TPCT's

College of Engineering, Osmanabad

Laboratory Manual

Electrical Machines and Instrumentation

For

Second Year Students

Prepared by

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TPCT's

College of Engineering

Solapur Road, Osmanabad

Department of Electronics &Telecommunication

Vision of the Department:

To be recognized by the society at large as an excellent department offering quality higher education in the Electronics & Telecommunication Engineering field with research focus catering to the needs of the public and being in tune with the advancing technological revolution.

Mission of the Department:

To achieve the vision the department will

- **Establish a unique learning environment to enable the student's face the challenges of the Electronics & Telecommunication Engineering field.**
- **Promote the establishment of centers of excellence in technology areas to nurture the spirit of innovation and creativity among the faculty & students.**
- **Provide ethical & value based education by promoting activities addressing the needs of the society.**
- **Enable the students to develop skill to solve complete technological problems of current times and also to provide a framework for promoting collaborative and multidisciplinary activities.**

College of Engineering

Technical Document

This technical document is a series of Laboratory manuals of Electronics and Telecommunication Department and is a certified document of College of Engineering, Osmanabad. The care has been taken to make the document error-free. But still if any error is found, kindly bring it to the notice of subject teacher and HOD.

Recommended by,

HOD

Approved by,

Principal

FOREWORD

It is my great pleasure to present this laboratory manual for second year engineering students for the subject of **Electrical Machines and Instrumentation** to understand and visualize the basic concepts of various circuits using Electrical Machines. **Electrical Machines and Instrumentation** covers basic concepts of electrical engineering and instrumentation engineering. This being a core subject, it becomes very essential to have clear theoretical and designing aspects.

This lab manual provides a platform to the students for understanding the basic concepts of **Electrical Machines and Instrumentation**. This practical background will help students to gain confidence in qualitative and quantitative approach to electrical machines.

H.O.D

ECT Dept

LABORATORY MANUAL CONTENTS

This manual is intended for the Second Year students of ECT branches in the subject of **Electrical Machines and Instrumentation**. This manual typically contains practical/ Lab Sessions related to **Electrical Machines and Instrumentation** covering various aspects related to the subject for enhanced understanding.

Students are advised to thoroughly go through this manual rather than only topics mentioned in the syllabus as practical aspects are the key to understanding and conceptual visualization of theoretical aspects covered in the books.

SUBJECT INDEX:

1. Do's & Don'ts in Laboratory.

2. Lab Exercises

    1. Speed control of DC Shunt motor and 3-ph Induction Motor.
    2. Study of Starters used for DC Motors.
    3. Load test on DC series Motor.
    4. Load test on DC shunt Motor.
    5. Load test on 3-ph Induction Motor.
    6. To study LVDT characteristics.
    7. To study Thermocouple characteristics.
    8. Study of Burglar Alarm.
    9. Study of types of Display.

3. Quiz

4. Conduction of viva voce examination

5. Evaluation & marking scheme

Dos and Don'ts in Laboratory :-

- Never hurry. Work deliberately and carefully.
- Connect to the power source last.
- If you are working with a lab kit that has internal power supplies, turn the main power switch OFF before you begin work on the circuit.
- Check circuit power supply voltages for proper values and for type (DC, AC, frequency) before energizing the circuit.
- Do not run wires on moving or rotating equipments or on the floor.
- Remove conductive watch, bands, chain, finger rings, etc and do not use metallic pencils, metal edge rulers, etc when working with exposed circuits.
- Don't use an electrical outlet or switch if the protective cover is cracked or missing.
- Only use dry hands and tools & stand on dry surface when using electrical equipments plugging in an electric cord, etc.
- Be as neat as possible. Keep the work area and work bench clear of items not used in experiments.
- Do not handle any equipment before reading the instructions /Instruction manuals.
- Read carefully the power ratings of the equipment before it is switched ON, whether ratings 230 V/50 Hz or 115V/60 Hz. For Indian equipment, the power ratings are normally 230V/50Hz. If you have equipment with 115/60 Hz ratings, do not insert power plug, as our normal supply is 230V/50Hz., which will damage the equipment.
- Observe type of sockets of equipment power to avoid mechanical damage.
- Do not forcefully place connectors to avoid the damage.
- Strictly observe the instructions given by the Teacher/ Lab Instructor.

Instruction for Laboratory Teachers:-

1. Submission related to whatever lab work has been completed should be done during the next lab session.
2. Students should be instructed to switch on the power supply after getting the checked by the lab assistant / teacher. After the experiment is over, the students must hand over the wires, measuring instruments to the lab assistant/teacher.
3. The promptness of submission should be encouraged by way of marking and evaluation patterns that will benefit the sincere students.

EXPERIMENT NO 1

Speed control of DC Motor and 3-ph Induction Motor.

AIM: i) To study speed control of DC shunt Motor by flux control method.

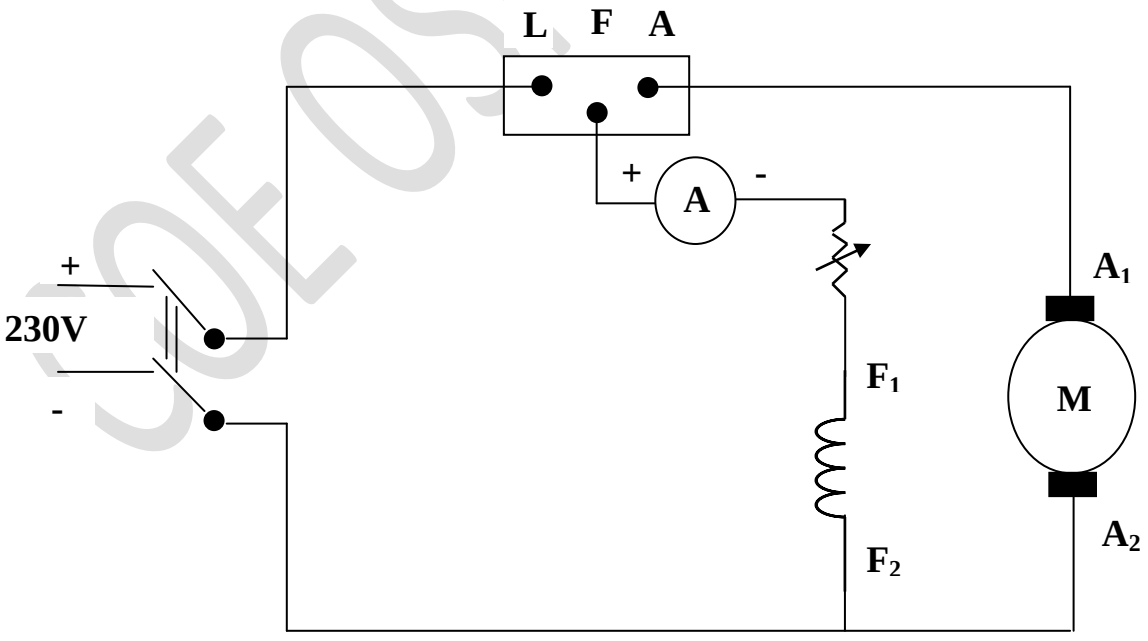
ii) To study speed control of I.M. by varying rotor resistance.

OBJECTIVES: To plot the graph between field current and speed for DC Motor.

EQUIPEMENTS:

1) DC shunt Motor-3HP, 220V, 1500rpm.
2) Field rheostat.
3) Slip ring I. M.
4) DC Ammeter (0-1A)
5) Tachometer

CIRCUIT DIAGRAM:

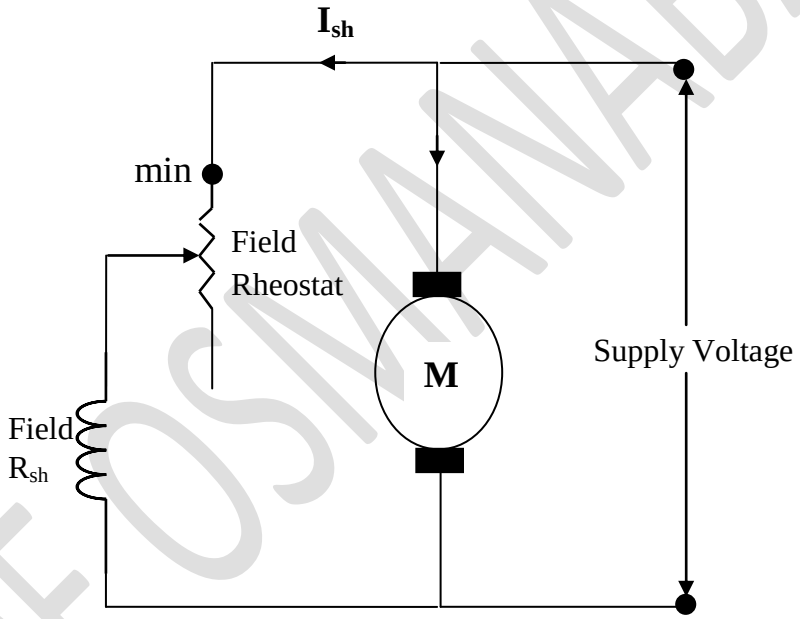


Flux control method

THEORY:

A) Flux control method of DC shunt Motor

The flux of DC Motor is a function of field current (I_{sh}). As supply voltage is constant the I_{sh} can only varied by inserting extra resistance in the field circuit. This decreases I_{sh} and hence flux φ. Decrease in flux increases speed. Hence this method is used to increase the speed above rated speed. The variation in speed obtained can be twice of that of minimum speed. The circuit arrangement is as shown in fig. below.



Flux control method

Advantages of Flux control method:

1) Speed control above rated speed is possible.
2) It gives relatively smooth and easy control.
3) As the field current is very small, copper losses are small, hence efficiency is more.

Disadvantages of Flux Control method:

1) Speed control below rated speed is not possible
2) For very high speed motor undergoes commutation problem.

B) Rotor resistance method for I. M.

For the normal operating portion of induction motor (When speed of motor is very near to synchronous speed), the torque $T \propto \frac{S}{R_2}$. Hence for a given torque i. e. for given load slip can be varied by varying rotor resistance, thereby speed of motor will change.

This method is suitable to only slip ring induction motor. The other disadvantages of this method are

1) Due to increase in rotor resistance the rotor copper losses will increase thereby decreasing the efficiency.
2) The speed regulation is poor for high rotor resistance.

PROCEDURE: A) For DC Motor

1) Make the connection as per the circuit diagram.
2) Start the DC Motor with the help of starter.
3) Apply rated voltage to the motor.
4) Vary the value of field resistance.
5) Observe the change in the value of field current.
6) Record speed drawn by Motor.
7) Plot speed Vs field current curve.

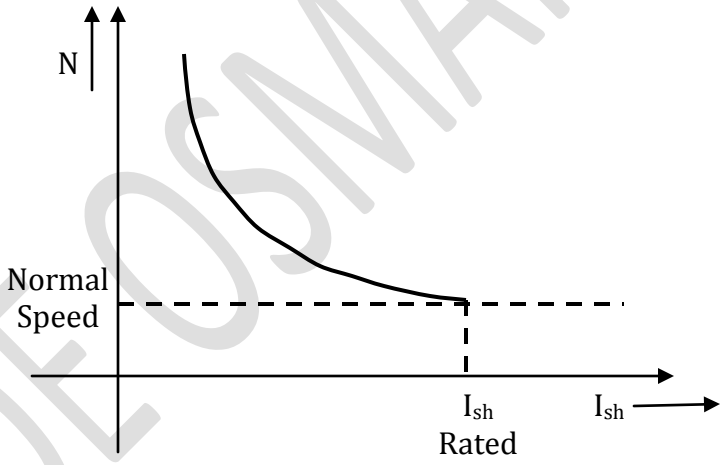
B) For slip ring I. M.

1) Vary rotor resistance step by step and observe the change in speed

OBSERVATION TABLE:

Sr. No.	Field Current(Amp)	Speed(rpm)
1.		
2.		
3.		
4.		
5.		
6.		

GRAPH:



CONCLUSION:

1) Plotted speed – field current curve.
2) Flux control method is used to raise the speed above the rated speed.
3) By varying rotor resistance variation in speed in slip ring I. M. can be achieved.

VIVA QUESTIONS:

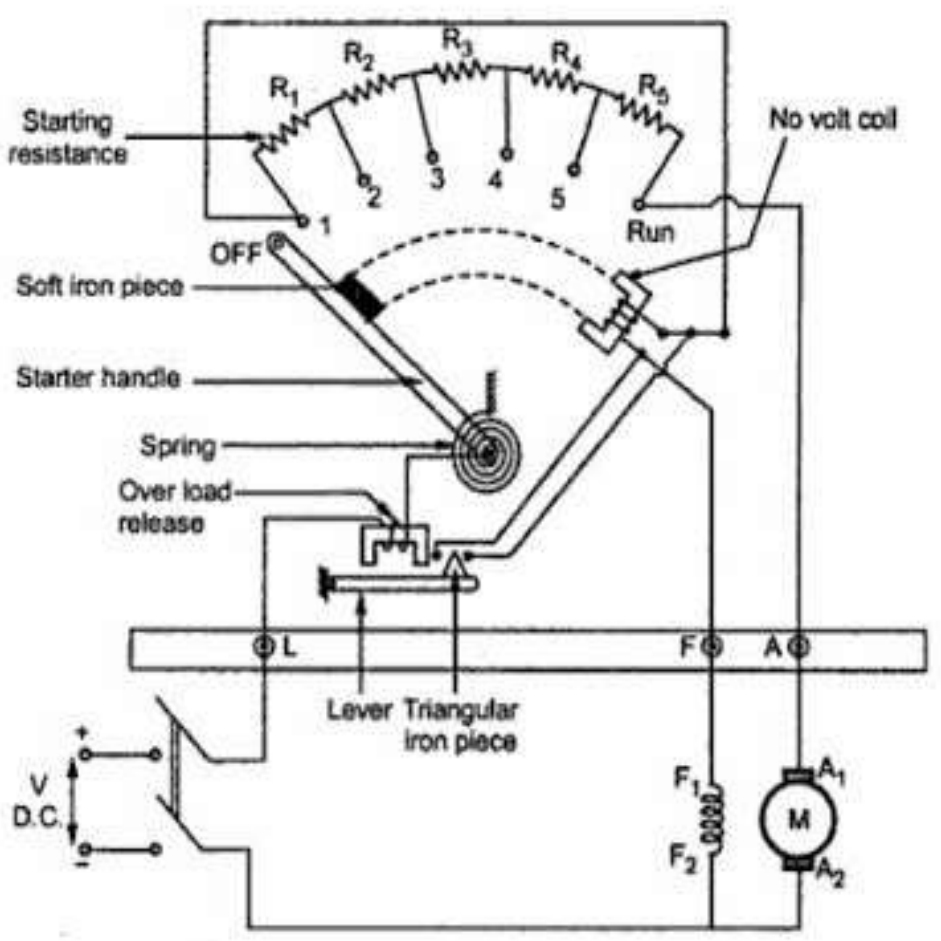
1) What are the different types of DC Motors?
2) What is the use of commutator?
3) Define Speed control.
4) What are different conventional speed control methods of DC Motors?
5) Which method is used to raise the speed above the rated value?
6) Which method is used to decrease the speed below the rated value?

EXPERIMENT NO. 2

STUDY OF STARTERS USED FOR DC MACHINES.

AIM: - To study starters used for dc machines.

CIRCUIT DIAGRAM:



Three Point Starter

THEORY: -

Necessity of Starter: The current drawn by the motor armature is given by the equation

$$Ia = \frac{(V - Eb)}{Ra}$$

When a DC Motor is at rest there is no back emf developed in the armature. If now full supply voltage is applied across stationary armature, it will draw very large current because armature resistance is relatively small. This excessive current will damage commutator and brushes. To avoid this, a resistance is introduced in series with armature which limits starting current to safe value.

A mechanism which adds resistance during starting only is known as starter.

There are two types of starters which are commonly used for DC shunt motor

1) 3-point starter -
2) 4 point starter

3- POINT STARTER

Three point starter is shown in the figure. The three point starter has three external points

1) L : To be connected to line (Mains)
2) F : To be connected to field and
3) A : To be connected to the armature.

Working: When arm touches the stud no. 1 full starting resistance gets connected in the armature circuit. The starting current taken by the armature is limited as

$$I_a = \frac{V}{R_a + R_s}$$

As the arm is further moved, the starting resistance is gradually cut off till the arm reaches to the last stud. Mean while the motor speed gradually increases which gradually increases . When arm reaches to last stud, full Eb is developed which keep current to safe value and now no starting resistance is required.

The arm is attached with soft iron piece S. When the arm is moved to the last stud, this iron piece is attracted and held by an electromagnet called HOLD-ON coil.

The arm is supported with spring. When the motor is disconnected from the supply, this spring brings the arm back to the first stud. Three point starter is incorporated with two protective parts namely

1) HOLD ON Coil(Low Voltage or No Voltage release)
2) Over load relay.

HOLD ON Coil

It is an electromagnet. It has two functions

i) It holds the arm in normal working of motor.
ii) It releases the arm during abnormal conditions and thereby protects the motor.

Over Load Relay

As the load on the motor increases, it takes more and more current. Under over load condition, the current taken by the motor is very large. To protect the motor from this large current Over Load Relay is used.

It is an electromagnet. It is designed in such a way that, it produces sufficient magnetic force under over load condition only. Due to this force it attracts bar below it. When this bar is lifted, the triangular portion on its one side short

circuit the HOLD-ON Coil. The HOLD-ON Coil gets deenergized and releases arm and hence motor is protected.

Drawback of Three Point Starter:

As this starter has only three points for external connection, the field winding and hold on coil are connected in series. When a flux control method is used to control this motor, due to addition of resistance in field circuit, the current through it reduces. This reduced current may not be sufficient to produce magnetic force by hold on coil to hold the arm. This may release the arm back to the off position.

The disadvantage of three point starter is corrected in four point starter by providing fourth point. This point is useful for separating the connections of HOLD-ON Coil and field winding.

CONCLUSION:

Hence studied the working of starters used for DC Shunt motor.

VIVA QUESTIONS:

1) What is the necessity of starter in a d.c. motor?
2) List the starters used for DC series Motor and DC Shunt Motor.
3) What is the function of Hold On coil?
4) What is the function of Over Load relay?
5) What is the limitation of Three point starter?

EXPERIMENT NO.3

Measurement of speed of DC series Motor as a function of the load

(Load test on DC Series Motor)

AIM: To study load characteristics & to plot torque speed characteristics of DC series Motor.

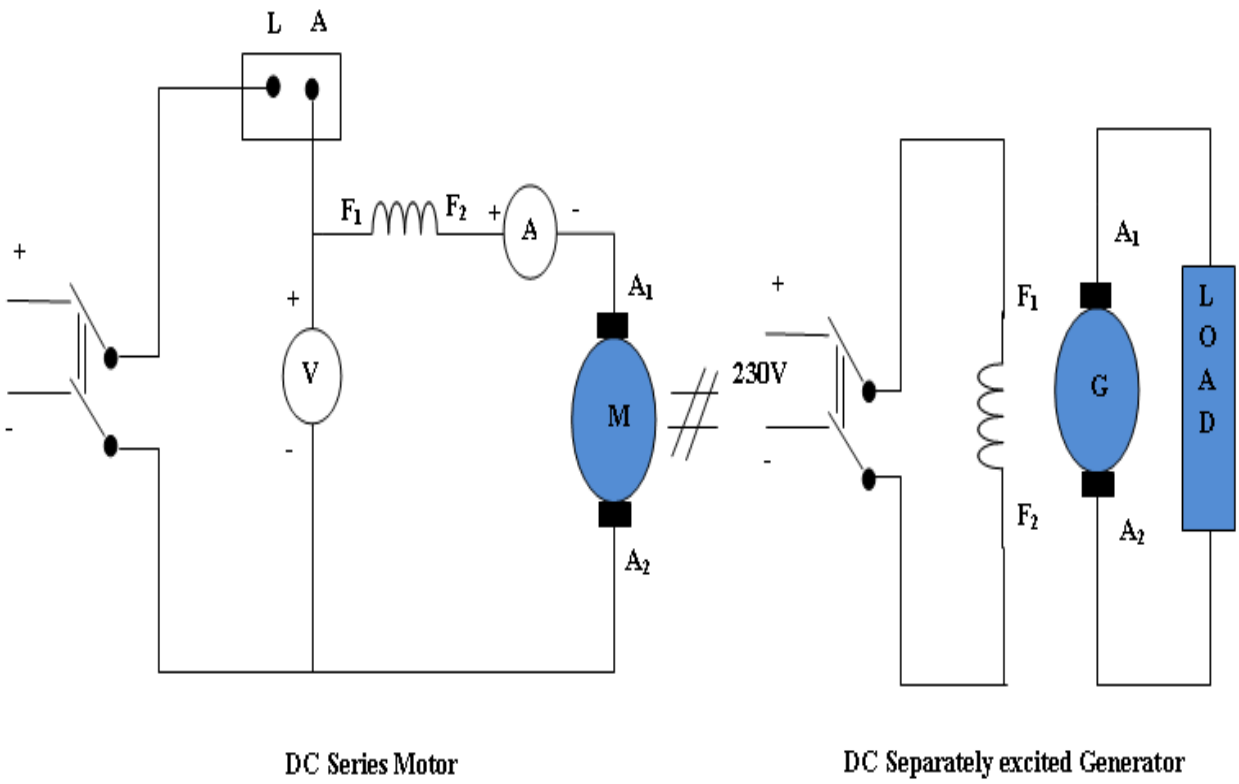
OBJECTIVES: To

1. Verify the effect of change in load on Torque & Speed
2. Draw the Torque Vs Armature current (I_a) characteristic curve.
3. Draw the Torque Vs Speed characteristic curve.
4. Draw the concluding Torque Vs Speed characteristic curve.

EQUIPEMENTS:

1) DC series Motor coupled with DC Generator.
2) Ammeter.
3) Voltmeter.
4) Lamp Load.
5) Tachometer.

CIRCUIT DIAGRAM:



DC Series Motor

DC Separately excited Generator

THEORY:

The characteristics of DC Motor are nothing but the performance of that motor. The application of motor for a specific work is decided by it's characteristics. For a DC Motor there are three types of characteristics.

1) Torque-Armature current characteristics(T_a/I_a)

   This characteristic is also known as **electrical characteristic**. We know that torque is directly proportional to the product of armature current and field flux, $T_a \propto \phi.I_a$. In DC series motors, field winding is connected in series with the armature, i.e. $I_a = I_f$. Therefore, before magnetic saturation of the field, flux ϕ is directly proportional to Ia. Hence, before

magnetic saturation Ta α Ia^2. Therefore, the Ta-Ia curve is parabola for smaller values of Ia.

After magnetic saturation of the field poles, flux ϕ is independent of armature current Ia. Therefore, the torque varies proportionally to Ia only, T ∝ Ia.Therefore, after magnetic saturation, Ta-Ia curve becomes a straight line.

In DC series motors, (prior to magnetic saturation) torque increases as the square of armature current, these motors are used where high starting torque is required.

2) Speed-Armature current characteristics(N/I_a)

We know the relation, $N \propto E_b/\phi$

For small load current (and hence for small armature current) change in back emf Eb is small and it may be neglected. Hence, for small currents speed is inversely proportional to ϕ. As we know, flux is directly proportional to Ia, speed is inversely proportional to Ia. Therefore, when armature current is very small the speed becomes dangerously high. That is **why a series motor should never be started without some mechanical load**.

But, at heavy loads, armature current Ia is large. And hence, speed is low which results in decreased back emf Eb. Due to decreased Eb, more armature current is allowed.

3) Speed-Armature Torque characteristics(N/T_a)

This characteristic is also called as **mechanical characteristic**. From the above two **characteristics of DC series motor**, it can be found that when speed is high, torque is low and vice versa.

PROCEDURE:

1) Make the connection as per the circuit diagram.
2) Switch on the loading resistance on the generator terminals because series motor should not be run on no load.
3) Start the DC series motor with the help of starter. Generator will act as a load on the motor.
4) Apply rated voltage to the motor.
5) Increase the load on the DC generator step by step.
6) Record speed & current drawn by Motor.
7) Plot graphs: N Vs I_a, T_a Vs I_a, N Vs T_a

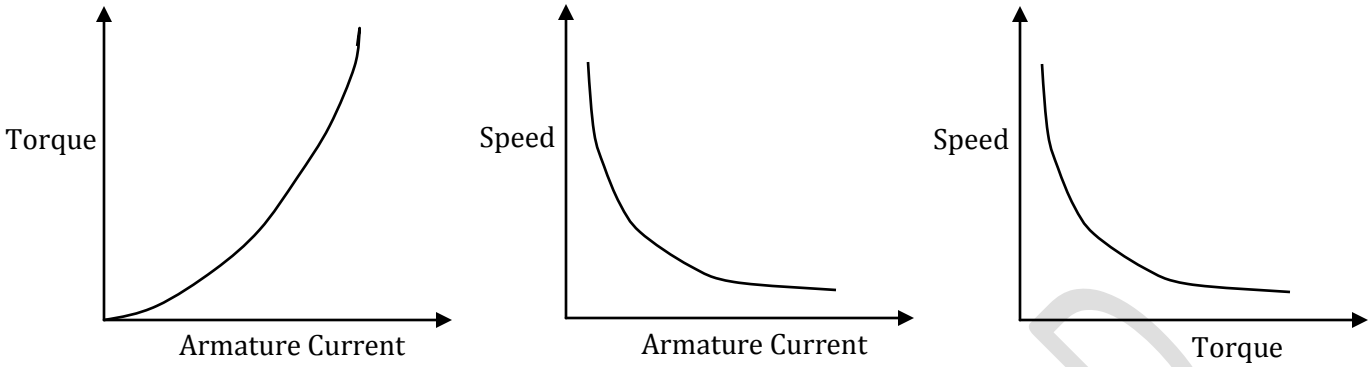
OBSERVATIONS:

1) Motor applied voltage =------- V.
2) Armature resistance=----------Ω

OBSERVATION TABLE:

Sr.No.	N(rpm)	I_a(Amp)	$E_b = V - I_a R_a$	$T_a = \frac{9.55 E_b I_a}{N}$
1.				
2.				
3.				
4.				
5.				

Graph:



CONCLUSION:

It is observed that, with increase in load,

1) Speed of DC Series motor decreases.
2) Torque of DC series motor increases, the characteristics gives parabola before saturation & straight line after saturation.

VIVA QUESTIONS:

1) What are the different characteristics of DC Motor?
2) Why is a d.c. series motor used to start heavy loads?
3) Why the D.C. series motor is not operated at zero or light loads?
4) What is the chief advantage of a d.c. series motor?
5) What are the applications of DC Series motor.

EXPERIMENT NO.4

Measurement of speed of DC shunt Motor as a function of the load

(Load test on DC shunt Motor.)

AIM: To study load characteristics & to plot torque speed characteristics of DC shunt Motor.

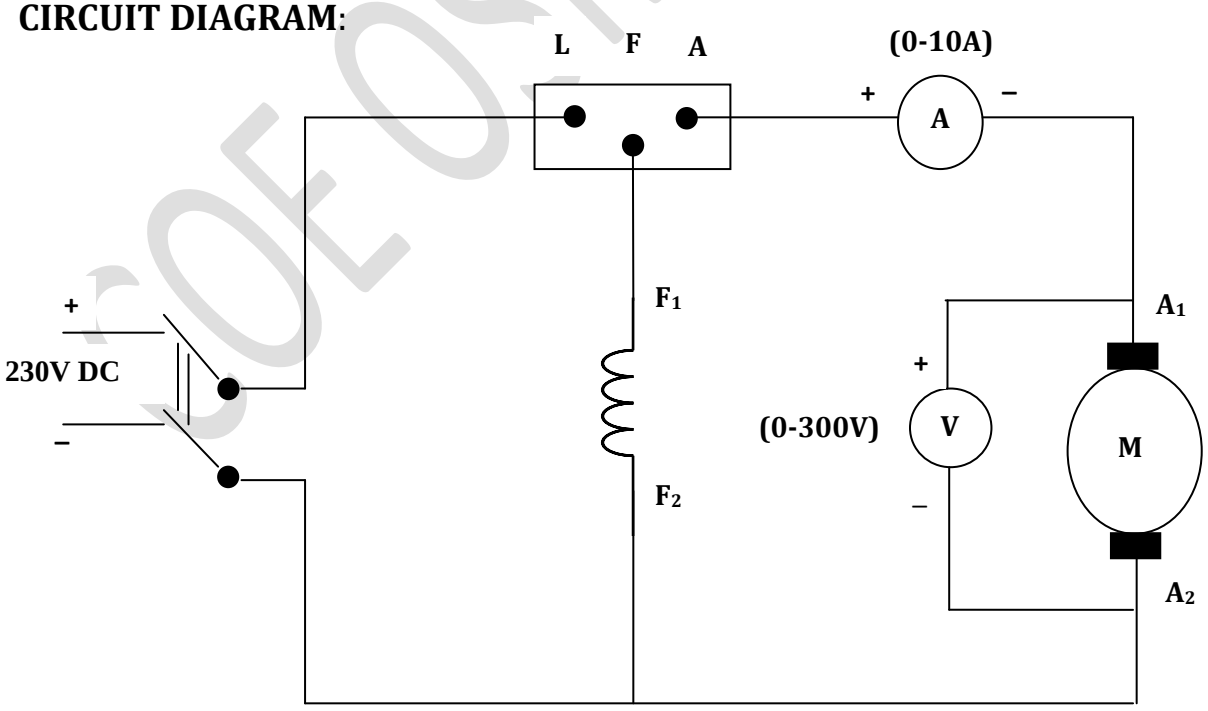
OBJECTIVES: To

1. Verify the effect of change in load on Torque & Speed
2. Draw the Torque Vs Armature current (I_a) characteristic curve.
3. Draw the Torque Vs Speed characteristic curve.
4. Draw the concluding Torque Vs Speed characteristic curve.

EQUIPEMENTS:

1) DC shunt Motor with loading arrangement.
2) Ammeter.
3) Voltmeter.
4) Tachometer.

CIRCUIT DIAGRAM:



THEORY:

1) Torque vs. armature current (Ta/Ia)

In case of DC shunt motors, we can assume the field flux ϕ to be constant. As we are neglecting the change in the flux ϕ, we can say that torque is proportional to armature current. Hence, the Ta-Ia characteristic for a dc shunt motor will be a straight line through the origin.
Since heavy starting load needs heavy starting current, **shunt motor should never be started on a heavy load**.

2) Speed vs. armature current (N/Ia)

As flux ϕ is assumed to be constant, we can say $N \propto Eb$. But, as back emf is also almost constant, the speed should remain constant. But practically, ϕ as well as Eb decreases with increase in load. Back emf Eb decreases slightly more than ϕ, therefore, the speed decreases slightly. Generally, the speed decreases only by 5 to 15% of full load speed. Therefore, **a shunt motor can be assumed as a constant speed motor**. In speed vs. armature current characteristic in the following figure, the straight horizontal line represents the ideal characteristic and the actual characteristic is shown by the dotted line.

PROCEDURE:

1) Make the connection as per the circuit diagram.
2) Start the DC shunt motor with the help of starter
3) Apply rated voltage to the motor.
4) Increase the load on the DC Motor step by step.
5) Record speed & current drawn by Motor.
6) Plot graphs: N Vs I_a, T_a Vs I_a, N Vs T_a

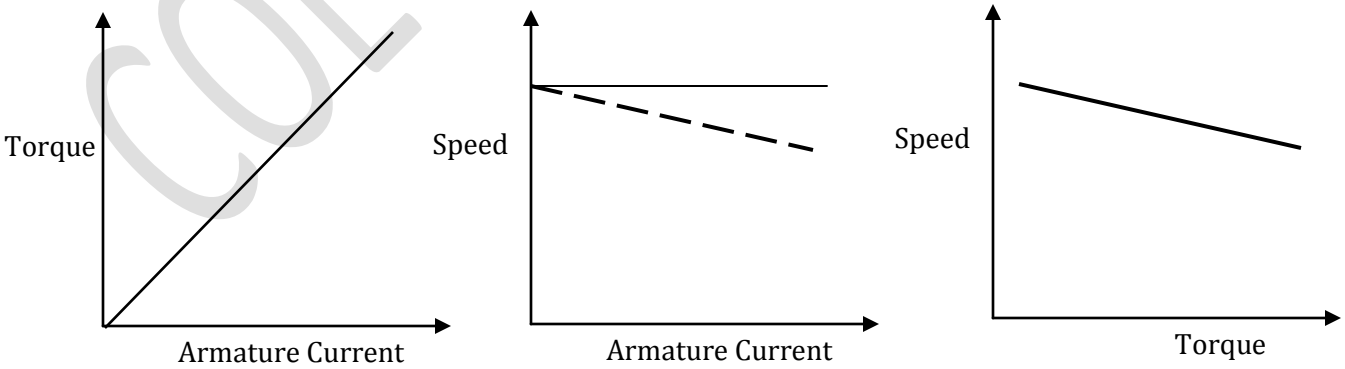
OBSERVATIONS:

1) Motor applied voltage =------- V.
2) Armature resistance=----------Ω

OBSERVATION TABLE:

Sr.No.	N(rpm)	I_a(Amp)	$E_b = V - I_a R_a$	$T_a = \frac{9.55 E_b I_a}{N}$
1.				
2.				
3.				
4.				
5.				

GRAPH:



CONCLUSION:

It is observed that, with increase in load,

1) Speed of DC Shunt motor decreases slightly.
2) Torque of DC shunt motor increases linearly, the characteristics gives straight line curve.

VIVA QUESTIONS:

1) Why DC Shunt motor should never be started on load?
2) What are the applications of dc shunt motor?
3) For what type of load DC shunt motor is suitable? Why?
4) How do you load the motor in this experiment?

EXPERIMENT NO.5

Load test on Induction motor.

AIM: To study load characteristics & to plot torque-slip characteristics of 3-ph Induction Motor.

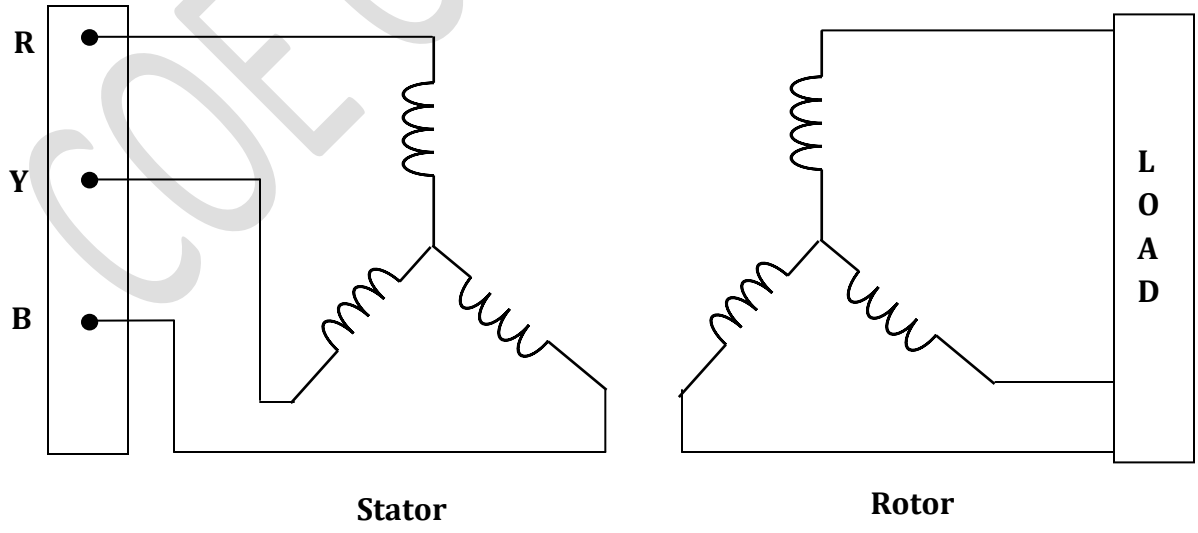
OBJECTIVES: To

1. Verify the effect of change in load on Torque & Speed
2. Draw the Torque Vs slip characteristic curve.

EQUIPEMENTS:

1) 3-ph Induction motor with loading arrangement
2) Voltmeter.
3) Tachometer.

CIRCUIT DIAGRAM:



THEORY:

Torque-slip Characteristics of 3-ph I. M.

On no load the motor runs with a speed very close to synchronous speed. As we go on increasing the load on the motor, its speed decreases and hence slips increases.

The torque is given by the equation

$$T = \frac{KSE_2^2 R_2}{R_2^2 + (SX_2)^2}$$

For a constant supply voltage E_2 is constant

$$T \propto \frac{SR_2}{R_2^2 + (SX_2)^2}$$

For a normal speed close to synchronous speed the slip is less , the term SX_2 is small hence it is negligible w. r. t. R_2.

$$T \propto \frac{SR_2}{R_2^2} \propto \frac{S}{R_2}$$

Thus for low value of slip as $T \propto S$, the torque slip characteristics is a straight line. This means that as we increase load the torque also increases to compensate the new load and motor behavior is normal.

With the further increase in load slip increases i. e. speed decreases the term SX_2 increases and at a particular load $SX_2 = R_2$. This is the condition for maximum torque.

If the load is further increased speed decreases, the slip increases and now the term SX_2 becomes greater than R_2, so that now R_2 may be negligible w. r. t. SX_2. The torque equation then becomes

$$T \propto \frac{S}{(SX_2)^2} \propto \frac{1}{S}$$

This shows that for this region of increase in load instead of increase torque decreases and the behavior of motor is abnormal. The curve is then rectangular hyperbola.

The figure shows the family of curve drawn for different resistance. The shaded part shows normal working region of induction motor.

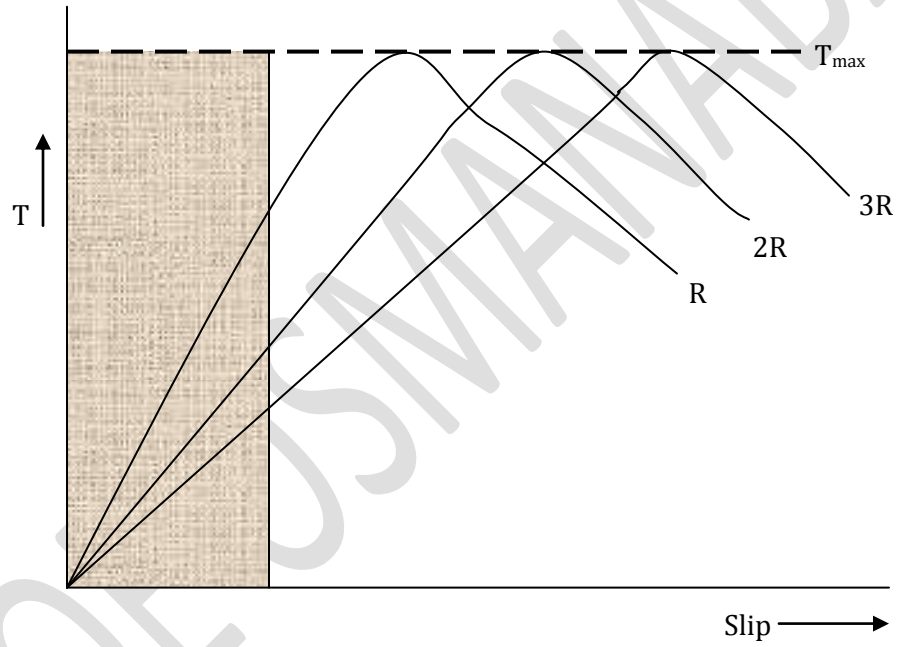


Fig: Torque Slip characteristics

PROCEDURE:

1) Make the connections as per the circuit diagram.
2) Start the Induction motor with the help of starter. Apply rated voltage to the motor.
3) Adjust the load to its minimum value.

4) Load the motor in steps through the mechanical loading arrangement
5) Record for each step net force and tachometer readings.
6) Plot graphs: T V_s S

OBSERVATIONS:

1) Motor applied voltage =------- V.
2) Frequency of supply (f) =50 Hz.
3) Radius of rotor=14mm.
4) N_s=120f/p=1500rpm.

OBSERVATION TABLE:

Sr. No.	F_1 Kg	F_2 kg	F kg	F Newton	T_{sh}=F*r	N	$S = \frac{N_s - N}{N_s}$	$O/P = \frac{T_{sh} * N}{9.55}$
1.								
2.								
3.								
4.								
5.								

GRAPH:

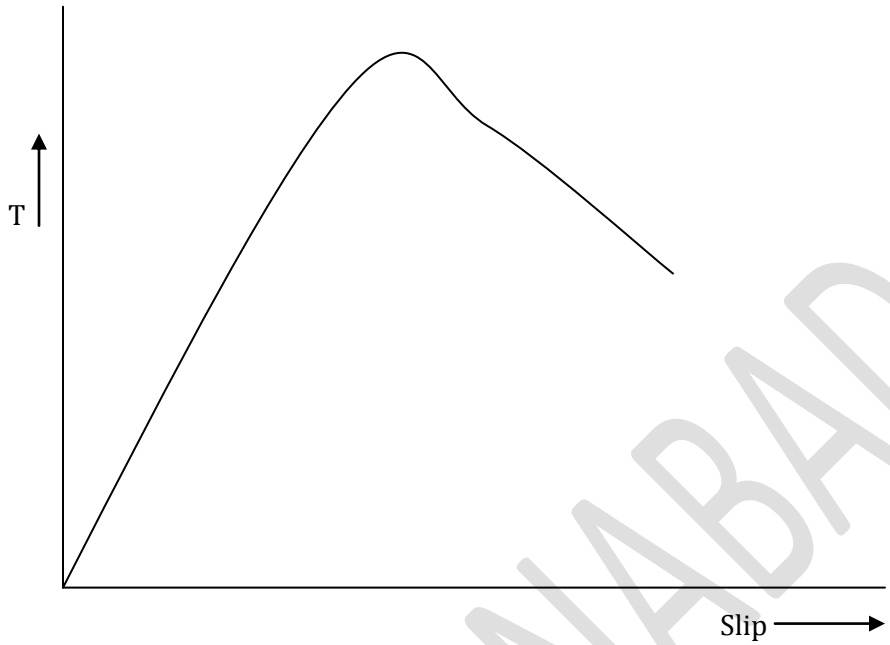


Fig: Torque Slip characteristics

CONCLUSIONS:

It is observed that with increase in load

1) Speed decreases.

2) Torque increases.

3) Torque slip characteristics give rectangular hyperbola.

VIVA QUESTIONS:

1) Define Slip.
2) At the time of starting, what is the Slip?
3) Draw slip torque characteristics.
4) A 3-ph, 4 pole, 50 Hz Induction Motor is running at 1445 rpm. Find Slip speed and Slip.

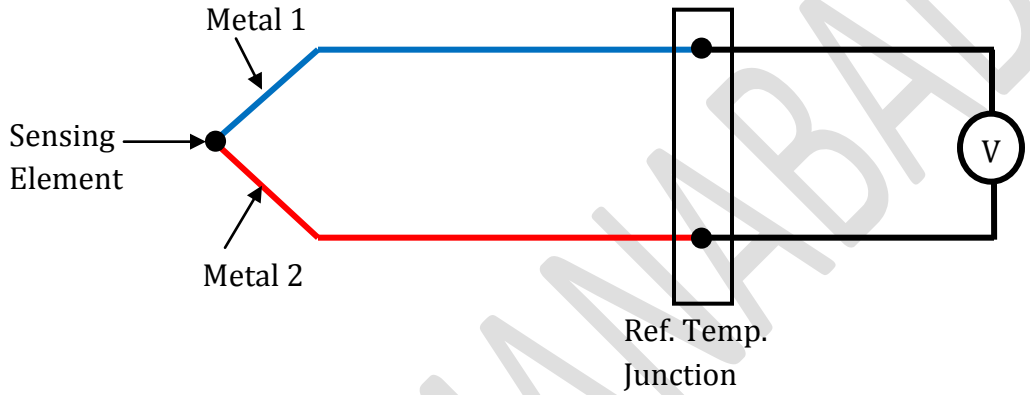
EXPERIMENT NO.6

THERMOCOUPLE

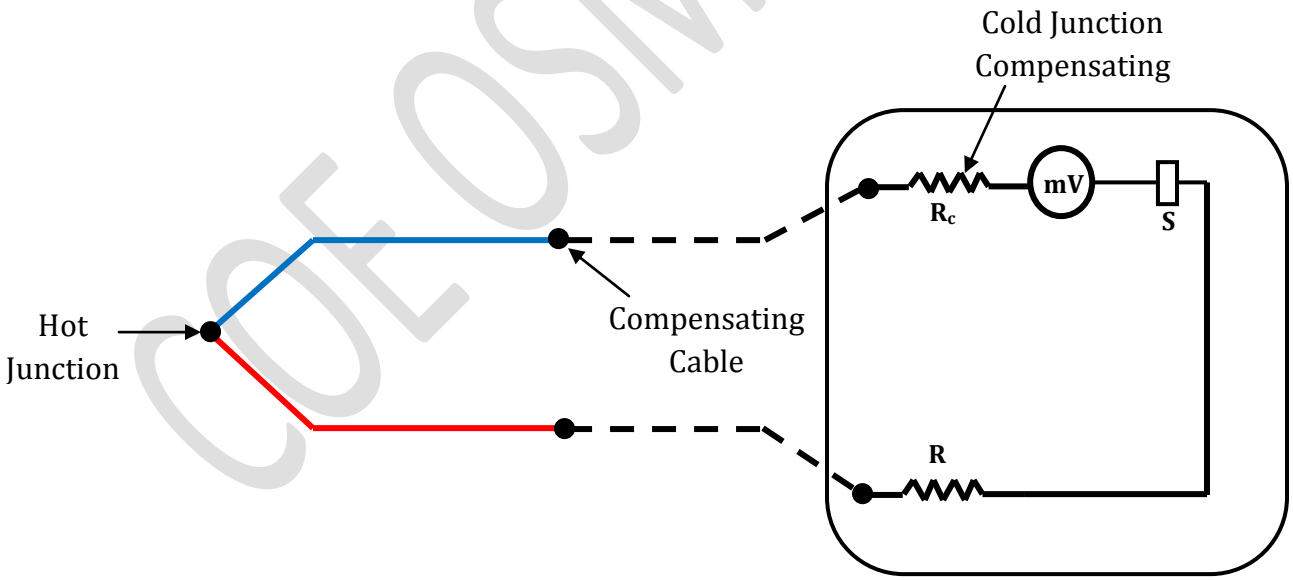
AIM: To study Thermocouple.

DIAGRAM:

1) Thermocouple



2) Cold Junction Compensation



R: Calibrating Resistance

S: Compensating Spring

R_c : Resistance with negative temperature coefficient.

THEORY: In 1821, Thomas J. Seebeck discovered that if metals of two different metal wires are twisted together and heated, a sensitive meter connected to the other end of the pair will indicate a voltage (electromotive force) which is very nearly directly proportional to difference in temperature between the heated or hot junction and other end, which is called the cold junction. This phenomenon is known as the Seebeck effect. This principle is used for measuring temperature and the element formed thus is called as 'Thermocouple'. The Thermocouple word is a combination of 'Thermo' for the heat requirement and couple denoting two junctions.

An ordinary Thermocouple consists of two different kinds of wires, each of which must be made up of a homogeneous metal or alloy. The wires are joined together at one end to form a measuring junction.. The free ends are connected to the measuring instrument to form a closed path in which current can flow. After the Thermocouple wires are connected to the measuring instrument, the junction side is designated as reference junction or cold junction. Thermocouple reads the difference between the temperatures of its measuring and reference junction.

Based on possible combination of metals there could be countless number of thermocouples; but as a matter of fact there are relatively few.

COLD JUNCTION COMPENSATION:

While using thermocouples it is always necessary to use cold junction compensation. As far as theoretical arrangements are concerned one junction must be at 0^0C reference.

The entire standard chart provides output voltage considering one reference junction at 0^0C temperature. The voltage due to simple temperature difference

between observed voltage and temperature at measuring point compensation can be achieved using resistor R_c.

COMPENSATING CABLE:

The two wires used in thermocouple are costly and can't be extended up till the indicator or transmitter kept far off. Hence cheap wire having same thermal properties as that of the original metals of thermocouple are used as compensating cable. Thus, compensating cable for each thermocouple is different.

Thermocouple can be connected in parallel to provide the average temperature in the system and they can be connected in the series with polarities reversed to measure difference between two temperatures.

CONCLUSION: Hence studied the construction and working of thermocouple.

VIVA QUESTIONS:

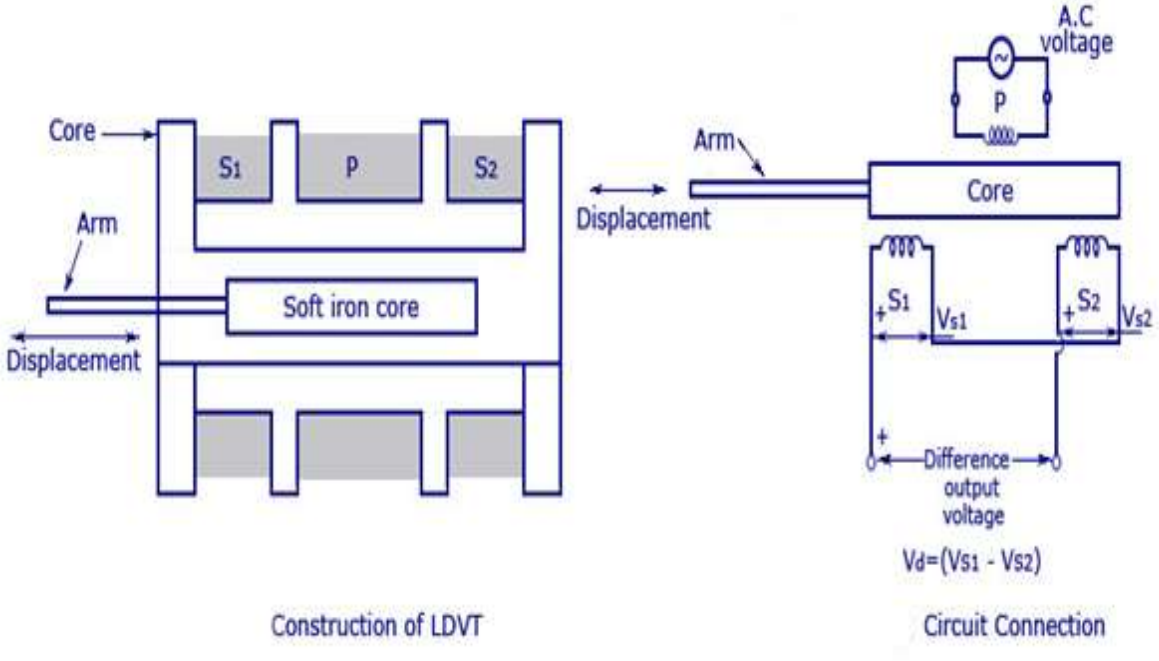
1) What is transducer?
2) Give the classification of transducers.
3) What are the points to be considered while selecting transducers?
4) Explain Seebeck effect.
5) What is thermocouple?
6) What are the applications of thermocouple?

EXPERIMENT NO.7

LINEAR VARIABLE DIFFERENTIAL TRANSFORMER

AIM: To study linear variable differential transformer

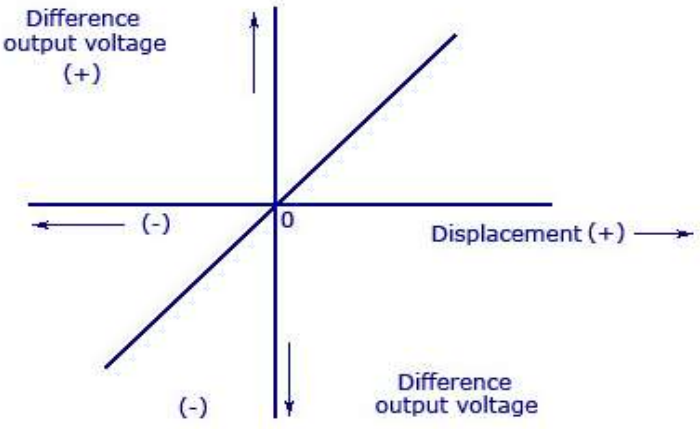
CIRCUIT DIAGRAM:



Construction of LDVT

Circuit Connection

Construction and Circuit Connection of LVDT



Difference output Voltage Versus Displacement Curve For LVDT

THEORY:

Like other inductive transducers**,** this transducer is also used for converting a linear motion into an electrical signal. The differential transformer transducer measures force in terms of the displacement of the ferromagnetic core of a transformer.

Construction:

The device consists of a primary winding (P) and two secondary windings named S1 and S2. Both of them are wound on one cylindrical former, side by side, and they have equal number of turns. Their arrangement is such that they maintain symmetry with either side of the primary winding (P). A movable soft iron core is placed parallel to the axis of the cylindrical former. An arm is connected to the other end of the soft iron core and it moves according to the displacement produced.

Working:

As shown in the figure, an ac voltage with a frequency between (50-400) Hz is supplied to the primary winding. Thus, two voltages VS1 and VS2 are obtained at the two secondary windings S1 and S2 respectively. The output voltage will be the difference between the two voltages (VS1-VS2) as they are combined in series. Let us consider three different positions of the soft iron core inside the former.

- **Null Position** – This is also called the central position as the soft iron core will remain in the exact center of the former. Thus the linking magnetic flux produced in the two secondary windings will be equal. The voltage induced because of them will also be equal. Thus the resulting voltage VS1-VS2 = 0.

- **Right of Null Position** – In this position, the linking flux at the winding S2 has a value more than the linking flux at the winding S1. Thus, the resulting voltage VS1-VS2 will be in phase with VS2.
- **Left of Null Position** – In this position, the linking flux at the winding S2 has a value less than the linking flux at the winding S1. Thus, the resulting voltage VS1-VS2 will be in phase with VS1.

From the working it is clear that the difference in voltage, VS1-VS2 will depend on the right or left shift of the core from the null position. Also, the resulting voltage is in phase with the primary winding voltage for the change of the arm in one direction, and is 180 degrees out of phase for the change of the arm position in the other direction.

The magnitude and displacement can be easily calculated or plotted by calculating the magnitude and phase of the resulting voltage.

The graph shows the plot between the resulting voltage or voltage difference and displacement. The graph clearly shows that a linear function is obtained between the output voltage and core movement from the null position within a limited range of 4 millimeter.

The displacement can be calculated from the magnitude of the output voltage.

Advantages:

1. Maintains a linear relationship between the voltage difference output and displacement from each position of the core for a displacement of about 4 millimeter.

2. Produces a high resolution of more than 10 millimeter.

3. Produces a high sensitivity of more than 40 volts/millimeter.

4. Small in size and weighs less. It is rugged in design and can also be assigned easily.

5. Produces low hysteresis and thus has easy repeatability.

Disadvantages:

1. The whole circuit is to be shielded as the accuracy can be affetced by external magnetic field.

2. The displacement may produce vibrations which may affect the performance of the device.

3. Produces output with less power.

4. The efficiency of the device is easily affected by temperature. An increase in temperature causes a phase shift. This can be decreased to a certain extent by placing a capacitor across either one of the secondary windings.

5. A demodulator will be needed to obtain a d.c output.

CONCLUSION: Hence studied construction and working of LVDT.

VIVA QUESTIONS:

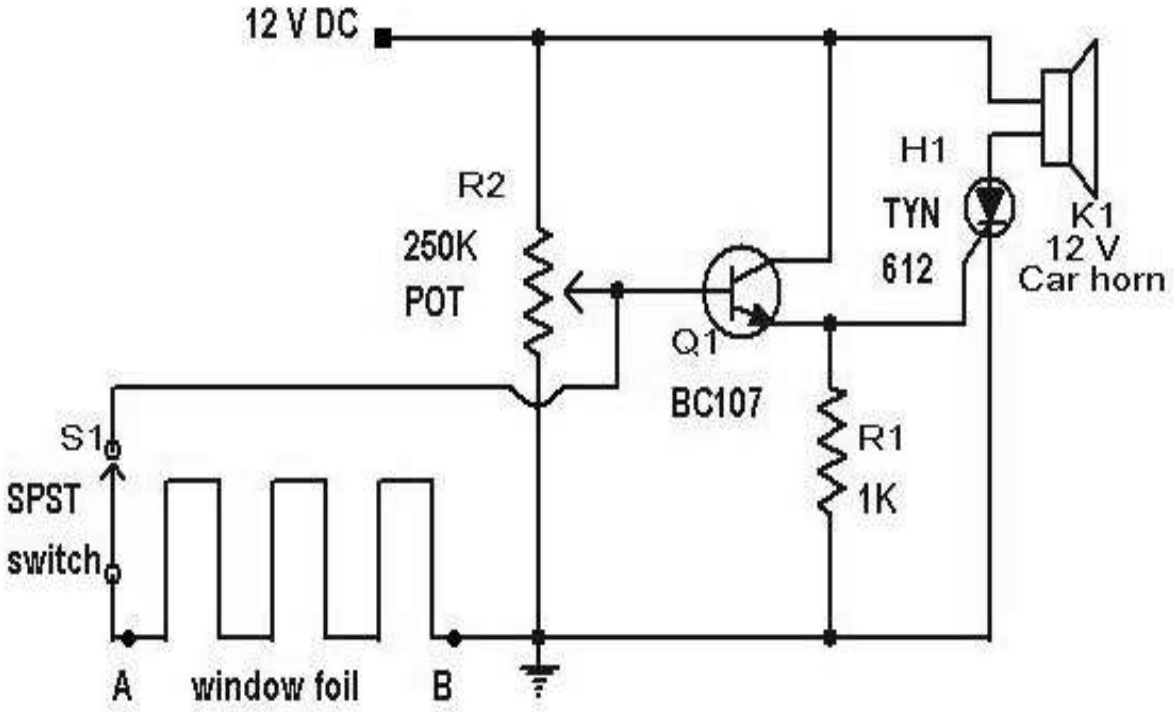
1) What is LVDT?
2) Why it is called as LVDT?
3) Mention the major applications of LVDT?
4) What are the advantages of LVDT?

EXPERIMENT NO.8

BURGLAR ALARM

AIM: To study burglar alarm.

CIRCUIT DIAGRAM:



THEORY: A burglar alarm is a system to detect intrusion-unauthorized entry-into a building or area. They are also called security alarms, security systems, alarm systems, intrusion detection systems, perimeter detection systems and similar terms.

Burglar alarms are used in residential, commercial, industrial and military properties for protection against burglary (theft) or property damage as well as personal protection against intruders. Car alarm likewise protects vehicles and their contents.

Some alarm systems serve a single purpose of burglary protection, combination system provide both fire and intrusion protection. Intrusion alarm system may also be combined with closed circuit television surveillance systems to automatically record the activities of intruders and may interface to access control systems for electrically locked doors. Systems range from small, self contained noisemakers to complicated multi-area systems with computer monitoring and control.

Design: The most basic alarm consist of one or more sensors to detect intruders and an alerting device to indicate the intrusion. However a typical premises security alarm employs the following components

- **Premises control unit (PCU) or panel:** The brain of the system, it reads sensor inputs; tracks arm/disarm status and signal intrusions. In modern systems this is typically one or more computer circuit boards inside a metal enclosure along with a power supply.
- **Sensors:** Devices which detects intrusions. Sensors may place at the perimeter of the protected area, within it or both. Sensors can detect intruders by variety of methods such as monitoring doors or windows for opening or by monitoring unoccupied interiors for motions, sound, vibrations or other disturbances.
- **Alerting devices:** These indicate an alarm condition. Most commonly these are bells, sirens, and/or flashing lights.

Alerting devices serves the purpose of warning occupants of intrusion and potentially scaring off burglars.

- **Keypads:** Small devices typically wall mounted which functions as the human machine interface to system. In addition to buttons, keypads typically feature indicator lights, a small mulch character display, or both.
- **Interconnections between components:** This may consist of direct wiring to the control unit or wireless links with local power supplies.
- **Security devices:** Devices to detect thieves such as spotlights, cameras or lasers.

Detection of window break through circuit

The circuit uses a fine wire element fixed as network through the window glass for sensing the break through.

Normally the base of Q_1 is held to ground potential by the wire element. As the V_b is less than V_e, Q_1 is 'OFF', The SCR is not conducting and hence the alarm is OFF.

When the wire element is broken (due to intrusion), the base of Q_1 will be raised to positive potential, Q_1 will be 'ON', The SCR is then conducts making the alarm to sound.

This condition is latched by the SCR. The circuit remains 'ON' till the normal condition is restored or the power supply is switched OFF.

CONCLUSION: Studied burglar alarm.

EXPERIMENT NO.9

TYPES OF DISPLAYS

AIM: To study different types of displays

Students are advised to do market survey on the following topics and prepare a report on the basis of survey they have done.

A report should cover following points

- History of displays
- Types of displays
- Recent trends of displays.
- Market survey on "Television" with parameters like manufacturing companies, type of screen, screen revolution, Features.

3. Quiz on the subject

1. The direction of rotation of a D.C. series motor can be changed by
(a) interchanging supply terminals
(b) interchanging field terminals
(c) either of (a) and (b) above
(d) None of the above

2. Which D.C. motor is preferred for elevators?
(a) Shunt motor
(b) Series motor
(c) Differential compound motor
(d) Cumulative compound motor

3. The speed of a D.C. shunt motor more than its full-load speed can be obtained by
(a) decreasing the field current
(b) increasing the field current
(c) decreasing the armature current
(d) increasing the armature current

4. By looking at which part of the motor, it can be easily confirmed that a particular motor is D.C. motor?
(a) Frame
(b) Shaft
(c) Commutator
(d) Stator

5. In which of the following applications D.C. series motor is invariably tried?
(a) Starter for a car
(b) Drive for a water pump
(c) Fan motor
(d) Motor operation in A.C. or D.C.

6. A three point starter is considered suitable for
(a) shunt motors
(b) shunt as well as compound motors
(c) shunt, compound and series motors
(d) all D.C. motors

7. In case-the conditions for maximum power for a D.C. motor are established, the efficiency of the motor will be
(a) 100%
(b) around 90%
(c) anywhere between 75% and 90%
(d) less than 50%

8. The power mentioned on the name plate of an electric motor indicates
(a) the power drawn in kW
(b) the power drawn in kVA
(c) the gross power
(d) the output power available at the shaft

9. D.C. series motors are used
(a) where load is constant
(b) where load changes frequently
(c) where constant operating speed is needed
(d) in none of the above situations.

10. For which of the following applications a D.C. motor is preferred over an A.C. motor ?
(a) Low speed operation
(b) High speed operation
(c) Variable speed operation
(d) Fixed speed operation

11.Which one of the following is not necessarily the advantage of D.C. motors over A.C. motors ?
(a) Low cost
(b) Wide speed range
(c) Stability
(d) High starting torque.

12. Which of the following motors is usually used in house-hold refrigerators?
(a) D.C. shunt motor
(b) D.C. series motor
(c) Single phase induction motor (split phase start or induction run motor)
(d) Reluctance motor
(e) Synchronous motor

13. D.C. generators are normally designed for maximum efficiency around
(a) full-load
(b) rated r.p.m.
(c) rated voltage
(d) all of the above

14. In a D.C. generator, the iron losses mainly take place in
(a) yoke
(b) commutator
(c) armature conductors
(d) armature rotor

15. D.C. generators are installed near the load centres to reduce
(a) iron losses
(b) line losses
(c) sparking
(d) corona losses

16. During rheostat braking of D.C. series motors
(a) motor is run as a generator
(b) motor is reversed in direction
(c) motor is run at reduced speed

17. For which types of D.C. motor, dynamic braking is generally used ?
(a) Shunt motors
(b) Series motors
(c) Compound motors
(d) All of the above

18. Which method of braking is generally used in elevators ?
(a) Plugging
(b) Regenerative braking
(c) Rheostatic braking
(d) None of the above

19. One D.C. motor drives another D.C. motor. The second D.C. motor when excited and driven
(a) runs as a generator
(b) does not run as a generator

(c) also runs as a motor comes to stop after sometime

20. Which of the following component is usually fabricated out of silicon steel?
(a) Bearings
(b) Shaft
(c) Stator core
(d) None of the above

21. In squirrel cage induction motors, the rotor slots are usually given slight skew in order to
(a) reduce windage losses
(b) reduce eddy currents
(c) reduce accumulation of dirt and dust
(d) reduce magnetic hum

22. The number of slip rings on a squirrel cage induction motor is usually
(a) two
(b) three
(c) four
(d) none

23. In case of the induction motors the torque is
(a) inversely proportional to (Vslip)
(b) directly proportional to (slip)2
(c) inversely proportional to slip
(d) directly proportional to slip

24. The injected e.m.f. in the rotor of induction motor must have
(a) zero frequency
(b) the same frequency as the slip frequency
(c) the same phase as the rotor e.m.f.
(d) high value for the satisfactory speed control

25. Which of the following methods is easily applicable to control the speed of the squirrel-cage induction motor?
(a) By changing the number of stator poles
(b) Rotor rheostat control
(c) By operating two motors in cascade

(d) By injecting e.m.f. in the rotor circuit

26. The speed of a squirrel-cage induction motor can be controlled by all of the following except
(a) changing supply frequency
(b) changing number of poles
(c) changing winding resistance
(d) reducing supply voltage

27. A 3-phase slip ring motor has
(a) double cage rotor
(b) wound rotor
(c) short-circuited rotor
(d) any of the above

28. The shape of the torque/slip curve of induction motor is
(a) parabola
(b) hyperbola
(c) rectangular parabola
(d) straigth line

29 . The stating torque of the slip ring induction motor can be increased by adding
(a) external inductance to the rotor
(b) external resistance to the rotor
(c) external capacitance to the rotor
(d) both resistance and inductance to rotor

30. The torque developed by a 3-phase induction motor least depends on
(a) rotor current
(b) rotor power factor
(c) rotor e.m.f.
(d) shaft diameter

31. When R2 is the rotor resistance, X2 the rotor reactance at supply frequency and s the slip, then the condition for maximum torque under running conditions will be
(a) sR2X2 = 1
(b) sR2 = X2

(c) R2 = sX2
(d) R2 = s2X2

32 . A squirrel cage induction motor is not selected when
(a) initial cost is the main consideration
(b) maintenance cost is to be kept low
(c) higher starting torque is the main consideration
(d) all above considerations are involved

33. Slip ring motor is preferred over squirrel cage induction motor where
(a) high starting torque is required
(b) load torque is heavy
(c) heavy pull out torque is required
(d) all of the above

34. induction motor is also known as
(a) rotating transformer
(b) stationary transformer

35. The speed at which rotating magnetic field revolves is called
(a)Induction speed
(b)Synchronous speed
(c)Relative speed
(d) Rotating speed

36. The magnitude of rotating flux _____ at all instants of time.
(a)Changes
(b)Remains constant
(c)Pulsates
(d) Any of the mentioned

37. The shunt motor starters that can be used is/are
(a) 3-point and 4-point starter
(b) 5-point starter
(c) 4-point starter
(d) 5-point and 3-point starter

38.when load increases speed….
(a) increases

(b) decreases
(c) remains constant
(d) none

39. back emf is also called as
(a) counter emf
(b) apposing emf
(c) reduced emf

40. flux control method is used to increase speed
(a) above rated value
(b) below rated value
(c) both a and b
(d) none

41.Synchronous motor can operate at
(a) lagging power factor only
(b) leading power factor only
(c) unity power factor only
(d) lagging, leading and unity power factor only.

42.In case the field of a synchronous motor is under excited, the power factor will be

(a) leading

(b) lagging

(c) zero

(d) unity.

43. The damping winding in a synchronous motor is generally used

(a) to provide starting torque only

(b) to reduce noise level

(c) to reduce eddy currents

(d) to prevent hunting and provide the starting torque.

44. An over excited synchronous motor draws current at

(a) lagging power factor

(b) leading power factor

(c) unity power factor

(d) depends on the nature of load.

45. In a synchronous motor if the back emf generated in the armature at no load is approximately equal to the applied voltage, then

(a) the torque generated is maximum

(b) the excitation is said to be zero percent

(c) the excitation is said to be 100%

(d) the motor is said to be fully loaded.

46. Which of the following motors is non-self starling ?

(a) squirrel cage induction motor

(b) wound rotor induction motor

(c) synchronous motor

(d) dc series motor.

47. The constant speed of a synchronous motor can be changed to new fixed value by

(a) changing the applied voltage

(b) interchanging any two phases

(c) changing the load

(d) changing the frequency of supply.

48. In a synchronous motor, the torque angle is

(a) the angle between the rotating stator flux and rotor poles

(b) the angle between magnetizing current and back emf

(c) the angle between the supply voltage and the back emf

(d) none of the above.

49. The hunting in a synchronous motor takes place when

(a) friction in bearings is more

(b) air gap is less

(c) load is variable

(d) load is constant.

50. A synchronous motor is said to be 'floating' when it operates

(a) on no load and without losses

(b) on constantly varying load

(c) on pulsating load

(d) on high load and variable supply voltage.

4. Conduction of Viva-Voce Examinations:

Teacher should conduct oral exams of the students with full preparation. Normally, the objective questions with guess are to be avoided. To make it meaningful, the questions should be such that depth of the students in the subject is tested. Oral examinations are to be conducted in cordial environment amongst the teachers taking the examination. Teachers taking such examinations should not have ill thoughts about each other and courtesies should be offered to each other in case of difference of opinion, which should be critically suppressed in front of the students.

5. Evaluation and marking system:

Basic honesty in the evaluation and marking system is absolutely essential and in the process impartial nature of the evaluator is required in the examination system to become. It is a primary responsibility of the teacher to see that right students who are really putting up lot of hard work with right kind of intelligence are correctly awarded.

The marking patterns should be justifiable to the students without any ambiguity and teacher should see that students are faced with just circumstances.