the external characteristics and lies above it.

$$E_g = V + I_a R_a$$

$$\& I_a = I_L + I_{sh}$$

PROCEDURE

- Connections are made as shown in the diagram.
- Rheostat Rh_1 is kept in minimum position and Rh_2 in maximum position.
- Switch S_2 is kept open. Supply is switched on and the motor is started usinga 3-point starter.
- The motor field rheostat Rh_1 is varied till the speed equals the rated speed ofthe motor.
- The generator field rheostat Rh_2 is varied till the voltmeter reads the ratedvoltage of the machine.
- Switch S_2 is then closed. The load on the generator is increased. Thereadings of the voltmeter and ammeters are noted down.
- The experiment is repeated for different values of load current till the ratedcurrent of the generator is reached.
- During the experiment, the speed is to be maintained constant at the ratedvalue.
- The load is then switched off completely, the rheostats are brought back tothe original position and the machine is switched off.

Measurement of R_a

Connections are made as shown in the diagram. Keeping the rheostat in the minimum output voltage position, supply is switched on. The rheostat is then varied in steps and the voltmeter and ammeter readings are noted. The ratio gives the armature resistance.

The readings are then tabulated as shown. The external and internal characteristics are then plotted.

Sample Calculation (set no ...)

Terminal Voltage (V) =......... V

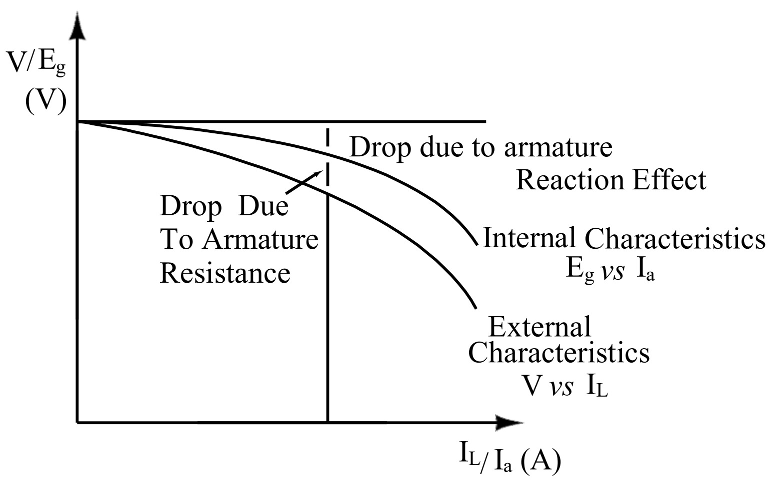
Load Current (I_L) =......... A

Shunt Field Current (I_{sh}) =......... A

Armature Current (I_A) = $I_L + I_{sh}$ =......... A

Generated *emf*(E_g) = $V + I_a R_a$ = ...

Internal and External Characteristics



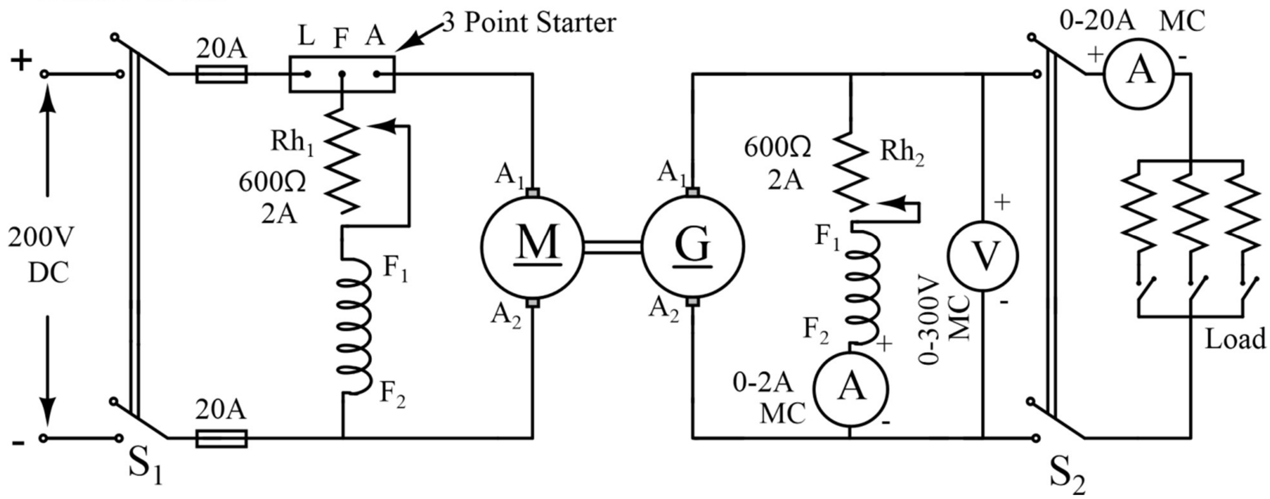
RESULT

Conducted load test on the given DC shunt generator and plotted the external and internal characteristics.

VIVA QUESTIONS

1. What is the need for starter with a d.c motor?
2. How does a 3-point starter function?
3. Why is Rh_1 kept in minimum position at starting?
4. Why is Rh_2 kept in maximum position at starting?
5. Why does the terminal voltage of a generator decrease with increase in load?
6. How are the meter ratings selected for this experiment?
7. What are the different losses in a d.c generator?
8. What is the condition for maximum efficiency in a d.c machine?
9. What is armature reaction? How does it effect the functioning of the machine?

LOAD TEST



OBSERVATION - LOAD TEST

Sl no.	V ($volts$)	IL (A)	Ish (A)	Ia (A)	E_g (V)

3. LOAD TEST ON DC COMPOUND GENERATOR

Aim:

To perform on load test on DC compound generator and to draw its performance characteristics

Name plate details:

Details	Motor	Generator
Rating		
Voltage		
Current		
Speed		

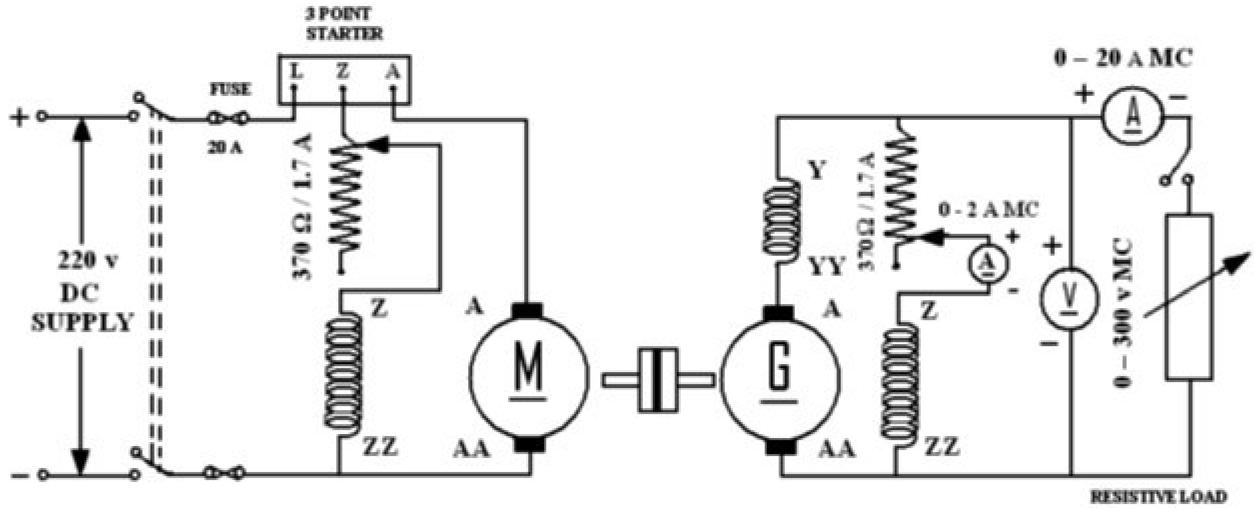
Apparatus:

S. No	Apparatus	Range	Type	Quantity
1.	Ammeter	0-10/20 A, 0-1/2 A	MC	02
2.	Voltmeter	0-300 V	MC	01
3.	Rheostat	0-350 Ohms / 2A	WW	02
4.	Tachometer	0-1000 rpm	Digital	01
5.	Load rheostat	4 KW	-	01
6.	Connecting wire	-	-	required

Procedure:

1. Make the connections as per the circuit diagram
2. Initially keep the motor field rheostat in minimum position and generator field rheostat in maximum position
3. Close the DPST switch and start motor slowly with the help of starter.
4. Adjust the motor field rheostat till rated speed of motor is obtained.
5. Now decrease generator field resistance till voltmeter decreases rated emf.
6. Note down readings of meters at no load.
7. Increase load in steps and note down voltmeter and ammeter readings till generator generates rated current.
8. Switch off load bring back rheostats to their initial position and open DPST.
9. Connect the generator for differential compounding by interchanging the series field terminals and repeat the above procedure.

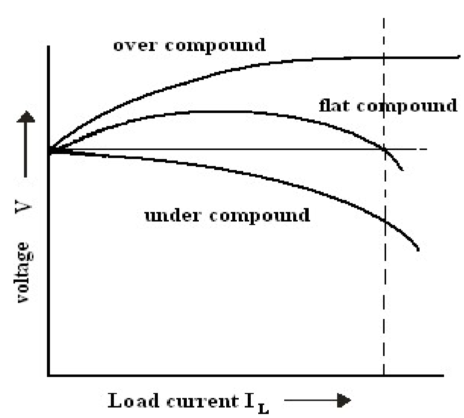
Circuit Diagram:



Tabular column:

S. No.	Voltage V in volts	Load current I_L in Amps	Field current I_{SH} in Amps	Armature current I_A in Amps	Generated EMF E_G in volts

Model Graph:



Precautions:

1. Before opening the DPST switch ensure that rheostats are in their original position.
2. Loose connections are to be avoided.
3. Avoid parallax error.

Result:

Conclusion:

Viva questions:

1. What do you understand from load curves?
2. Which causes the drop between internal & external characteristics?
3. A cumulative compound generator is generating full load, what will happen if its series field winding gets short – circuited?
4. Explain the difference between cumulative and differential compound generators.
5. Where you can use DC Compound Generator?
6. Comment on the shape of load current Vs speed curve of the differential compounded generator.
7. How do you reverse the terminal voltage of an over compounded short shunt generator without effecting the over compounding?
8. Mention the applications of differential compound generator.
9. Mention the applications of over compound generator.

4. LOAD TEST ON DC SERIES MOTOR

AIM

To conduct Load test on DC series motor and plot the performance characteristics.

APPARATUS REQUIRED

Sl. No.	Name of the instrument	Specification	Quantity
1	Ammeter	(0-15)A, MC	1 No.
2	Voltmeter	(0-250)V, MC	1 No.
3	Tachometer		1 No.

MACHINE DETAILS

Take down the name plate ratings of motor

Sl. No.	Name Plate details
1	
2	
3	

PRINCIPLE

In a series motor, the field winding is connected in series with the armature winding. Thus the same current flows through the field and armature windings. Speed of a dc series motor.

$$N = \frac{V - I_a(R_a + R_{se})}{K_e \times \phi}$$

Where Ia is the armature current, Ra is the armature resistance, Rse is the series field resistance, ϕ is the flux per pole and N is the speed in rpm.

Electrical characteristics (T vs Ia):- It shows the variation of torque with the armature current.

We have

T α ɸIa where ɸ is the flux/pole

α IaIa (as ɸ α Ia up to the point of magnetic saturation)

Thus T α Ia2

However after magnetic saturation ɸ remains almost constant, Hence Tα Ia. Thus the curve is a parabola up to magnetic saturation and shows a linear variation after the point.

Mechanical Characteristics (N1 vs T): It shows the variation of speed with torque.

We have $N \propto \frac{Eb}{\varnothing} \propto \frac{1}{\varnothing}$ as Eb is almost constant where Eb is back emf.

In a series motor $\varnothing \alpha$ Ia. So $N \propto \frac{1}{Ia}$

That is, as Ia increases, Speed decreases. The same pattern is followed in the N-T characteristics. The curve traced is a rectangular hyperbola. A series motor should never be started at no load. At no load, Ia is very small, hence the speed of the motor becomes dangerously high as N α 1/Ia

The efficiency of a small motor can be measured directly by brake test. The motor is loaded directly by a belt placed on a pulley mounted on the shaft of the motor. The desired load is put by tightening belt. The tension applied on the belt is measured by using spring balance.

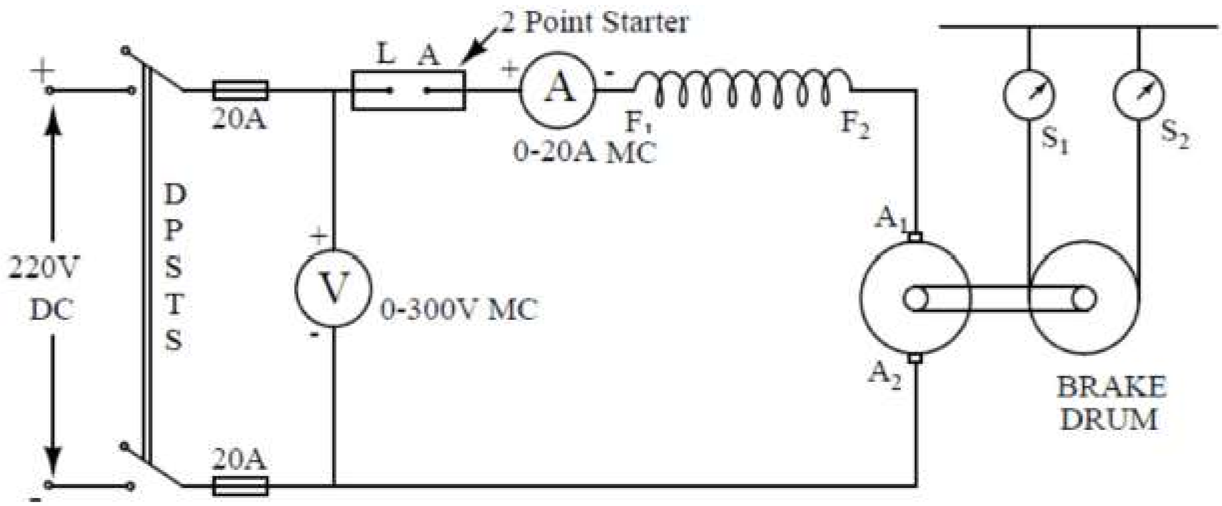
Output Torque = (S1-S2) x R x 9.81 Nm.

Where W1 is the tension on the tight side of brake in Kg. W2 is the tension on the slack side of the brake in Kg. R is the radius of the pulley in m. If N is the speed of the motor in rpm, then Power Output = ((S1-S2) x R x 9.81x 2πN)/60

PROCEDURE

1. Connections are made as per the circuit diagram.
2. Apply some load to the motor using spring and break drum.
3. Switch on the motor using the starter.
4. Note down the motor voltmeter reading and keep it at rated value.
5. Note down the current and spring balance readings.
6. The experiment is repeated for different loads till the rated current of the machine is reached.
7. During the experiment when the machine gets heated up, it is cooled by pouring water into the brake-drum.
8. The load is then reduced till the current reaches a small value and the supply is switched off.

CONNECTION DIAGRAM



OBSERVATIONS

Sl. No.	Vin(V)	Iin(A)			Speed (rpm)	Torque (Nm)	Output (Watts)	Input (Watts)	% Efficiency
			S_1(Kg)	S_2(Kg)					

SAMPLE CALCULATIONS

Sample Calculation (set no. . . .)

Voltmeter reading (V) = ...

Current (I) = ...

Spring balance readings, S1 = ... S2 = ...

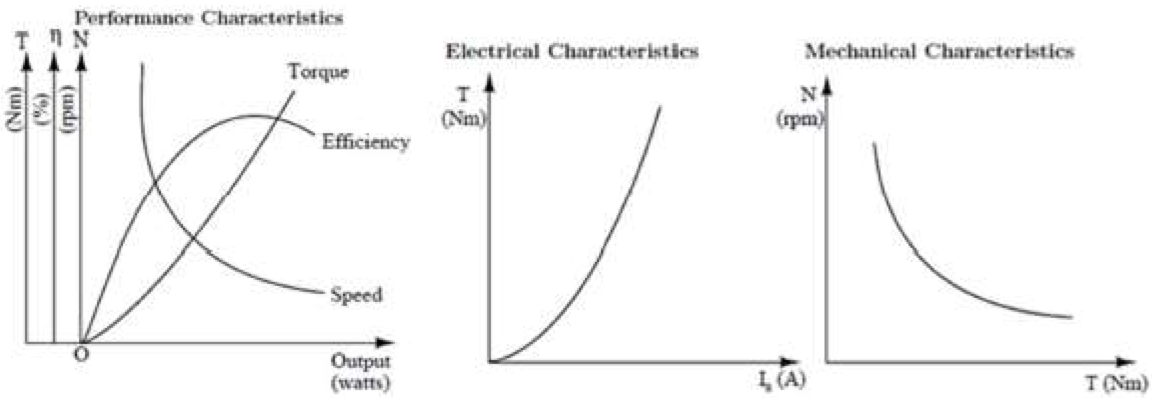
Speed (N) = ...

Torque (T) = 9.81 (S1 − S2) R = ... Where R is the radius of brake drum.

Output power = = ... $(2\pi NT)/60$

Input power = V I = ...

Efficiency = Output power/ Input power = ...



RESULTS AND DISCUSSIONS

CONCLUSION

VIVA QUESTIONS

1. What is the precaution to be taken when working with a d-c series motor?
2. What is the need for starter with a d-c motor?
3. What is the condition for maximum efficiency in a d-c motor?
4. What are the different losses occurring in a d-c machine?
5. Give some applications of d-c series motor.

5. LOAD TEST ON DC SHUNT MOTOR

AIM

To conduct Load test on DC shunt motor and plot its performance characteristics.

APPARATUS REQUIRED

Sl. No.	Name of the instrument	Specification	Quantity
1	Ammeter	(0-20)A, MC	1 No.
2	Voltmeter	(0-300)V, MC	1 No.
3	Rheostat	1300Ω; 1.5A	1 No.
4	Tachometer		1 No.

MACHINE DETAILS

Take down the name plate ratings of motor

Sl. No.	Name Plate details
1	
2	
3	

PRINCIPLE

A shunt DC motor connects the armature and field windings in parallel or shunt with a common D.C. power source. When electric voltage is supplied to the shunt DC motor, due to high resistance of the shunt winding, it draws very low current. The higher number of turns of the shunt winding helps in generating a strong magnetic field. The armature draws high current, thus also generating a high magnetic field. The motor starts rotating as the magnetic field of the armature and shunt winding interact. As the magnetic fields grow stronger, rotational torque will increase, thus resulting in an increase of rotational speed of the motor.

$$N = \frac{V - I_a R_a}{K_e \times \phi}$$

Where Ia is the armature current, Ra is the armature resistance, ϕ is the flux per pole and N is the speed in rpm.

Output Torque = (S1-S2) x R x 9.81 Nm

Where W1 is the tension on the tight side of brake in Kg. W2 is the tension on the slack side of the brake in Kg. R is the radius of the pulley in m. If N is the speed of the motor in rpm, then

Power Output = ((S1-S2) x R x 9.81x 2πN)/60

PRECAUTIONS:

1. DC shunt motor should be started and stopped under no load condition.
2. Field rheostat should be kept in the minimum position.
3. Brake drum should be cooled with water when it is under load.

PROCEDURE

1.Connections are made as per the circuit diagram.

2.After checking the no load condition, and minimum field rheostat position, DPST switch is closed and starter resistance is gradually removed.

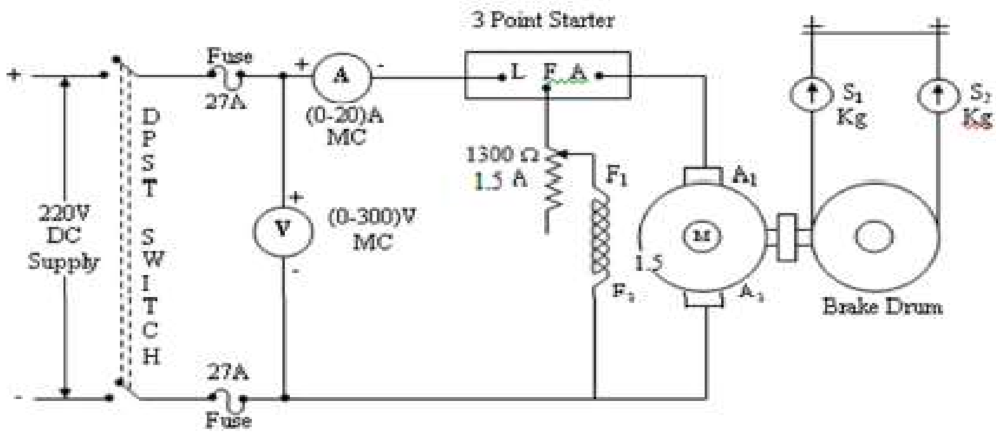
3.The motor is brought to its rated speed by adjusting the field rheostat.

4.Ammeter, Voltmeter readings, speed and spring balance readings are noted under no load condition.

5.The load is then added to the motor gradually and for each load, voltmeter, ammeter, spring balance readings and speed of the motor are noted.

6.The motor is then brought to no load condition and field rheostat to minimum position, then DPST switch is opened.

CONNECTION DIAGRAM



FUSE RATING:

125% of rated current

$$\frac{125 \times \text{rated current}}{100} =$$

NAME PLATE DETAILS:

Rated Voltage : 220V
Rated Current :
Rated Power :
Rated Speed :

OBSERVATIONS

Sl. No.	Vin(V)	Iin(A)			Speed (rpm)	Torque (Nm)	Output (Watts)	Input (Watts)	% Efficiency
			S_1(Kg)	S_2(Kg)					

SAMPLE CALCULATIONS

Sample Calculation (set no. . . .)

Voltmeter reading (V) = ...

Current (I) = ...

Spring balance readings, S1 = ... S2 = ...

Speed (N) = ...

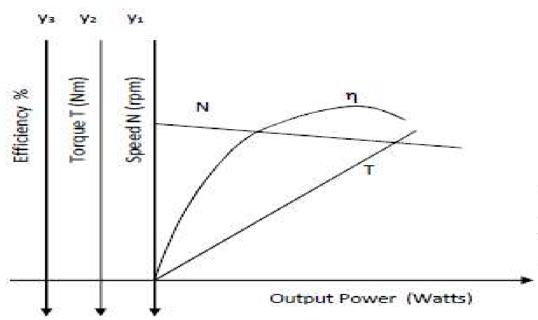
Torque (T) = 9.81 (S1 − S2) R = ... Where R is the radius of brake drum.

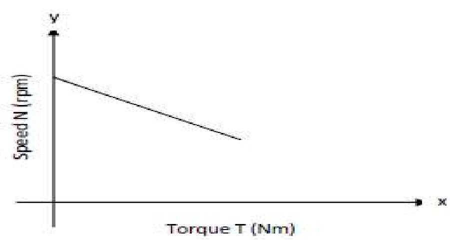
Output power = = ... (2πNT)/60

Input power = V I = ...

Efficiency = Output power/ Input power = ...

MODEL GRAPHS:





RESULTS AND DISCUSSIONS

CONCLUSION

VIVA QUESTIONS

1. What is the significance of back emf in a d-c motor?
2. What is the difference between a three point starter and a four point starter?
3. What are the different methods to control speed of a d-c shunt motor?
4. What are the different factors which make effects on efficiency of a d-c machine?
5. Give some applications of d-c shunt motor.

6. LOAD TEST ON SINGLE PHASE TRANSFORMER

AIM

To conduct load test on the given single phase transformer at unity power factor and determine the efficiency and regulation curve.

APPARATUS REQUIRED

Sl. No.	Name of the instrument	Specification	Quantity
1	Ammeter	(0-10)A,MI (0-5)A,MI	1 No. 1 No.
2	Voltmeter	(0-250)V, MI (0-150)V, MI	1 No. 1 No.
3	Wattmeter	150V,10A,UPF 300V, 5A, UPF	1 No. 1 No.
4	Autotransformer	230/(0-230)V	1 No.

PRINCIPLE

Regulation of a transformer is defined as the drop in terminal voltage of a transformer expressed as a percentage of the no-load terminal voltage.

$$\%\text{ Voltage Regulation}=\frac{V\text{ no load}-V\text{ on load}}{V\text{ no load}}$$

When a purely resistive load is connected across the secondary, the transformer will be working at unity power factor.

$$\text{Terminal voltage, } V = \text{Induced emf } [E_2] - I_2r_2 - I_2x_2$$

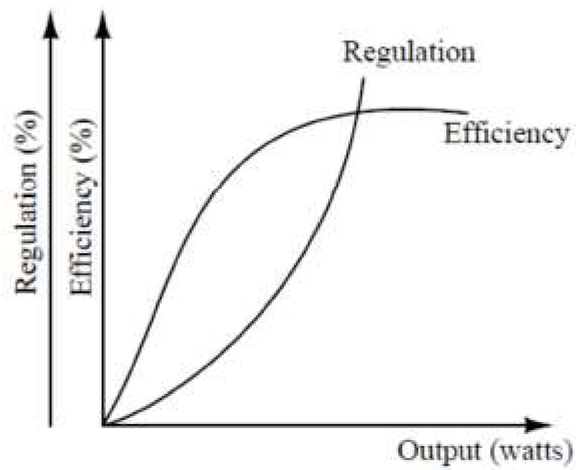
Where r2 and x2 are the secondary winding resistance and leakage reactance respectively and I2 is the secondary load current. The efficiency of transformer is defined as (output/input) x 100. As the load current increases the power output increases.

The iron loss remains constant from no load to full load. The copper loss increases as the square of the load current. Thus the efficiency curve starts from zero, increases to a maximum value (When iron loss = Cu loss) and thereafter starts decreasing.

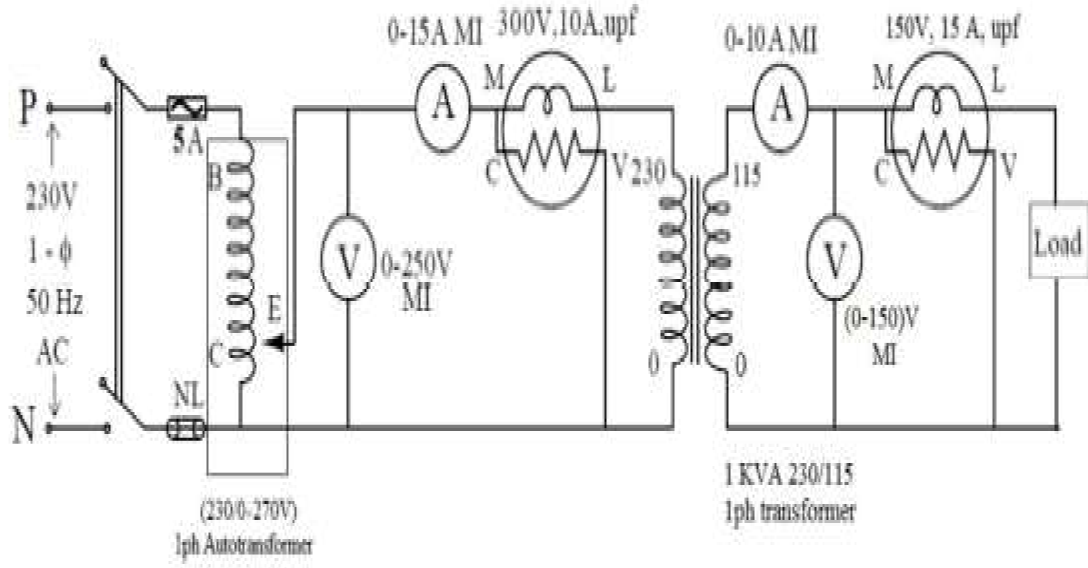
PROCEDURE

1. Connections are made as per the circuit diagram.
2. Auto transformer is kept at minimum position and supply was switched on.
3. Rated voltage is applied to the primary by varying the auto transformer.
4. The meter readings corresponding to no load was noted.
5. Load was applied gradually.
6. Each time the auto transformer is adjusted to maintain primary voltage.
7. The loading can be done up to 125% of the rated current of the load side.
8. The load is then reduced till the current reaches a small value and the supply is switched off.

REGULATION AND EFFICIENCY CURVES



CONNECTION DIAGRAM



OBSERVATIONS

Sl. No.	V_1(V)	I_1(A)	V_2(V)	I_2(A)	W_1(W)	W_2(W)	Efficiency (%)	Regulation (%)

SAMPLE CALCULATIONS

Sample Calculation (set no. . . .)

Primary Voltage (V1) = ...

Primary Current (I1) = ...

Wattmeter Reading (W1) = Input power = ...

Secondary Voltage (V2) = ...

Secondary Current (I2) = ...

Wattmeter Reading (W2) = Output power = ...

Efficiency = (Output power/Input power) ×100= . . . .

Regulation = (VNL – VL)/VNL ×100 = ...

VNL = V2NL

VL=V2FL

RESULT AND DISCUSSION

CONCLUSION

VIVA QUESTIONS

1. What do you understand by regulation of a transformer?
2. What are the other methods of testing transformers?
3. What is the disadvantage of testing a transformer using load test?
4. Is a high or low value of regulation preferred for a transformer? Give reasons.
5. What are the reasons for the drop in terminal voltage as the secondary current is increased?

7. LOAD TEST ON THREE PHASE INDUCTION MOTOR

AIM

To conduct load test on the given 3-ph squirrel cage induction motor and plot the performance characteristics.

APPARATUS REQUIRED

Sl. No.	Name of the instrument	Specification	Quantity
1	Ammeter	(0-15)A,MI	1 No.
2	Voltmeter	(0-500)V, MI	1 No.
3	Wattmeter	500V,15A,UPF	2 Nos.
4	Autotransformer	415/(0-415)V	1 No.
5	Tachometer		1 N0.

MACHINE DETAILS

Take down the name plate ratings of motor

Sl. No.	Name Plate details
1	
2	
3	

PRINCIPLE

A squirrel cage induction motor essentially consists of a stator and a rotor. The stator is a hollow cylindrical structure with slots on the inner periphery and carries a three phase winding. The winding can be connected in star or delta and is connected across a 3-ph supply. The rotor is also a cylindrical structure with slots on the outer periphery. The slots carry thick Al or Cu bars. These bars are short circuited at both ends by means of end rings. When a 3-ph supply is given to a 3-ph winding displaced by 120 degree in space, a magnetic field of constant magnitude but rotating at synchronous speed is produced. This flux links with the stationary rotor, thus inducing an emf in it. As the rotor circuit is closed, a current flows through it. The direction of the induced current is such as to oppose the cause producing it. The cause is the relative motion between the stator magnetic field and the rotor. So the rotor starts rotating in the same direction as the stator magnetic field and tries to catch up with it. But practically it is never able to do so. Because if it does so, there would be no relative motion, no emf and hence no torque.

Thus an induction motor always runs at a speed slightly less than the synchronous speed. The term slip is of importance in an induction motor and is defined as

$\%slip = ((Ns - N)/Ns) * 100$

Where, Ns - Synchronous speed $=120 \times fP$

N - rotor speed

f - frequency

P - No. of poles of the machine

An induction motor can never operate at s=0. It always operates between s=0 and s=1(starting).

The performance characteristics are plots of efficiency, torque, speed, slip, pf and line current versus output.

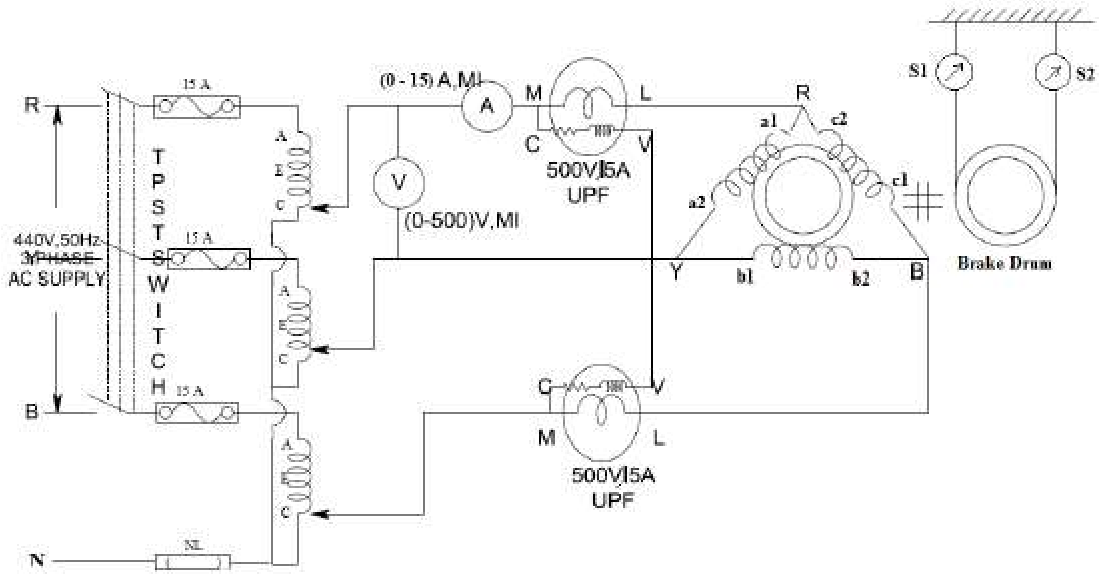
Current and torque increases with increase in output. The induction motor is essentially a constant speed motor. However speed reduces gradually with increase in output and slip increases gradually with increase in output. The pf is low at low

loads and increases with increase in output. The efficiency increases with increase in output, reaches a peak value and then gradually drops with further increase in output.

PROCEDURE

1. Connections are made as shown in figure.
2. Close the TPST switch.
3. Adjust the 3phase autotransformer till the voltmeter shows the rated line voltage of the induction motor.
4. Note down the line voltage, line current, power input and the speed indicated by the respective voltmeter, ammeter, wattmeter and tachometer under no load condition.
5. Load the machine by means of brake drum arrangement and note down the corresponding meter readings and speed.
6. Repeat the same procedure up to the rated current of the induction motor.

CONNECTION DIAGRAM

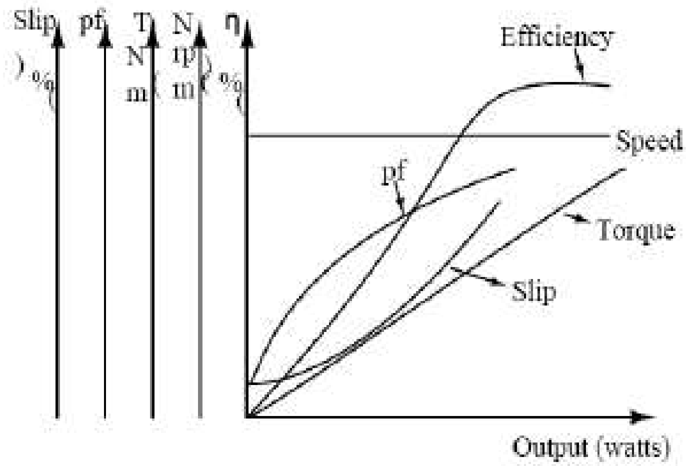


Voltage V - 415 V
Current I - 7.5A
Power - 5HP
Connection - Δ
Speed(*rpm*) - 1440
Phase - 3φ

OBSERVATIONS

Sl. No.	V (*volts*)	I (*Amp*)	W_1 (*watts*)	W_2 (*watts*)	S_1 (Kg)	S_2 (Kg)	N (*rpm*)	T (*Nm*)	Output (*watts*)	Input (*watts*)	slip (%)	*pf*	Efficiency (%)

Model Graph



SAMPLE CALCULATIONS

Voltage V = ...

Current I = ...

Wattmeter reading W1 = ...

Wattmeter reading W2 = ...

Input power P = W1 +W2 = ...

Spring balance Readings S1 = ... S2 = ...

Speed (N) = ...

Torque (T) = 9.8 (S1 − S2) R = ... Where R is the radius of brake drum.

Synchronous speed = 120 × fP

% slip = ((Ns – N)/Ns)∗100

46 NCERC, PAMPADY Prepared by Rajesh P & Sebin Joseph

Power factor = cos ϕ = $(w1+w2)$ / ($\sqrt{3}*VI$) =…….

Output power = ($2\Pi NT$) / 60 =…….

% Efficiency = (output power) / (input power) ∗ 100

RESULT AND DISCUSSION

CONCLUSION

VIVA QUESTIONS

1.What is ‘slip’ in an induction motor?

2. What are the two types of 3-ph induction motors and what is the difference between the two.

3. What is the value of slip at starting?

4. What are the advantages and disadvantages of squirrel cage induction motor?

5. Give some applications of 3-ph squirrel cage induction motor?

EX.NO. 08

SPEED CONTROL OF THREE PHASE SLIP RING INDUCTION MOTOR

AIM:

To Control the speed control of 3 phase slip ring induction motor by rotor resistance control.

APPARATUS REQUIRED

S.NO	NAME OF THE APPARATUS	TYPE	RANGE	QUANTITY
1	Ammeter	MI	(0-10A)	1
2	Voltmeter	MI	(0-600V)	1
3	Rotor Resistance Starter	-	-	1
4	Auto transformer	3 Phase	415/(0-470)V	1
5	Tachometer	Digital	-	1
6	Wattmeter	LPF	600V,10A	2
7	Connecting Leads	-	-	Required

THEORY:

Rotor Rheostat Control:

In this method, which is applicable to slip ring induction motors alone, the motor speed is reduced by introducing an external resistance in the rotor circuit. For this purpose, the rotor starter may be used provided it is continuously rated. This method is in fact similar to the armature rheostat control method of d.c shunt motors.

NAME PLATE DETAILS:

3Φ Induction motor

Rated Voltage	:
Rated Current	:
Rated Speed	:
Rated Power	:
Rated Frequency	:

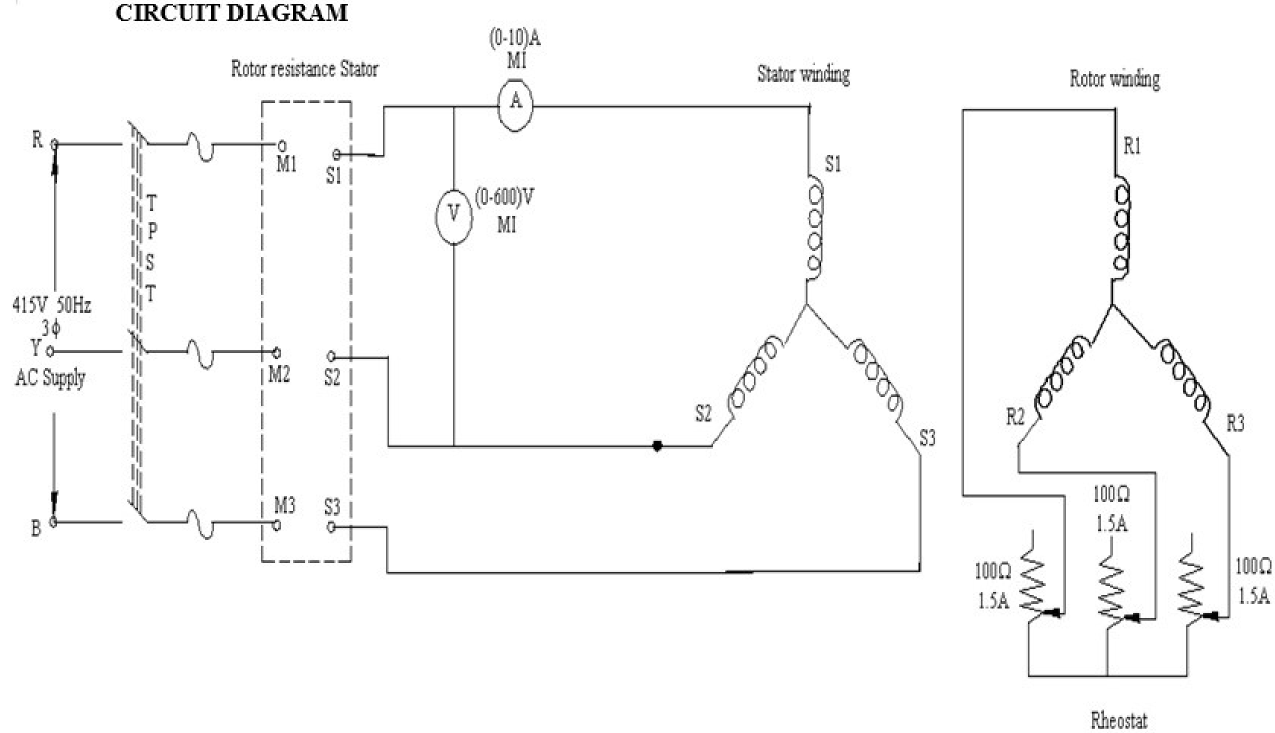
PRECAUTION:

The motor input current should not exceed its rated value.

PROCEDURE:

1) Connections are given as per the circuit diagram.
2) Keep the rotor resistance stator output as zero voltage & the external rotor resistance at minimum resistance position.
3) Switch ON the supply & increase the input voltage to stator winding upto its rated value.
4) Measure the speed.
5) Now increase the rotor resistance in steps & note the corresponding values of speed.
6) Draw a graph of rotor resistance versus speed.

CIRCUIT DIAGRAM



TABULAR COLUMN:

S.NO.	EXTERNAL ROTOR RESISTANCE IN OHMS	SPEED (RPM)

GRAPH:

- Draw a graph of rotor external resistance versus speed.

RESULT:

Thus the speed of 3 phase slip ring induction motor was controlled by rotor resistance control method.

VIVAQUESTIONS

1) What will happen if the rotor circuit of a slip ring I.M. is kept open & electric supply is given to its stator winding.
2) What is the constructional difference between a slip-ring & a squirrel cage I.M.
3) Draw & explain the Torque-speed characteristic of a slip ring I.M. for different values of rotor resistance.
4) What is the effect of changing the rotor resistance on the slip at max torque SMT.
5) Can a I.M. rotate at synchronous speed? Justify your answer.

EX.NO. 09

LOAD TEST ON SINGLE PHASE INDUCTION MOTOR

AIM:

To conduct the direct load test on the given single phase induction motor and to determine and plot its performance characteristics.

APPARATUS REQUIRED*:*

S.No.	Name of Apparatus	Range	Type	Quantity
1.	Voltmeter	(0-300)V	MI	1
2.	Wattmeter	300V,10A	UPF	1
3.	Ammeter	(0-10)A	MI	1
4.	Tachometer	-	Digital	1
5.	TPST Switch	-	-	1
6.	Single phase Variac	-	-	1
7.	Connecting Wires	-	-	As Needed

NAME PLATE DETAILS:

1Φ Induction motor

Rated Voltage :
Rated Current :
Rated Speed :
Rated Power :
Rated Frequency :

FUSE RATING :

Fuse rating = 125% of rated current

FORMULA USED:

Torque = 9.81 × (S_1-S_2) × R Nm, where R is the radius of the brake drum in meter.

Output power, P_o= 2πNT/60 Watts

Input power, P_i = W_1+W_2 Watts

%Efficiency, %η = (output power/input power) ×100

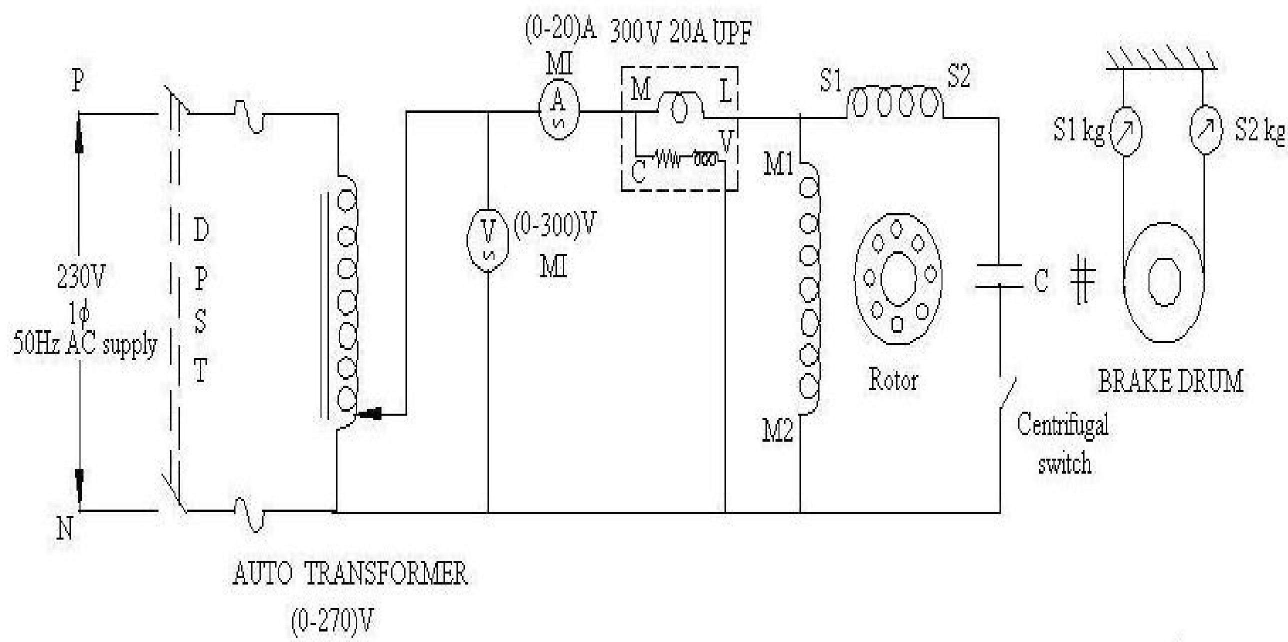
% Slip = (Ns-N)/N ×100

Power factor = Cos φ=W/VI

THEORY:

1phase Induction motor are not self-starting IM. One method of making them of self-starting is by providing auxiliary winding on the stator. The rotor has a proper 3-phase winding with three leads brought out through slips rings and brushes. These leads are normally short circuited when the motor is running. Resistances are introduced in the rotor circuit via the slip rings at the time of starting to improve the starting torque.

The rotating field created by the stator winding moves past the shorted rotor conductors inducing currents in the latter. These induced currents produce their own field which rotates at the same speed (synchronous) with respect to the stator as the stator – produced field. Torque is developed by the interaction of these two relatively stationary fields. The rotor runs at a speed close to synchronous but always slightly lower than it. At the synchronous speed no torque can be developed as zero relative speed between the stator field and the rotor implies no induced rotor currents and therefore no torque.



PRECAUTION:

1) Before switching on the supply the variac is kept in minimum position.
2) Initially these should be on no load while starting the motor

PROCEDURE:

Connections are given as per the circuit diagram.

1) Switch on the supply at no load condition.
2) Apply the rotor voltage to the motor using the variac and note down the readings at ammeter And wattmeter.
3) Vary the load in suitable steps and note down all the meter readings till fill load condition.

VIVAQUESTIONS

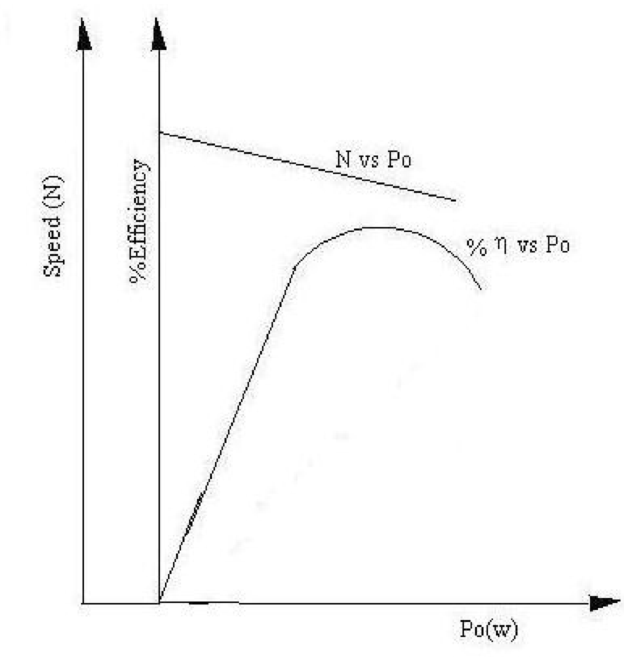
1. What is the purpose of this experiment?
2. Whether single phase induction motor self starting motor?
3. What are the starting methods of single phase induction motor?

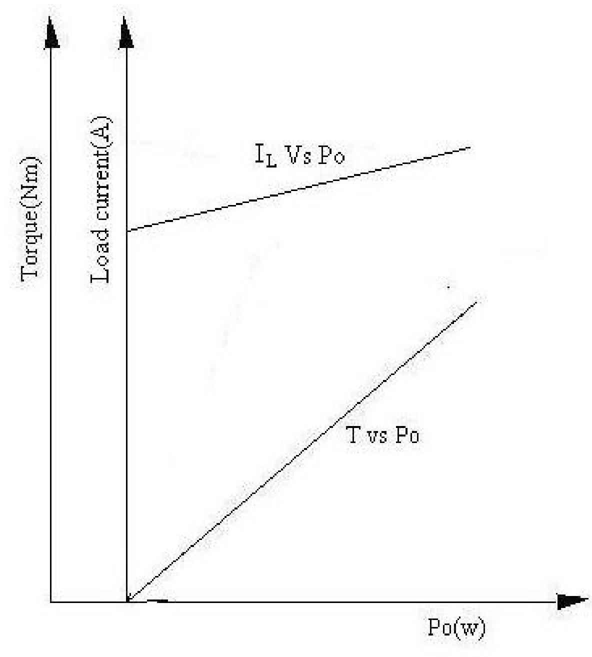
TABULAR COLUMN:

R= ....m

S.no	V_L volts	I_L Amps	S1 kg	S2 kg	S kg	W1 watts	W2 watts	Speed rpm	Torque Nm	P_o watts	P_i watts	Slip %	%η

MODEL GRAPH:





RESULT:

Thus load test on the single phase induction motor has been conducted and its performance characteristics determined.

10. O.C AND S.C TESTS ON SINGLE PHASE TRANSFORMER

AIM

To conduct open circuit and short circuit tests on the given 120/240 V, 1KVAtransformer and predetermine the following:-

1. Equivalent circuit as referred to l.v side
2. Equivalent circuit a referred to h.v side

APPARATUS REQUIRED

Sl. No.	Name of the instrument	Specification	Quantity
1	Ammeter	(0-2.5)A, MI (0-5)A, MI	1 No. 1 No.
2	Voltmeter	(0-150)V ,MI (0-50)V, MI	1No. 1 No.
3	Wattmeter	150V, 2.5A, LPF 30V, 5A, UPF	1 No. 1 No.
5	Autotransformer	230/(0-270)V, 10A	1No.
6	Connecting wires	-	few

PRINCIPLE

Open Circuit Test

This test is usually conducted on the l.v side of the transformer. It is conducted to determine the core loss(iron loss or no load loss). The low voltage side of the transformer is supplied at rated voltage with the h.v side left open. The current, voltage and power on the input side is noted. Since the no-load primary current is small(2-10% of the rated current) the copper losses in the primary winding can be neglected and the power loss read by the wattmeter is the core loss of the transformer. Since the flux linking with the core is constant at all loads, the core loss remains same for all loads. The parameters R0 and X0 (the shunt branch) are determined using this test.

Short Circuit test

The short circuit test is conducted to determine the full load copper loss and the equivalent resistance and leakage reactance referred to the winding in which the test is conducted. The test is conducted on the h.v side with the l.v side short circuited by a thick conductor. A low voltage just enough to circulate the rated current of the transformer is supplied to the transformer. The voltage supplied is usually only 5-10% of the normal supply voltage and so the flux linking with the core is small. Thus core losses can be neglected and the wattmeter reading gives the full load Cu loss of the transformer.

PROCEDURE

Open Circuit test

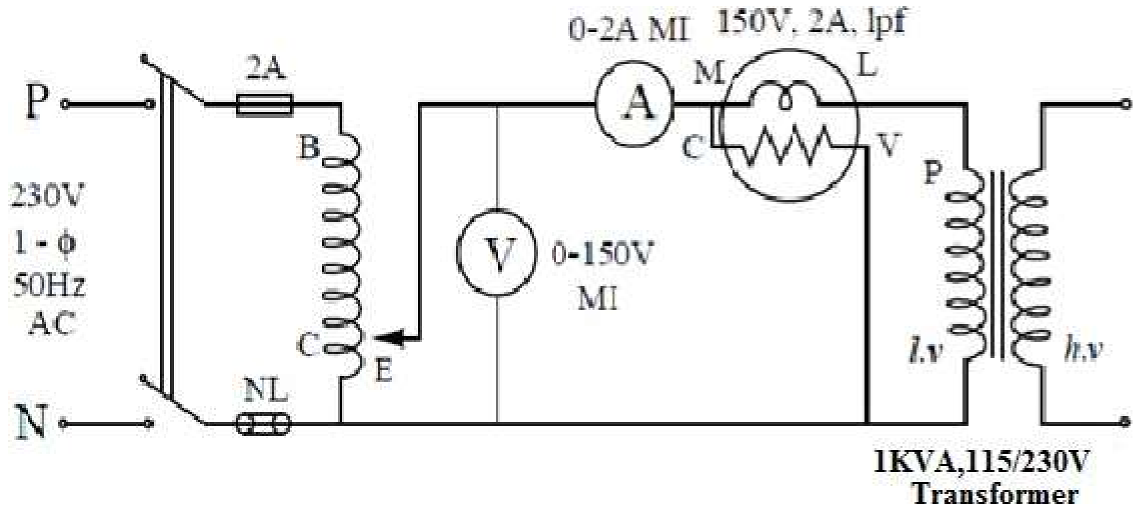
- Connections are made as shown in the connection diagram 1.
- The h.v side is left open. The supply is switched on with the autotransformerin the minimum position.
- The autotransformer is gradually varied till the voltmeter reads the ratedvoltage of the primary side of the transformer.
- The corresponding ammeter and wattmeter readings are noted down andtabulated as shown.

Short Circuit test

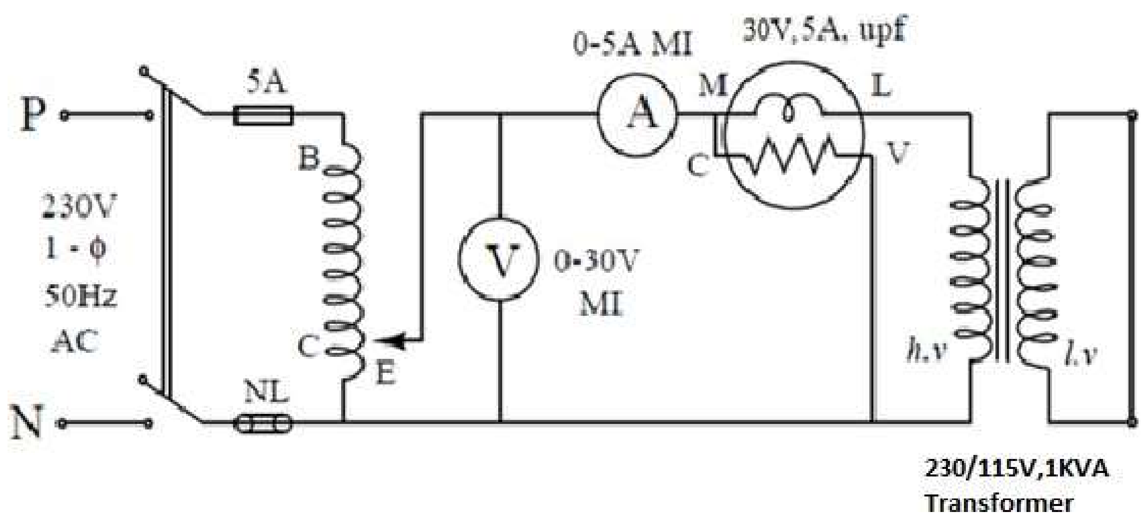
- Connections are made as shown in the diagram 2.
- The l.v side is short circuited. Supply is switched on with the autotransformer in the minimum position.
- The autotransformer is gradually varied till the ammeter reads the rated current of the transformer on the h.v side.

$$\text{Rated current} = \frac{\text{Rated volt Amperes of transformer}}{\text{Rated voltage on h.v side}}$$

CONNECTION DIAGRAM FOR OC TEST



CONNECTION DIAGRAM FOR SC TEST



OBSERVATIONS

OC TEST

V_{OC}	I_{OC}	W_O

SC TEST

V_{SC}	I_{SC}	W_{SC}

SAMPLE CALCULATIONS

From O.C test (l.v side) :-

V_0 = ... I_0 = ... W_0 = ...

$W_0 = V_0 I_0 \cos\Phi_0$

$\cos\Phi_0$ =

$\sin\Phi_0$ = ...

$I_w = I_0 \cos\Phi_0$ = ...

$I_\mu = I_0 \sin\Phi_0$ = ...

Core loss component resistance as referred to l.v side R0 =

$\frac{V_0}{I_w}$ = ...

Magnetising reactance as referred to l.v side X0 =

$\frac{V_0}{I_\mu}$ = ...

The parameters R0 and X0 as referred to the h.v side are

$R0' = R0 \times k^2$ = ...

$X0' = X0 \times k^2$ = ... where $k = \frac{N2}{N1} = \frac{E2}{E1}$ =

From S.C test (h.v side) :-

V_{SC} = ... I_{SC} = ... W_{SC} = ...

Total eqvt.wdg. resistance as referred to h.v side R02 = WSC = ...

ISC

Total eqvt.impedance as referred to toh.v side Z02 = VSC = ...

ISC

Total eqvt.leakage reactance referred to h.v side X02 = $\sqrt{Z02^2 - R02^2} =$

The parameters R02, Z02, and X02 as referred to l.v side are

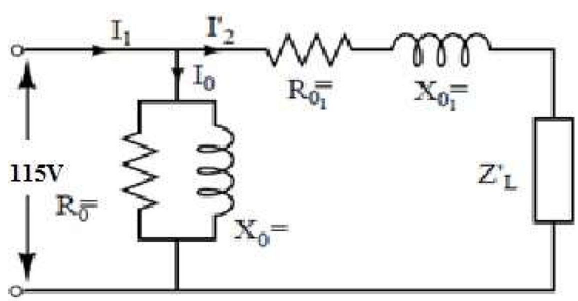
R01 = R02 $|K^2$ = ...

X01 = X02 $|K^2$ = ...

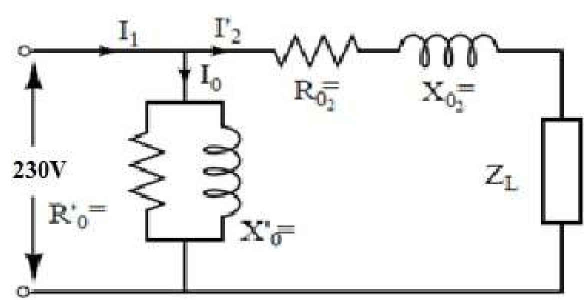
Z01 = Z02 $|K^2$ = ...

EQUIVALENT CIRCUIT

REFERRED TO LV



REFERRED TO HV



RESULT AND DISCUSSION

CONCLUSION

VIVA QUESTIONS

1. Why OC test is preferred on LV side and SC test preferred on HV?
2. Can we obtain copper loss from OC test? Justify.
3. Why do we use LPF wattmeter in OC test?
4. What is the need of equivalent circuit in analysis of a transformer?
5. Can we use (0-1) A ,MI ammeter to conduct SC test on 1KVA,230/115 V transformer?

11. CHARACTERISTICS OF P-N JUNCTION DIODE

I. AIM

1. Study of semiconductor diode characteristics under forward and reverse bias condition
2. To find the static and dynamic resistance

II. i. EQUIPMENT

1. Regulated dual power supply (0 – 30 V)	– 1 No.
2. Moving coil ammeter (0 – 30) mA	– 1 No.
3. Moving coil voltmeter (0-1) V, (0-300) V	- 1 No. each
4. Bread board	– 1 no.
5. Single strand connecting wires	

ii. COMPONENTS

1. 1N4148	- 1 No.
2. OA79	- 1 No.
3. 1 kΩ Resistor	- 1 No. (1/2 W, carbon)

III THEORY

A p-type semiconductor in contact with an n-type semiconductor constitutes a p-n junction. p-n junction is a p-n diode which permits the easy flow of current in one direction but restrains the flow in opposite direction.

In forward bias condition, the positive terminal of the battery is connected to the p-side of the diode and negative terminal to the n side. In forward bias, when the applied voltage is increased from zero, hardly any current flows through the diode in the beginning. It is so because the external voltage is being opposed by the barrier voltage V_B whose value is 0.7 volts for silicon and 0.3 volts for germanium. As soon as V_B is neutralized, current through the diode increases rapidly with increase of applied voltage. Here, the current is in the order of mA

When the diode is in reverse bias, the majority carriers are blocked, and only a small current due to minority carriers flows through the diode. As the reverse voltage is increased from zero, the reverse current increases and reaches a maximum saturation value I_o, which is also known as reverse saturation current. This is in the order of nA for silicon and μA for germanium.

The current I flowing through the diode is related to the applied voltage by the following equation whether the diode is in forward bias or in reverse bias.

$$I = I_O\left(e^{V/\eta V_T} - 1\right)$$

I_O= Reverse saturation current
V = applied voltage
I = current for the applied voltage V
η = 1 for Ge and 2 for Si
V_T = T/ 11600 volts

IV CIRCUIT DIAGRAM

i. Forward bias

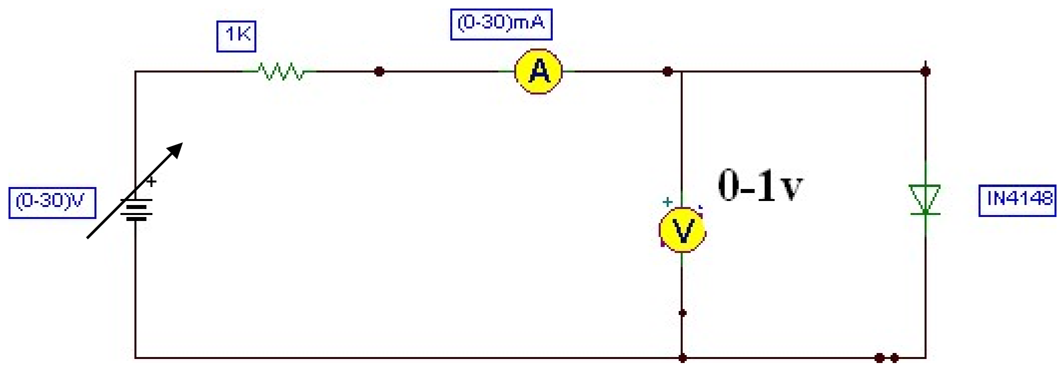


Figure.1

ii. Reverse bias

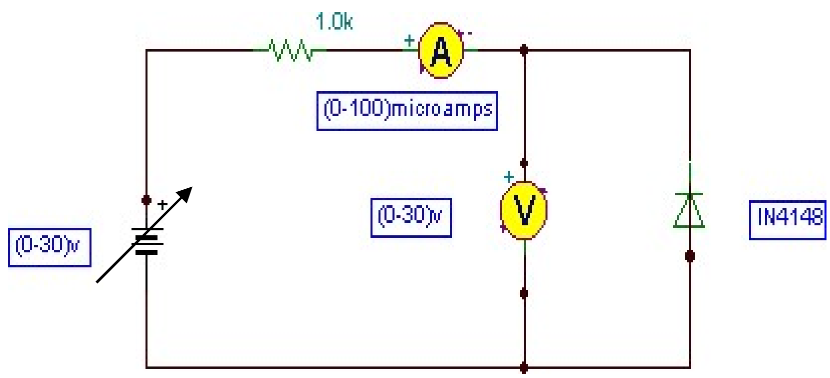


Figure. 2

V PROCEDURE

i. Forward Bias condition

1. Connect the circuit as per the given circuit diagram shown in figure:1
2. Vary the power supply voltage in such a way that the voltmeter reading is 0.1V. Note the corresponding current reading in Ammeter.
3. Repeat step-2 by increasing the voltage in steps of 0.1V, till 1.0V.
4. Plot a graph taking voltage (V) on X axis and current (I) on Y axis
5. Draw a vertical line at 0.7 V, note down the corresponding current value.

Static Resistance $r_{dc} = \frac{0.7}{I}$

6. Draw the vertical line at 0.75V, note down the corresponding current value.

Dynamic Resistance $\gamma_{ac} = \frac{\Delta V}{\Delta I}$ = (0.75 – 0.7)/ ($I_2 - I_1$)

Where, I_1 and I_2 are the corresponding values of current at 0.7 and 0.75 V.

ii. Reverse bias condition

1. Connect the circuit as per the circuit diagram shown in figure:2
2. Vary the power supply voltage in such a way that the volt meter reading is 1V. Note the corresponding current reading in Ammeter.
3. Repeat step-2 by increasing the voltage in steps of 1V, till 20V.
4. Plot a graph taking the voltage (V) on X-axis and current (I) on Y-axis.
5. Draw the horizontal line at -4V, note down the corresponding current values.
6. Reverse dc Resistance $R_R = \frac{Reverse\ voltage}{Reverse\ current}$ = 4/I

VI. <u>OBSERVATIONS</u>

i. Forward Bias

V_D (volts)	I_D (mA)
0	
0.1	
0.2	
..	
..	
..	
..	
1	

ii. Reverse Bias

V_D (volts)	I_D (µA)
0	
1	
2	
..	
..	
..	
..	
20	

VII. <u>CALCULATIONS</u>

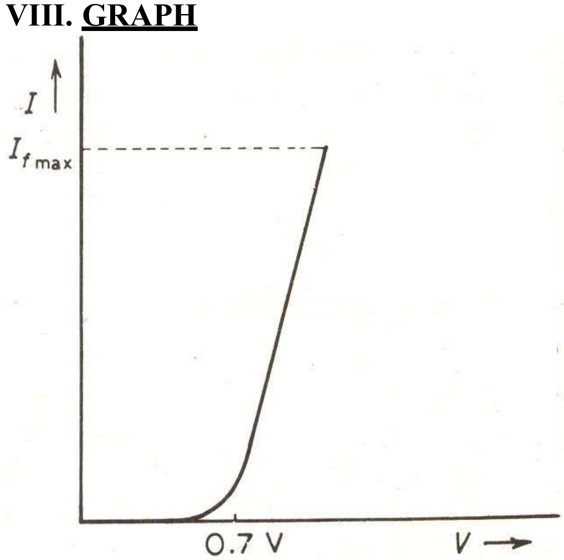
Forward Bias

Dynamic Resistance = $\frac{\Delta V_D}{\Delta I_D}$

Static Resistance = $\frac{V_D}{I_D} = \frac{0.7}{I_D}$

Reverse Resistance = R_R = $\frac{\text{Reverse voltage}}{\text{Reverse current}}$

VIII. <u>GRAPH</u>



Forward characteristics of a silicon diode

IX RESULT

Dynamic Resistance =
IN4148
Static Resistance =
IN4148
Reverse Resistance =
IN4148

X. INFERENCE

The current in the forward bias is observed in the order of mA. The current in the reverse bias is observed in the order of μA for Ge and mA for Si diode. Usually, the forward resistance range is 0 Ω to 100 Ω and in the reverse bias, it is in the order of MΩ. Therefore the characteristics of pn junction diode are verified.

XI. PRECAUTIONS

1. Maximum forward current should not exceed the value which is given in the datasheet. If the forward current in a pn junction is more than this rating, the junction will be destroyed due to overheating

2. Reverse voltage across the diode should not exceed peak inverse voltage (PIV). PIV is the max. reverse voltage that can be applied to a pn junction without any damage to the junction.

XII. APPLICATIONS

1. It is used in several Electronic circuits like rectifiers etc.
2. It is used in communication circuits for modulation and demodulation of high frequency signals.
3. It is used in logic circuits that are fundamental building blocks of computers.
4. It is used in wave shaping circuits like clippers and clampers.

XIV. TROUBLE SHOOTING

S.No.	Fault	Diagnosis
1	No reading in the Ammeter	Check the diode for any open circuit
2	No reading in Voltmeter	Check the diode for any short circuit
3	No increase in the power supply voltage	Check the current limit in RPS. Increase the current limit, if required

XV. QUESTIONS

1. What is cut-in voltage for germanium diode?
2. What is cut-in voltage for silicon diode?
3. What is meant by PIV?

4. What is reverse saturation current?
5. What are the reasons for the development of potential barrier across a pin junction?
6. What is meant depletion region?
7. Mention the materials used for doping an intrinsic semi conductor material?
8. What is meant by majority carriers and minority carriers?
9. Describe the effect of increasing the reverse bias voltage to high values?
10. What are essential differences between Ge and Si diode?

12. ZENER DIODE

1. AIM:

1. To plot the V-I characteristics of ZENER diode under forward and reverse bias conditions.
2. To find ZENER voltage, forward bias resistance & reverse bias resistance after ZENER Breakdown.

2. i. EQUIPMENTS REQUIRED:

1. Bread Board
2. Connecting wires
3. Volt meter (0 - 20V)
4. Ammeter (0 - 20 mA), (0 – 20mA)
5. Regulator DC power supply.

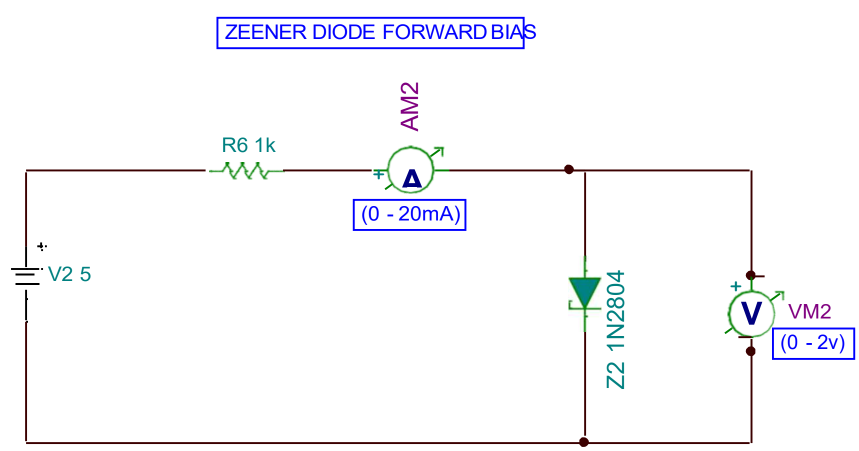
ii. COMPONENTS REQUIRED:

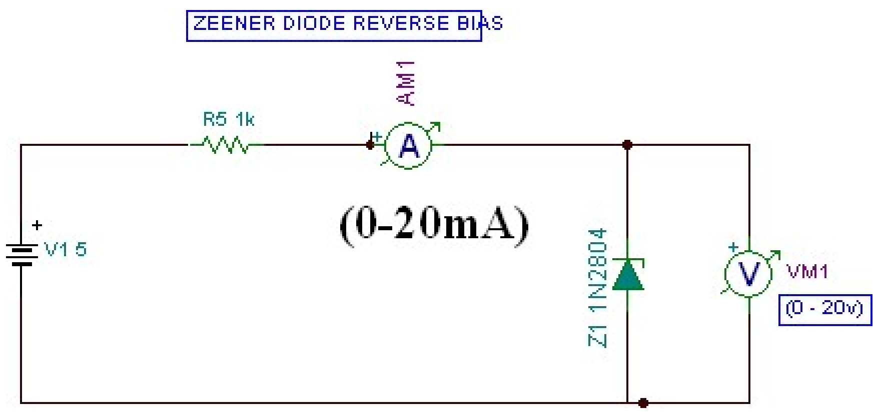
1. Zener diode (IN 2804)
2. Resistor (1kΩ)

3. **THEORY**:

Zener diode acts as normal PN junction diode. And during reverse bias as reverse voltage reaches breakdown voltage diode starts conducting. To avoid high current, we connect series resistor with it. Once the diode starts conducting it maintains constant voltage across it. Specially made to work in the break down region. It is used as voltage regulator.

4. **CIRCUIT**





5. PROCEDURE:

Forward Bias:

1. Connect the circuit as per the circuit diagram.
2. The DC power supply is increased gradually in steps of 1 volt.
3. Corresponding Voltmeter and Ammeter readings are noted and the V-I characteristics are plotted with zener voltage on X axis and current along the Y axis.
4. Break voltage is found and the break down resistance of zener diode is calculated.

Reverse Bias:

1. Connect the circuit as per the circuit diagram.
2. The DC power supply is increased gradually in steps of 1 volt.
3. Corresponding Voltmeter and Ammeter readings are noted and the V-I characteristics are plotted with zener voltage on X axis and current along the Y axis.
4. Break voltage is found and the break down resistance of zener diode is calculated

6. OBSERVATION TABLE

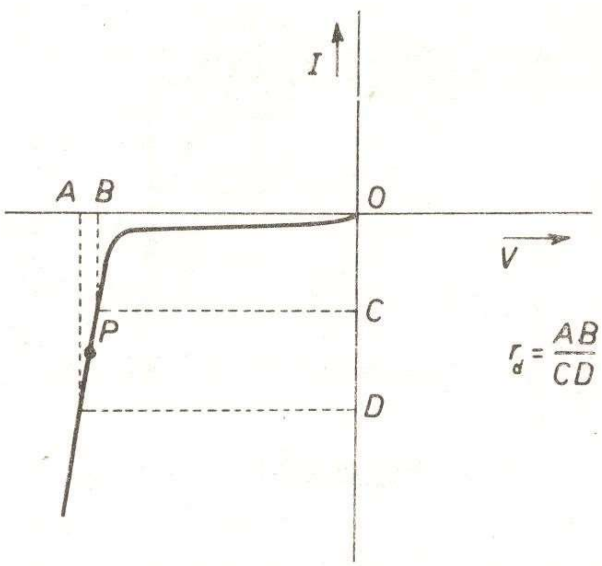
Forward bias

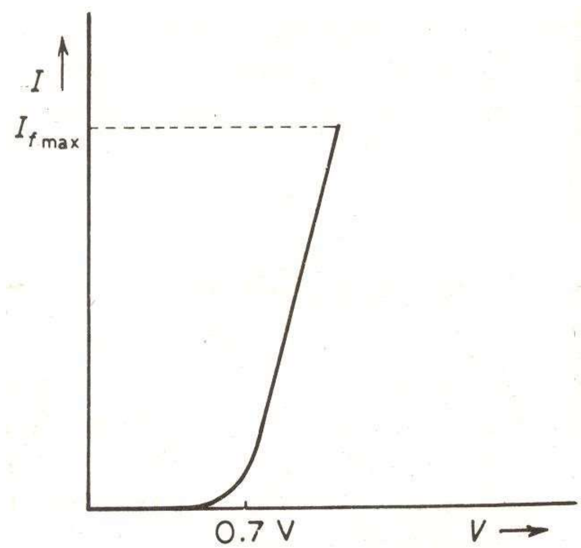
Sl No	Voltmeter reading In volt	Ammter reading In mA

Reverse bias

Sl. No	Voltmeter reading In volt	Ammeter reading In mA

GRAPH





7. INTERFERENCE:
Zener diode is having a very sharp break down. That is for constant voltage different currents can flow through it Zener diode can be operated in reverse bias.

8. PRECAUTION
1. It is preferable to use digital Multimeter in place of analog voltmeter
2. Maximum current should not exceed the value which is given on the data sheet.

9. TROUBLE SHOOTING

If no deflection on ammeter and voltmeter, check the should not be loose contacts in the circuit.

10. RESULT:

Zener Voltage = _______________

Forward bias resistance =__________

Reverse bias resistance = __________

11. EXTENSION

Zener diode can be used as a voltage regulator.

12. APPLICATION

1. Zener diode is used as voltage regulator.
2. Used in some clipper circuit.
3. Used as reference voltage in some circuits.

13. QUESTIONS

1. What is Zener diode
2. What is breakdown voltage of Zener diode
3. What is avalanche breakdown
4. What is doping concentration of Zener diode
5. How is Zener diode different from PN junction diode

13. CHARACTERISTICS OF BJT IN CE CONFIGURATION

1) AIM:

1) To study and plot the input and output characteristics of BJT in CE configuration.
2) Find the current amplification factorβ.
3) Find the dynamic input & output Resistance.

2) i. APPARATUS:

Dual Regulated power supply (0 – 30) V
Moving coil ammeter (0 – 10 mA), (0 -1mA)
Moving coil voltmeter (0 – 1 V), (0 – 10 V)
Bread board - 1
Connecting wires (single strand)

ii.) COMPONENTS: –

Transistor BC107
Resistor – (10 kΩ)

3) THEORY:

In this CE arrangement, input is applied between base & emitter terminals and output is taken from collector and emitter terminals. Here emitter of the transistor is common to both input and output circuits. Hence the name Common Emitter (CE) configuration.

For CE configuration, we define the important parameters as follows:

1. The base current amplification factor (β) is the ratio of change in collector current ΔI_C to the change in base current ΔI_B is known as Base current amplification factor.

$$\beta = \frac{\Delta I_C}{\Delta I_B} | V_{CB} = const$$

In almost any transistor, less than 5% of emitter current flows as the base current. The value of β is generally greater than 20.Usually its value ranges from 20 to 500. This type of arrangement or configuration is frequently used as it gives appreciable current gain as well as voltage gain.

2. Input resistance is the ratio of change in base-emitter voltage to the change in base-current at constant V_{CE}

i.e.,

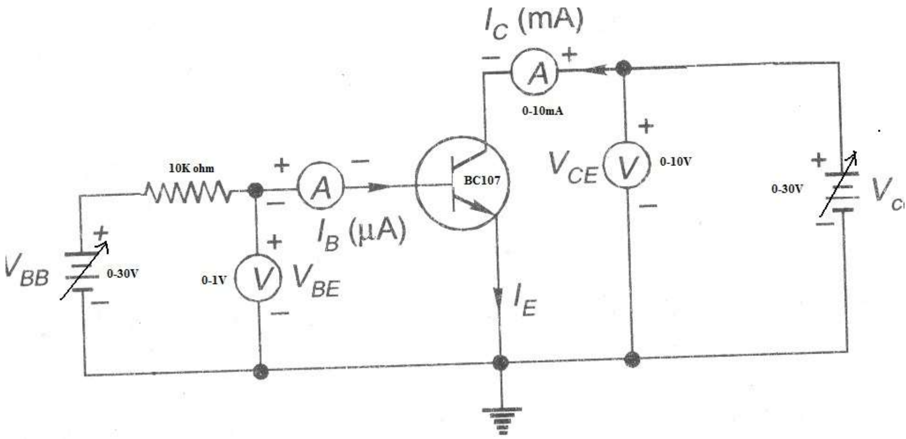
$$r_i = \frac{\Delta V_{BE}}{\Delta I_B} | .V_{CE} = const$$

The value of input resistance for the CE circuit is of the order of a few hundredΩ's.

3. Output resistance is the ratio of change in collector-emitter voltage to change in collector current at constant I_B.

$r_O = \frac{\Delta V_{Ce}}{\Delta I_C} |_{I_E = const}$ .It is in the order of 50 kΩ

4. **CIRCUIT DIAGRAM**:



5. PROCEDURE

Input characteristics

1. Connect the circuit as per the given circuit diagram on bread board
2. Set V_{CE} = 5V, vary V_{BE} in steps of 0.1V & note down the corresponding I_B. Repeat the above procedure for 10V, 15V & 20V
3. Plot the graph V_{BE} Vs I_B for a constant V_{CE} taking V_{BE} is taken on x axis & I_B on y axis
4. Calculate input resistance $\frac{\Delta V_{BE}}{\Delta I_B} |_{V_{CE} = const}$

Output Characteristics

1. Connect the circuit as per the given circuit diagram on the bread board
2. Open the input circuit, vary the collector voltage V_{CE} in steps of 1V and note down the corresponding collector current Ic.
3. Set I_B= 20µA, vary V_{CE} in steps of 1V and note down the corresponding I_C. Repeat the above procedure for 40µA, 80µA, 100µA.
4. Plot the graph taking V_{CE} on X-axis & I_C on y-axis at corresponding constant I_B
5. Calculate the output resistance $\frac{\Delta V_{CE}}{\Delta I_C} |_{I_B = const}$
6. Calculate the current amplification factor $\beta = \frac{\Delta I_C}{\Delta I_B} |_{V_{CB} = const}$

6. TABULAR FORM

I/p Characteristics

V_{CE} = 5V	
V_{BE}(V)	I_B(mA)

V_{CE} = 10V	
V_{BE}(V)	I_B(mA)

V_{CE} = 15V	
V_{BE}(V)	I_B(mA)

O/p Characteristics

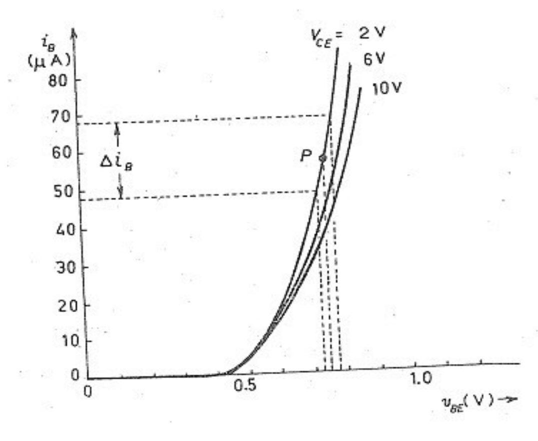
I_B = 20μA	
V_{CE}	I_C(mA)

I_B = 40μA	
V_{CE}	I_C(mA)

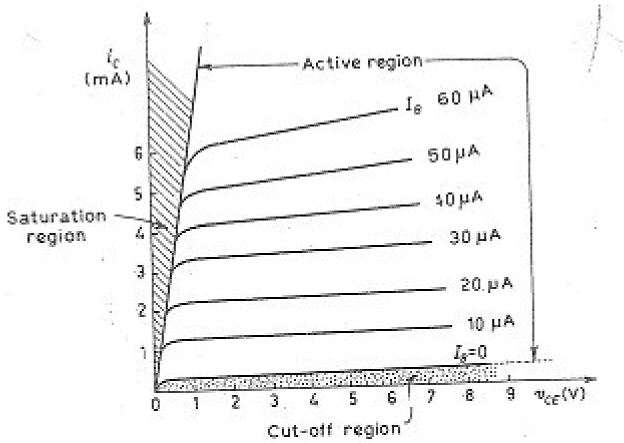
I_B = 60μA	
V_{CE}	I_C(mA)

7. GRAPH: -

Input Characteristics: -



Output Characteristics: -



8) CALCULATIONS: -

I/p Resistance $= \frac{\Delta V_{BE}}{\Delta I_B} \Big| _{V_{CE} = const}$

O/p Resistance $= \frac{\Delta V_{CE}}{\Delta I_C} \Big| _{I_B = const}$

Current amplification factor $\beta = \frac{\Delta I_C}{\Delta I_B} \Big| _{V_{CB} = const}$

9) RESULTS: -

1. Input and output characteristics are plotted on the graph.
2. The transistor parameters are given below

Dynamic I/p Resistance =________

Dynamic O/p Resistance =________

Current amplification factor β=______

10) INFERENCE: -

I/p characteristics: -

1. As compared to CB arrangement I_B increases less rapidly with V_{BE}. Input resistance of CE circuit is higher than that of CB circuit.
2. Input characteristics resemble that of a forward biased pn junction diode curve. This is expected since the base emitter section of a transistor is a pn junction.

O/p characteristics

1. For any value of V_{CE} above knee voltage, the collector current I_C is approximately equal to βI_B.
2. The collector current is not zero when I_B is zero. It has a value of I_{CEO}, the reverse leakage current.

11. APPLICATIONS:

1) Used as amplifier
2) Used in communication circuits
3) Used as a switch
4) Used in audio frequency applications

12. QUESTIONS:

1) What is Transistor?
2) Draw the npn & pnp transistor symbols.
3) Why base region is made thin?
4) Why is transistor not equivalent to two pn junction diodes connected back to back?
5) Why is collector current slightly less than emitter current?
6) What is the significance of arrow in the transistor symbol?
7) What is β?
8) What is the range of input resistance?
9) What is the range of output resistance?
10) Why small change in α leads to large change in β.

14. HALF WAVE RECTIFIER WITH AND WITHOUT FILTER

1. AIM:

1. To examine the input and output waveform of half wave rectifier
2. To find ripple factor and percentage regulation.

2. i. EQUIPMENTS REQUIRED:

1. Bread Board
2. CRO
3. Connecting wires
4. Digital multimeter
5. TransformerPrimary voltage (0-230v)
6. BNC probes

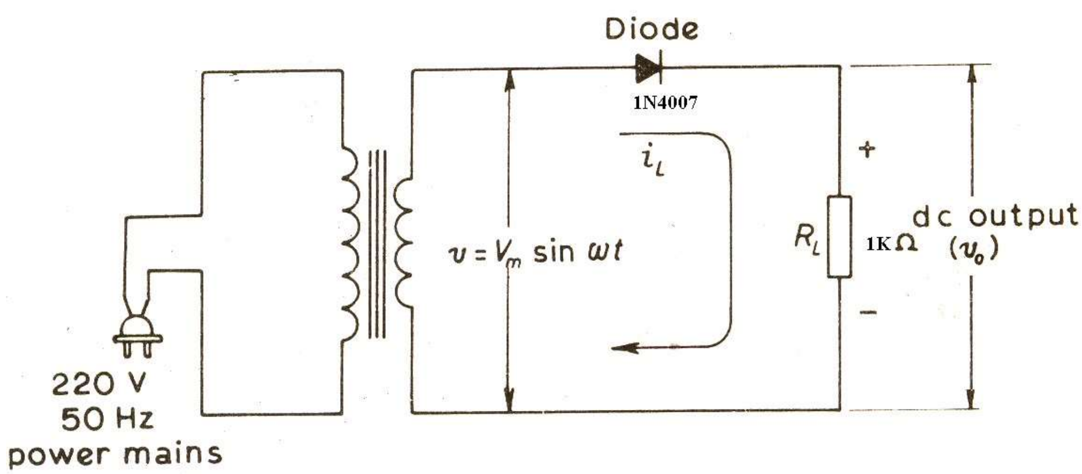
ii. COMPONENTS REQUIRED:

1. Capacitor (100µF)
2. Diode (1N4007)
3. Resistor (1kΩ)

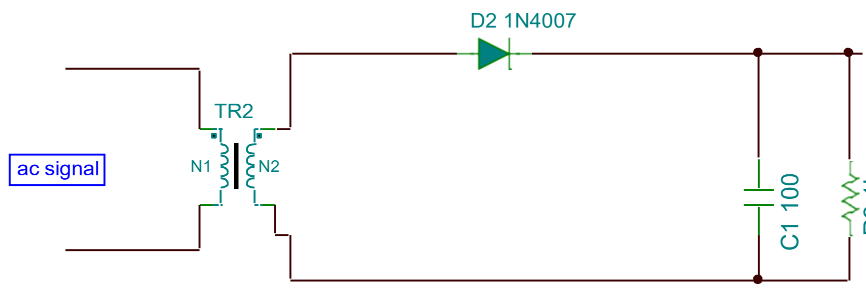
3. THEORY:

In Halfwave rectifier there is one diode, transformer and a load resistance. During the positive half cycle of the input, diode is ON and it conducts current and flows through load resistance ,voltage is developed across it. During the negative half cycle the diode is reversed biased, no current conduction so no current through load resistance and no voltage across load resistance

4. CIRCUIT DIAGRAM



Half-wave rectifier circuit



5. PROCEDURE:

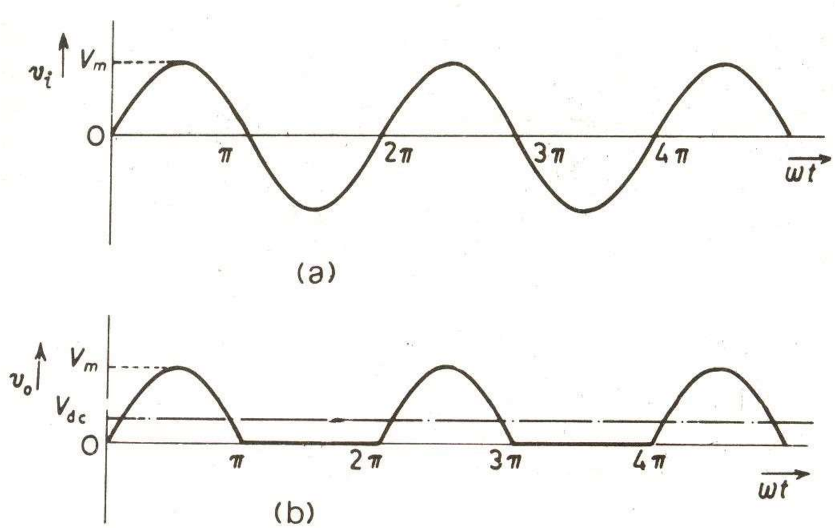
Without filter:

1. Connect the circuit as per the circuit diagram
2. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO.
3. Measure ac voltage, dc voltage, no load and full load voltages with DMM.

With filter:

1. Connect the circuit as per the circuit diagram
2. Do not connect the capacitor, first get the circuit is verified.
3. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO Connecting the capacitor.
4. Measure ac voltage, dc voltage, no load and full load voltages with DMM.

Graph:



Half-wave rectifier: (*a*) Input voltage waveform (*b*) Output voltage waveform

6. OBSERVATIONS

Without filter:

Ac voltage= no load voltage=
Dc votage= full load voltage=

With filter:

Ac voltage= no load voltage=
Dc votage= full load voltage=

7. INFERENCE

As diode can be used as a switch so it is used in rectifier circuit to convert AC signal to DC signal, but not perfect DC IT IS PULSETING dc.

8. PRECAUTIONS

1. Waveforms should be observed on CRO keeping in DC mode.
2. Use digital meter instead of analog meter.

9. TROUBLE SHOOTINGS

No meter reading then check if there are any loose connection.

10. RESULT:

Ripple factor = ac voltage/dc voltage = ____________________

$$\text{Percentage regulation} = \frac{V_{noload} - V_{fullload}}{V_{fullload}} x100\% = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

11. EXTENSSION

Efficiency of the circuit is less so we go for full wave rectifier.

12. APPLICATIONS

1. Used to convert AC signal to pulsating DC.
2. Clippers.

13. QUESTION

1. Explain the operation of half wave rectifier.
2. Derive rms & avg value of output of half wave rectifier.
3. Derive ripple factor of half wave rectifier.
4. Derive efficiency of half wave rectifier
5. What is peak factor, form factor of half wave rectifier
6. What is TUF of half wave rectifier
7. What should be PIV of diode in half wave rectifier

15. FULL WAVE RECTIFIER WITH AND WITHOUT FILTER

1. AIM:
1. To examine the input and output waveform of full wave rectifier
2. To find ripple factor and percentage regulation.

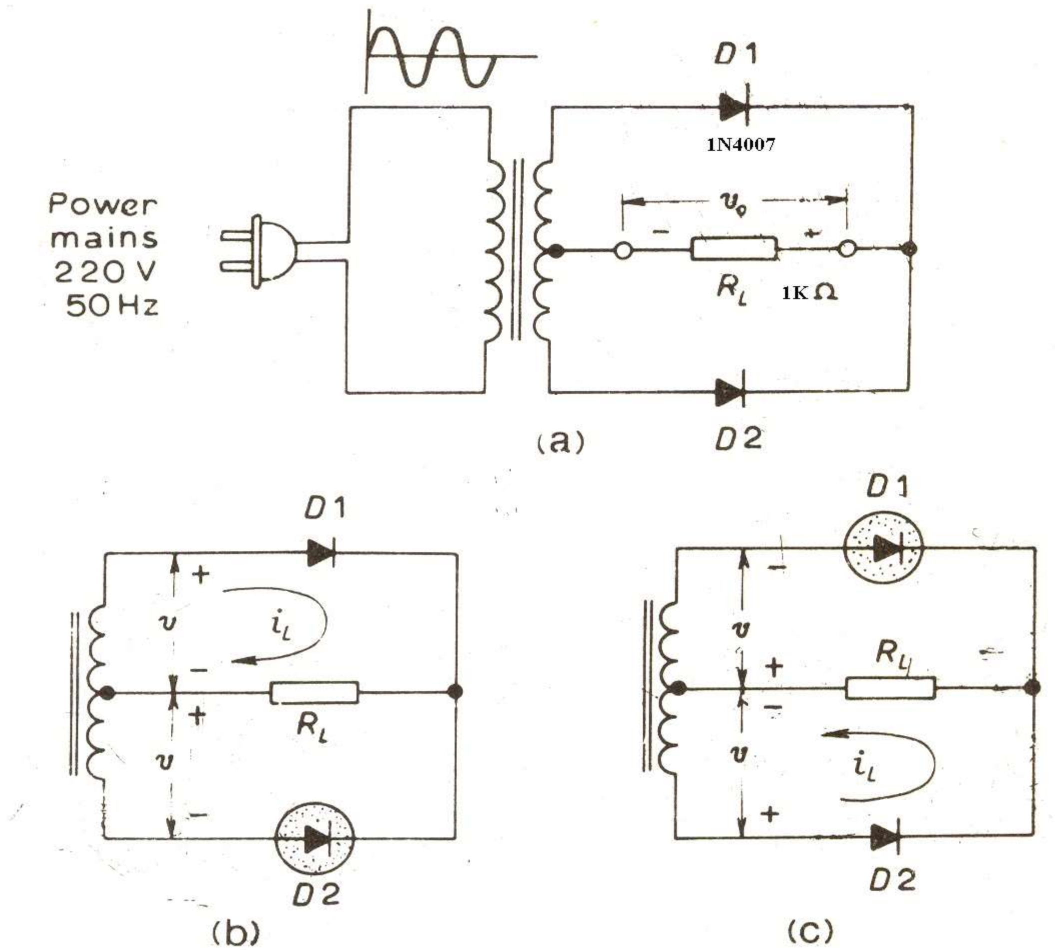
2. EQUIPMENTS REQUIRED:

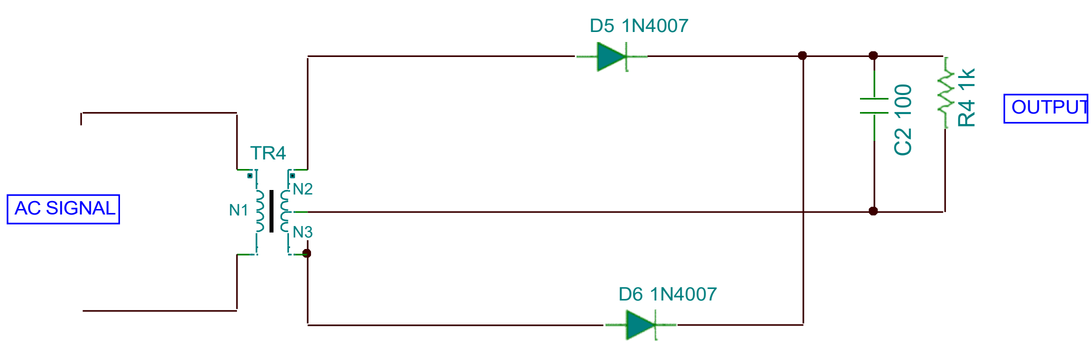
i. Apparatus:
1. Bread Board
2. CRO
3. Connecting wires
4. Digital Multimeter
5. TransformerPrimary voltage (0-230v)
6. BNC probes

ii. COMPONENTS REQUIRED:
1. Capacitor (100µF)
2. Diode (1N4007)
3. Resistor (1kΩ)

3. THEORY:
During positive half cycle Diode D1 is forward biased and diode D2 is reversed biased so current conducts through D1 due to which voltage is developed across the load resistance. and During negative half cycle Diode D2 is forward biased and diode D1 is reversed biased so current conducts through D2 due to which voltage is developed across the load resistance.

4. CIRCUIT DIAGRAM:





5. PROCEDURE:

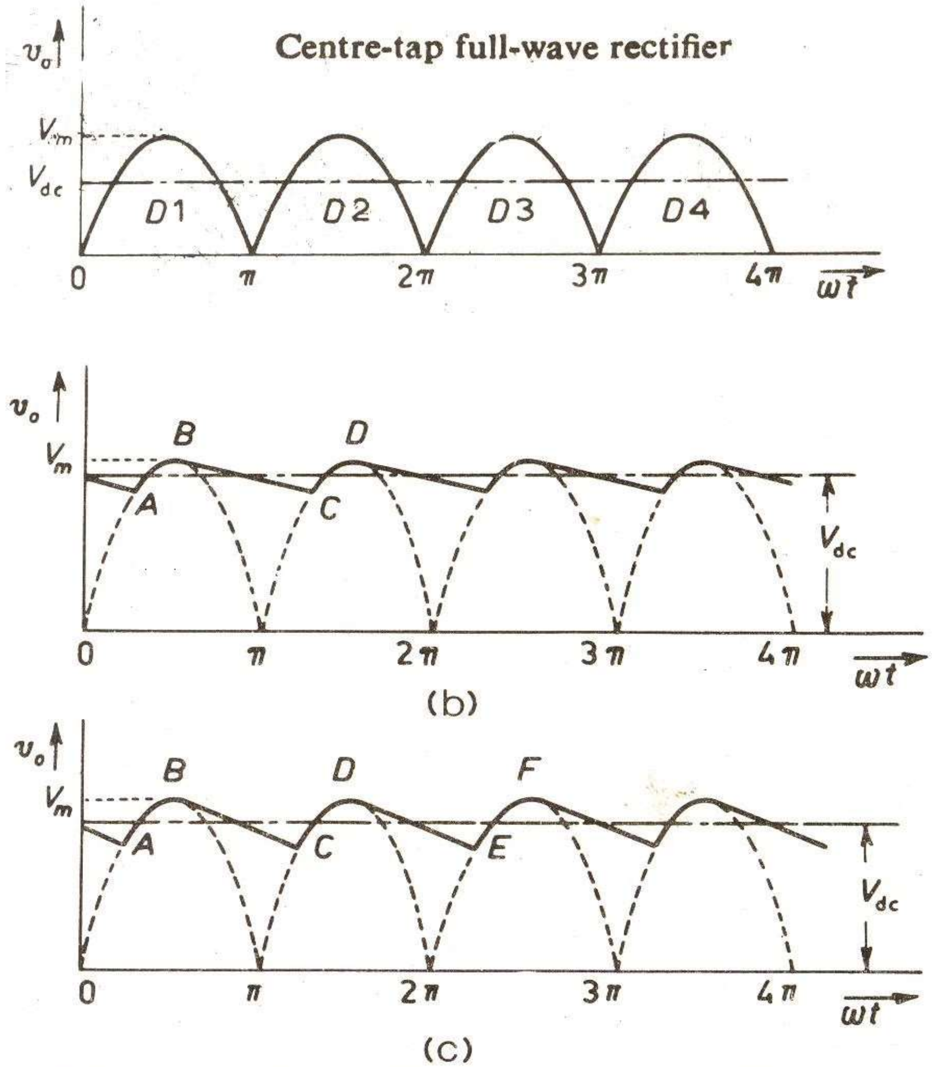
Without filter:

1. Connect the circuit as per the circuit diagram
2. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO.
3. Measure ac voltage, dc voltage, no load and full load voltages with DMM.

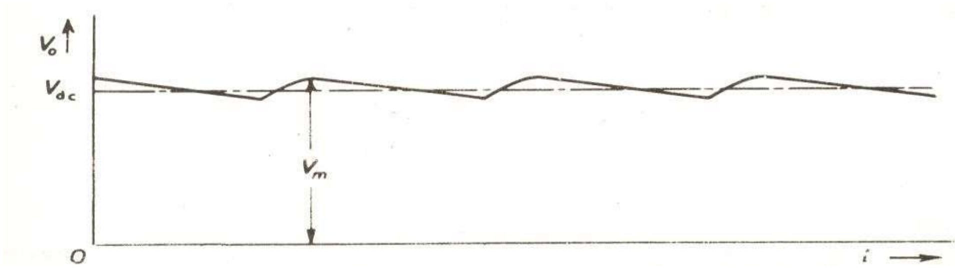
With filter:

1. Connect the circuit as per the circuit diagram
2. Do not connect the capacitor, first get the circuit is verified.
3. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO Connecting the capacitor.
4. Measure ac voltage, dc voltage, no load and full load voltages with DMM.

Graph:



Full-wave rectifier with shunt capacitance filter



6. OBSERVATIONS

Without filter:

Ac voltage= no load voltage=

Dc votage= full load voltage=

With filter:

Ac voltage= no load voltage=

Dc votage= full load voltage=

7. INFERENCE

As diode can be used as a switch so it is used in rectifier circuit to convert AC signal to DC signal, but not perfect DC it is pulsating DC.

8. PRECAUTIONS

1. Waveforms should be observed on CRO keeping in DC mode.
2. Use digital meter instead of analog meter.

9. TROUBLE SHOOTINGS

No meter reading then check if there are any loose connection.

10. RESULT:

Ripple factor = ac voltage/dc voltage = ______________________

$$\text{Percentage regulation} = \frac{V_{noload} - V_{fullload}}{V_{fullload}} x100\% = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

11. EXTENSSION

Efficiency of the circuit is less so we go for fullwave rectifier.

12. APPLICATIONS

1. Used to convert AC signal to pulsating DC.
2. Clippers.

13. QUESTION

1. Explain the operation of half wave rectifier.
2. Derive rms & avg value of output of full wave rectifier.
3. Derive ripple factor of full wave rectifier.
4. Derive efficiency of full wave rectifier
5. What is peak factor, form factor of full wave rectifier?
6. What is TUF of full wave rectifier?
7. What should be PIV of diode in full wave rectifier?