I

Name _____

Roll No. _____ Year 20____20____

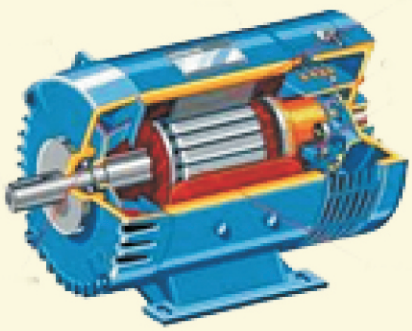
Exam Seat No. _____

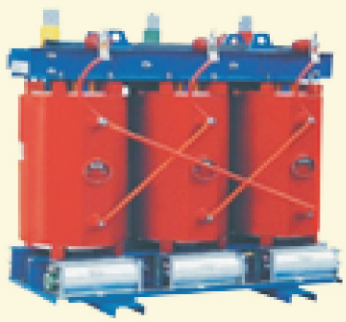
ELECTRICAL GROUP | SEMESTER - IV | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

ELECTRIC MOTORS AND TRANSFORMERS (22418)





MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual
For

Electrical Motors and Transformers

(22418)

Semester– (IV)

(EE, EP, EU)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on November 2018)

Maharashtra State
Board of Technical Education

Certificate

This is to certify that Mr. / Ms…….
Roll No…….of Fourth Semester of Diploma in
…….of Institute
…… (Code……..)
has completed the term work satisfactorily in course(Course Code…….) **Electrical Motors and Transformers (22418)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No……
Date:…..... Exam Seat No. …….....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a 'vehicle' to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to focus on the outcomes, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

The electrical diploma holder has to work in industry as technical person in middle level management. He has to work as production, maintenance, testing engineer in various industries like power generation, transmission, distribution, traction etc. and has to deal with different electrical measurement. While performing above task he has to measure different electrical and electronic parameters with testing, therefore he/she must require the skills for these measurements and broad idea of different meters and equipments.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course

Following POs and PSO are expected to be achieved through the practicals of the Electrical and Electronic Measurement course.

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electrical engineering problems.
PO 2. **Discipline knowledge:** Apply Electrical engineering knowledge to solve broad-based electrical engineering related problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
PO 4. **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.
PO 5. **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in the field of Electrical engineering.
PO 6. **Environment and sustainability:** Apply Electrical engineering solutions also for sustainable development practices in societal and environmental contexts.
PO 7. **Ethics:** Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Electrical engineering.
PO 8. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.
PO 9. **Communication:** Communicate effectively in oral and written form.
PO 10. **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the Electrical engineering and allied industry.

Program Specific Outcomes (PSOs):

PSO 1. Electrical Equipment: Maintain various types of rotating and static electrical equipment.
PSO 2. Electric Power Systems: Maintain different types of electrical power systems.

List of Industry Relevant Skills

The following industry relevant skills of the competency 'Use electrical motors and transformers' are expected to be developed in the students by undertaking the laboratory work in this practical manual.

1. Follow safety practices while handling electrical motors and transformers.
2. Connect and operate the dc motors.
3. Connect and operate the three phase transformers for different applications.
4. Connect and operate the single phase transformers for different applications.
5. Connect and use the special purpose transformers for specified applications.

Practical- Course Outcome matrix

Course Outcomes (COs):-

a. Use different electrical motors.
b. Use DC machines.
c. Use single phase transformer for different applications.
d. Use three phase transformers for different applications.
e. Use relevant special purpose transformers for different applications.

S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Dismantle a DC machine	√	√	-	-	-
2.	Reverse the direction of rotation of the DC shunt motor.	√	√	-	-	-
3.	Perform brake test on DC shunt motor.	√	√	-	-	_
4.	Control the speed of DC shunt motor by different methods.	√	√	-	-	-
5.	Control the speed of DC series motor by different methods.	√	√	-	-	-
6.	Perform the brake test on DC series motor.	√	√	-	-	-
7.	Check the functioning of single phase transformer.	-	-	√	-	-
8.	Determine regulation and efficiency of single phase transformer by direct loading.	-	-	√	-	-
9.	Perform open circuit and short circuit test on single phase transformer to determine equivalent circuit constants.	-	-	√	-	-
10.	Perform open circuit and short circuit test on single phase transformer to determine voltage regulation and efficiency.	-	-	√	-	-
11.	Perform parallel operation of two single phase transformers to determine the load current sharing.	-	-	√	-	-
12.	Perform parallel operation of two single phase transformers and determine the apparent and real power load sharing.	-	-	√	-	-
13.	Perform polarity test on a single phase transformer whose polarity markings are masked.	-	-	√	-	-

14.	Perform phasing out test on a three phase transformer whose phase markings are masked.	-	-	-	√	-
15.	Connect the auto-transformer in step-up and step-down modes noting the input/output readings.	-	-	-	√	-
16.	Check the functioning of the CT.	-	-	-	-	√
17.	Check the functioning of the PT.	-	-	-	-	√
18.	Check the functioning of the isolation transformer.	-	-	-	-	√
19.	Check the operation of pulse transformer.	-	-	-	-	√

Guidelines to Teachers

1. ***Teacher need to ensure that a dated log book*** for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question bank for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Electricity act/rules, technical manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practicals.
5. Select the proper range of meters referring to the machine/s specifications/ratings.

Content Page

List of Practicals and Progressive Assessment Sheet

S. No	Practical Outcome	Page No.	Date of performance	Date of submission	Assessment marks(25	Dated sign. of teacher	Remarks (if any)
1*	Dismantle a DC machine	1					
2	Reverse the direction of rotation of the DC shunt motor.	7					
3*	Perform brake test on DC shunt motor.	14					
4	Control the speed of DC shunt motor by different methods.	21					
5	Control the speed of DC series motor by different methods.	28					
6	Perform the brake test on DC series motor.	36					
7	Check the functioning of single phase transformer.	43					
8*	Determine regulation and efficiency of single phase transformer by direct loading.	51					
9*	Perform open circuit and short circuit test on single phase transformer to determine equivalent circuit constants.	58					
10	Perform open circuit and short circuit test on single phase transformer to determine voltage regulation and efficiency.	66					
11	Perform parallel operation of two single phase transformers to determine the load current sharing.	74					
12*	Perform parallel operation of two single phase transformers and determine the apparent and real power load sharing.	82					
13	Perform polarity test on a single phase transformer whose polarity markings are masked.	90					

S. No	Practical Outcome	Page No.	Date of performance	Date of submission	Assessment marks(25	Dated sign. of teacher	Remarks (if any)
14*	Perform phasing out test on a three phase transformer whose phase markings are masked.	98					
15*	Connect the auto-transformer in step-up and step-down modes noting the input/output readings.	104					
16	Check the functioning of the CT.	111					
17	Check the functioning of the PT.	117					
18*	Check the functioning of the isolation transformer.	123					
19	Check operation of the pulse transformer.	129					
Total							

Note: To be transferred to relevant proforma of CIAAN-2017

Practical No.1: Dismantle a DC machine

I Practical Significance

In Industry, it is required to dismantle machines for overhauling purpose and reassemble. Through this practical student identifies different parts and their functions.

II Relevant Program Outcomes (POs)

- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.
- **Electrical Equipment:** Maintain various types of rotating and static electrical equipment. (PSO -1)

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers.**

- To use various tools such as spanner, plier, screw driver.
- To identify the dc machine and its different internal parts.
- To reassemble the dc machine.

IV Relevant Course Outcome(s)

- Use DC machines.

V Practical Outcome

- Dismantle a DC machine.

VI Affective Domain Outcome

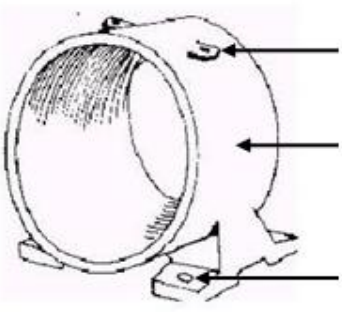
- Follow ethical practices.
- Demonstrate as a team leader.

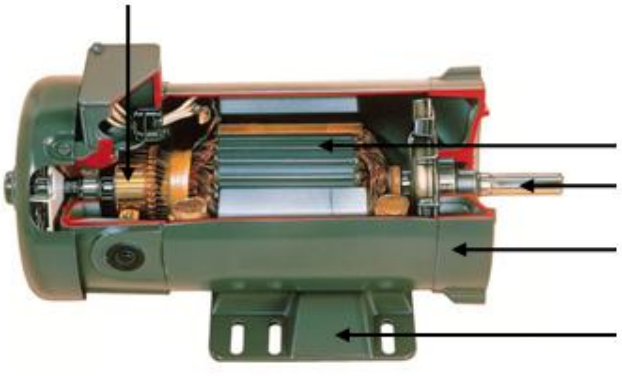
VII Minimum Theoretical Background

- Constructional features of dc machine.
- Functions of different parts of DC machine.

VIII Practical set-up/ Work Situation

(Students are expected to write the names of different parts in the following figure)





IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	DC motor	230V,2 HP,DC motor	01
2	Screw Driver	Set	01
3	Spanner	Set	01
4	Wooden mallet		01
5	Hammer	(1/2 kg)	01

X Precautions to be followed

1. Make sure that the main switch on the panel board is in 'OFF' position and DC machine is disconnected from the supply.
2. The motor is mechanically disconnected from the load.

XI Procedure

1. Remove the mechanical load/pulley of motor on the shaft.
2. View the external parts such as frame, eye bolt and foundation plate etc.
3. Remove the end covers.
4. Observe the various internal parts and their shapes and positions.
5. Note the material with which each part is made up of.
6. Write down in brief the function of each part after observation.
7. Reassemble the motor by putting back the end cover in original place.

XII Resources Used

Sr. No.	Name of Resources	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed (use blank sheet, if space is not sufficient)

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XIV Precautions Followed

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XV Observations (use blank sheet, if space is not sufficient)

Sr.No	Name of the Part	Material used	Function
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XVI Results

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XVII Interpretation of Results (Write meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

(Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO)

1. Write the reasons for laminating the cores of armature and poles.
2. Write the function of air ducts provided in the armature core.
3. State the reason for larger area of cross section of pole shoe than the pole core.

[Space for answers]

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XX References / Suggestions for Further Reading:

Sr.No.	Title of Book	Author	Publication
1	Principals of Electrical Machines	Rohit Mehta and V. K. Mehta	S Chand
2	Electrical Technology:Vol-2	B. L.Theraja	S Chand
3	www.Electrical4u.com		
4	https://www.youtube.com/watch?v=oI-O9FCDqmg		
5	https://www.youtube.com/watch?v=xsWNGcZ-jds		
6	https://www.youtube.com/watch?v=IC-PWxtcirI		

XXI Assessment Scheme

Performance Indicators		Weightage %
Process Related (15 Marks)		**60%**
1	Handling of the tools	10 %
2	Identification of parts	20 %
3	Recognizing the material of parts	20 %
4	Working in team	10 %
Product Related (10 Marks)		**40%**
5	Noting down the observation	05 %
6	Interpretation of result	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.2: Reverse the direction of Rotation of DC Shunt Motor

I Practical Significance

In the industry it is often required to use the dc motor in both the directions in some applications without damaging or unnecessarily overloading it. This practical will enable the student to perform such operations.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers.**

- To start DC shunt motor.
- To reverse the direction of rotation of DC shunt motor

IV Relevant Course Outcome(s)

- Use DC machines.

V Practical Outcome

- Reverse the direction of rotation of the DC shunt motor.

VI Affective Domain Outcome

1. Follow ethical practices.
2. Follow safety rules.

VII Minimum Theoretical Background

1. Working principle of DC motor.
2. Fleming's Left hand rule.

VIII Practical set-up/ Circuit diagram /Work Situation

1. With Normal connection of armature and field winding

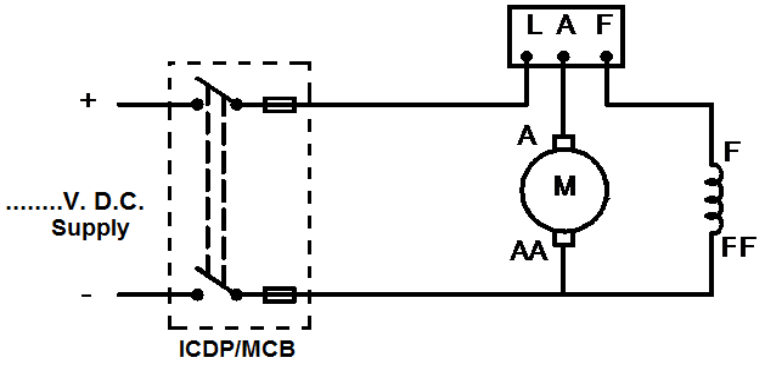

Fig.1 (Forward / Normal Rotation)

2. With Field connections reversed

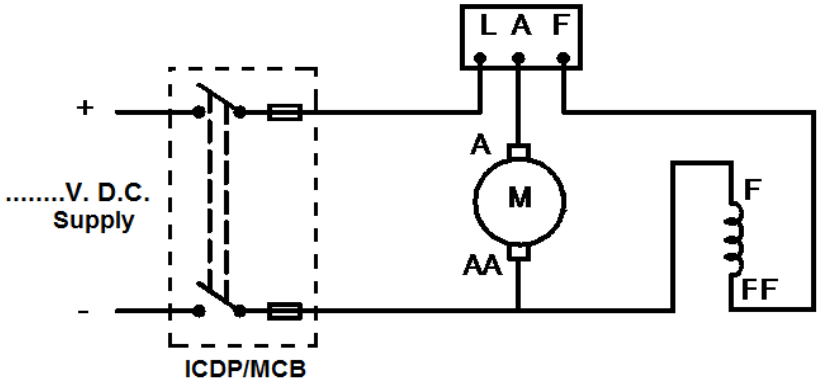

Fig.2 (Reversed Rotation by Reversing Field Current)

3. With armature winding connections reversed:

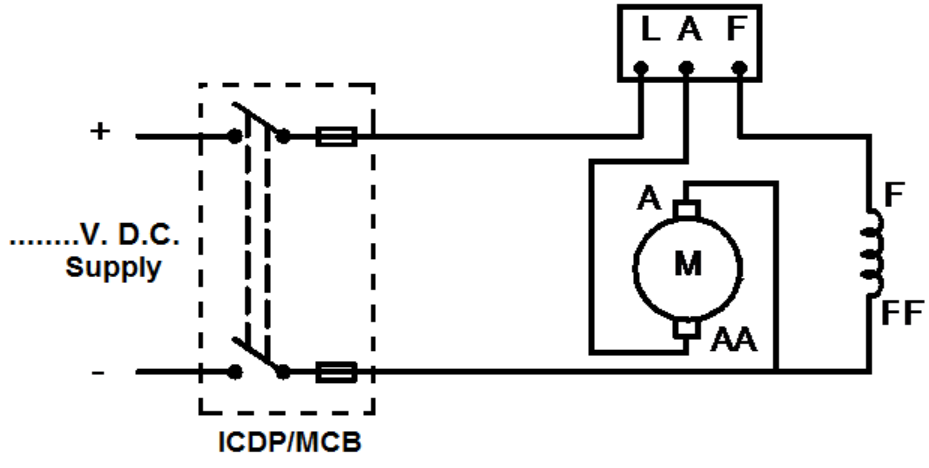

Fig.3 (Reversed Rotationby Reversing Armature Current)

4. When both winding connections are reversed :

Fig.4 (Student shall draw the circuit diagram)

IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	DC shunt motor	230V, 1HP to 5HP, (1500 RPM suggested) DC shunt motor	01
2.	Three point starter	Suitable rating	01
3.	Tachometer	0 – 5000 RPM	01

X Precautions to be followed

1. Make sure that the main switch on the panel board is in 'OFF' position while making connections.
2. While using starter, make sure that the handle is in 'OFF' position.
3. Wires used for circuit connection should have proper insulation cover.

XI Procedure

1. Connect the circuit as per Fig 1 and **get it checked by subject teacher.**
2. Switch 'ON' the supply.
3. Using the starter, start the motor.
4. Observe the direction of rotation and record the same.
5. Switch OFF the supply and ensure that the starter handle comes back to OFF position.
6. Reverse the connection of the field winding as shown in Fig.2 and again start the motor and observe the direction of rotation.
7. Reverse the connection of the armature winding as shown in Fig.3 and observe the direction of rotation.
8. Reverse the connection of the armature and field winding simultaneously as in figure 4.
9. Observe the effect of change in direction of rotation and record the same
10. Disconnect the circuit.
11. Place the wires used for connection in the wire box.
12. Switch 'OFF' the supply.

XII Resources Used

Sr. No.	Name of Resources	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed (use blank sheet, if space is not sufficient)

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XIV Precautions Followed

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XV Observations and Calculations (use blank sheet, if space is not sufficient)

Sr.No.	Connections	Direction of rotation	Remarks
1.	As per fig.1		
2.	As per fig.2		
3.	As per fig 3		
4.	As per fig.4		

XVI Results

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XVII Interpretation of Results (Write meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Why does a motor rotate in reverse direction when the current through the field or armature circuit is reversed?
2. What will be the effect on the direction of rotation of a DC shunt motor if the supply terminals are reversed?
3. Which protective device is provided for protection of motor against low/no voltage condition?

[Space for answers]

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XX. References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Principals of Electrical Machines	Rohit Mehta V. K.Mehta	S. Chand
2	Electrical Technology:Vol. 2	B. L.Theraja	S. Chand
3	A textbook of laboratory courses in Electrical Engineering	S. G. Tarnekar. P. K. Karbanda	S. Chand ISBN:9788121901048 8121901049

XXI. Assessment Scheme

Performance Indicators		Weightage %
Process Related (15Marks)		**60%**
1.	Identification of the motor & different windings	10 %
2.	Taking required precautions	20 %
3.	Connecting the circuit and making observation	20 %
4.	Working in team	10 %
Product Related (10 Marks)		**40%**
5.	Noting the result	05 %
6.	Interpretation of result	10 %
7.	Conclusions	10 %
8.	Practical related questions	10 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

1. ……..……..
2. …….
3. ……..……
4. ……..……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 3: Perform brake test on DC shunt motor

I Practical Significance

In Industry it is sometimes required to test the dc motor by direct methods to ensure its performance as per name plate details. This practical enables him to conduct such a test. The test aims him with the skills needed to perform the brake load test on the DC shunt motor.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- To test the DC Shunt motor

IV Relevant Course Outcome(s)

- Use DC machines

V Practical Outcome

- Perform brake test on DC shunt motor

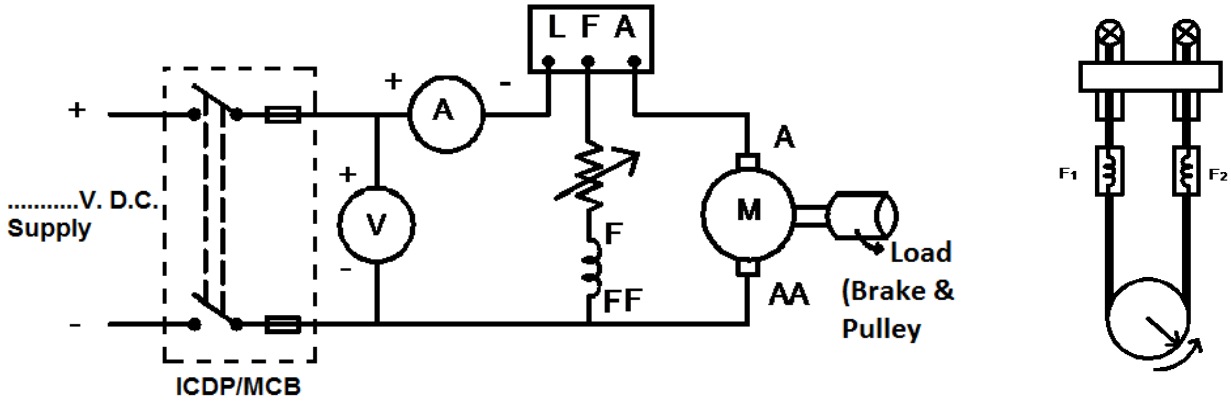
VI Affective Domain Outcome

- Take precautionary measures for safety
- Work as a team member

VII Minimum Theoretical Background

- Shaft torque=Output in watts/(2πN), where N is the speed of the motor in RPM.
- Iron losses, copper losses, frictional losses and efficiency of D.C. motor.

VIII Practical set-up/ Circuit diagram /Work Situation



IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	DC shunt motor with load and pulley arrangement	230V,2 to 5HP DC shunt motor	01
2.	Three point starter	Suitable rating	01
3.	Ammeter	PMMC type,0-5A	01
4.	Voltmeter	PMMC type,0-250V	01
5.	Rheostat	Suitable rating	01

X Precautions to be followed

1. Make sure that the main switch on the panel board is in 'OFF' position while making connections.
2. While using starter, make sure that the handle is in 'OFF' position.
3. Wires used for circuit connection have proper size and insulation cover.
4. Belt/Rope used for pulley should be properly cooled at the regular interval in between the practical

XI Procedure

1. Connect the circuit as per the circuit diagram.
2. Measure the radius of pulley (brake drum).
3. Keep the field circuit rheostat R to the minimum value.
4. Ensure that there is no load on the brake drum
5. Switch 'ON' the supply and start the motor with the help of three point starter.
6. Adjust the field rheostat of motor to obtain rated speed of motor.
7. Note the speed using tachometer.
8. After setting the speed, rheostat position should not be altered.
9. Note down the input voltage, current using voltmeter, ammeter at no load.
10. Increase the load on the brake drum gradually up to full load in steps and record the corresponding readings of voltmeter, ammeter, tachometer and belt tensions.
11. Pulley must be water cooled at regular intervals.
12. Release the spring tension slowly and at no load switch 'OFF' the supply.

XII Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
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XIII Actual Procedure Followed (use blank sheet if space is not sufficient)

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XIV Precautions Followed

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XV Observations and Calculations (use blank sheet if space is not sufficient)

Radius of Pulley (Brake drum) r = …….m

Thickness of the belt/rope = t = …….m

$$\text{Effective radius of pulley} = r_e = r + \frac{t}{2}$$

= …….m

Sr. No	Supply voltage V volts	Supply current I amp	Input Power W_1 =V×I watt	F_1 in kg	F_2 in kg	Speed N rpm	Torque T = 9.81x r_e×(F_1-F_2) N.m	Output Power W_2 watt =2πNT/ 60	%Efficiency $= (\frac{W_2}{W_1}) \times 100$
1	2	3	4	5	6	7	8	9	10

Note: Plot the speed(Y axis) V/s Torque (X axis) characteristics on a Graph paper.

XVI Results

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XVII Interpretation of Results (Write meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Explain "Brake test is performed on small machines".
2. State various losses in d.c. machines.
3. State the effect of speed if the field rheostat is kept to its maximum at the time of starting the motor.
4. State the value of efficiency of motor under no load condition.

5. State the need for cooling the brake drum.
6. State any two industrial applications of d.c. shunt motor based on the above characteristics.

[Space for answers]

XX References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Principals of Electrical Machines	Rohit Mehta and V. K. Mehta	S. Chand
2	Electrical Technology: Vol2	B. L.Theraja	S. Chand
3	A text book of Laboratory Courses in Electrical Engineering	S. G. Tarnekar P. K. Karbanda	S. Chand. ISBN: 9788121901048 , 8121901049

XXI Assessment Scheme

Performance Indicators		Weightage %
Process Related (15 Marks)		**60%**
1.	Handling of the motor and load	10 %
2.	Identification of components/dial/scale	20 %
3.	Connecting the circuit and making observation	20 %
4.	Working in team	10 %
Product Related (10 Marks)		**40%**
5.	Noting the result	05 %
6.	Interpretation of result	10 %
7.	Conclusions	10 %
8.	Practical related questions	10 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.4: Control the speed of DC Shunt Motor by different methods

I Practical Significance

In industry the electrical supervisor is required to control the speed of dc shunt motor for various applications. This practical enables the student to confidently control the speed of dc shunt motor by different methods.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Identify the type of dc motor.
- Used Tachometer for speed measurement.
- Run the dc shunt motor below/above the rated speed.

IV Relevant Course Outcome(s)

- Use DC machines

V Practical Outcome

- To control the speed of DC shunt motor.

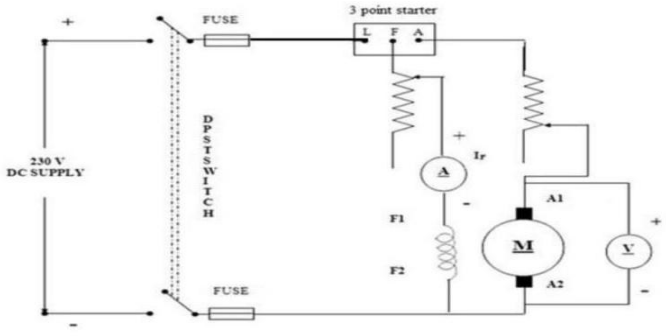
VI Affective Domain Outcome

- Follow safety precautions.
- Demonstrate as a team member

VII Minimum Theoretical Background

- Types of d.c. motor.
- Back e.m.f.(Eb) and speed equation $\left(N \alpha \frac{E_b}{\phi}\right)$

VIII Practical set-up/ Circuit diagram /Work Situation



IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	DC shunt motor with load and pulley arrangement	230V,2 to 5HP, DC shunt motor preferably 1500 RPM	01
2.	Three point starter	Suitable for above motor	01
3.	Ammeter	PMMC, 0-1A	01
4.	Voltmeter	PMMC, 0-250V	01
5.	Rheostat	Suitable rating relevant to armature current rating	01
6.	Rheostat	Suitable rating relevant to field current rating	01
7.	Tachometer	Suitable range around 0 to 5000 RPM	01

X Precautions to be followed

1. Make sure that the main switch on the panel board is in 'OFF' position while making connection
2. Wires used for circuit connections are of proper size and insulation.
3. Ensure that the meters/components used in this practical have proper rating.
4. Motor field rheostat should be at minimum position at the time of starting.

XI Procedure

Part A: Speed control of DC Shunt Motor by Armature Voltage control method.

1. Make the connections as per circuit diagram shown in the Figure.
2. Both motor field rheostat and armature rheostat should be kept at minimum position at the time of starting.
3. DPST switch is closed and motor is started using three point starter.
4. Bring the motor to the rated speed using rheostat connected in series with field circuit.
5. Maintain the field current at a constant value by adjusting the field rheostat and note down its value.
6. Note down the value of corresponding armature voltage(V_a) and speed(N)

7. Vary the armature rheostat to get different values of armature voltage (V_a) and note down the corresponding speed (N).
8. Bring the field and armature rheostats to the original position and switch "OFF" the supply.

Part B: Speed control of DC Shunt Motor by Field Current control method.

1. Make the connection as per circuit diagram shown in Fig.
2. Keep both field rheostat and armature rheostat at minimum position at the beginning of the practical.
3. Switch "ON" the supply. Start the motor with the help of starter.
4. Bring the motor to the rated speed using rheostat connected in series with field circuit.
5. Armature voltage is kept at a constant value by adjusting the armature rheostat.
6. Note down the corresponding values of field current (I_f) and speed (N).
7. Vary the field rheostat, take corresponding readings of field current and speed.
8. Bring the field and armature rheostats to the original position and switch "OFF" the supply.

XII Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
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XIII Actual Procedure Followed (use blank sheet if space is not sufficient)

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(Part B)

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XIV Precautions Followed

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XV Observations and Calculations (use blank sheet if space is not sufficient)

For part A:

Field current =……..amp (To be kept constant)

Sr. No.	Armature Voltage (V_a) in volt	Speed in RPM
1.		
2.		
3.		
4.		
5.		
6.		

Note: A graph is plotted by taking Armature voltage along the X-axis and Speed along the Y-axis

For Part B:

Armature Voltage = ……. volt (To be kept constant)

Sr.No.	Field Current in (I_f)amp	Speed in RPM
1.		
2.		
3.		
4.		
5.		
6.		

Note: A graph is plotted by taking field current along the X-axis and Speed along the Y-axis.

XVI Results

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XVII Interpretation of Results (Write the meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the advantages of d.c. shunt motor.
2. List the application of d.c. shunt motor.
3. State the type of starter used for a d.c. shunt motor.
4. Give the reason for high starting current of the d.c. shunt motor.
5. A dc shunt motor is constant speed motor. Explain.

[Space for answers]

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XX References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Principals of Electrical Machines	Rohit Mehta and V. K. Mehta	S Chand
2	Electrical Technology:Vol2	B. L.Theraja	S Chand
3	A text book of Laboratory Courses in Electrical Engineering	S. G. Tarnekar P. K. Karbanda	S. Chand. ISBN: 9788121901048, 8121901049

XXI Assessment Scheme

Performance Indicators		Weightage %
Process Related (15 Marks)		**60%**
1.	Handling of the meters and components	10 %
2.	Identification of motor and its windings	20 %
3.	Connecting the circuit and making observation	20 %
4.	Working in team	10 %
Product Related (10 Marks)		**40%**
5.	Noting the result	05 %
6.	Interpretation of result	10 %
7.	Conclusions	10 %
8.	Practical related questions	10 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.5: Control the speed of DC Series Motor by different methods

I Practical Significance

In the industry it is often required to use the DC series motors for various applications. The DC series motor is one that has huge variation in its speed with respect to the torque generated. This practical enables the student to control speed of such motors safely which is of utmost importance in the case of DC series motor.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Connect the motor with proper rated components such as rheostats.
- Control the speed of the motor.
- Use tachometer for speed measurement.

IV Relevant Course Outcome(s)

- Use DC machines.

V Practical Outcome

- Control the speed of DC series motor by different methods.

VI Affective Domain Outcome

- Follow safety precautions.
- Demonstrate as a team member

VII Minimum Theoretical Background

- Types of d.c. motor.
- Back e.m.f.(Eb) and speed equation $\left(N\alpha\frac{E_b}{\phi}\right)$

VIII Practical set-up/ Circuit diagram /Work Situation

Part A: For Armature Voltage control method (Fig.1)

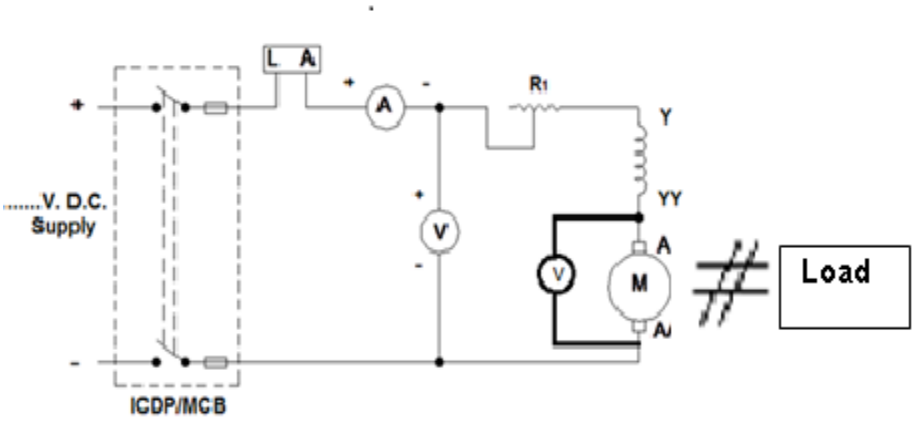

Fig. 1: Speed control of DC Series Motor by Armature Voltage Control Method

Part B: For Field or Flux Control Method (Fig. 2)

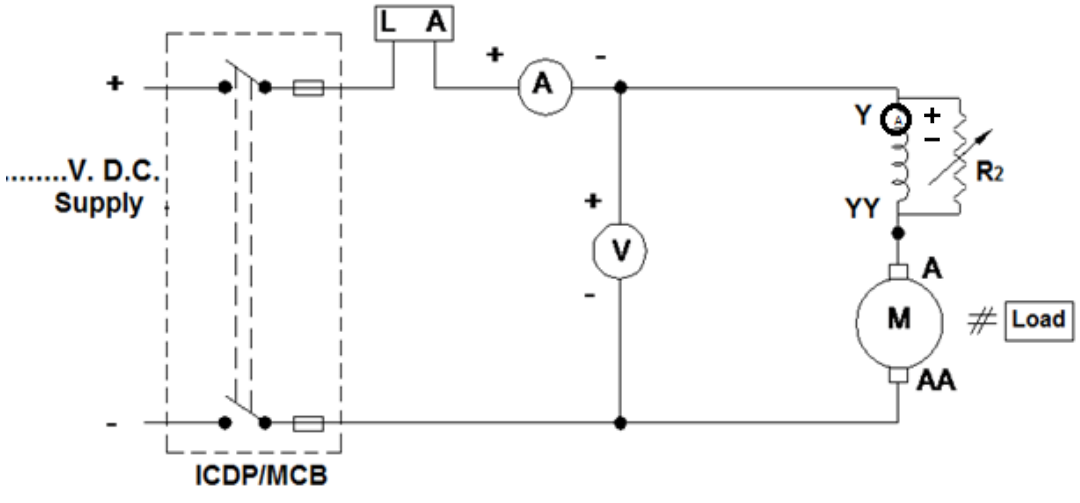

Fig. 2: Speed control of DC Series Motor by Field or Flux Control Method

IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	DC series motor with load and pulley arrangement	230V, 2 to 5HP,1500rpm	01
2.	Two point starter	Suitable for the above motor	01
3.	Ammeter	PMMC, (0-5-10A)	01
4.	Voltmeter	PMMC, (0-250V)	01
5.	Rheostat	Suitable rating	02
6.	Tachometer	Suitable rating	01

X Precautions to be followed

1. Make sure that the main switch on the panel board is in ‘OFF’ position while making connections.
2. While using starter, make sure that the handle is in ‘OFF’ position.

3. Belt/ Rope used for pulley should be properly cooled at the regular interval of the practical.
4. Make sure to apply mechanical load before starting the motor.

XI Procedure

For Part A: Armature Voltage Control Method

1. Calculate the full load torque using the formula, $T_{Fl}= P_{output}/(2\pi N/60)$
2. Calculate the torque to be set on belt(i.e, $2/3^{rd}$ of T_{FL})
3. Obtain the net tension, F_1-F_2= (Required torque)/ (r_ex9.81), where r_e is the effective radius of the pulley (Brake drum).
4. Apply the mechanical load as per the net tension obtained.
5. Make the connections as per circuit diagram shown in Fig.1
6. Switch “ON “the supply.
7. Start the motor with the help of starter.
8. Bring the motor to the rated speed by adjusting the rheostat connected in series with the field.
9. Note down speed (N), field current (I_f) and armature voltage (V_a).
10. For various positions of increased armature resistance, take corresponding readings of armature voltage and speed.
11. Bring the variable rheostat to the minimum position
12. Switch “OFF” the supply.

For Part B: Flux or Field Current Control Method

1. Calculate the full load torque using the formula, $T_{Fl}= P_{output}/(2\pi N/60)$
2. Calculate the torque to be set on belt(i.e, 2/3rd of TFL)
3. Obtain the net tension , F1-F2=(Required torque)/(rex9.81)
4. Apply the mechanical load as per the net tension obtained.
5. Make the connection as per circuit diagram shown in Fig.2
6. Keep the field diverter to its maximum position.
7. Switch “ON” the supply. Start the motor with the help of starter.
8. Note down speed (N), field current (If) and armature voltage (Va).
9. For various positions of field diverter resistance take corresponding readings of field current and speed.
10. Bring the field diverter to the original position.
11. Switch “OFF” the supply.

XII Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
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Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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XIII Actual Procedure Followed (use blank sheet if space is not sufficient)

For Part A: Armature Voltage Control Method

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For Part B: Flux or Field Current Control Method

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XIV Precautions Followed

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XV Observations and Calculations (use blank sheet if space is not sufficient)

Effective radius of the pulley, r_e= …….m
Full load Torque = $P_{out}/(2\pi N/60)$ N-m
Required Torque= (2/3) T_{FL}
Net tension required, F_1-F_2= Required Torque/(9.81r_e)

For part A: Armature Voltage Control Method

Sr.No.	Armature Voltage in volt	Speed in RPM
1.		
2		
3		
4		
5		
6		

Note: Plot the graph for speed(Y-axis) V/s Armature voltage (X-axis) on a Graph paper.

For Part B: Flux or Field Current Control Method

Sr. No.	Field Current in amp	Speed in RPM
1.		
2		
3		
4		
5		
6		

Note: Plot the speed (Y-axis) V/s Field current (X-axis) characteristics on a Graph paper.

XVI Results

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XVII Interpretation of Results (Write meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the reason for not starting the dc series motor on no load?
2. State the advantages of d.c. series motor?
3. List the applications of d.c. series motor?
4. Give the reason for high starting torque of the d.c. series motor .
5. List the disadvantages of armature voltage control method of speed control of dc series motor.
6. A d.c. series motor is a variable speed motor. Explain.
7. Justify the armature voltage control method of speed control is only for small dc motors.

[Space for Answer]

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XX References / Suggestions for Further Reading

Sr. No.	Title of Book	Author	Publication
1.	Principals of Electrical Machines	Rohit Mehta and V. K. Mehta	S Chand
2.	Electrical Technology- vol 2	B. L.Theraja	S Chand
3.	A text book of laboratory courses in electrical engineering	S. G. Tarnekar P. K. Karbanda	S. Chand. ISBN: 9788121901048, 8121901049

XXI Assessment Scheme

Performance Indicators		Weightage %
Process Related (15 Marks)		**60%**
1.	Handling/Identification of the meters and components	10 %
2.	Identification of motor/ windings and taking adequate precautions	20 %
3.	Connecting the circuit and making observation	20 %
4.	Working in team	10 %
Product Related (10 Marks)		**40%**
5.	Noting the result	05 %
6.	Interpretation of result	10 %
7.	Conclusions	10 %
8.	Practical related questions	10 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 6: Perform Brake Test on D.C Series Motor

I Practical Significance

D.C Series Motor is a preferred motor for electric traction and in many industries where the inverse torque-speed characteristics are essential. Analyzing the performance of the motor is prime requirement for selecting a motor for a particular industrial application. Brake test provides an insight into performance of the D.C. series motor (by the characteristics).

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Selection of relevant meters with proper range
- Perform brake test on the given D.C series motor
- Interpret the performance characteristics of D.C series motor.

IV Relevant Course Outcome(s)

- Use D.C Machines.

V Practical Outcome

- Judge the performance of D.C series motor.
- Determine torque and efficiency at different load conditions.
- Plot and interpret the speed versus output power, efficiency versus output power characteristics of DC series motor.

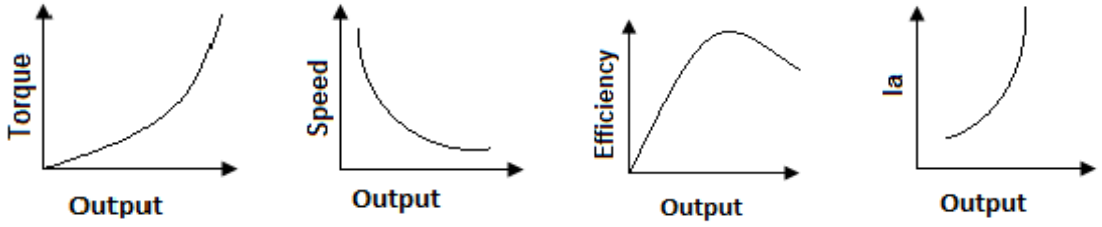
VI Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

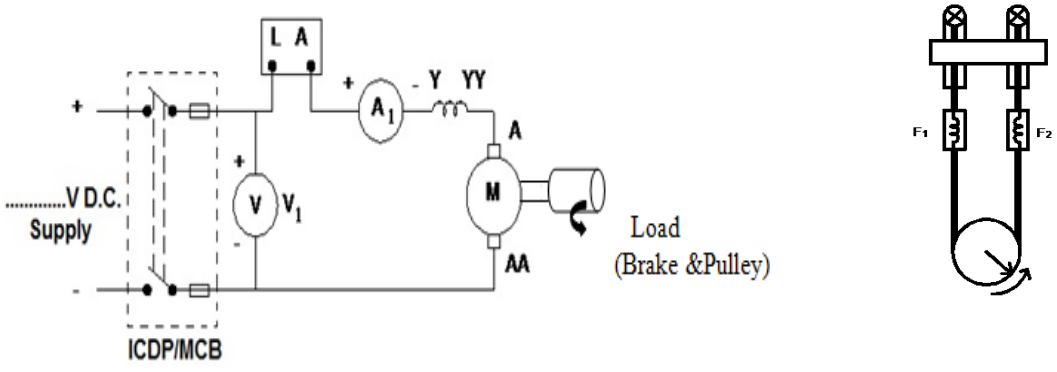
VII Minimum Theoretical Background

Brake test: It is a direct method of testing in which the motor is loaded by applying load on the mechanically coupled braking arrangement. It normally consists of mechanically coupled brake drum (i.e. pulley and belt arrangement) with spring balances at the two ends of the belt that goes halfway around the pulley. By adjusting belt tension, motor can be loaded from no load to full load.

Expected nature of performance curves



VIII Practical set-up / Circuit diagram / Work Situation



Note: Students should write range of meters and rating of equipment on circuit diagram.

IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	D.C Series Motor	230 V, 2HP to 5HP	1 No.
2.	D.C Voltmeter	0-150/300/600 V PMMC type	1 No.
3.	D.C Ammeter	0-5-10 A PMMC type	1 No.
4.	Tachometer	Relevant to the motor speed range	1 No.
5.	2 point starter	For the motor as per its rating	1 No.
6.	ICDP/MCB	As per motor rating	1 No

X Precautions to be followed

1. Check the belt for damages before starting.
2. Check the water cooling arrangements.
3. Ensure that the belt is sufficiently tight before the motor is switched on to the supply as DC Series Motor shall not be started on no-load.
4. Follow Safety practices.
5. DO NOT make any connections when the power supply is “ON”.
6. Get in the habit of turning OFF the power supply at the end of the experiment.

XI Procedure

1. Make the connection as per the circuit diagram shown in figure
2. Calculate full load torque using formula T_{FL}= Output Power in Watts /(2πN/60)
3. Calculate the torque to be set on the belt (2/3 of F.L)
4. Obtain the net tension (F1 – F2) to be adjusted to get the torque to be set so that motor shall not be started at no load using formula T= 9.81* r (F1-F2).
5. Switch on the D.C supply with the above load and start the motor with the help of two point starter.
6. Note down the input voltage, current and speed using voltmeter, ammeter and tachometer at initial load. For load note the spring balance reading.
7. Increase the load on the brake drum gradually in steps up to full load and record the corresponding voltmeter, ammeter readings and speed, spring balance readings.
8. Pulley must be water cooled at regular intervals.
9. Release the spring tension slowly and at sufficient load switch OFF the supply.
10. Calculate the torque developed by the motor.
11. Plot the graph of (i) Speed versus Torque and (ii) Efficiency versus Output power.

XII Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					
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7.					
8.					

XIII Actual Procedure Followed (use blank sheet if space is not sufficient)

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XIV Precautions followed:

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XV Observations and Calculations (use blank sheet if space is not sufficient)

Radius of Pulley (brake drum) r = …….m

Thickness of the belt t = ……..m

Effective radius of pulley $=r_e = r + \frac{t}{2}$

= ……m

Sr. No.	Motor Supply Voltage V volt	Motor Supply Current I amp	F_1 kg	F_2 kg	Speed N in rpm	Torque T = 9.81× r_e× (F_1-F_2) N.m	Motor input power = VI watt	Motor output power $W_2 = \frac{2\pi NT}{60}$ watt	Motor % Efficiency $= \frac{W_2}{W_1} \times 100$
1									
2									
3									
4									
5									

XVI Results

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XVII Interpretation of Results (Write meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX Practical Related Questions :(Use separate sheet if space is not sufficient)

(Teacher should provide various questions related to practical- sample are given below)

1. Does the field flux become stronger or weaker as a series motor is loaded? Explain.

2. A hoist should travel fast when it does not have a load, and slow when lifting a load. Would you choose a series motor or shunt motor? Explain why.

[Space for answers]

XX References / Suggestions for further reading

Sr.No.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G. and Karbanda P.K.	S.Chand and Co.Ltd. New Delhi, Edition 2013 ISBN : 9788121901048, 8121901049
2	Electrical Machines	Kothari D. P. and Nagrath, I. J.	McGraw Hill Education, New Delhi. ISBN :9780070699670
3	Laboratory Manual for Electrical Machines	Kothari D. P. and B.S.Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. www.machineryequipmentonline.com
ii. https://electricalbaba.com
iii. https://www.youtube.com/watch?v=hMDItqFJz8Q
iv. https://www.youtube.com/watch?v=CUMgA1jH0tc

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Writing result	05 %
6	Interpretation of result	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 7: Check the Functioning of Single-phase Transformer

I Practical Significance

Transformer is a very essential and efficient device in A.C system. Power transformer plays a vital role in power system, generally used for stepping up and down the voltage level of power in transmission and distribution power system network.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **PSO 1. Electrical Equipment:** Maintain various types of rotating and static electrical equipment.
- **PSO 2. Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Connect the transformer and meters with proper range.
- Use transformer as step up and step down mode.

IV Relevant Course Outcome(s)

- Use single phase transformer for different application.

V Practical Outcome

- Check the function of transformer in step-up and step-down mode.
- Measure voltage, current and volt-Ampere power.

VI Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.

VII Minimum Theoretical Background

- Basic principle: Electrical transformer is a static device which transforms electrical energy from one circuit to another without any direct electrical connection and with the help of mutual induction between two windings. It transforms electric power from one circuit to another without changing its frequency but with convenient change in voltage levels.
- Transformation ratio: It is the ratio of secondary voltage to primary voltage. It is denoted by “k” and is given by relation

$$k = E_2/E_1 = N_2/N_1 \doteqdot V_2/V_1 \doteqdot I_1/I_2$$

- Step up transformer: In a step up transformer, the number of turns of the secondary winding (N_2)is more than the number turns of the primary winding(N_1) or the emf induced in secondary winding(E_2) is more than the emf induced in the primary winding (E_1).

$$N_2 > N_1 \quad \text{or} \quad E_2 > E_1 \quad \text{i.e} \quad k > 1$$

- Step down transformer: In a step down transformer, the number of turns of the secondary winding (N_2) is less than the number turns of the primary winding(N_1) or the emf induced in the secondary winding (E_2) is less than the emf induced in the primary winding (E_1)

$$N_2 < N_1 \quad \text{or} \quad E_2 < E_1 \text{ie } k < 1$$

VIII Practical set-up / Circuit diagram / Work Situation

Step-down Mode

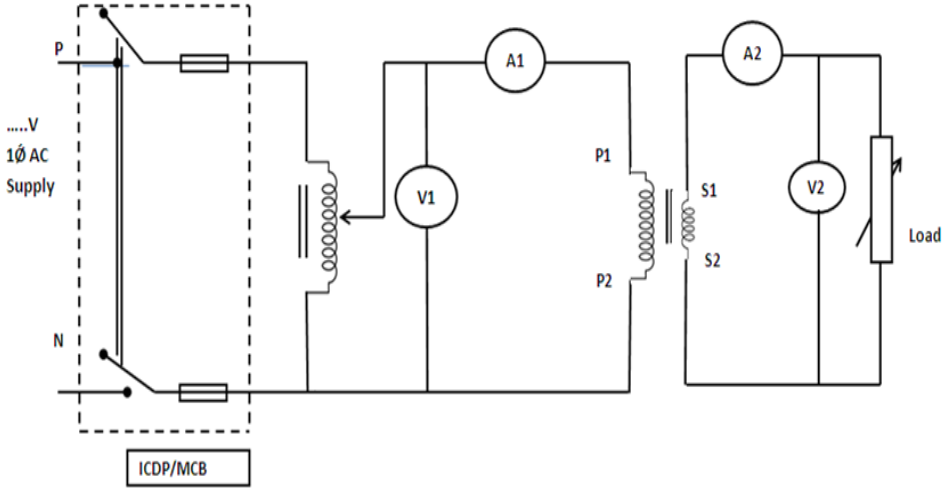

Fig.1: Step-down Mode

Step-up Mode

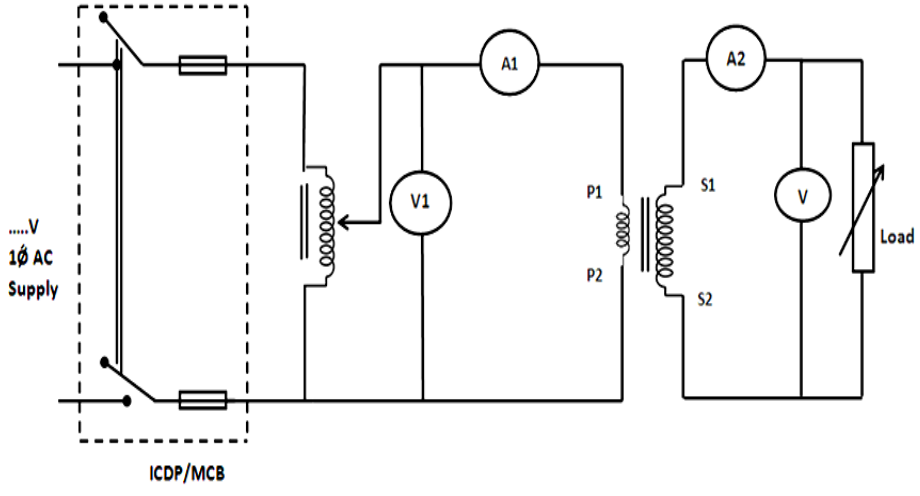

Fig.2: Step-up Mode

Note: Students should write range of meters used and rating of transformer used

IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single phase transformer of suitable size	500 VA to1kVA, 230 / 115 V	1 No.
2	Single phase autotransformer	Input voltage 230 V, output: 0-270 V, 15 A	1 No.
3	A.C Voltmeter	0-75/150/300 V, Portable analog MI type as per relevant BIS standard	2 No.
4	A.C Ammeter	0-2.5-5-10 A Portable analog MI type as per relevant BIS standard	2 No.
5	Lamp Load	10-20A	1 No.

X Precautions to be Followed

1. Follow Safety practices.
2. DO NOT make any connections with the power supply ON. Get in the habit of turning OFF the power supply after the practical.
3. The load should be in the "OFF" position in the beginning.

XI Procedure

Step-down Mode:

1. Calculate the full load currents of primary and secondary and select the meters accordingly.
2. Make the connections as per circuit diagram shown in Fig.1
3. Set the autotransformer to its minimum output position and keep the load switches OFF. Turn "ON" the supply.
4. Increase the output voltage of autotransformer gradually till the rated voltage of primary winding is reached.
5. Switch on the load in steps and record voltmeter and ammeter reading on both primary and secondary side at 1/3 of full load, half of full load and full load.
6. Switch "OFF" the load and bring the autotransformer to minimum position and switch "OFF" the supply.

Step up Mode:

1. Make the connections as per circuit diagram as shown in Fig. 2
2. **Follow the same steps mentioned in the procedure for step-down mode.**

XII Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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3.					
4.					
5.					
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XIII Actual Procedure Followed (Use separate sheet if space is not sufficient)

A) Step down mode:

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B) Step up mode:

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XIV Precautions Followed

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XV Observations and Calculations (Use separate sheet if space is not sufficient)

A) Step down mode:

Sr. No.	Primary voltage V_1volt	Secondary Voltage V_2 volt	Primary Current I_1amp	Secondary current I_2amp	Voltage ratio V_1/V_2	Current ratio I_1/I_2	Trans. Ratio k $=V_2/V_1$	Input Power $=V_1.I_1$ (VA)	Out put power $= V_2.I_2$ (VA)
1									
2									
3									

B) Step-up mode:

Sr. No.	Primary voltage V_1volt	Secondary Voltage V_2 volt	Primary Current I_1 amp	Secondary current I_2 amp	Voltage ratio V_1/V_2	Current ratio I_1/I_2	Trans. Ratio k $=V_2/V_1$	Input Power $=V_1.I_1$ (VA)	Out put power $= V_2.I_2$ (VA)
1									
2									
3									

XVI Results

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XVII Interpretation of Results (State meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results)

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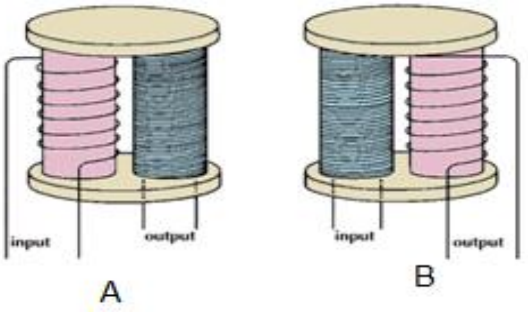
XIX Practical Related Questions: (Use separate sheet for answer)

(Teacher should provide various questions related to practical- sample are given below)

1. Why there is difference between input power and output power.
2. A single phase transformer has primary winding rated for 230 volt and has turns double than that of secondary winding. Find emf induced in secondary winding when transformer is connected to (i) 230 volt, 50 Hz, (ii) 230 volt D.C
3. Identify the type of transformer for the figures shown below



[Space for answers]

XX References / Suggestions for further reading

Sr.No.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G and Karbanda P.K	S.Chand and Co.Ltd. New Delhi, Edition 2013 ISBN : 9788121901048,8121901049
2	Electrical Machines	Kothari D. P. and Nagrath, I. J.	McGraw Hill Education. New Delhi.ISBN :9780070699670
3	Laboratory Manual for Electrical Machines	Kothari D. P and B.S Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. https://www.electrical4u.com
ii. https://www.quora.com
iii. https://www.youtube.com/watch?v=w990FVhXCLY
iv. https://www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Noting the results	05 %
6	Interpretation of results	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……...
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 8: Determine Regulation and Efficiency of Single-phase Transformer by Direct Loading

I. Practical Significance

Computation of Regulation and efficiency of transformers with utmost accuracy and precision is prime requirement of the power system and industry. These two important parameters decide the acceptance of transformer. Direct loading test is a direct method to determine the efficiency & regulation of transformer.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad-based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Select relevant meters with proper range
- Determine regulation and efficiency of single phase transformers.

IV. Relevant Course Outcome(s)

- Use single phase transformer for different application.

V. Practical Outcome

- Determine regulation and efficiency at different load conditions.
- Judge the suitability of the transformer.

VI. Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.

VII. Minimum Theoretical Background:

Voltage Regulation of a transformer:

It is defined as the change in secondary terminal voltage from no load to full load, expressed as fraction of no load secondary voltage, keeping the primary voltage constant. It is usually expressed as a percentage of full load secondary voltage value.

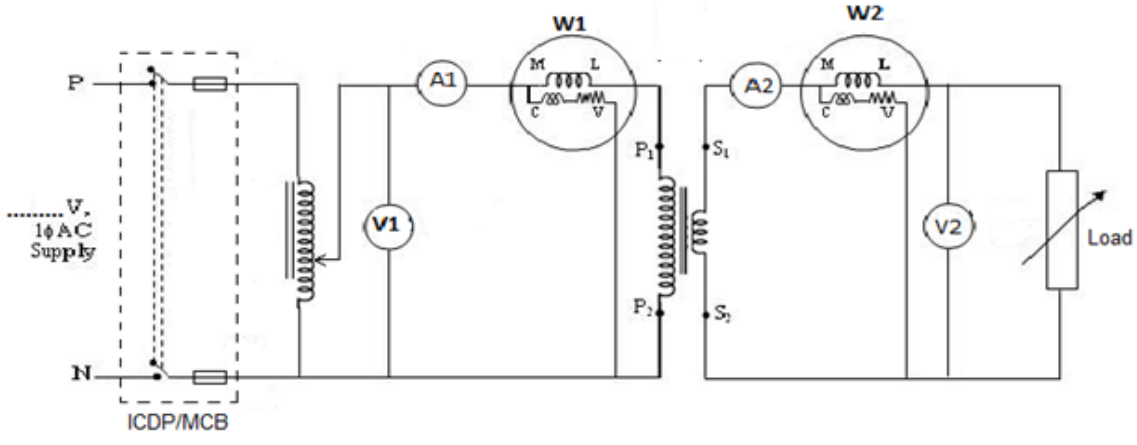
$$\%\, Voltage\ Regulation = \frac{No\ load\ secondary\ voltage - Full\ load\ secondary\ voltage}{No\ load\ secondary\ voltage} \times 100$$

Efficiency of Transformer:

Efficiency of transformer defined as the ratio of output power to input power. It is usually expressed in percentage.

$$\%Efficiency = \frac{Output\ Power}{Input\ Power} \times 100$$

VIII. Practical set-up / Circuit diagram / Work Situation



Note: Students should write range of meters and rating of transformer in the circuit diagram.

IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single phase transformer of suitable size	500 VA to 2 kVA, 230 / 115 V	1 No.
2	Single phase autotransformer	0-270 V, 15 A	1 No.
3	A.C Voltmeter	0-75/150/300 V, Portable analog MI type as per relevant BIS standard	2 No.
4	A.C Ammeter	0-2.5-5-10 A, Portable analog MI type as per relevant BIS standard	2 No.
5	Lamp Load	10-20 A	1 No.
6	Wattmeter	0-150/300/600V, 5/10A	2 No.

X. Precautions to be followed

1. Follow Safety practices
2. DO NOT make any connections with the power supply ON. Get in the habit of turning OFF the power supply after the practical.
3. The load should be in the "OFF" position in the beginning.

XI. Procedure

1. Set the autotransformer to its minimum output and keep the load switches “OFF”.
2. Switch “ON” the supply.
3. Vary the auto transformer output to increase the primary voltage to its rated value and note down the meter reading at no load.
4. By varying the lamp load in steps, corresponding ammeter, voltmeter and wattmeter readings are noted down.
5. The same procedure is repeated up to the rated current.
6. Switch “OFF” the load, bring the autotransformer to minimum position and Switch “OFF” the supply.

XII. Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
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XIII. Actual Procedure Followed (use blank sheet if space is not sufficient)

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XIV. Precautions followed:

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XV. Observations and Calculations (use blank sheet if space is not sufficient)

Primary voltage V_1 =…….volt (constant)
No load secondary terminal voltage V_{20} =…….volt

Sr. No.	Secondary current	Secondary voltage	Primary current	Input power	Output power	% Efficiency	% Voltage regulation
	I_2 amp	V_2 Volt	I_1 amp	W_1 watt	W_2 watt	$= \frac{W_2}{W_1} \times 100$	$= \frac{V_{20} - V_2}{V_{20}} \times 100$
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2							
3							
4							
5							

XXII Results

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XXIII Interpretation of Results (Write meaning of the above obtained results**)**

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XXIV Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XXV Practical Related Questions :(use blank sheet if space is not sufficient)

(Teacher should provide various questions related to practical- sample are given below)

1. For no output power, there is still some input power. Write the reason.
2. State the effect of load on efficiency and regulation of the transformer referring the observation.
3. What changes are to be made, if the primary and secondary winding of the given transformer are interchanged. Draw corresponding circuit diagram.

[Space for answers]

XXVI References / Suggestions for further reading

Sr.No.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G. and Karbanda P.K.	S.Chand and Co.Ltd. New Delhi, Edition 2013 ISBN : 9788121901048, 8121901049
2	Electrical Machines	Kothari D. P. and Nagrath I. J.	McGraw Hill Education. New Delhi.ISBN :9780070699670
3	Laboratory Manual for Electrical Machines	Kothari D. P and B.S.Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. www.gopracticals.com
ii. https://ieeexplore.ieee.org/document/6661181/
iii. https://www.quora.com
iv. https://www.youtube.com/watch?v=9ioLnBc2iIQ
v. https://www.youtube.com/watch?v=Q-rErIPsE1g
vi. https://www.youtube.com/watch?v=gEqVSe49Eus

XXVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Writing result	05 %
6	Interpretation of result	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……...
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 9: Perform Open Circuit (OC) and Short Circuit (SC) Test on Single-phase Transformer to determine Equivalent Circuit Constants

I. Practical Significance

Determination of equivalent circuit parameters of a transformer is utmost important in electrical power system and industry. Percentage impedance is very essential parameter of transformer during installing and parallel operation .Open circuit test and short circuit test are very economical and convenient method to determine equivalent circuit parameters to analyze the performance of transformer for various industrial applications.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Select relevant meters with proper range
- Determine equivalent circuit parameters

IV. Relevant Course Outcome(s)

- Use single phase transformer for different application.

V. Practical Outcome

- Determine equivalent circuit constant.
- Draw equivalent circuit of transformer referred to both winding.

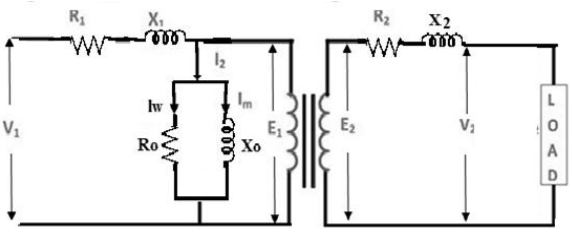
VI. Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.

VII. Minimum Theoretical Background

Equivalent Circuit:

Equivalent circuit is a very useful way of understanding or predicting the operation and behavior of a transformer. In a transformer equivalent circuit we can account for winding losses and flux leakage with a series resistance and reactance on the primary side. Core losses can be modeled similarly with a parallel resistance and reactance on the primary side.



Open Circuit test (O.C. Test)

It is used to estimate iron losses, transformation ratio and parameters of magnetizing branch of equivalent circuit. It is determined by applying rated voltage to the low voltage winding and keeping the high voltage winding open.

Short Circuit test (S.C. Test)

It is to estimate copper losses and parameters of impedance branch by applying low voltage sufficient to circulate rated full load current in the high voltage winding, keeping the low voltage winding short circuited.

VIII. Practical set-up / Circuit diagram / Work Situation

Open circuit Test: **VIII.**

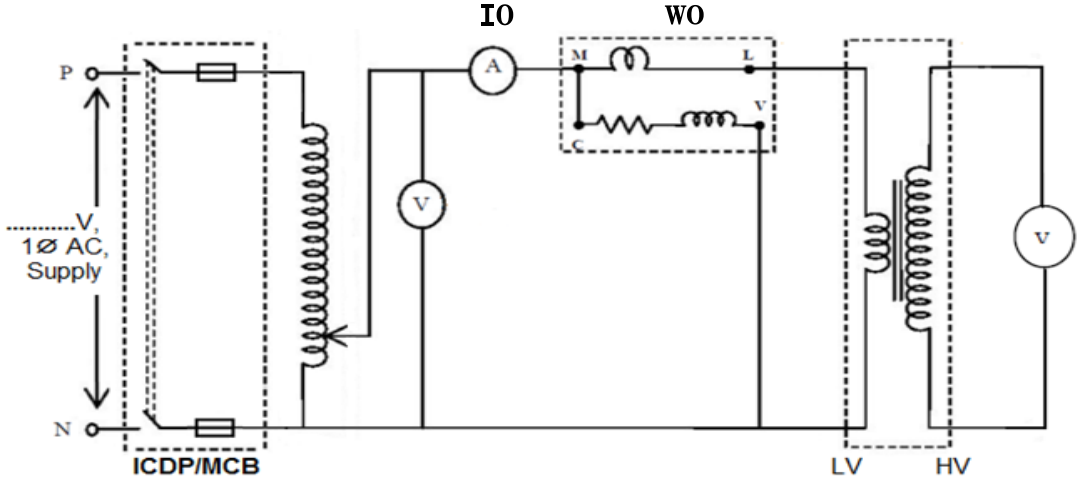


Fig.1: Open Circuit (OC) Test

Short circuit test:-

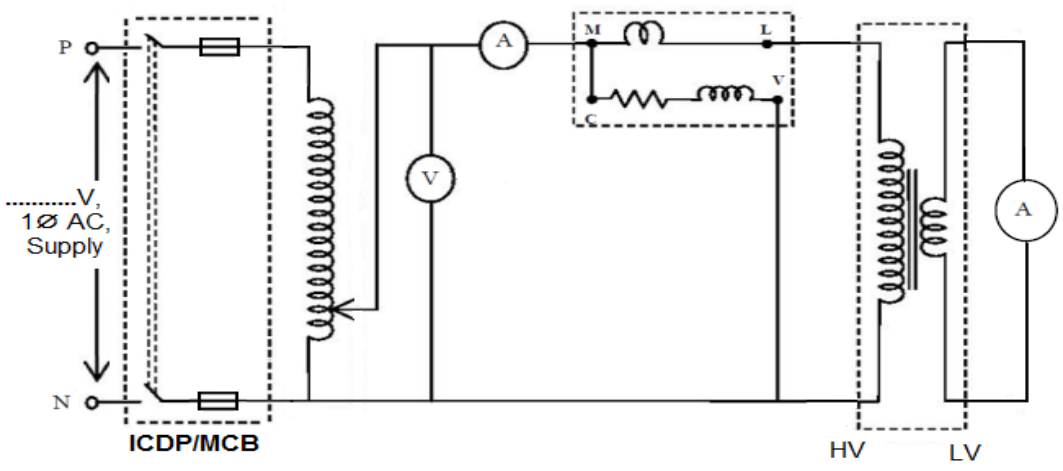


Fig.2: Short Circuit (SC) Test

Note: Students should write range of meters used and rating of transformer used.

IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single phase transformer of suitable size	500 VA to1kVA, 230/115V	1 No.
2	Single phase autotransformer	0-270 V, 15 A	1 No.
3	A.C Voltmeter	0-75/150/300 V, Portable analog MI type as per relevant BIS standard	2 No.
4	A.C Ammeter	0-2.5-5-10A Portable analog MI type as per relevant BIS standard	2 No.
5	LPF Wattmeter	0-150/300/600V, 1/2/A	1No.
6	Wattmeter	0-75/150/300V, 5/10/A	1No.

X. Precautions to be followed

1. DO NOT make any connections with the power supply “ON”. Get in the habit of turning “OFF” the power supply after experiment.
2. Due care must be taken while taking reading in O.C. test to avoid any accident as open terminals of H.V winding are at higher voltage. (for higher voltage rated transformers the HV terminals are at fatally high voltages and hence due precautions must be taken to avoid contact and the specified procedure to be followed then).
3. It is extremely important to note that a low voltage is to be applied to the high-voltage winding during S.C test, just sufficient to circulate full-load current through it.

XI. Procedure

Open circuit test:

1. Make the connections as per the circuit diagram shown in Fig.1
2. Note the rated voltage to determine the range of instruments required
3. Set the auto transformer output to zero and switch “ON” supply.
4. Increase the auto transformer output voltage gradually till rated voltage of low-voltage winding is reached.
5. Note down the readings of voltmeter, ammeter and wattmeter.
6. Bring the autotransformer to minimum position and switch “OFF” the supply

Short circuit test:

1. Make the connections as per the circuit diagram shown in Fig.2
2. Note down the name plate ratings and determine the rated currents for both the windings.
3. Set the auto transformer output to zero and switch “ON” supply.
4. Increase the auto transformer output voltage very slowly & carefully till rated current flows through the winding.
5. Note the readings of voltmeter, ammeters and wattmeter.
6. Bring the autotransformer to minimum position and switch “OFF” the supply.

XII. Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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XIII. Actual Procedure Followed (use blank sheet if space is not sufficient)

A) O. C. test:

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B) S. C. test:

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XIV. Precautions followed:

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XV. Observations and Calculations (use blank sheet if space is not sufficient)

C) Open Circuit test:

Sr. No.	Applied voltage V_0 Volt (V_1)	No load current I_0 amp	No load power W_0 Watt	Secondary voltage V_2 Volt	Transformation Ratio K= V_2/V_1
1	(rated)				

Calculations:

D) Short Circuit test:

Sr. No.	Voltage applied V_{sc} volt	Current circulated I_{sc}amp	Short circuit power W_{sc}watt
1		Rated or F.L =	

Calculations:

XVI. Results

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XVII. Interpretation of Results (Write meaning of the above obtained results)

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX. Practical Related Questions :(Use separate sheet for answer)

(Teacher should provide various questions related to practical- sample are given below)

1. Draw equivalent circuit of transformer referred to primary side. (with above calculated values inserted in proper position)
2. Explain the need for low power factor (LPF) wattmeter for the O.C test.
3. Open circuit and short circuit tests on a transformer are carried out first at 50 Hz and then the same tests are repeated at 60 Hz. Will the parameters obtained from the test in two cases be different? Justify your answer

[Space for answers]

XX. References / Suggestions for further reading

Sr.No.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G. and Karbanda P.K.	S.Chand and Co.Ltd. New Delhi, Edition 2013 ISBN : 9788121901048, 8121901049
2	Electrical Machines	Kothari D. P. and Nagrath I. J.	McGraw Hill Education. New Delhi. ISBN :9780070699670
3	Laboratory Manual for Electrical Machines	Kothari D. P and B.S.Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. https://www.ee.iitb.ac.in
ii. https://www.electrical4u.com
iii. https://www.electricaleasy.com
iv. https://www.electrical4u.com
v. https://www.youtube.com/watch?v=SHi_20pAWiE
vi. https://www.youtube.com/watch?v=nuiDOinVRg8

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Noting the results	05 %
6	Interpretation of results	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No. 10: Perform open circuit and short circuit test on single phase Transformer to determine regulation and efficiency

I Practical Significance

Pre-determining the regulation and efficiency of a transformer at any load condition (at any power factor) is of utmost importance in electrical power system or the relevant industry. Open circuit test and short circuit test are very economical and convenient methods to predetermine the regulation and efficiency of high capacity transformer as they are performed without actually loading of the transformer.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Use electrical motors and transformers.'**

- Select relevant meters with proper range
- Determine total losses of the transformer
- Predetermine regulation and efficiency from test value

IV Relevant Course Outcome(s)

- Use single phase transformer for different application.

V Practical Outcome

- Predetermine regulation and efficiency at different load condition and power factor
- Interpret performance of transformer from the measured value.

VI Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical practices.

VII Minimum Theoretical Background

Open Circuit test (O.C.Test)

It is used to estimate iron losses, transformation ratio and parameters of magnetizing branch of equivalent circuit. It is determined by applying rated voltage to the low voltage winding and keeping the high voltage winding open.

Short Circuit test (S.C.Test)

It is to estimate copper losses and parameters of total equivalent transformer winding impedance by applying low voltage to high-voltage winding, just sufficient to circulate rated full load current or the required load current in the high voltage winding, keeping the low voltage winding short circuited.

Expressions for percentage efficiency and regulation

a) $$\% \text{ Regulation at full load} = \frac{(I_2 R_{02}\cos\emptyset \pm I_2 X_{02}\sin\emptyset)}{V_2} \times 100$$

OR

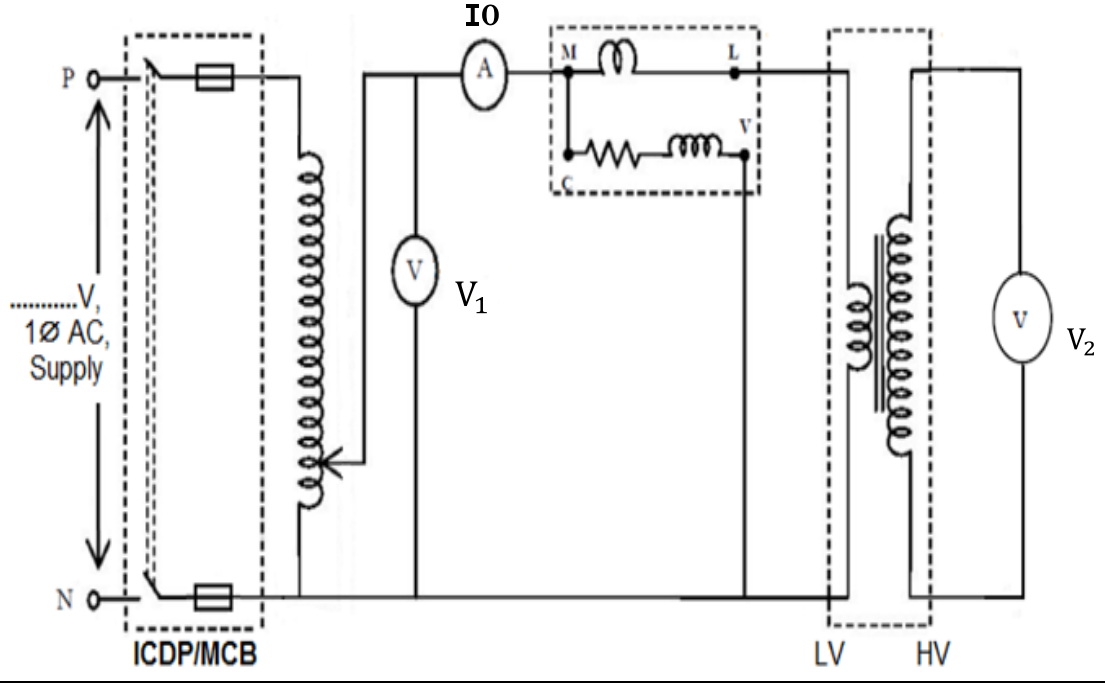
$$= \frac{(I_1 R_{01}\cos\emptyset \pm I_1 X_{01}\sin\emptyset)}{V_1} \times 100$$

$$\% \text{ Regulation at any load} = \frac{(xI_2 R_{02}\cos\emptyset \pm xI_2 X_{02}\sin\emptyset)}{V_2} \times 100$$

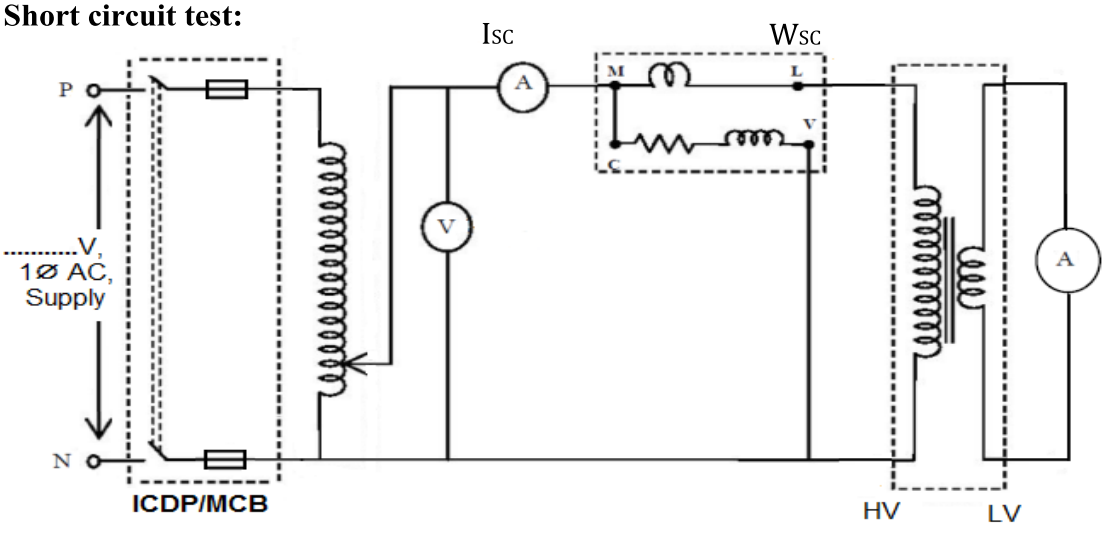
b) $$\% \text{ Efficiency at any load} = \frac{x(\text{VA rating})\times\cos\emptyset}{x(\text{VA rating})\times\cos\emptyset + W_0 + x^2 W_{sc}} \times 100$$

VIII Practical set-up / Circuit diagram / Work Situation

Open circuit Test:



Short circuit test:



Note: Students should write ranges of meters used and rating of transformer used.

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single phase transformer of suitable size	500 VA to1kVA, 230V/115V	1 No.
2	Single phase autotransformer	0-270 V, 15 A	1 No.
3	A.C Voltmeter	0-75/150/300 V, Portable analog MI type as per relevant BIS standard	2 No.
4	A.C Ammeter	0-2.5-5-10 A Portable analog MI type as per relevant BIS standard	2 No.
5	LPF Wattmeter	0-150V/300V, 1/2A	1No.
6	Wattmeter	0-75V/150V/300V, 5/10A	1No.

X Precautions to be followed

1. DO NOT make any connections when the power supply is ON. Get in the habit of turning OFF the power supply after measurement.
2. Ensure that autotransformer knob is at “0” before switching ON the supply.
3. Due care must be taken while taking reading in O.C. test to avoid any accident as open terminals of H.V winding are at high voltage.
4. It is extremely important to note that a low voltage is to be applied to the HV winding during S.C test

XI Procedure

Open circuit test:

1. Note the rated voltages to determine the range of instruments required.
2. Make the connection as per the circuit diagram for O.C Test
3. Set the auto transformer output to zero and switch ON supply.
4. Increase the auto transformer output voltage gradually till rated voltage is reached.
5. Note down the readings of voltmeter, ammeter and wattmeter.
6. Bring the autotransformer knob to minimum position and switch OFF the supply.

Short circuit test:

1. Note down the name plate ratings and determine the rated currents for both the windings of given transformer.
2. Make the connection as per the circuit diagram for S.C Test.
3. Set the auto transformer output to zero and switch ON supply.
4. Increase the auto transformer output voltage very slowly & carefully till rated current flows through the windings.
5. Note the readings of voltmeter, ammeters and wattmeter.
6. Bring the autotransformer to minimum position and switch OFF the supply.

XII Resources Used

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					
5					
6					
7					
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XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

A) O. C. test:

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B) S. C. test:

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XIV Precautions Followed

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XV Observations and Calculations (use blank sheet if space is not sufficient)

E) Open Circuit Test:

Sr. No	Applied voltage (V_1) or (V_o) volt	No load current (I_o) amp	No load power (W_o) watt	Secondary voltage (V_2) volt	Transformation Ratio K= V_2/V_1
1	(rated)				

Calculations:

F) Short Circuit Test:

Sr. No.	Voltage applied (V_{sc}) volt	Current circulated (I_{sc}) amp	Short circuit Input power (W_{sc}) watt
1		Half F.L =	
2		Rated or F.L =	

Calculations:

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions :(Use separate sheet for answer)

(Teacher should provide various questions related to practical- sample given)

1. A single phase transformer is rated at 10 kVA, 440/230V,suggest the ratings of the meters used to measure the voltages, currents and powers on the relevant sides.
2. Calculate total full load losses of transformer under test.
3. Determine the copper losses and core losses of the transformer under the test at: i) half F.L and ii) 60% of F.L

[Space for answers]

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XX References / Suggestions for further reading

Sr. No.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G and Karbanda P.K	S.Chand and Co.Ltd. New Delhi, ISBN : 9788121901048,8121901049 Edition 2013
2	Electrical Machines	Kothari D. P. and Nagrath, I. J.	McGraw Hill Education. New Delhi . ISBN :9780070699670
3	Laboratory Manual for Electrical Machines	Kothari D. P and B.S Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. https://www.ee.iitb.ac.in
ii. https://www.electrical4u.com
iii. https://www.electricaleasy.com/2014
iv. https://www.youtube.com/watch?v=BwlBTZgiIkQ
v. https://www.youtube.com/watch?v=PKo182BBTkc

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Noting the results	05 %
6	Interpretation of results	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 11: Perform parallel operation of two single phase transformers and determine the load current sharing

I. Practical Significance

A power transformer is one of the most vital and an expensive component in the power system. For supplying a load in excess of the rating of an existing transformer, two or more transformers may be connected in parallel with the existing transformer. The transformers are connected in parallel when load on one of the transformers is more than its capacity. The reliability is increased with parallel operation than that having single larger unit. The cost associated with maintaining the spares is less when two transformers are connected in parallel.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.
- **PSO 1. Electrical Equipment:** Maintain various types of rotating and static electrical equipment.
- **PSO 2. Electric Power Systems:** Maintain different types of electrical power systems.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Use electrical motors and transformers.'**

- Select relevant meters with proper range.
- Use transformers to perform parallel operation of two single phase transformers.

IV. Relevant Course Outcome(s)

- Use single phase transformer for different application.

V. Practical Outcome

- Use two single phase transformers for parallel operation to share the load current.

VI. Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/team member.

VII. Minimum Theoretical Background

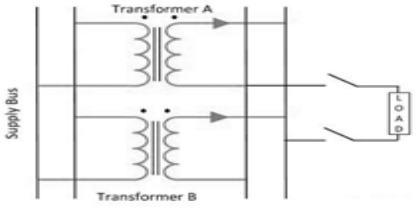
Parallel Operation:

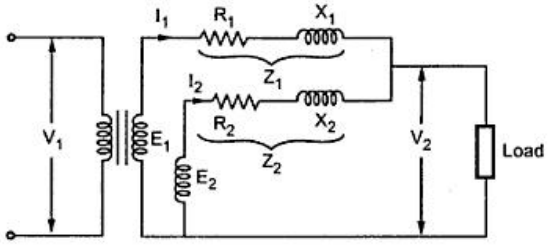
Two transformers are connected in parallel means that the two primary windings are connected in parallel to supply bus and the two secondary windings are connected in parallel to load bus-bar.

Two or more transformers may be connected in parallel with the existing transformer to supply a load in excess of the ratings of an existing transformer. Parallel operation of transformers provides more reliability i.e. even in the failure or out off service of one transformer, critical load can be driven using single transformer in emergency cases.

Conditions for Parallel operation of Transformers

- The line voltage ratio of two transformers must be equal.
- The per unit impedance of each transformer should be equal for load sharing in proportion to their kVA ratings.
- They should have same ratio of equivalent leakage reactance to the equivalent resistance(X/R) for sharing at identical power factors.
- Identical polarity terminals on the respective sides of the transformers are to be connected to each other.





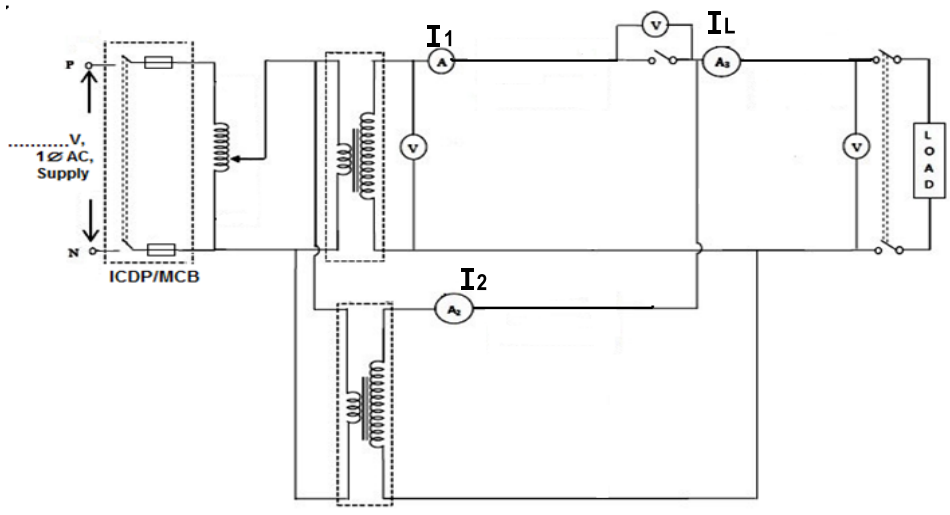
Formula for load current sharing

If $\mathbf{I_L}$ is the load current, then the load current shared by the transformers can be found out by

$$I_1 = I_L \times \frac{Z_2}{Z_1 + Z_2}$$

$$I_2 = I_L \times \frac{Z_1}{Z_1 + Z_2}$$

VIII. Practical set-up / Circuit diagram / Work Situation



Note: Students should write range of meters and rating of equipment on circuit diagram.

IX. Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single phase transformer of suitable size	500 VA to1kVA, 230V/115V	2 No.
2	Single phase autotransformer	0-270 V, 15 A	1 No.
3	A.C Voltmeter	0-75/150/300 V,Portable analog MI type as per relevant BIS standard	3 No.
4	A.C Ammeter	0-2.5-5-10 A Portable analog MI type as per relevant BIS standard	3 No.
5	Lamp Load	10-20 A	1 No.

X. Precautions to be followed

1. DO NOT make any connections with the power supply ON. Get in the habit of turning OFF the power supply after measurement.
2. The load should be in the off position while starting of the practical.
3. The two units must have identical voltage ratings and the same transformation ratio.
4. Transformers should be connected in such a way that the terminals of similar polarity are connected together

XI. Procedure

Note: Perform the following tests before attempting the parallel operation.

- Perform short-circuit tests to determine leakage impedance of each transformer.
- Perform the polarity test on each transformer and label or note down terminals with the same polarity.

Actual Procedure:

1. Set the autotransformer to its minimum output position and keep the load switches OFF.
2. Slowly increase the autotransformer output voltage to the rated value of transformer primary voltage.
3. Verify the voltage across the switch in the secondary circuit by observing the volt meter reading. If it is zero, then close the switch, otherwise switch off the supply and change the transformer secondary connections for correct polarity and repeat the above steps
4. After closing the switch, gradually increase the load and note the values of all meters at half full load and full load.
5. Decrease the load and switch off the mains supply.
6. Switch off the load and bring the autotransformer to minimum position and switch OFF the supply
7. Calculate load current shared by each transformer using relevant formula.

XII. Resources Used

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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3					
4					
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XIII. Actual Procedure Followed (use blank sheet if space not sufficient)

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XIV. Precautions Followed

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XV. Observations and Calculations (use blank sheet if space not sufficient)

Sr. No	I_1 amp	I_2 amp	Measured Load current I_L amp	Calculated Load current I_L amp
1				
2				
3				

Check the result obtained with the analytical calculations

Calculation

XVI. Results

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XVII. Interpretation of Results (Give meaning of the above obtained results)

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX. Practical Related Questions :(Use separate sheet if space is not sufficient)

(Teacher should provide various questions related to practical- sample given)

1. What is the use of voltmeter connected across the switch connected in the secondary circuit?
2. What will happen if two transformers are connected in parallel with unequal impedances?
3. Write the equation for circulating current, if the transformers with unequal voltage ratios.(Consider E1>E2).

[Space for answers]

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XX. References / Suggestions for further reading

Sr.N.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G and Karbanda P.K	S.Chand and Co.Ltd. New Delhi. ISBN : 9788121901048,8121901049 Edition 2013
2	Electrical Machines	Kothari D. P. and Nagrath I. J.	McGraw Hill Education. New Delhi. ISBN :9780070699670
3	Laboratory Manual for Electrical Machines	Kothari D. P and B.S.Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. https://www.electrical4u.com
ii. https://www.electricaleasy.com/2014/06
iii. https://www.youtube.com/watch?v=uFAKbX-ifgg
iv. https://www.youtube.com/watch?v=f07onVbEXTk
v. https://www.youtube.com/watch?v=kuuMR0x2dZ8
vi. https://www.youtube.com/watch?v=UPSa_l8dSfY

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Writing result	05 %
6	Interpretation of result	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 12: Perform parallel operation of two single phases Transformers and determine the apparent and real power load sharing

I. Practical Significance

A power transformer is one of the most vital and an equally expensive component in a power system. Due to load growth an existing transformer may not be able to withstand the demand during peak-hours without exceeding its long-term MVA rating. In most cases, instead of commissioning an entirely new higher capacity unit, a more viable alternative exists in connecting a new smaller unit in parallel to the existing one such that the two share a large peak load in a specific proportion and the one operating near limits is relieved of the burden.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Use electrical motors and transformers.'**

- Select relevant meters with proper range
- Connect the transformers in parallel
- Load the parallel operated transformers with the help of load bank.

IV. Relevant Course Outcome(s)

- Use single phase transformer in relevant industrial application.

V. Practical Outcome

- Measure load shared by each transformer at different load condition.
- Interpret load sharing performance of transformer from the measured values.

VI. Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/team member.

VII. Minimum Theoretical Background

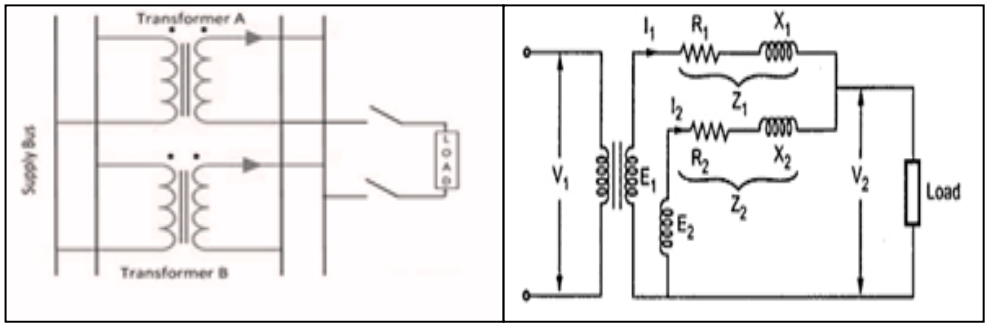
Parallel Operation:

Two transformers are connected in parallel means that the two primary windings are connected in parallel to supply bus and the two secondary windings are connected in parallel to load bus-bars.

Two or more transformers may be connected in parallel with the existing transformers to supply a load in excess of the ratings of an existing transformer. Parallel operation of transformers provides more reliability i.e. even in the failure or out off service of one transformer, half of the bus load can be driven using single transformer in emergency cases.

Conditions for parallel operation of Transformers

- The line voltage ratio of two transformers must be equal.
- The per unit impedance of each transformer should be equal and they should have same ratio of equivalent leakage reactance to the equivalent resistance(X/R) so that they share the load in proportion to their kVA ratings and at identical power factors.
- The polarities of corresponding primary and secondary winding of the two transformers must be same.
- The Transformers should have same phase sequence (Three phase transformer)

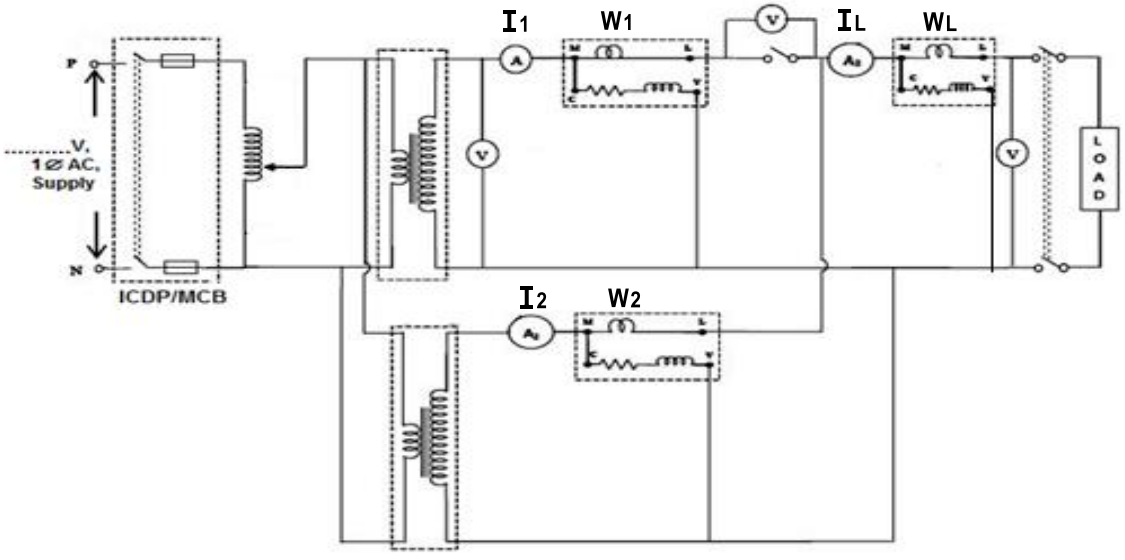


If **S** is the load power in KVA, then the KVA shared by the transformers can be found out by

$$S_1 = S \times \frac{Z_2}{Z_1 + Z_2}$$

$$S_2 = S \times \frac{Z_1}{Z_1 + Z_2}$$

VIII. Practical set-up / Circuit diagram / Work Situation



Note: Students should write range of meters and rating of equipment on circuit diagram.

IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Single phase transformer of suitable size	500 VA to1kVA, 230V/115V	2 No.
2.	Single phase autotransformer	0-270 V, 15 A	1 No.
3.	A.C Voltmeter	0-75V/150V/300 V,Portable analog MI type as per relevant BIS standard	3 No.
4.	A.C Ammeter	0-2.5-5-10 A Portable analog MI type as per relevant BIS standard	3 No.
5.	Lamp Load	10-20 A	1 No.
6.	Wattmeter	0-/150V/300V/600V, 5/10/A	3 No.

X. Precautions to be followed

1. DO NOT make any connections with the power supply ON. Get in the habit of turning OFF the power supply after measurement.
2. The load should be in the off position while starting of the experiment
3. The two units must have identical voltage ratings and the same transformation ratio
4. Transformers should be connected in such a way that the terminals of similar polarity are connected together.

XI. Procedure

Note: perform the following tests before attempting the parallel operation

- Perform short-circuit test and determine the leakage impedance of each transformer.
- Perform the polarity test on each of the units and label or note down terminals with the same polarity.

Actual Procedure:

1. Set the autotransformer to its minimum output, keep the load switches OFF and switch ON the supply.
2. Slowly increase the autotransformer output voltage up to threated voltage value of transformer primaries.
3. Verify the voltage across the switch in secondary circuit, by observing the voltmeter reading. If it is zero, then close the switch, otherwise switch off the supply and change the connections of transformer secondaries for correct polarity and repeat the above steps.
4. After closing the switch, gradually increase the load and note the values of all meters at half full load and full load.
5. Switch off the load, bring the autotransformer to minimum position and switch OFF the supply.
6. Calculate load shared by each transformer using relevant formula.

XII. Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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XIII. Actual Procedure Followed (use blank sheet if space not sufficient)

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XIV. Precautions Followed

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XV. Observations and Calculations (use blank sheet if space not sufficient)

Sr. No	I_1 amp	Real Power W_1 watt	I_2 amp	Real Power W_2 Watt	Real Load Power $W_L = (W_1 + W_2)$ watt	Apparent power S_1 (VA)	Apparent power S_2 (VA)	Total Apparent power S (VA)
1								
2								
3								

Check the result obtained with the analytical l calculations

Calculation

XVI. Results

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XVII. Interpretation of Results (Give meaning of the above obtained results)

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX. Practical Related Questions :(Use separate sheet if space is not sufficient)

(Teacher should provide various questions related to practical- sample given)

1. State the purpose of voltmeter connected across the switch for parallel operation. What does it indicate if voltmeter reading is zero?
2. What will happen if two transformers are connected in parallel with wrong polarity?
3. Compare the experimental and analytical results.
4. When is the circulating current present in the winding circuit of the two transformers connected in parallel?

[Space for answers]

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XX. References / Suggestions for further reading

Sr. No.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G and Karbanda P.K	S.Chand and Co.Ltd. New Delhi, ISBN : 9788121901048,8121901049 Edition 2013
2	Electrical Machines	Kothari D. P. and Nagrath I. J.	McGraw Hill Education. New Delhi. ISBN :9780070699670
3	Laboratory Manual for Electrical Machines,	Kothari D. P and B.S. Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. https://www.electrical4u.com
ii. https://www.electricaleasy.com/2014/06
iii. https://www.youtube.com/watch?v=uFAKbX-ifgg
iv. https://www.youtube.com/watch?v=f07onVbEXTk
v. https://www.youtube.com/watch?v=kuuMR0x2dZ8
vi. https://www.youtube.com/watch?v=UPSa_l8dSfY

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 13: Perform polarity test on a single phase transformer whose polarity markings are masked.

I. Practical Significance

Polarity test is must for transformers when parallel operation is done. Because while doing parallel operation, if you connect terminals of opposite polarity, it will result in a dead short - circuit. So, to connect the same polarity windings together both in primary and secondary, polarity test is done.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **PSO 1. Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.
- **PSO 2. Electric Power Systems:** Maintain different types of electrical power systems.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Determine the relative polarity of the primary and secondary of a transformer at any instant.
- Use transformer for additive and subtractive polarity

IV. Relevant Course Outcome(s)

- Use single phase transformer for different application.

V. Practical Outcome

- Mark the terminals of the primary and secondary winging of the transformer with respect to polarity.
- Connect the transformer for additive and subtractive polarity.

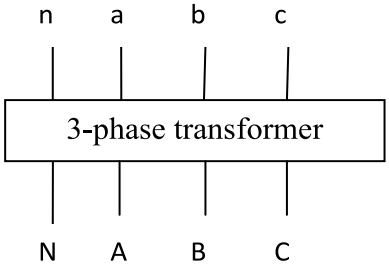
VI. Relevant Affective domain related Outcome(s)

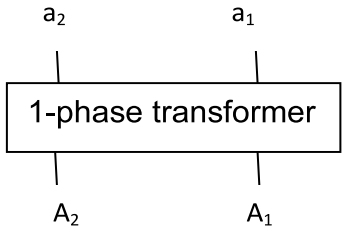
- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/team member.

VII. Minimum Theoretical Background

Terminal marking:

It is the marking of corresponding terminals of H.V. and L.V. sides of a single phase and three phase transformer. High voltage terminals are always marked with upper case letters while low voltage terminals are marked with lower case letters. For a 3 phase transformer viewed from H.V. side, the arrangement of both sets of terminals shall be in alphabetical order from left to right. If neutral is provided, it should be on extreme left.





Types of polarity:

1. Additive polarity **2. Subtractive polarity**

Polarity test: It is essential to know the relative polarity of primary and secondary terminals, at any instant for making correct connections, when the two transformers are to be connected in parallel to share the load on the system.

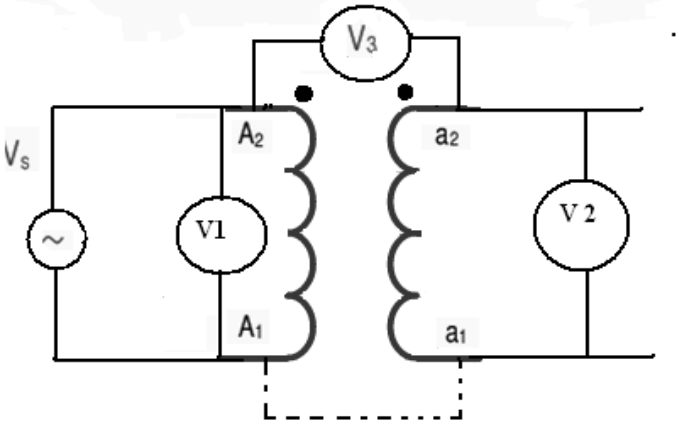


Fig a) A.C Test

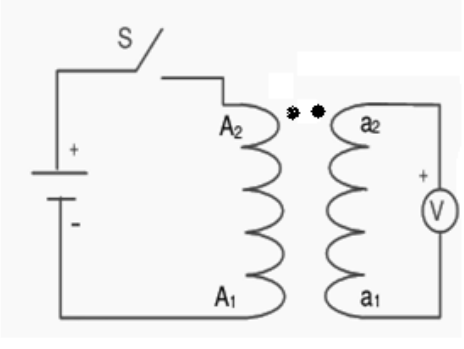


Fig b) D.C Test

Both A.C. and D.C methods can be used for detecting the polarities of the induced e.mfs. The dot method is used to indicate the polarities. The transformer is connected to a low voltage A.C. source with the connection made as shown in the fig.(a). A supply voltage V_s is applied to the primary and the readings of the voltmeters V_1, V_2 and V_3 are noted.

- If V_3 readsV_1-V_2 then assumed dot locations are correct (for the connection shown). The beginning and end of the primary and secondary may then be marked by A_1-A_2 and a_1-a_2 respectively.

- If the voltage rises from A_1 to A_2 in the primary, at that instant it does so from a_1 to a_2 in the secondary.

Fig.(b) shows the D.C method of testing the polarity. When the switch S is closed if the pointer of voltmeter shows momentary deflection (kick) towards positive reading the assumed polarity is correct. If the pointer shows a kick towards negative side (below zero), the assumed polarity is wrong.

VIII. Practical set-up / Circuit diagram / Work Situation

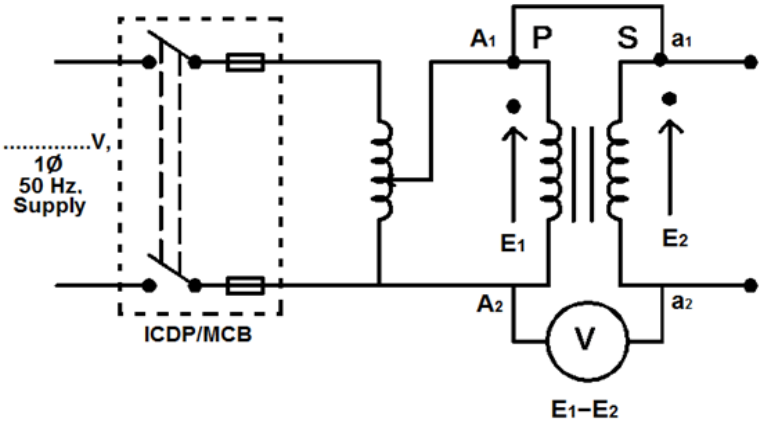


Fig 1 Subtractive polarity

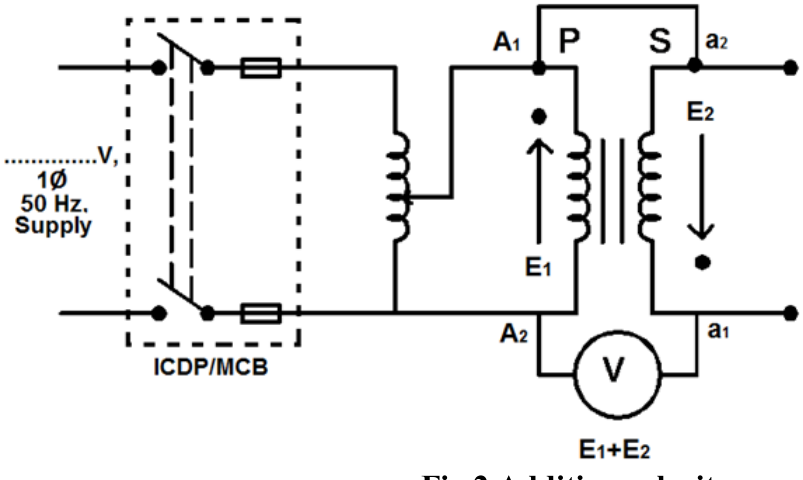


Fig 2.Additive polarity

Note: Students should write range of meters used and rating of transformer used.

IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single phase transformer of suitable size	500 VA to1kVA, 230V/115 V	1 No.
2	Single phase autotransformer	0-270 V, 15 A	1 No.
3	A.C Voltmeter	0-75V/150V/300V, Portable analog MI type as per relevant BIS standard	3 No.

X. Precautions to be followed

1. Follow Safety practices
2. DO NOT make any connections with the power supply ON. Get in the habit of turning OFF the power supply after the practical.
3. Keep the auto transformer output position to zero at start before switching on.

XI. Procedure

1. Make the connections as per circuit diagram. (Fig.1)
2. Primary terminals are marked A_1 and A_2.
3. Short A_1 and a_1 by low resistance wire.
4. Apply suitable voltage through auto transformer across primary.
5. Measure primary voltage E_1,secondary voltage E_2 and voltmeter reading
6. If voltmeter reading is equal to difference of primary voltageE_1 and secondary voltage E_2, then the connected (shorted) terminals are of same polarity.
7. Make the connections as per circuit diagram (Fig.2).
8. Short A_1 and a_2 by low resistance wire.
9. Apply voltage through auto transformer across primary and measure voltage across the remaining terminals of the interconnected windings.
10. If voltmeter reading is equal to sum of primary voltage E_1 and secondary voltage E_2 then the connected terminals are of opposite polarity.
11. Bring the autotransformer to minimum position and switch OFF the supply

XII. Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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XIII. Actual Procedure Followed (use blank sheet if space not sufficient)

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XIV. Precautions Followed

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XV. Observations and Calculations (use blank sheet if space not sufficient)

Sr. No.	Figure No.	E_1volt	E_2volt	Measured Voltage (V)	Calculated Voltage V = (E1- E2) or V = (E1 + E2)	Type of Polarity
1						
2						

Voltmeter Reading

$V = E_1 - E_2$ indicates subtractive polarity connection

$V = E_1 + E_2$ indicates additive polarity connection.

XVI. Results

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XVII. Interpretation of Results (Give meaning of the above obtained results)

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results).

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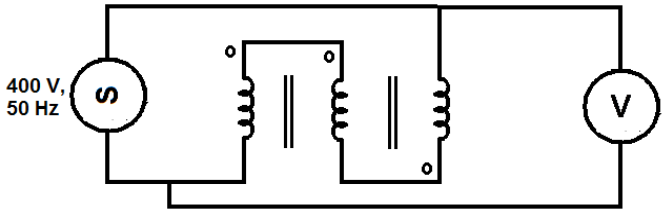
XIX. Practical Related Questions :(Use separate sheet if space is not sufficient)

(Teacher should provide various questions related to practical- sample given)

1. Why is subtractive polarity preferred*?*
2. What will be the effect on parallel operation of transformer if polarity is not proper?
3. A 400V/200V/200V, 50Hz three winding transformer is connected as shown in figure what will be the voltmeter reading



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XX. References / Suggestions for further reading

Sr. No.	Title of Book	Author	Publication
1	A text book of Laboratory Course in Electrical Engineering	Tarnekar S.G. and Karbanda P.K.	S.Chand and Co.Ltd. New Delhi, ISBN : 9788121901048,8121901049 Edition 2013
2	Electrical Machines	Kothari D. P. and Nagrath I. J.	McGraw Hill Education. New Delhi. ISBN :9780070699670
3	Laboratory Manual for Electrical Machines,	Kothari D. P and B.S.Umre	I.K. International Publishing House Pvt. Ltd. ISBN : 9789385909757

i. https://www.electrical4u.com
ii. https://circuitglobe.com
iii. https://www.quora.com
iv. https://electricallive.com/2015/03
v. https://www.youtube.com/watch?v=-jXEco7Mnos

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Noting the results	05 %
6	Interpretation of results	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……..
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.14: Perform Phasing out test on a three phase transformer whose phase markings are masked.

I Practical Significance

Identifying the primary and secondary winding terminals belonging to the same phase of a three phase transformer is a very essential requirement of the power industry. Phasing out test is performed to identify the windings corresponding to the same phase.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers.**

- Use three phase transformer to identify the primary and secondary winding terminals belonging to the same phase.

IV Relevant Course Outcome(s)

- Use three phase transformer for different application.

V Practical Outcome

- Identify the primary and secondary winding terminals belonging to the same phase of the given three phase transformer using phasing out test.

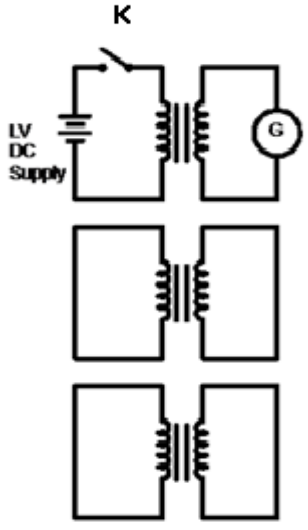
VI Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/ team member.

VII Minimum Theoretical Background

Phasing out is required only in case of three phase transformer to identify primary and secondary winding terminals belonging to the same phase A small direct current is circulated in one of the primary windings and a galvanometer is connected across one of the secondary windings. All remaining primary and secondary windings are short-circuited. A momentary noticeable deflection in the galvanometer on making and breaking of primary current confirms that this secondary winding corresponds to the primary chosen. The test is repeated for other windings.

VIII Practical set-up / Circuit diagram / Work Situation



Note: Students should write range of meters used and rating of transformer used.

IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Three phase transformer of suitable size	2 to3 kVA, 230V/115V	1 No.
2	Low Voltage D.C source	Up to 30V	1 No.
3	Galvanometer	30 mA – 0 – 30 mA	1 No.

X Precautions to be followed

1. Follow Safety practices
2. DO NOT make any connections with the power supply ON. Get in the habit of turning OFF the power supply after the practical.
3. For this test, winding terminals of all the phase should be separate and be available.

XI Procedure

1. Make the connections as per circuit diagram.
2. Apply low voltage D.C. supply using a battery or DC power supply to primary winding.
3. Connect Galvanometer across one of the secondary windings and short all the other windings.
4. Press the key “K” and observe Galvanometer deflection carefully.
5. Connect the Galvanometer to other secondary winding and repeat the procedure.
6. The secondary winding across which maximum deflection occurs, corresponds to primary winding to which D.C. supply is connected.
7. Repeat the same procedure steps 2-5 for other primary windings and identify their respective secondary windings.

XII Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
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XIII Actual Procedure Followed (use blank sheet if space is not sufficient)

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XIV Precautions Followed

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XV Observations and Calculations (Use separate sheet if space is not sufficient)

Sr. No.	D.C. supply given to primary winding	Deflection of Galvanometer observed between secondary terminals.			Remarks
		Deflection across first secondary	Deflection across second secondary	Deflection across third secondary	
1	P1				
2	P2				
3	P3				

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions :(Use separate sheet if space is not sufficient)
(Teacher should provide various questions related to practical- sample given)

1. Can we use low voltage A.C. supply in place of low voltage D.C. for phasing out test? Suggest the modifications in the given experimental setup draw the circuit diagram.
2. What does the deflection of galvanometer on the secondary side indicate?
3. What does null deflection of galvanometer on the secondary side indicate?

[Space for answers]

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XX References / Suggestions for further reading

Sr. No.	Title of Book	Author	Publication
1	Theory and performance of Electrical Machines	J.B. Gupta	Kataria& Sons Publishers of Engineering & Computer Books, Delhi.ISBN : 9789350142776, 9350142775
2	The performance and Design of alternating current machines	M.G. Say	CBS Publishers & Distributors, Delhi ISBN: 9788123910277, 8123910274 – 3rd Edition 2002

i. https://www.allinterview.com/showanswers/128205

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Noting the results	05 %
6	Interpretation of results	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.15: Connect the autotransformer in step-up and step-down modes noting input/output readings

I. Practical Significance

In Industry it is quite often required for diploma Electrical Engineer to use the autotransformer for testing electrical equipment at the limits of specified voltage ranges. This practical gives confidence to use the auto transformers to obtain output voltages above or below the input value.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers.**

- Ability to use Autotransformer to get variable AC voltage.

IV. Relevant Course Outcome(s)

- Use relevant special purpose transformers for different applications.

V. Practical Outcome

- Connect the auto-transformer in step-up and step-down modes noting the input/output readings.

VI. Affective Domain Outcome

- Take precautionary measures for safety.
- Work as a team member

VII. Minimum Theoretical Background

- Working principle of the transformer.
- Transformer turns ratio, voltage ratio.
- Autotransformer is a single winding transformer wherein a part of winding works as the primary winding as well as the secondary winding.

VIII. Practical set-up/ Circuit diagram /Work Situation

PART A: Autotransformer in step-down mode

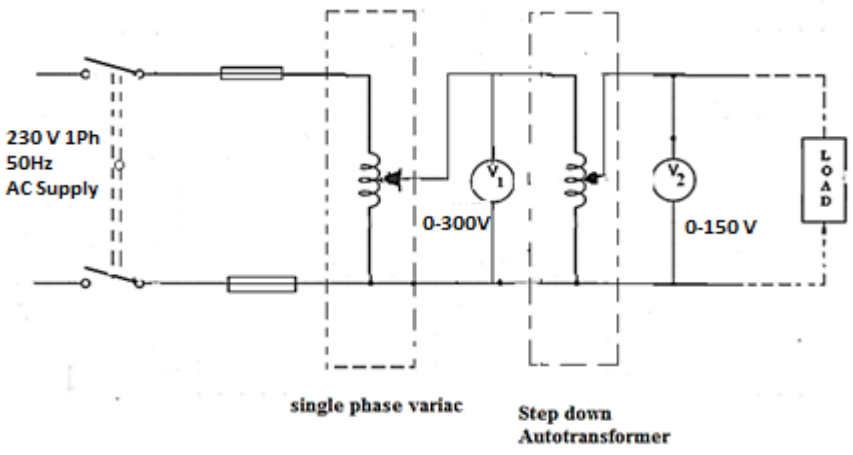

Fig.1 Autotransformer in step-down mode

PART B: Autotransformer in step-up mode

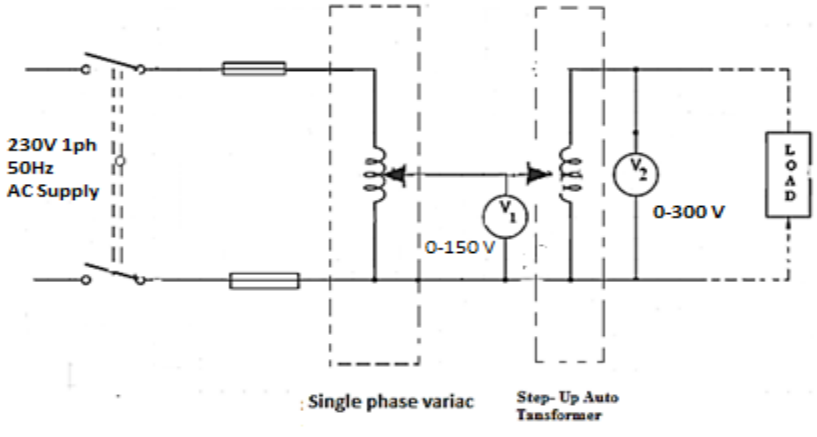

Fig.2 Autotransformer in step-up mode

IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single-phase Autotransformer	Input 230 V, Output 0 to 270 V, 15A, Class B insulation	02(one for stepping up/down, another for variable supply)
2	Voltmeter	(0 – 150 / 300V) MI as per BIS	02
3	Rheostat or lamp bank	750 ohms, 5 Amperes	01

X. Precautions to be followed

1. Make sure that the main switch is in 'OFF' position while making connections.
2. Make sure variable knob of the autotransformer to be stepped down/up is at zero position at the beginning of the practical for part A and at maximum position at the beginning of practical for part B.
3. Make sure load is switched off at the beginning of the practical.*

***Note: Connecting load is optional. Practical may be performed without the load also.**

XI. Procedure

Part A:

1. Make the connections as per the circuit diagram shown in Fig.1
2. Keep the knob of autotransformer to be stepped down at minimum position.
3. Switch on the single phase AC supply.
4. Increase the input voltage so that the voltmeter V_1 reads some voltage, say 100 volts using variac. Note down this voltmeter reading as input voltage V_1.
5. Turn the knob of step-down auto transformer clock wise, so as to apply some voltage across the load.
6. Turn on some load.
7. Observe the reading in voltmeter V_2, and note down this as output voltage V_2.
8. Repeat the steps 4 to 7for different readings of V_1 (say 150V, 200V) and note down input voltage V_1 and corresponding output voltage V_2.
9. Switch off the load.
10. Bring back the knob of the step-down autotransformer to the zero position.
11. Bring the variac output voltage to the minimum.
12. Switch off the supply.

Part B:

1. Make the connections as per the circuit diagram shown in Fig.2
2. Keep the variac at minimum position.
3. Keep the knob of step up autotransformer at the maximum position.
4. Switch on the AC supply.
5. Increase the variac output voltage so that to voltmeter V_1 reads some voltage, say 20 volts. Note down this voltmeter reading as input voltage V_1.
6. Turn the knob of the step-up autotransformer (anticlockwise),so asto apply voltage higher than the input voltage to the load.
7. Turn on some load.
8. Observe the reading in voltmeter V_2 and note down this as output voltage V_2.
9. Repeat the steps 4 to 8 for different readings of V_1 (say 25V, 30V) and note down input voltages V_1 and corresponding output voltages V_2.
10. Switch off the load.
11. Bring back the knob of the step-up autotransformer to the maximum position.
12. Bring back the variac output voltage to minimum.
13. Switch off the supply.

XII. Resources Used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
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XIII. Actual Procedure Followed (use blank sheet if space is not sufficient)

Part A: For using autotransformer in step down mode

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Part B: For using autotransformer in step up mode

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XIV. Precautions Followed

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XV. Observations and Calculations (Use separate sheet if space is not sufficient)

Part A: Autotransformer in step-down mode

Sr.No.	Input voltage V_1 volt	Output voltage V_2 volt	Transformation ratio (V_2/V_1)
1			
2			
3			
4			

Part B: Autotransformer in step-up mode

Sr. No.	Input voltage V_1 volt	Output voltage V_2 volt	Transformation ratio (V_2/V_1)
1			
2			
3			
4			

XVI. Results

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XVII. Interpretation of Results (Write meaning of the above obtained results)

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List the differences between two winding transformer and autotransformer.
2. Give the applications of autotransformer.
3. Give the reason for not using the autotransformers as distribution transformers.
4. List the advantages of autotransformers.
5. List the disadvantages of autotransformers.

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XX. References / Suggestions for Further Reading

Sr. No.	Title of Book	Author	Publication
1	Laboratory Manual for Electrical Machines	Dr.D.P.Kothari B.S.Umre	I K International Publishing House Pvt. Ltd. ISBN-13 978-9385909757
2	Electrical engineering Laboratory Practice	P.Tiwari	S.K.Kataria& Sons ISBN-13 978-8189757892
3	Laboratory Courses in Electrical Engineering	S. G. Tarnekar	S.Chand& Company ISBN-13 978-8121901048
4	Mod-1 Lecture 17 autotransformers on NPTEL		

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
1	Noting the results	05 %
2	Interpretation of results	10 %
3	Conclusions	10 %
4	Practical related questions	10 %
5	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.16: Check the functioning of CT

I. Practical Significance

Current transformers are used at generating stations, electrical substations and in industrial and commercial electric power distribution systems. This practical enables the student to check the functioning of such CTs.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.
- **PSO 1. Electrical Equipment:** Maintain various types of rotating and static electrical equipment.
- **PSO 2. Electric Power Systems:** Maintain different types of electrical power systems.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Ability to check the functioning of the current transformer.

IV. Relevant Course Outcome(s)

- Use relevant special purpose transformers for different applications.

V. Practical Outcome

- Check the functioning of the CT.

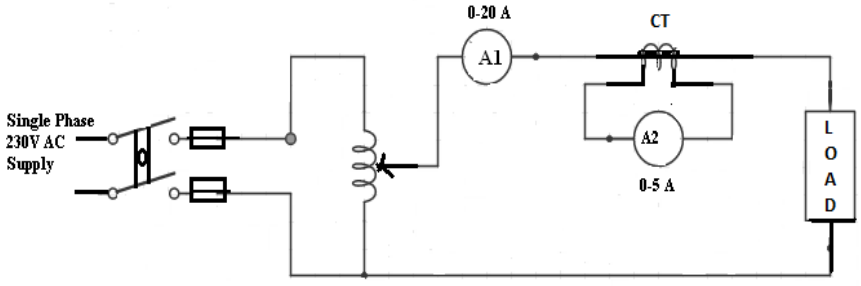
VI. Affective Domain Outcome

- Take precautionary measures for safety
- Work as a team member

VII. Minimum Theoretical Background

- Current transformer is a step-up transformer.
- It is used to measure high current, which is normally not possible to measure using an ammeter.

VIII. Practical set-up/ Circuit diagram /Work Situation



IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Current Transformer	20/5A	01
2	Single phase autotransformer	0 to 270V, 15A, class B insulation	01
3	Ammeter	0-20A	01
4	Ammeter	0-5A	01
5	Load	100 ohms, 5A Or as needed with reference to the CT rating	01

X. Precautions to be followed

1. Identify primary and secondary windings properly.
2. Do not leave the secondary of CT open circuited.

XI. Procedure

1. Make the connections as per the circuit diagram.
2. Keep the auto transformer at minimum output position.
3. Switch ‘ON’ the supply.
4. Increase the supply to apply some voltage across the load terminals.
5. Switch ‘ON’ some load.
6. Observe primary current $I_1$and the corresponding secondary current $I_2$and note them.
7. Repeat the steps 4 to 6 and observe the readings of ammeters A_1 and A_2 for different loads.
8. At the end, switch off the entire load.
9. Bring the autotransformer knob to the minimum position.
10. Switch ‘OFF’ the supply

XII. Resources Used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII. Actual Procedure Followed (use blank sheet if space is not sufficient)

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XIV. Precautions Followed

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XV. Observations and Calculations (use blank sheet if space is not sufficient)

Sr.No.	Primary current I_1 A	Secondary current I_2 A	CT ratio I_1/ I_2

XVI. Results

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XVII. Interpretation of Results (Write meaning of the above obtained results**)**

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results**)**

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the different types of current transformer.
2. List the applications of current transformers.
3. List the precaution while using the CT.

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XX. References / Suggestions for Further Reading

Sr. No.	Title of Book	Author	Publication
1	Laboratory Manual for Electrical Machines	Dr. D. P. Kothari B. S. Umre	I K International Publishing House Pvt. Ltd. ISBN-13 978-9385909757
2	Electrical engineering Laboratory Practice	P. Tiwari	S. K. Kataria& Sons ISBN-13 978-8189757892
3	Laboratory Courses in Electrical Engineering	S. G. Tarnekar	S. Chand & Company ISBN-13 978-8121901048

XXI. Assessment Scheme

Performance Indicators		Weightage %
Process Related:(15 Marks)		**60%**
1	Handling of the Autotransformer (variac)	10%
2	Handling of the current transformer	20%
3	Connecting the circuit	20%
4	Working in team	10%
Product Related (10 Marks)		**40%**
5	Making the observation	05%
6	Interpretation of result	10%
7	Conclusions	10%
8	Practical related questions	10%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100%**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.17: Check the functioning of PT

I. Practical Significance

Potential transformer or **voltage transformer** is used in electrical power system for stepping down the system **voltage** to a safe value which can be fed to low rating meters and relays. Commercially available relays and meters used for protection and metering, are designed for low **voltage**. A diploma Electrical Engineer must possess the knowledge to test the accuracy of the voltage ratio given on the name plate. This practical provides him the confidence to check the accuracy of potential transformer.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers.**

- Ability to check the functioning of the potential transformer.

IV. Relevant Course Outcome(s)

- Use relevant special purpose transformers for different applications.

V. Practical Outcome

- Check the functioning of the PT.

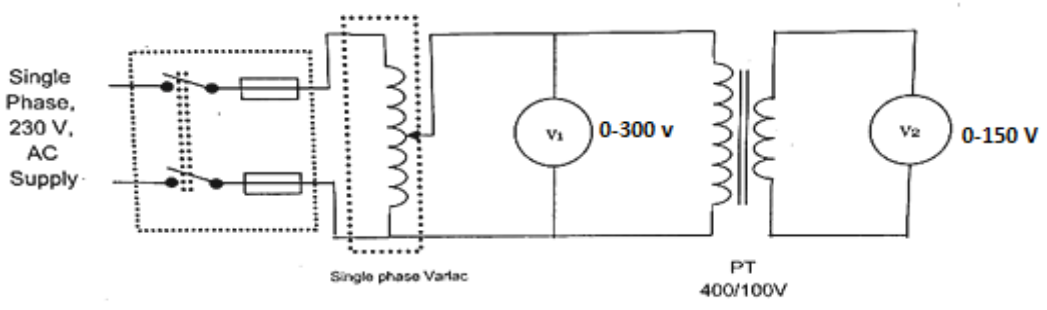
VI. Affective Domain Outcome

- Take precautionary measures for safety
- Work as a team member
- Maintain good housekeeping.

VII. Minimum Theoretical Background

- Working principle of transformer.
- Turns ratio = N_2/N_1, PT ratio= V_1/V_2.

VIII. Practical set-up/ Circuit diagram /Work Situation



IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Potential Transformer with suitable ratio	1100V/ 110V	01
2	Single phase Autotransformer	0-270V, 15A	01
3	Voltmeter	Higher range, suitable to measure primary voltage (0-300V AC)	01
4	Voltmeter	Lower range, suitable to measure secondary voltage (0-150V AC)	01

X. Precautions to be followed

1. Make sure that the main switch on the panel board is in 'OFF' position while making connections.
2. Never short-circuit the secondary terminals of a potential transformer even when it is not in use. The short-circuited secondary will cause the PT to overheat and fail in a very short period of time.

XI. Procedure

1. Connect the circuit as per the circuit diagram.
2. Switch 'ON' the supply.
3. Apply some voltage to the primary of the Potential Transformer through variable power supply.
4. Note down the primary voltage V_1 and the corresponding secondary voltage V_2.
5. Repeat the steps 4-5 for different sets of primary voltage V_1.
6. Bring the variable power supply to the minimum value.
7. Switch 'OFF' the supply.

XII. Resources Used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
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XIII. Actual Procedure Followed (Use separate sheet if space is not sufficient)

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XIV. Precautions Followed

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XV. Observations and Calculations (use blank sheet if space is not sufficient)

Sr. No.	Primary voltage V_1 volt	Secondary voltage V_2 volt	PT ratio (V_1/V_2)
1			
2			
3			
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XVI. Results

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XVII. Interpretation of Results (Write meaning of the above obtained results)

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the differences between CT and PT.
2. List the applications of CT and PT.
3. Give the meaning of burden of PT.

[Space for answers]

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XX. References / Suggestions for Further Reading

Sr. No.	Title of Book	Author	Publication
1	Laboratory Manual for Electrical Machines	Dr. D. P. Kothari B. S. Umre	I K International Publishing House Pvt. Ltd. ISBN-13 978-9385909757
2	Electrical engineering Laboratory Practice	P. Tiwari S. Gairola	S. K. Kataria & Sons ISBN-13 978-8189757892
3	A Text book of Laboratory Courses in Electrical Engineering	S. G. Tarnekar P. K. Karbanda	S. Chand & Company ISBN-13 978-8121901048

XXI. Assessment Scheme

Performance Indicators		Weightage %
Process Related (15 Marks)		**60%**
1	Handling of the auto transformer(variac)	10 %
2	Connecting the circuit and making observation	20 %
3	Working in team	20 %
4	Handling of the potential transformer	10 %
Product Related (10 Marks)		**40%**
5	Noting the result	05 %
6	Interpretation of result	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.18: Check the functioning of Isolation transformer

I. Practical Significance

In Industry an **isolation transformer** is used to transfer electrical power from a source of alternating current (AC) to some equipment or device while **isolating** the powered device from the power source, usually for safety reasons. Through this practical the student will be able to use Isolation transformer.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **PSO 1. Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.
- **PSO 2. Electric Power Systems:** Maintain different types of electrical power systems.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Ability to check Isolation Transformer.

IV. Relevant Course Outcome(s)

- Use relevant special purpose transformers for different applications.

V. Practical Outcome

- Check the functioning of the isolation transformer.

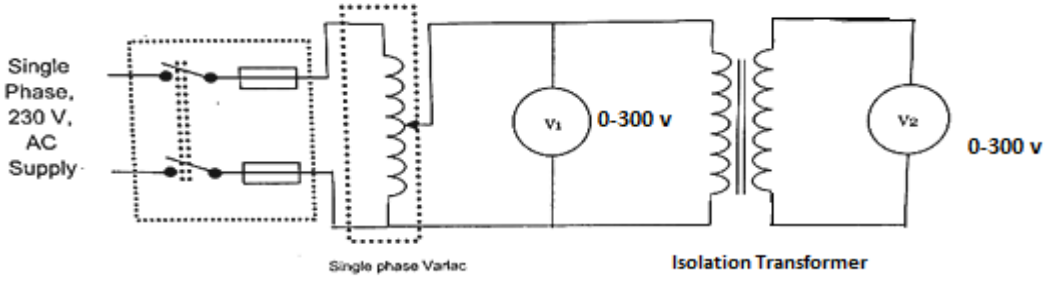
VI. Affective Domain Outcome

- Take precautionary measures for safety
- Work as a team member

VII. Minimum Theoretical Background

- Isolation transformer is 1:1 transformer

VIII. Practical set-up/ Circuit diagram /Work Situation



IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Isolation transformer	Single phase, 1KVA, 230V, class B insulation	01
2	Single phase variable AC supply (Autotransformer)	Input 230V AC, Output 0-270V AC Class B insulation	01
3	Voltmeter	0-300V, AC	02

X. Precautions to be followed

1. Make sure that the main switch on the panel board is 'OFF' while making connections.

XI. Procedure

1. Connect the circuit as per the circuit diagram.
2. Keep the output of variable ac power supply at minimum.
3. Switch ON the supply.
4. Increase the variable supply output of autotransformer to give some input voltage to the primary of isolation transformer.
5. Note down the Input voltage V_1 and corresponding Output voltage V_2 of the Isolation Transformer.
6. Repeat the steps 4 to 5 for different sets of readings V_1.

XII. Resources Used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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XIII. Actual Procedure Followed (Use separate sheet if space is not sufficient**)**

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XIV. Precautions Followed

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XV. Observations and Calculations (Use separate sheet if space is not sufficient)

Sr. No.	Primary voltage V_1 volt	Secondary voltage V_2 volt	Voltage ratio (V_2/V_1)
1			
2			
3			
4			

XVI. Results

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XVII. Interpretation of Results (Write meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List the applications of Isolation Transformer.
2. State the difference between an Isolation transformer and an autotransformer.
3. State the difference between isolated and non-isolated power supply.

[Space for answers]

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XX References / Suggestions for Further Reading

Sr. No.	Title of Book	Author	Publication
1	Laboratory Manual for Electrical Machines	Dr. D. P. Kothari B. S. Umre	I K International Publishing House Pvt. Ltd. ISBN-13 978-9385909757
2	Electrical engineering Laboratory Practice	P. Tiwari S. Gairola	S. K. Kataria & Sons ISBN-13 978-8189757892
3	A Text book of Laboratory Courses in Electrical Engineering	S. G. Tarnekar P. K. Karbanda	S. Chand & Company ISBN-13 978-8121901048
4	https://www.electrical4u.com/isolation-transformer/		

XXI Assessment Scheme

Performance Indicators		Weightage %
Process Related (15 Marks)		**60%**
1	Handling of the Autotransformer(variac)	10%
2	Handling of the isolation transformer	10%
3	Connecting the circuit	20%
4	Working in team	20%
Product Related (10 Marks)		**40%**
5	Making the observation	05%
6	Interpretation of result	10%
7	Conclusions	10%
8	Practical related questions	10%
9	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.19: Check the operation of Pulse Transformer

I. Practical Significance

Pulse transformers can be divided into two major types, power type and signal type.The power type pulse transformer applications include precise control of heating elements fed from fixed DC source for temperature control. The signal type pulse transformer delivers a “pulse-like” signal or a series of pulses. The turns ratio of the pulse transformer can be used to adjust signal amplitude and provide impedance matching between the source and load. Pulse transformers are often used in the transmittal of digital data and in the gate drive circuitry of transistors, F.E.T.s, S.C.R.s etc. Pulse transformer is a very essential and widely used device for low power circuits, high power switched mode power supplies and gate signal generation.Signal type of pulse transformers handle relatively low levels of power. The pulse transformers are usually operated at high frequencies.

II. Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.
- **Engineering tools:** Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **Use electrical motors and transformers**

- Use pulse transformer to test its operation.

IV. Relevant Course Outcome(s)

- Use relevant special purpose transformers for different applications.

V. Practical Outcome

- Identify the terminals of the pulse transformer.
- Test the given pulse transformer for its operation.

VI. Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.

VII. Minimum Theoretical Background

Pulse transformers are a diverse family of transformers designed to transfer a digital control signal from a control circuit to a load. They provide galvanic isolation to a circuit, whilst allowing fast control signals to be transmitted without distorting the signal shape. The input and output signal is typically a rectangular wave of a few volts with a frequency above 100 kHz, not a sinusoidal wave as with conventional transformers. Pulse transformers have a low number of windings (to minimize flux leakage) and low inter-winding capacitance (to ensure that the profile of the signal is maintained on the secondary as cleanly as possible.)As they operate with high frequency signals, the core material must be able to cope with repeated and rapid magnetization and demagnetization. The turn's ratio is typically 1:1 as their main purpose is not to increase or transform the voltage, but to maintain it across the isolation barrier.

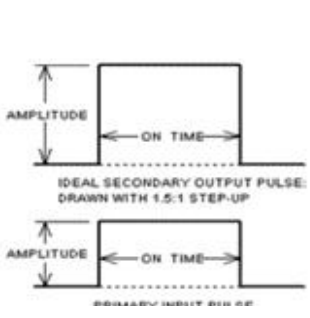


Fig 1. Ideal pulse, Pulse Transformer

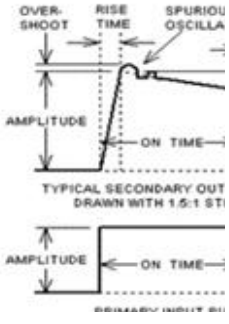
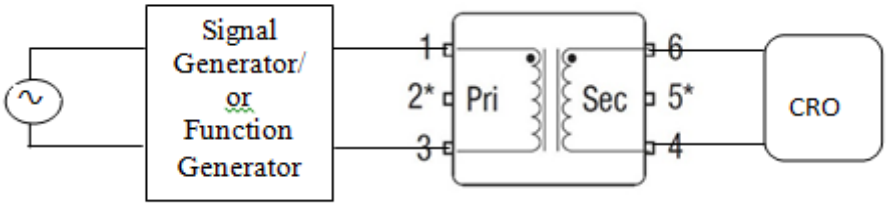


Fig 2.Non-Ideal pulse, Pulse Transformer

VIII. Practical set-up / Circuit diagram / Work Situation



* Pulse transformer of Murata 786 series (78601/1C, 1:1)

Note: Students should write rating of pulse transformer used.

IX. Resources Required

Sr.No.	Name of Resource	Suggested Broad Specification	Quantity
1	Pulse transformer of suitable rating	Input voltage and frequency of relevant rating. 1 vpp signal @ 1khz	1 No.
2	Function Generator	2 MHz multi waveform signal	1 No.
3	Cathode Ray Oscilloscope	20/30/100MHz frequency with attenuator probes	1 No.

X. Precautions to be Followed

1. Follow Safety practices
2. DO NOT make any connections with the power supply is ON. Get in the habit of turning OFF the power supply after the practical.

XI. Procedure

1. Make the connections as per circuit diagram.
2. Energize primary pins 1&3 at relevant suitable voltage and frequency say 1k Hz, 100mV.
3. Observe the waveform at the secondary pins 4 &6.
4. Measure the input and output voltage and check for turns ratio and +/- 1% positive polarity.

XII. Resources Used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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XIII. Actual Procedure Followed (Use separate sheet if space is not sufficient**)**

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XIV. Precautions Followed

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XV. Observations and Calculations (use blank sheet if space is not sufficient)

Sr. No.	Input Voltage	Output voltage	Nature of input waveform	Nature of output waveform	Remarks
1					
2					
3					

XVI. Results

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XVII. Interpretation of Results (Write meaning of the above obtained results)

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XVIII. Conclusions (Actions/decisions to be taken based on the interpretation of results)

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XIX. Practical Related Questions:

(Teacher should provide various questions related to practical- sample questions given below)

1. Why the pulse transformer has less number of turns and low inters winding capacitance.
2. Differentiate between conventional transformer and pulse transformer on any four points.
3. List any two applications of Pulse transformer and state its role in the application.

[Space for answers]

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XX. References / Suggestions for further reading

Sr. No.	Title of Book	Author	Publication
1	Pulse transformers : Design and Fabrication	M.A. Nadkarni, S. Ramesh Bhat	New Delhi : Tata McGraw-Hill ; Bangalore : Centre for Electronics Design and Technology, Indian Institute of Science, ©1985 *ISBN*: 0070965293, 9780070965294.

i. https://www.youtube.com/watch?v=gaitnKYZ-V0Mar 27, 2013
ii. https://www.youtube.com/watch?v=upVkAoA3V7IAug 26, 2010
iii. https://www.youtube.com/watch?v=GgTfUKQQGCk Mar 25, 2017

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10Marks		**40%**
5	Noting the results	05 %
6	Interpretation of results	10 %
7	Conclusions	10 %
8	Practical related questions	10 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101W
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics Engineering	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	C Language programming	22218
15	Basic Electronics	22225
16	Programming in C	22226
17	Fundamental of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemical	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurement	22420
12	Digital Electronic And Microcontroller Application	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048
20	Micro Project & Industrial Training Assessment Manual	22049

Fifth Semester:

1	Network Management & Administration	17061
2	Solid Modeling	17063
3	CNC Machines	17064
4	Behavioral Science(Hand Book)	17075
5	Behavioral Science (Assignment Book)	17075
6	Windows Programming using VC++	17076
7	Estimation and Costing	17501
8	Public Health Engineering	17503
9	Concrete Technology	17504
10	Design of Steel Structures	17505
11	Switchgear and Protection	17508
12	Microprocessor & Application	17509
13	A.C. Machines	17511
14	Operating System	17512
15	Java Programming	17515
16	System Programming	17517
17	Communication Technology	17519
18	Hydraulic & Pneumatics	17522
19	Advanced Automobile Engines	17523
20	Basic Electrical & Electronics	17524
21	Measurement and Control	17528
22	Power Engineering	17529
23	Metrology & Quality Control	17530
24	Computer Hardware & Networking	17533
25	Microcontroller	17534
26	Digital Communication	17535
27	Control System & PLC	17536
28	Audio Video Engineering	17537
29	Control System	17538
30	Industrial Electronics and applications	17541
31	Heat Transfer Operations	17560
32	Chemical Process Instrumentation & control	17561

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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