SCHEME : K

Name : _____

Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

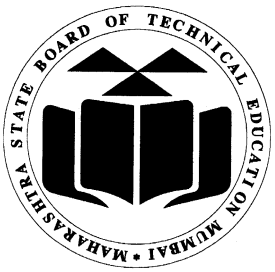
LABORATORY MANUAL FOR

BASIC MECHANICAL ENGINEERING

(312006)

ELECTRICAL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF
TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)



Maharashtra State
Board of Technical Education, Mumbai

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 challenging technological & environmental challenges.

A Practical Manual
for

Basic Mechanical Engineering
(312006)

Semester– (II)

(Diploma in Electrical Engineering)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO-9001-2008) (ISO/IEC 27001:2013)

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Board of Technical Education, Mumbai

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4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai -400051.

Maharashtra State
Board of Technical Education

Certificate

This is to certify that Mr. / Ms ……. Roll No……. of Second Semester of Diploma in …….of Institute ……..

(Code……..) has completed the term work satisfactorily in course Basic Mechanical Engineering **(312006)** 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**

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 'K' Scheme curricula for engineering diploma programmes with National Education Policy2020 (NEP2020) and outcome-based 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 practical to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practical 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.

Knowledge of Thermal Power Plant, Industrial Material handling system and different mechanical equipment are essential in all fields of engineering.

The Practical manual development team wishes to thank MSBTE who took initiative in the development of curriculum and implementation and also acknowledge the contribution of individual course experts who have been involved in laboratory manual as well as curriculum development (K scheme) directly or indirectly.

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.

Lab Manual Development Team

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

Following POs are expected to be achieved through the practicals of the (Basic Mechanical Engineering) course.

PO1. Basic and Discipline specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the mechanical engineering problems.

PO 2. Problem analysis: Identify and analyse well-defined mechanical engineering problems using codified standard methods.

PO 3. Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs in mechanical engineering.

PO 4. Engineering Tools, Experimentation and Testing: Apply modern mechanical engineering tools and appropriate technique to conduct standard tests and measurements.

PO 5. Engineering practices for society, sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO 6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about welldefined engineering activities in diverse and multidisciplinary fields.

PO 7. Life-long learning: Ability to analyse individual needs and engage in updating in the context of technological changes in mechanical engineering.

List of Industry Relevant Skills-

The following industry relevant skills of the competency 'Maintain electrical systems used in industrial mechanical machinery and equipment' are expected to be developed in you by undertaking the practical of this laboratory manual.

1. Understand working of hydraulic pumps, Air compressors and Refrigeration system
2. Measure different properties of system using appropriate measuring instrument.
3. Identify different components of mechanical Engineering system.
4. Identify different faults in the mechanical and hydraulic equipment.
5. Understand working of industrial material handling system.

Practical- Course Outcome matrix

Course Outcomes (COs)

a) Understand working of Thermal Power Plant.
b) Select different components used in Material handling system.
c) Use of Hydraulic turbine and Hydraulic pumps.
d) Understand working of Air compressor and Refrigeration system

S. No.	Laboratory Practical Titles	CO a.	CO b.	CO c.	CO d.
1	Identify Steam Boilers using Models and Charts*	√	-	-	-
2	Demonstrate working of Steam Turbine	√	-	-	-
3	Measure temperature of different equipment using temperature measuring devices.	√	-	-	-
4	Measure pressure of different equipment using pressure measuring devices.	√	-	-	-
5	Measure speed of different rotating elements using speed measuring devices	√	-	-	-
6	Measure heat of given fluid using calorimeter.	√	-	-	-
7	Demonstrate working of portable generator	√	-	-	-
8	Identify drive system using models / actual set up.	-	√	-	-
9	Calculate Velocity ratio of given gear/belt drive of suitable mechanical System*	-	√	-	-
10	Demonstrate of working of lift/conveyor used in industry.	-	√	-	-
11	Demonstrate of working of overhead crane used in industry.	-	√	-	-
12	Demonstrate of working of Hydraulic Power Plant*.	√	-	√	-
13	Identify different components of Centrifugal Pump	√	-	√	-
14	Identify different components of Reciprocating Pump	√	-	√	-
15	Measure Pressure, temperature of air compressor at different points. *				√
16	Calculate speed ratio of Belt drive used in Air compressor and Driven motor. *				√
17	Demonstrate working of Household refrigerator for identifying different components and type. *				√
18	Demonstrate working of Window air conditioner for identifying different components.				√
19	Collect water lifting systems in an ancient India relation with hydraulic pumps. (IKS)*	-	√	√	-

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 practical.
3. For difficult practical 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 teacher can maintain various practical related question banks 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, Technical Manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practical.

Content Page

List of Practical and Progressive Assessment Sheet

S. No	Laboratory Practical Titles	Page No.	Date of performance	Date of submission	FA PR marks (25)	Dated sign. of teacher	Remarks (if any)
18	Demonstrate working of Window air conditioner for identifying different components.	109					
19	Collect water lifting systems in an ancient India relation with hydraulic pumps. (IKS)*	115					
Total							

Note: To be transferred to Proforma of CIAAN-2023.

A suggestive list of LLOs is given in the above table. More such LLOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practical marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

Practical No.1
Identify Steam Boilers using Models and Charts

I. Practical Significance

Boilers are widely used in Industry like Thermal power plant, Chemical Industry, Processing Industry, Dairy etc. To identify different faults and its causes of steam boilers, it is essential to understand working and different types of boilers using in the power plants and industries.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer 'Interpret various mechanical faults in industrial mechanical systems'

III. Course Level Learning Outcome (CO)

CO1- Understand working of Steam power plant.

IV. Laboratory Learning Outcome(s)

Identify Different components of Thermal Power Plants

V. Relative Affective Domain related Outcome(s)-

- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

A steam boiler is a closed vessel in which fluid (typically water) is heated. The steam exits from the boiler used for various processes or heating applications or boiler-based thermal power plant power generation. Boilers are an essential part of thermal power plants.

VII. Experimental setup

1. Name of Boiler- Babcock and Wilcox Boiler

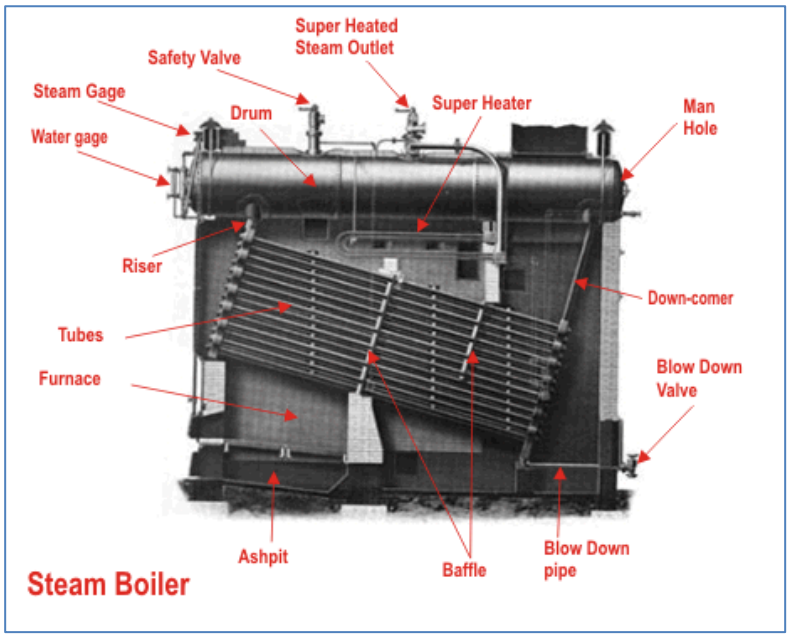


Figure 1 (Source:https://www.electrical4u.com/steam-boiler-working-principle-and-types-of-boiler/#google_vignette)
Babcock and Wilcox Boiler

2. Name of Boiler - Lamont Boiler

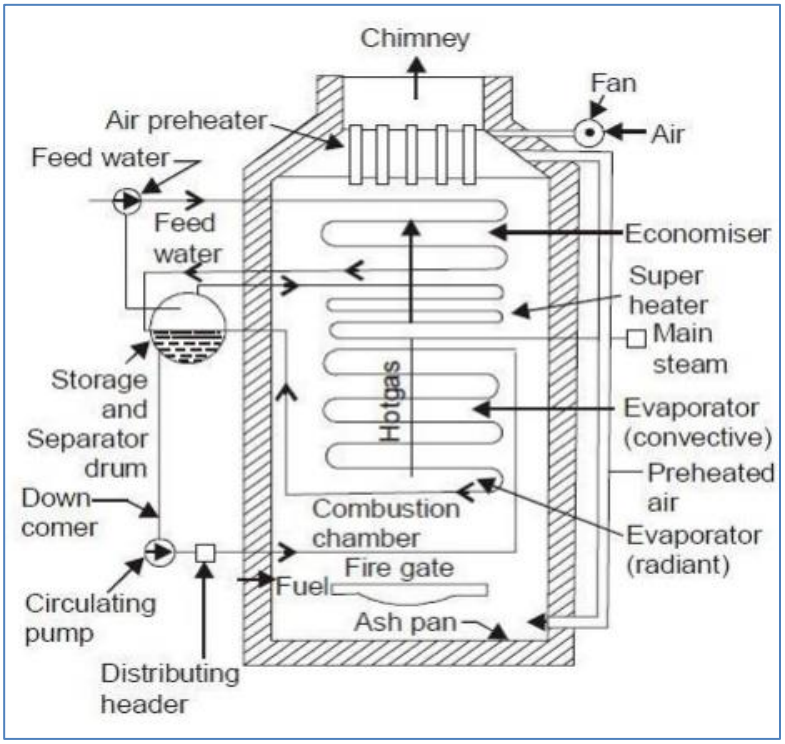


Figure 2 (Source:https://www.eeeguide.com/la-mont-boiler-construction-and-working/)
Lamont Boiler

3. Name of Boiler- Loeffler Boiler

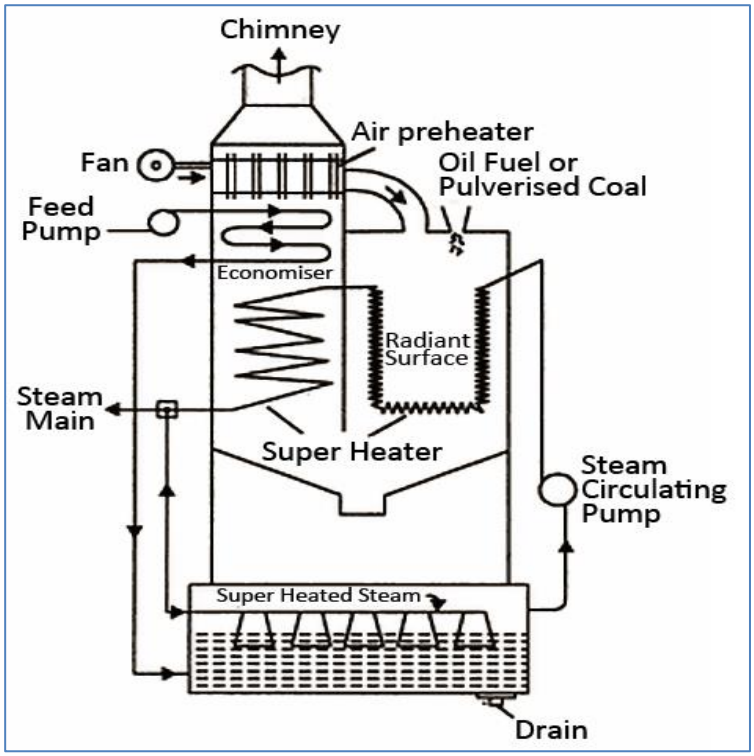


Figure 3
Loeffler Boiler (Source: https://electricguider.com/what-is-loeffler-boiler/)

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
	Babcock and Wilcox Boiler	Model of Babcock and Wilcox Boiler showing all important parts	01
	Babcock and Wilcox Boiler	Chart of Babcock and Wilcox Boiler showing all important parts	01
	Lamont Boiler	Chart of Lamont Boiler showing all important parts	01
	Loeffler Boiler	Chart of Loeffler Boiler showing all important parts	01

IX. Precautions to be Followed

Avoid improper handling of Boiler Model.

X. Procedure

1. Explain layout of Thermal Power Plant
2. Explain the use of steam boiler in steam power plant
3. Classify steam Boilers used in industry
4. Explain applications of low pressure and high-pressure boilers in the industry
5. Demonstrate working of Babcock Wilcox boiler using model
6. Demonstrate working of Lamont boiler using chart
7. Demonstrate working of Loeffler boiler using chart

XI. Observations and calculations

Name of Boiler	Name the components	Function
Babcock and Wilcox Boiler		

Name of Boiler	Name the components	Function
Lamont Boiler		
Loeffler Boiler		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Draw any one Steam Boiler on graph paper
2. Write specification of any one boiler used in sugar industry/pharmaceutical industry/thermal power plant.
3. State necessity of steam boiler in steam power plant.
4. Differentiate between Babcock-Wilcox boiler and Lamont Boiler on the basis of steam generation capacity, Pressure of steam, Size of Boiler, application

[Space for Answer]

XVI. References / Suggestions for Further Reading

- **https://www.youtube.com/watch?v=ae_QmSRhD5w**
- **https://www.youtube.com/watch?v=YbXAGF-gMh0**
- **https://www.youtube.com/watch?v=fc8AKkEDFhc**
- **https://www.youtube.com/watch?v=Pa7xoGJ3y8g**
- **https://www.youtube.com/watch?v=ChvI2v85fsU**
- **https://www.youtube.com/watch?v=Ht2wgH_EWQU**

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the measuring Instruments	20%
	Calculation of final readings	00%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

Marks Obtained			Dated signature of Teacher
Process Related(5)	**Product Related(20)**	**Total (25)**	

Practical No. 02
Demonstrate working of steam turbines

I. Practical Significance

Steam turbines are important devices in the field of Thermal Engineering and Electrical engineering. Steam turbines are employed as the prime movers together with the electric generators in thermal and nuclear power plants to produce electricity. They are also used to propel large ships, ocean liners, submarines and to drive power absorbing machines like large compressors, blowers, fans and pumps.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

List different components of Steam turbines.

State functions of each component of a Steam turbine.

III. Course Level Learning Outcome (CO)

COa.- Understand working of Steam turbine..

COc.- Use of Steam turbine and Electric generators in thermal power plant.

IV. Laboratory Learning Outcome(s)

Use of Steam turbine for given application.

V. Relative Affective Domain related Outcome(s)-

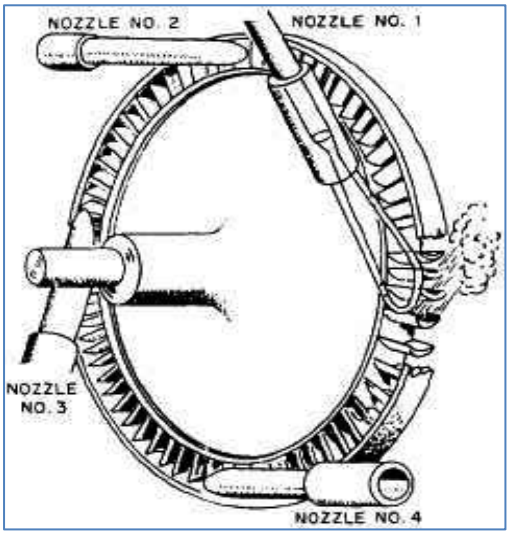
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

Impulse turbine has nozzles and moving blades. The nozzles are convergent-divergent type while moving blades are symmetrical in shape. Reaction turbines employs aerofoil shaped blades. The shape of fixed as well as moving blades are same.

VII. Experimental setup (Model)-

Name of Turbine----------



(Name the components)

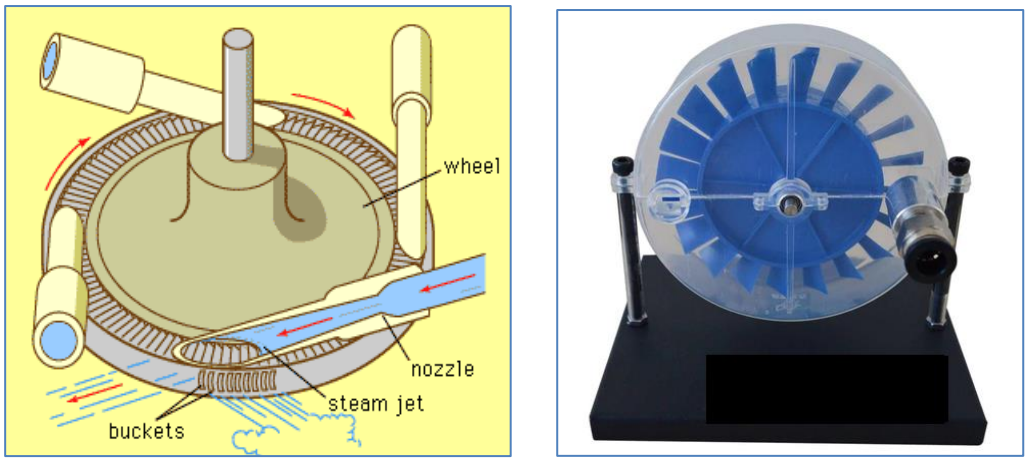


Fig.1 De- laval recation turbine and model of steam turbine

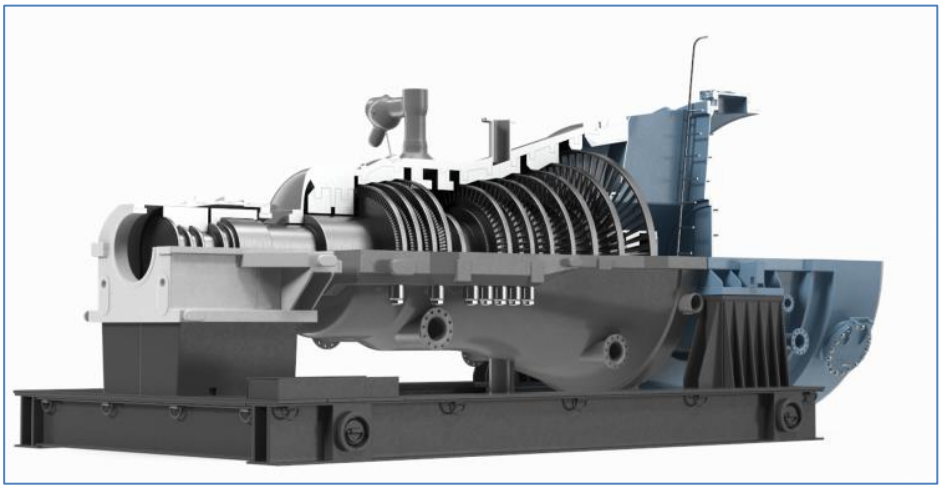
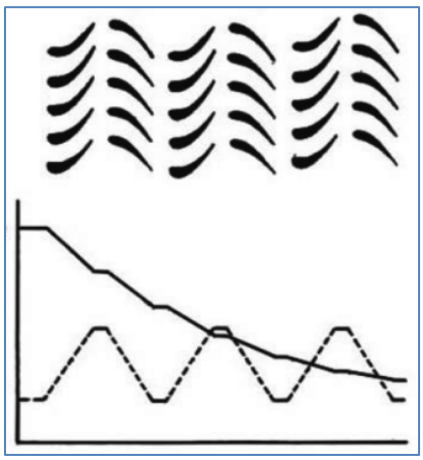


Fig.2 Cut section of steam turbine(https://www.turbosquid.com/FullPreview/1400502)

Name of Turbine----------



(Name the components)

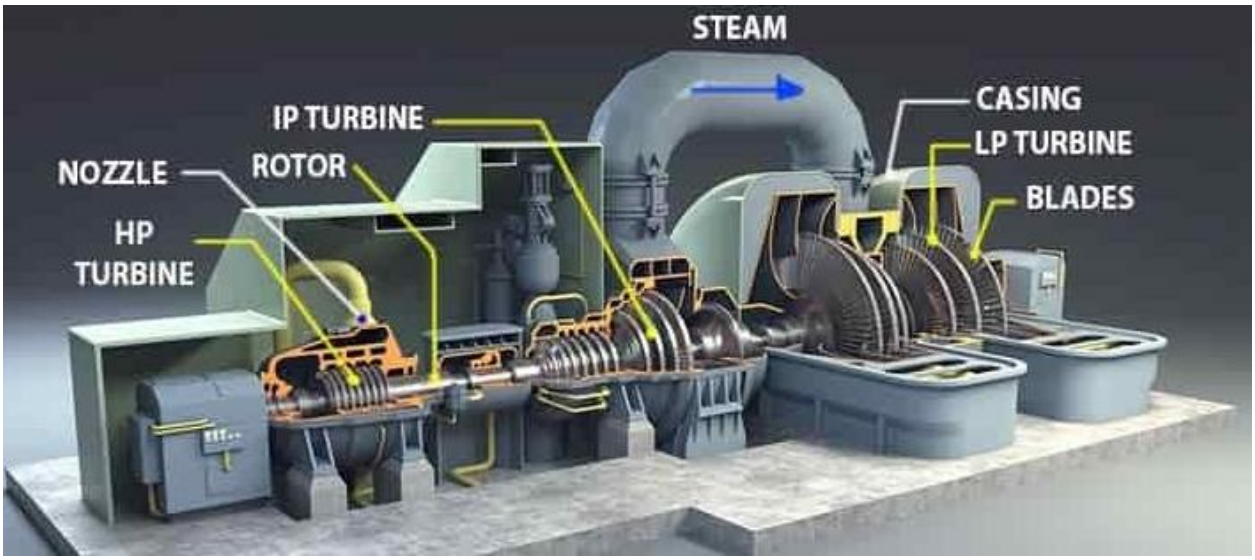


Fig.3 Construction of Steam turbine (components)

(Source:https://www.quora.com/What-safety-measures-ensure-the-secure-operation-of-industrial-steam-turbines)

VIII. Required Resources /Apparatus/Equipment with specification

S.No.	Name of Resource	Suggested Broad Specification	Quantity
1	Impulse Turbine	Model of Steam turbines showing all important parts	01
2	Reaction Turbine	Chart of Steam turbines showing all important parts	01

IX. Precautions to be Followed

- Avoid improper handling of Turbine Models.
- Use safety shoes.
- Use tools safely.

X. Procedure

1. Explain working principle of steam turbine.
2. Explain the difference between Impulse and reaction turbines along with applications.
3. Explain the main components of a Steam turbine.
4. Explain functions of each component of Steam turbine.
5. Demonstrate working of Steam turbine using chart.
6. Demonstrate working of Steam turbine using model.

XI. Observations and calculations

Turbine type	Name the components	Shape/Location	Function
Impulse	Fixed Blades		

Turbine type	Name the components	Shape/Location	Function
Turbine			
	Movable Blades		
	Turbine-Rotor		
	Diaphragm		
	Bearings		
	Turbine Seals		

Turbine Type	Name the components	Shape/Location	Function
Reaction Turbine	Fixed Blades		
	Movable Blades		
	Turbine-Rotor		
	Diaphragm		
	Bearings		
	Turbine Seals		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV 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. Collect specifications of steam turbines used in different applications.
2. State eight differences between Impulse and Reaction turbines.
3. State the necessity of compounding in steam turbines. Explain velocity compounding with neat sketches.
4. Collect data of steam turbines used in non-conventional power sector.
5. Explain why Impulse turbine is not used in high pressure applications.

[Space for Answer]

XVI. References / Suggestions for Further Reading

- https://www.mechanicalengineeringsite.com/steam-turbine-basic-parts/
- https://www.gepower.com/steam/steam-turbines.

XVII Rubrics for Assessment Scheme

Performance Indicators	Weightage
Process Related (15 Marks)	**(20**%)
Handling of the models/set up	20%
Observations of the models/set up	00%
Product Related (10 Marks)	**(80**%)
Interpretation of result	40%
Conclusions	20%
Practical related questions	20%
T**otal**	100 %

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

Practical No. 03
To Measure temperature of different equipment's using temperature measuring devices.

I. Practical Significance

Temperature is an intensive thermodynamic property, which determines the degree of hotness or the level of heat intensity of a body. The temperature of a body is measured by an instrument known as thermometer. In different industrial applications the temperature of body or fluids is required to be measured by appropriate temperature measuring device to check, analyze and control the systems. The temperature measurement is required in furnaces, boilers, steam turbines, automobile sector in engines, refrigeration and air-conditioning systems,etc

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer.

List different types of temperature measuring devices.

State working principle of temperature measuring device along with its applications.

State the function of each component of temperature measuring device.

III. Course Level Learning Outcome (CO)

COa.- Understand working of different temperature measuring devices.

COc.- Use of thermocouples, mercury thermometer and other temperature measuring devices to measure temperature at different points in system.

IV. Laboratory Learning Outcome(s)

Use of thermocouple for given application.

V. Relative Affective Domain related Outcome(s)-

- Maintain tools and equipment's.
- Follow safety practices

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VI. Minimum Theoretical Background with diagram (if required)

Optical pyrometers measure temperatures in the visible spectrum, usually between 700°C and 4,000°C. It works by comparing the photometric brightness of the heated object with the brightness of a reference source. Thermocouple is an active transducer which generates e.m.f. It is simple electrical temperature sensitive device. It provides a reliable method of temperature measurement. It is widely used in industrial applications to monitor temperature of liquid and gaseous in storage and pipes. Thermocouple basically consist of two dissimilar metallic wires connected together so as to form two junctions. One junction is kept at constant temperature (cold junction) and other is heated (hot junction).

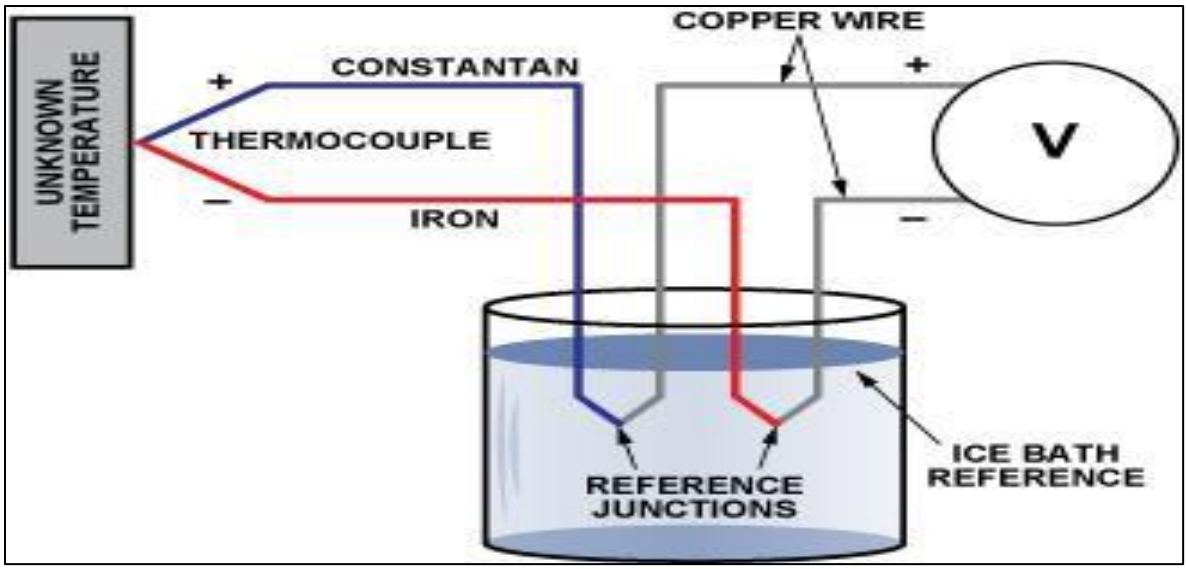
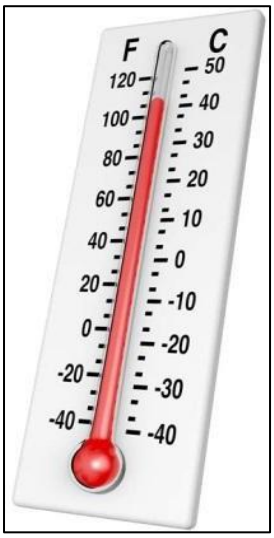


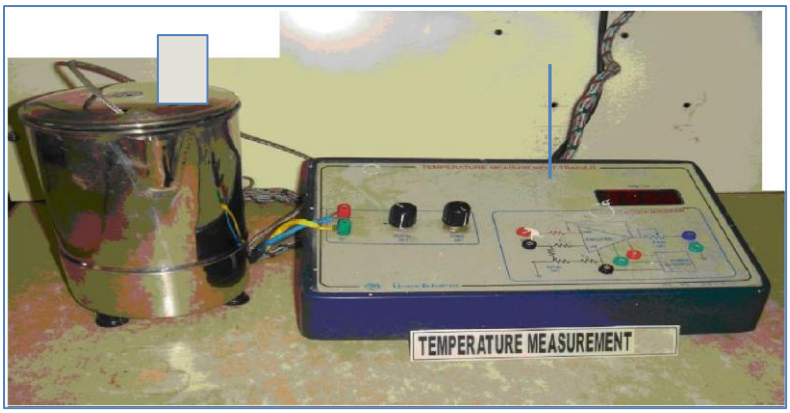
Fig. 3.1 Principle of Thermocouple



Thermometer

Infrared Thermometer (Source: Thermometermgbin.com/png/tt17nMLr/pyrometer-infrared-thermometers-optics-measurement-png)

VII. Experimental setup (Model)-



VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Thermocouple Set up assembly with heating arrangement.	Thermocouple, Mercury-thermometer, Vessels for hot and cold junctions, Milli-voltmeter/Multimeter, Induction heater for hot junction.	1
2	Optical or infrared thermometer	Up to 2000° C	1
3	Display	3.5 digital display showing temperature reading.	1
4	Power supply	12V, 500 mA to drive AC to DC converter	1

IX. Precautions to be Followed

- Avoid improper handling thermocouple experimental set up.
- Handle the mercury thermometer with due care.
- Use safety shoes.
- Use tools safely.

X. Procedure

1. Immerse Thermocouple hot junction and cold junction in the pan.
2. Place Thermometer at hot pot.
3. Keep system in 'ON' position for 10 minutes.
4. Note down the temperature of thermometer and indicator display of thermocouple.
5. Note down the EMF reading with the help of Multi meter.
6. Check initial setting of infrared thermometer
7. Note down reading for any three hot objects

XI. Observations and calculations -

a. Thermocouple

Sr No.	Indicator reading of thermocouple set up (°C)	EMF generated (Mili-Volt)	Actual temperature by thermometer (°C)
1			
2			
3			

b. Optical/Infrared Thermometer

Sr No.	Name of Hot object	Temperature (°C)
1	Welding spark	
2	Hot flame	
3	Furnace in smithy shop	

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Collect specifications of different temperature measuring devices used in different applications.
2. Explain the construction and working of thermocouple with neat sketch.
3. Explain see-back effect on which thermocouples work.
4. List the different types of temperature measuring instruments used in industries.
5. Explain the construction and working of optical pyrometer.
6. Suggest instrument to measure a. Temperature of hot plate

[Space for Answer]

XVI. References / Suggestions for Further Reading

- www.youtube.com/watch?v=Xp7ZNAc9Fis
- www.youtube.com/watch?v=0DdzZLkQL98
- www.youtube.com/watch?v=xaxGZZR2lsc

XVII Rubrics for Assessment Scheme

Performance Indicators		**Weightage**
Process Related (15 Marks)		**(20**%)
	Handling of the measuring Instruments	10%
	Calculation of final readings	10%
Product Related (10 Marks)		**(80**%)
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No. 04
To Measure pressure of different equipment's using pressure measuring devices.

I. Practical Significance

Pressure measurement is the analysis of an applied force by a fluid on a surface. Pressure is typically measured in units of force per unit of surface area. Many techniques have been developed for the measurement of pressure. The instruments used to measure and display pressure in the integral unit are called pressure gauges. The pressure gauges are commonly used in pumps, turbines, Hydraulic/Pneumatic operated machines,etc

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

- List different components of Bourdon's pressure gauge.
- State functions of each component of a Bourdon's pressure gauge.

III. Course Level Learning Outcome (CO)

COa.- Understand working of Bourdon's pressure gauge..

COc.- Use of Bourdon's pressure gauge to measure pressure at different points in system.

IV. Laboratory Learning Outcome(s)

Use of Bourdon's pressure gauge for given application.

V. Relative Affective Domain related Outcome(s)-

- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

Bourdon pressure gauge is used to measure pressure of fluid in the system. The pressure to be measured is applied to the curved tube oval in cross section. Pressure applied to the tube tends to cause the tube to strengthen out. The deflection of the tube is communicated through the system of levers to the recording needle.

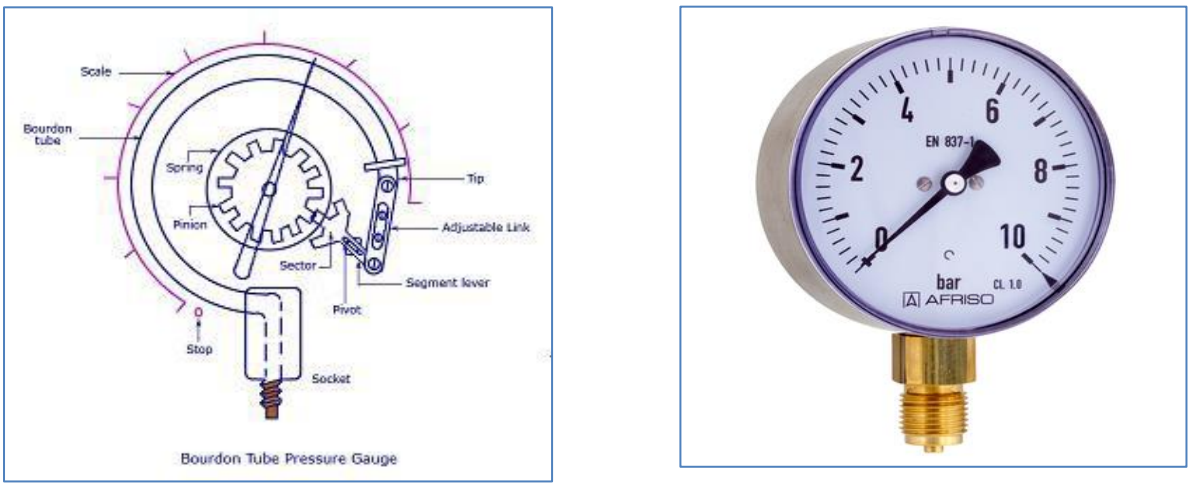


Fig.1 Bourdon Tube Pressure gauge
(Source:https://www.afriso.com/en/PM/Industrial-technology/Mechanical-pressure-measuring-instruments)

VII. Experimental setup (Model)-

1) Name of Equipment – Two Stage Reciprocating Air Compressor Test Rig.

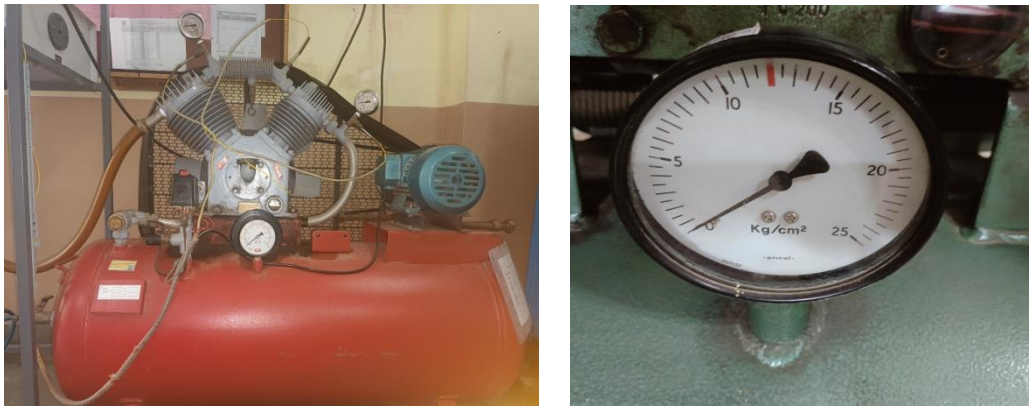


Fig.1 Compressor test rig and pressure gauge mounted on air receiver

2) Vapour Compression Refrigeration System Test Rig.

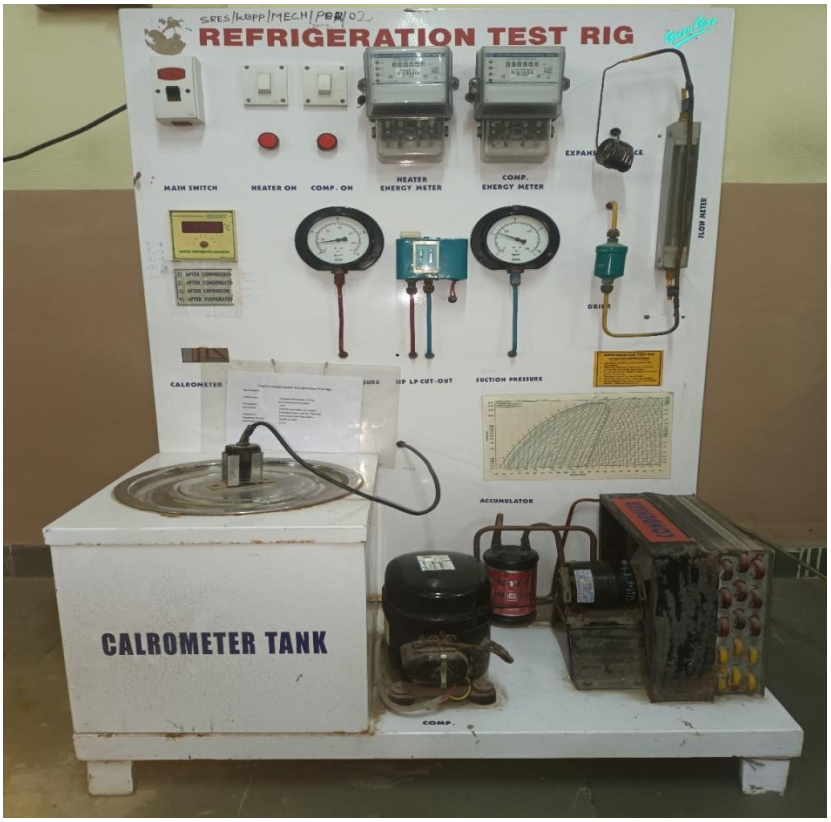


Fig.2 Vapour Compression Refrigeration System Test rig

3) Centrifugal /Reciprocating Pump test rig

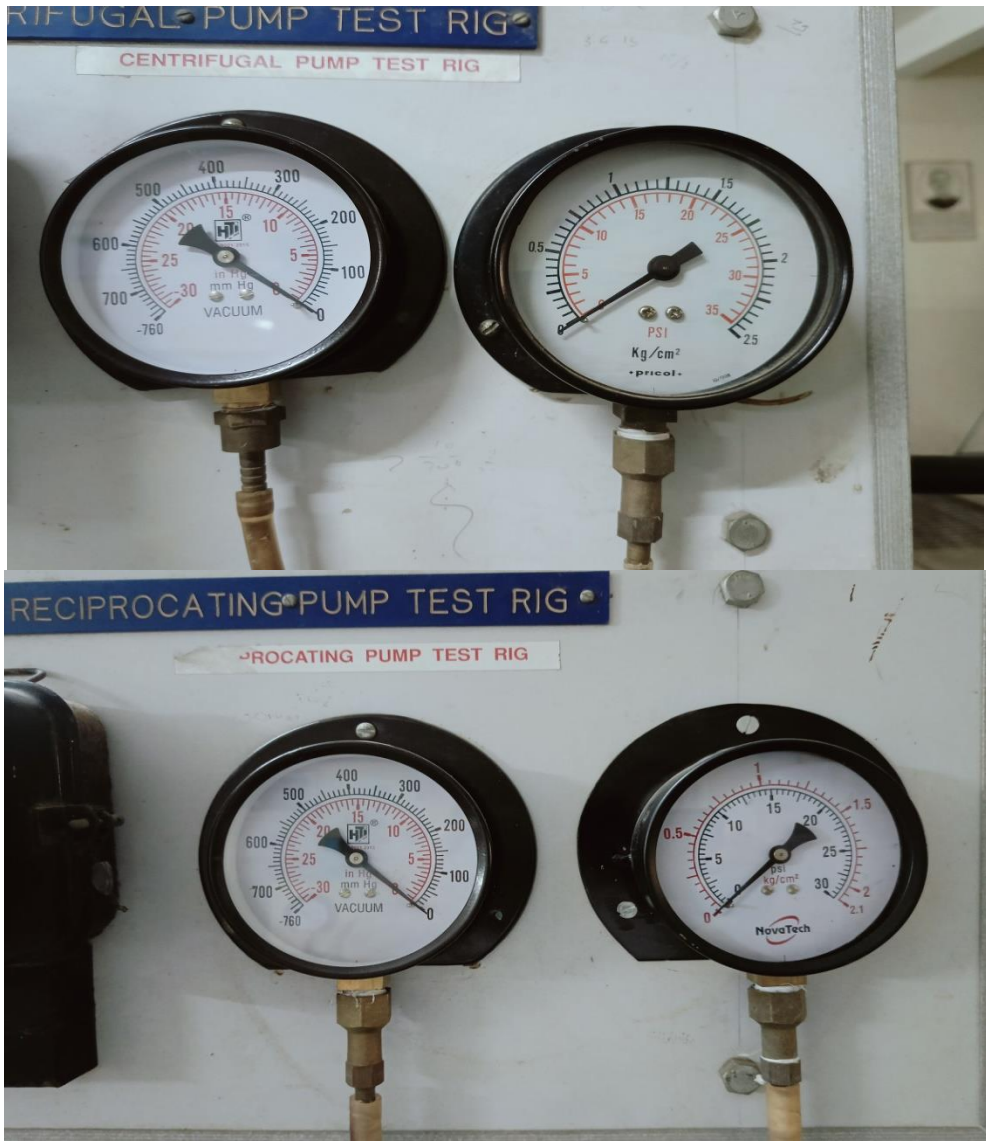


Fig.3 prssure gauges mounted on Centrifugal /Reciprocating Pump Test rig

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Reciprocating Air Compressor Test Rig	Working model of reciprocating air compressor showing bourdon pressure gauge (Range 0-12 Kg/cm²)/bar) at various locations.	01
2	Vapour Compression Refrigeration System Test Rig.	Working model of vapour compression refrigeration system showing bourdon pressure gauge (Range 0-12 Kg/cm²)/bar) on high pressure and low pressure side.	01

S. No.	Name of Resource	Suggested Broad Specification	Quantity
3	Centrifugal / Reciprocating Pump test rig	Vacuum gauge (0-760 mm of Hg) and pressure gauge (0-2.5 Kg/cm^2) Any other working model having bourdon Pressure gauge mounted.	01

IX. Precautions to be Followed

- Avoid improper handling of electrical connections of set up or working models in laboratory.
- Handle the Bourdon pressure gauge with due care.
- .Use safety shoes.
- Use tools safely.

X. Procedure

1. Explain working principle of Bourdon pressure gauge.
2. Explain functions of each component of Bourdon pressure gauge
3. Explain the various scales marked on Bourdon pressure gauge along with units.
4. Start the experimental set up and observe the change in pressure readings.
5. Take readings of bourdon pressure gauge mounted at various location on set up.
6. Write the readings in observation tables provided for various equipment's.

XI. A) Observations Table-

Equipment Type	**Pressure at outlet of L.P cylinder (**Kg/cm^2)**Bar)**	**Pressure at outlet of H.P cylinder. (**Kg/cm^2/**Bar)**	**Receiver Tank Pressure (**Kg/cm^2)**Bar)**
Two Stage Reciprocating Air Compressor Test Rig.			

B) Observations Table-

Equipment Type	Evaporator Pressure (Low Pressure side) (Kg/cm²/ Bar)	Condenser Pressure (High Pressure side) (Kg/cm²/ Bar)
Vapour-Compression Refrigeration Test. Rig.		

c) Observations Table-

Equipment Type	Vacuum pressure (mm of Hg/Bar)	Delivery pressure (Kg/cm²/ Bar)
Centrifugal/Reciprocating Pump test rig		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Collect specifications of bourdon pressure gauge used in different applications.
2. Explain the construction and working of bourdon pressure gauge with neat sketch.
3. List the different applications where bourdon pressure gauges are used.
4. List the different types of pressure measuring instruments used in industries.
5. Explain why bourdon pressure gauges are preferred in high pressure applications.

[Space for Answer]

XVI. References / Suggestions for Further Reading

https://www.slideshare.net/Gauravsingh963/pressure-measuring-devices

- https://www.youtube.com/watch?v=-9IfpNAESlM
- https://www.youtube.com/watch?v=HYcuHgSQvyg

- https://www.youtube.com/watch?v=cq7g3FTsUbY

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20**%)
	Handling of the measuring Instruments	10%
	Observations/Calculation of final readings	10%
Product Related (10 Marks)		**(80**%)
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No. 05
To Measure speed of different rotating elements using speed measuring devices.

I. Practical Significance

Speed of a rotating element is the magnitude of angular velocity which can be measured by different types of tachometers. Contact type and non-contact type tachometers are used to measure rotational speed of different rotating elements in industries. Speed measurement is an important parameter to analyze the performance and design of rotary elements. Speed measurement plays important role in determination of power transmission in belt drives, chain drives, gear drives in machines and equipment.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer.

List different types of tachometers as speed measuring devices.

State working principle tachometers and stroboscope along with its applications.

State the function of each component of speed measuring device.

III. Course Level Learning Outcome (CO)

COa.- Understand working of different speed measuring devices.

COc.- Use of tachometers and stroboscope to measure rotational speed of rotating elements in industries.

IV. Laboratory Learning Outcome(s)

Use of tachometers and stroboscope to measure rotational speed of rotating elements in laboratory.

V. Relative Affective Domain Related Outcome(s)-

- Maintain tools and equipment's.
- Follow safety practices.

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VI. Minimum Theoretical Background with diagram (if required)

Mechanical tachometer counts the Revolutions per Minute (RPM) based on the period of rotating elements. It uses a series of reeds that help in identifying the speed of rotating element. Electronic tachometers uses a magnetic pickup to generate electric pulses having the frequency proportional to the rotational speed of shaft.

Stroboscope is a non-contact instrument that works on the phenomenon of flashing frequency which is known as stroboscopic effect. It creates a stop motion effect of rotating element by flashing a high intensity light on it. This appearance of a moving object to be stationary can be used to study rotating, oscillating or vibrating objects.

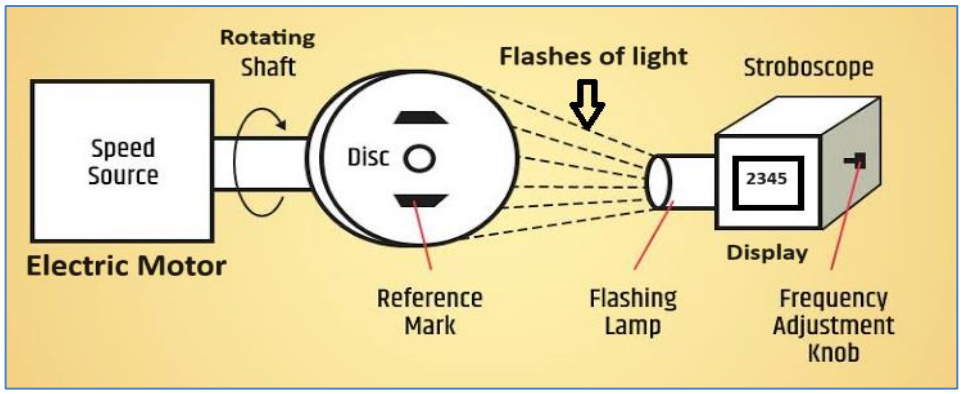

Fig.1 Principle of Stroboscopic Tachometer
(Source: https://megadepot.com/resource/what-is-a-tachometer-and-how-does-it-work)

Fig.2 Mechanical Tachometer (Analog Tachometer) and use of stroboscope

VII. Experimental setup (Model)-

Fig. 3 Experimental set up of speed measurement by Stroboscope & Analog Tachometer.
(Source:https://tktech.vn/may-do-toc-do-vong-quay-la-gi/)

Fig. 4 Laboratory Equipment – Single Stage Air Compressor

(Any other rotary equipment)

VIII. Required Resources /Apparatus/Equipment with specification

S.No.	Name of Resource	Suggested Broad Specification	Quantity
1	Stroboscope	• Course and fine flash rate adjustments to freeze and analyze rotating objects. • Battery operation brings motion analysis to any location. • Unique display features characters that reverse direction depending on measurement mode. • Large 0.4" (10mm) 5digit LCD display. • Microprocessor based with quartz crystal oscillator to maintain high accuracy. • Tachometer memory stores last, max, and min readings.	1
2	Tachometer	• Range 0 to 4000 RPM	1

IX. Precautions to be Followed

- Avoid improper handling of Stroboscope and tachometer.
- Use safety shoes.
- Use tools safely.

X. Procedure 1)

1) Mark a dark mark on the end section of rotating element.(E.g. motor shaft, table fan)
2) Switch on stroboscope.
3) Allow circular disc to attain constant speed by varying the RPM
5) Flash frequency is gradually increased from zero until the rotating element appears to be stationary.
6) Note down the reading.
7) Note down the reading of rotating member with the help of Mechanical Tachometer.
8) Take five different readings.

XI. Observations and calculations -

Sr No	Actual Speed using Tachometer (RPM)	Stroboscope Reading (RPM)	Error
1			
2			
3			
4			
5			

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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 technical specification of stroboscope & tachometer used in practical.
2. Explain the construction and working of Stroboscope with neat sketch.
3. List the different types of speed measuring instruments used in industries.
4. Explain the construction and working of Analog tachometer.
5. Name the device used by RTO for measuring of speed of running vehicle.

[Space for Answer]

XVI. References / Suggestions for Further Reading

www.youtube.com/watch?v=ngFZN311qnU
www.youtube.com/watch?v=0BRu3VxlH68

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the measuring Instruments	10%
	Observations/Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	Total	100 %

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

Practical No.6
Measure heat of given fluid using Calorimeter

I. Practical Significance

Calorimeter is the device to measure the amount of heat transferred to or from an object. It is commonly used for heat measurement of fluid like water or hot exhaust gas. In case of power engineering related to engine testing , it can be used for heat carried out by exhaust gases from the test engine mounted on the test set flow through the tubes. A jacket of constantly flowing cooling water surrounds the tubes, and the heat content of the gases is assessed by measuring the cooling water flow rate and the inlet and outlet temperatures.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

Measure heat of given fluid using different types of heat measuring devices.

III. Course Level Learning Outcome (CO)

COa.- Understand working of Thermal Power Plant

IV. Laboratory Learning Outcome(s)

Use heat measuring devices

V. Relative Affective Domain related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

- Identify construction of calorimeter
- Use of temperature measuring devices
- Use of water flow meter
- Knowledge of heat exhcangers

Calorimeter is the science of measurement of heat exchange or heat transfer between system and surrounding to calculate change in energy of system. It works on the principle of heat lost by hot body is equal to heat acquired by the cold body. The heat transfer is calculated by the equation

$$Q = mC (T1-T2)$$

Where Q= heat transfer

m= Mass of fluid

C= Specific heat

(T1-T2)= change in temperature

VII. Experimental setup

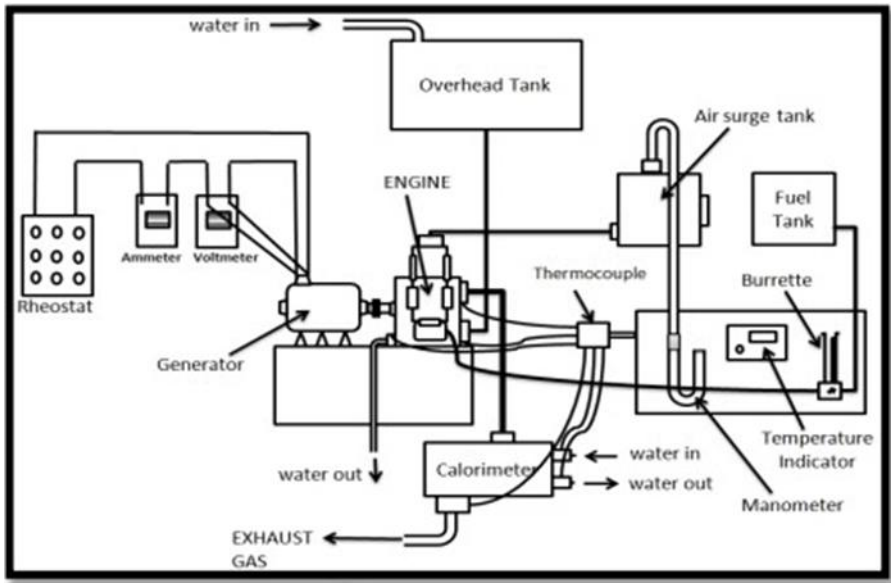

Fig.1 Line diagram of Experimental Set Up
(Source: Semanticscholar.org/paper/Performance-Analysis-of-Exhaust-Gas-Calorimeter-for-Patel-Gosai/70eddb8cdc51bfb445cd6f487aca3e1b62846eb9)

Fig.2 Experimental Set Up

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No	Name of Resource	Suggested Broad Specification	Quantity
1		Type – Single cylinder	1
		Bore - 0.875 m	

	Engine	Stroke – 0.017 m	
		Power developed- 7 HP	
		Torque -7.46 N-m At 1500 rpm	
2	Rope brake dynamometer OR	Diameter of rope brake drum, D = 0.3 m	1
		Diameter of Rope, d = 0.015 m	
3	Hydraulic dynamometer OR	Dynamometer constant, K = 2000	1
4	Eddy current dynamometer	Dynamometer constant, K = 200	
5	Orifice specification	Diameter of Orifice(d_0) = 0.014 m	1
		Coefficient of discharge for orifice, C_d = 0.65	
6	Tachometer	Standard (Range-1000 to5000 rpm)	1
7	Calorimeter	Type –Exhaust gas calorimeter	1
8	Fuel gauge	Burette of 50 ml	1
9	Temperature gauge/Thermocouple	RTD	1
10	Water manometer	Glass U tube manometer	1
11	Glass /Fiber Jar	Capacity - 1 lit.	1

IX. Precautions to be Followed

1. Avoid improper handling of I.C. Engine
2. Operate the I.C. Engine as per given procedure.
3. Before starting the engine, oil level in sump and jacket cooling water supply must be checked.
4. Never stop the engine on load and never use decompression lever for stopping.
5. Do not tamper with any of engine setting, like governor, fuel injector.

X. Procedure

1. Fill up sufficient diesel in diesel tank.
2. Check oil level in the engine.
3. Fill up water in Manometer up to half of the manometer height.
4. Start the water supply and see that water is flowing though engine jacket, brake drum and exhaust gas calorimeter.
5. Adjust the load on the dynamometer to zero, by releasing the loading screw, so that there is no tension in the rope.
6. Start the engine.
7. Measure engine room temperature **(t_r°C).**
8. i) Measure temperature of exhaust gases from the engine (**t_1^{0}C**)

ii) If exhaust gas calorimeter is used, then measure,

(a) Quantity of. water supplied to the exhaust gas calorimeter (**m_{cc}**) in lit/min.

(b) Temperature of water inlet to calorimeter **(t_{c1}°C)**

(c) Temperature of water outlet from the calorimeter **(t_{c2}°C)**

(d) Temperature of exhaust gas entering the calorimeter **(t_{g1}°C)**

(e) Temperature of exhaust gas leaving the calorimeter **(t_{g2}°C)**

X. Actual Procedure Followed

Please note: If the engine test rig available in laboratory is different from the test rig given in the manual, then there will be change in layout diagram, stepwise procedure, observation table and calculations. The teachers are advised to make the necessary changes and guide the students accordingly

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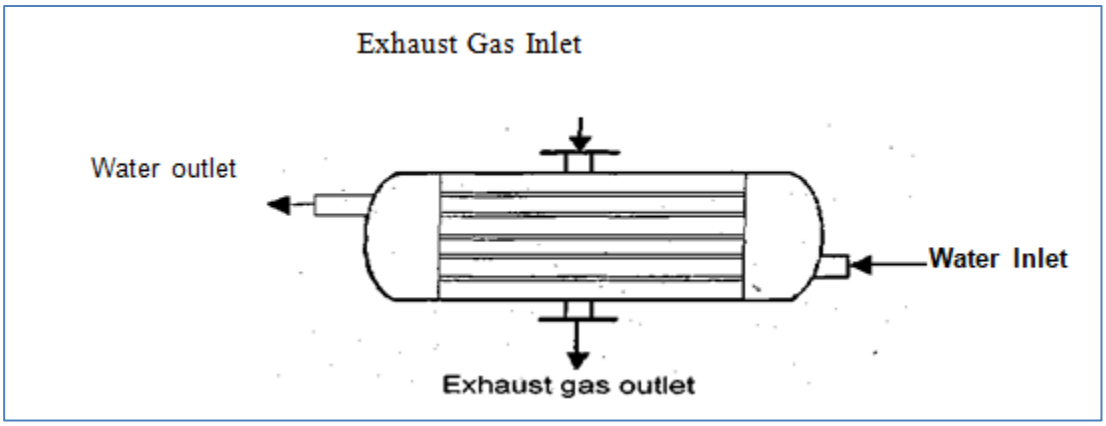
XI. Observations and calculations

Sr. No.	Load condition Particulars	Notation	Reading
1	Quantity of water supplied to exhaust gas calorimeter in lit / min	mc	
2	Exhaust gas temp. in °C	tg	
3	Engine room temp. in °C	tr	
4	Temp, of water inlet from calorimeter in °C	tc1	
5	Temp, of water outlet from calorimeter in °C	tc2	
6	Temp, of exhaust gases entering calorimeter in °C	tg1	
7	Temp, of exhaust gases leaving calorimeter in °C	tg2	

By using Exhaust gas Calorimeter



Writing the heat balance for calorimeter as -

Heat rejected by exhaust gases in the calorimeter = heat gained by the water in the calorimeter

Now, Total heat carried away by exhaust gases = Hg

= mg x Cpg x (tg1 – tg2) =[mc x Cpw x (tc2 - tc1)] mg x Cpg

= [mc x Cpw x (tc2 - tc1)] / (tg1 – tg2)

Now, total heat carried away by exhaust gases =

Hg = mg x Cpg x (tg - tr)

= { [mc x Cpw x (tc2 - tc1)] / (tg1– tg2) } x (tg - tr)

Hg = _____ kJ / min

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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 various types of calorimeters used to measure the heat of fluid.
2. State any four industrial applications of calorimeter.
3. Draw sketch of any one calorimeter.
4. Calculate heat absorbed in joules by mass of lead of 0.5 kg when inlet temperature is 20°C and outlet temperature is 40°C having specific heat (C) is 100 J/kgK

[Space for Answer]

-References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=wr5JsovSX_o
2. https://www.youtube.com/watch?v=HAFR9fVknso
3. https://www.youtube.com/watch?v=uOYslENZlnc

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the measuring Instruments	10%
	Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related(5)	**Product Related(20)**	**Total (25)**	

Practical No. 07
Demonstrate working of Portable generator.

I. Practical Significance

Portable generators are used for providing a source of temporary, easily transportable electric power and are very commonly found in daily household and commercial applications. They are also used in emergency electrification of construction sites, offices, petrol pumps, workshops, cultural events etc. The selection of proper portable generator is very important task for an engineer for a particular application taking into consideration electric load. The engineer should have knowledge of functions of each part of a portable generator to conduct its timely maintenance and repairs.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

- List different components and their functions of Portable electric generator.
- Select the portable generator with appropriate specifications for given application.

III. Course Level Learning Outcome (CO)

COa.- Understand working of Portable electric generator..

COc.- Use of Portable electric generator for household or industrial applications.

IV. Laboratory Learning Outcome(s)

- Use of Portable electric generator for given application.

V. Relative Affective Domain related Outcome(s)-

- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

The portable generator works by converting mechanical energy into electric energy on the basis of faraday's law. Portable electric generator consists of following primary components as given below-

1. **Internal combustion engine**- It is the prime mover for portable electric generator which may be petrol engine or diesel engine. Generally small capacity generators employ petrol engines while diesel engines are used for heavy load applications.

2. **Alternator** – The alternator converts the mechanical energy provided by engine into electric energy. It consists of stator and rotor along with respective windings inside the alternator body. The initial current to the rotor winding is supplied by the storage battery provided. This produces the magnetic flux around the rotor winding. As the engine of portable generator starts it provides rotational speed to rotor so the magnetic flux also rotates which is cut by stator winding producing the A.C current in it. This A.C supply can be used for desired applications.

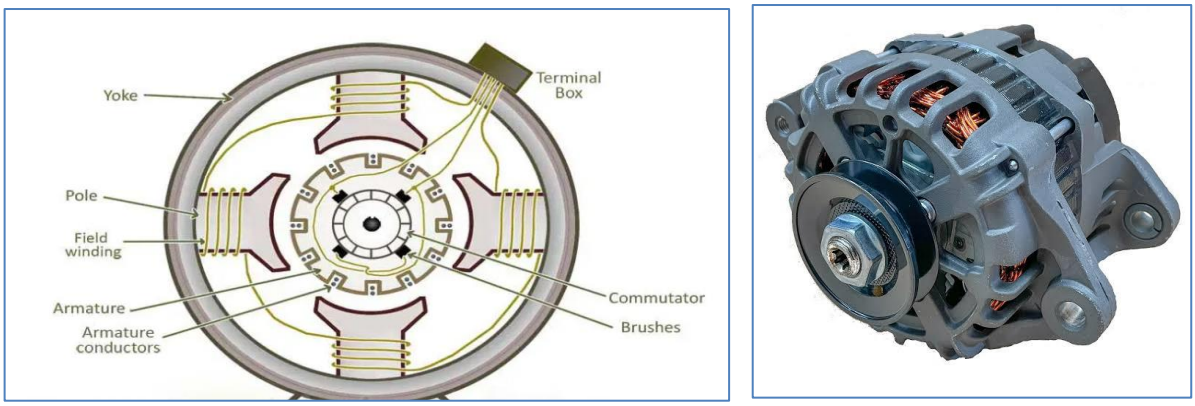


Fig.7. 1
Principle and image of an Alternator

3. Starter – The starter motor is provided in heavy duty portable generators to initially crank the engine for its starting. The starter motor is provide with electric supply from battery through the ignition switch provided on the front panel. Many small generators have manual cranking facility due to small engines provided which greatly reduce the cost. Most of the low duty household generators uses manual cranking method.

4. Fuel Tank- Fuel tank is provided on the top of the engine assembly of appropriate size to store the required fuel.

5. Outlets – The AC current outlets are provided according to capacity of the generator. Generally two AC outlets 120 V and 240 V are provided. The digital displays are also provided showing current and voltage produced by the generator.

Experimental setup (Model)-

Name of Model ----------

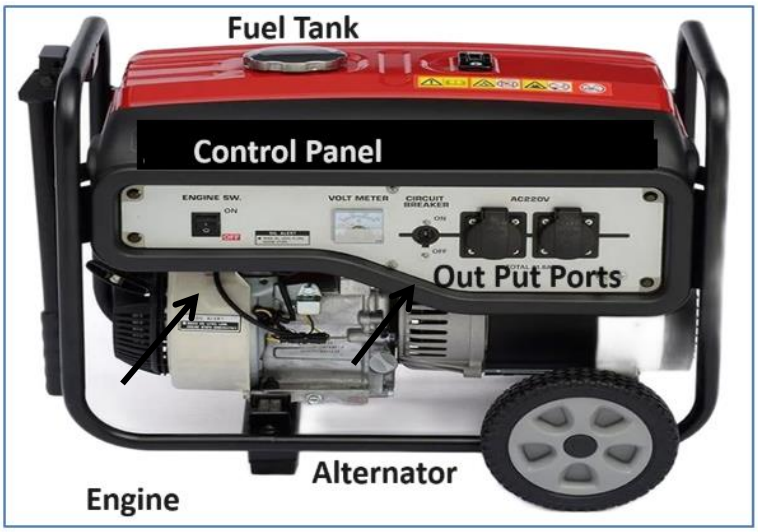


Fig.7.2
Labeled image of Portable Generator
(Source: https://totalpowerbd.net/product/perkins-uk-60-kva-48-kw-diesel-generator/)

VII. Required Resources /Apparatus/Equipment with specification.

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Portable Generator	A.C. Generator with output capacity of 1000-3000 Watt ,O/P Voltage :120 V-240 With output current and voltage displays. Prime mover- Petrol/Diesel Engine.	01
2	Analog /Digital Tachometer	Range: 1000-4000 RPM	01

VIII.Precautions to be Followed

- Avoid improper handling of portable generator model.
- Use measuring instruments carefully.
- Use electrical connections and tools safely.

IX. Procedure

1) Explain working principle of electric generator.
2) Explain the difference between portable and heavy duty generators along with applications.
3) Explain the main components of a portable electric generator.
4) Explain functions of each component of portable electric generator.
5) Start the generator and maintain the proper speed by adjusting the throttle control provided.
6) Measure the rotational speed of generator shaft by tachometer.
7) Take the readings current and voltage produced from output displays.
8) Find the power produced by the generator for particular speed by calculations.
9) Change the speed of generator and repeat the readings.

X. Observations and calculations

Sr No.	Speed of generator shaft (RPM)	Out Put Voltage (V) (Volt)	Output current (I) (Ampere)	Power out put (V X I) (Watt)
1				
2				
3				

XI. Results

XII. Interpretation of Results

XIII. Conclusions and Recommendation ----------

XIV. 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. Collect specifications of portable electric generators used in different applications.
2. State difference between alternator and dynamo.
3. State the necessity of portable generators and list its applications.
4. List the top manufacturers of portable generators.
5. Draw the neat sketch of alternator and explain its working.

[Space for Answer]

XV. References / Suggestions for Further Reading

- https://www.generac.com/portable generators.
- https://www.hondaindiapower.com/portable generators.

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the set up/measuring Instruments	10%
	Observation/Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	Total	100 %

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

Practical No. 08
Identify Drive system using models/actual set up.

I. Practical Significance

Mechanical energy produced by prime movers should be efficiently transmitted to the application devices. The power transmission can be done by either of following drive methods- A) Belt drives.

B) Chain drives.

C) Gear drives.

These power transmission elements transfer power from one place to another and also can provide mechanical advantages in terms of increase speed or torque at output. From the above mention products mechanical elements belts are one which can be used to transfer power from primary mover to mechanism when primary mover and mechanism is far apart and light weight power transfer mechanism is required. Belts have the ability to effectively transfer power even when primary power and mechanism are even meters away from each other.

Chain drives gives positive power transmission between driving and driven shafts having moderate distance between them. Chain drives are used in moderate duty applications.

Gear drives give's positive power transmission between driving and driven shafts having smallest distance between them. Gear drives are used in heavy duty applications.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

- Identify the type of drive used in given application.
- To be able to Select the appropriate drive method for different applications.

III. Course Level Learning Outcome (CO)

CO d. Understand working of different types of power transmission drives.

CO e Select different components used in material handling system.

IV. Laboratory Learning Outcome(s)

- Identify the type of drive used in given application in the laboratory.

V. Relative Affective Domain related Outcome(s)-

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

VI. Minimum Theoretical Background with diagram (if required)

The mechanical transmission system is required in various mechanical systems like belt drive for compressor, flour mill, machine tools like lathe machine, drilling, etc. The chain drives are mainly suitable for bicycle, motorcycle and material handling conveyors, etc. Gear drives are commonly used for compact power transmission in gear box for vehicle, wrist watch mechanism, gears in machine tools, etc. Pulleys are mounted on the shaft. The pulleys are connected by endless belt passing over the pulleys. The connecting belt is kept in tension so that motion of pulley is

transferred to other without slip. The speed of driven shaft can be varied by varying the diameters of two pulleys.

VII. A) Experimental setup no.1 (Any working model having belt drive)

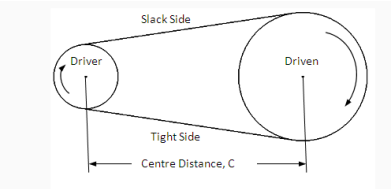
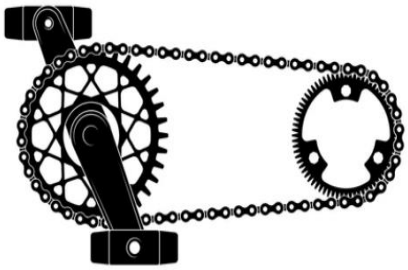
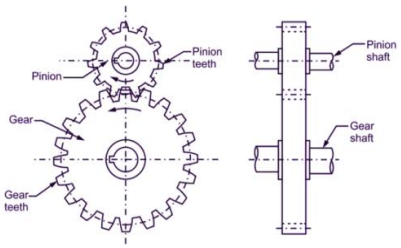
Drive system	Sketch	Set up/models
Belt Drive		 **Reciprocating Pump set up**
Chain drive		 **Model of Chain drive**
Gear Drive		 **Gear Box**

Fig.8.1
Practical set up/models of Drive systems

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Experimental set up/model showing belt drive system	Any typical Set up/model of belt drive system showing all important parts.(Compressor, Centrifugal /Reciprocation pump set up)	01
2	Experimental set up/model showing chain drive system	Any typical Set up/model of chain drive system showing all important parts. (Bicycle drive mechanism)	01
3	Experimental set up/model showing gear drive system	Any typical model of gear drive system showing all important parts. (Gear box, Wrist watch mechanism, Dial indicator mechanism)	01

IX. Precautions to be Followed

1. Avoid improper handling power transmission models.
2. Maintain proper distance from working models.
3. Use safety shoes.
4. Use tools safely.

X. Procedure

1. Explain working principle of each type of power transmission system.
2. Explain the difference between types of drive systems along with applications
3. Explain the main components of each drive system in the experimental set up/models.
4. Explain functions and working of all components of each drive system.
5. Ask each student to identify the drive system and its components.

XI. Observation Tables-

(Visit to Power Engineering, TOM, Fluid Mechanics, Automobile laboratory, workshop to observe types of drive system**)**

Sr No.	Type of Set up/models	Type of Drive system	Function
1	Compressor set up/Models		
2	Centrifugal pump set up/Models		
3	Reciprocation pump set up/Models		
4	Bicycle/ motor cycle set up or models		
5	Gear Box		
6	All Geared Lathe machine gear system		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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 difference between Belt drive, chain drive and gear drive system.
2. Write specification of different components of belt drive used for any practical application .(Size of pulley, Belt type, center distance)
3. List various types of belts used in belt drive mechanisms.
4. List various types of gears used in different gear drive mechanisms.
5. Collect specifications of different types of belts used in different industrial applications.
6. Select drive for a. Two shafts long distance apart d. Shafts close to each other

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.factory.com/belt
2. https://www.factory.com/chain-drives/
3. https://www.gearsandgeardrives.com/

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the Models/Set up	10%
	Observations/ Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No.09

Calculate Velocity ratio of given Gear/Belt drive of suitable mechanical system.

I. Practical Significance

Power transfer from primary mover to any mechanism which gives some useful outcome is one of the most common works done in mechanically engineered products.

In order to transfer power form primary mover to any mechanism products mechanical elements like gears, belts, rope and chains are used. These elements transfer power from one place to another and also can provide mechanical advantages in terms of increase speed or torque at output.

From the above mentioned products mechanical elements, gears are one which can be used to transfer power from primary mover to mechanism when primary mover and mechanism is close to each other and heavy duty power transfer mechanism is required. Belt drives are mostly suitable when prime mover and Mechanism are located at a considerable distance from each other.

Gear boxes have the ability to effectively transfer power at varying torque speed according to the need of applications.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer.

1. Identify different components of given gear drive system.
2. Calculate velocity ratio of given gear drive system.

II. Course Level Learning Outcome (CO)

Cod - Understand the nomenclature of gear drive system.

III. Laboratory Learning Outcome(s)

- Calculate velocity ratio of gear drive system available in the laboratory.

IV. Relative Affective Domain related Outcome(s)-

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

V. Minimum Theoretical Background with diagram (if required)

Gear are rotary mechanical elements which are provided with special shaped teeth uniformly on the periphery of circular disc. The gears are used in pairs in the form of toothed wheels that mesh with each other in order to change speed or direction of transmitted motion. The velocity ratio of gear depends on diameter and number of teeth of meshing gears.

Belt drive is drive which transmits power between two or more shafts with the help of friction in pulley surface surrounded by flat or V shaped belt. The velocity ratio of belt drive depends upon the diameter of pulleys used for power transmission.

VI. Experimental setup (Any gear drive mechanism available in laboratory).

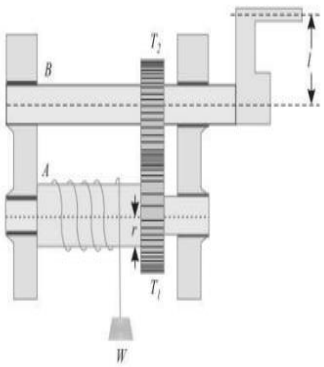
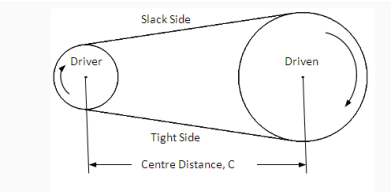
Type	Sketch	Set up
Gear Drive		 **Single purchase crab mechanism**
Belt Drive		 **Reciprocating Pump set up**

Fig.1 Set up for gear and belt drive

VII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Experimental set up of single purchase crab.	Single Purchase Crab winch (Table mounted/Wall mounted). The effort wheel is of C.I material of 25 cm diameter mounted on a shaft about 40 mm diameter. On the same shaft a geared wheel of 15 cm diameter.	01
2	Experimental set up of Reciprocating/ Centrifugal/compressor test rig.	Belt drive system having Pulleys of different diameters	01

S. No.	Name of Resource	Suggested Broad Specification	Quantity
2	Any other model of gear /belt drive mechanism available.	Any typical model of gear /belt drive system showing all important parts.	01

VIII. Precautions to be Followed

1. Avoid improper handling of gear drive system set up.
2. Maintain proper distance from gear drive system.
3. Wear safety shoes.
4. Use tools safely.

IX. Procedure

Gear drive

1. Observe the machine carefully and identify the various components of the machine.
2. Measure the D1 - diameter of wheel gear (big gear).
3. Measure the D2-diameter of pinion gear (small gear).
4. Measure the T1- number of teeth's on wheel gear.
5. Measure the T2-number of teeth's on pinion gear.
6. Measure the C-center distance between axis of wheel gear and pinion gear.
7. Calculate the velocity ratio = D1/D2=T1/T2.

Belt drive

1. Observe the Set up/ machine carefully and identify the various components of the machine.
2. Measure the D1 - diameter of pulley 1(driver)
3. Measure the D2-diameter of smaller pulley 2 (driven)
4. Calculate the velocity ratio = D1/D2

X. Observations and calculations

Gear Drive

No. of teeth's on gears		Diameter of Gears		Velocity Ratio
Wheel gear (Driver) (T1)	Pinion gear (Driven) (T2)	Wheel gear (Driver) (D1) (mm)	Pinion gear (Driven) (D2) (mm)	(D1/D2) or (T1/T2).

Belt Drive

Diameter of pulley		**Centre Distance**	**Velocity Ratio (D1/D2)**
Driver Pulley (D1) (mm)	Driven Pulley (D2) (mm)	C (mm)	

Calculate Velocity ratio using formula:

Velocity Ratio = D1/D2= T1/T2

XI Results

XII. Interpretation of Results

XIII. Conclusions and Recommendation

XIV. 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 four differences between belt drive and gear drive.
2. Collect specifications of gears used in different applications.
3. List various types of gears used in gear drive mechanisms used for various applications.
4. Draw the neat figure of spur gear showing its nomenclature.
5. List various applications were gear and belt drives are used.

[Space for Answer]

XV References / Suggestions for Further Reading

1. https://www.gearsandgeardrives.com.
2. https://www.mechanicdrive.com.

XVI Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
1	Handling of the Set up/measuring Instruments	10%
2	Observations/Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
1	Interpretation of result	40%
2	Conclusions	20%
3	Practical related questions	20%
4	T**otal**	100 %

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

Practical No. 10
Demonstrate working of lift/conveyor used in Industry

I. Practical Significance

Material handling is a very important process which includes movement of raw materials from their native places to the points of use in manufacturing, movement of semi-finished products through different manufacturing processes and transfer of finished products from factories and their distribution to sales outlets. The well-designed material handling system can improve customer service, lower costs and reduce the risk of accidents and damage. To achieve efficient material handling system in process industries the material handling equipment's plays vital role. Following are some of the material handling equipment's commonly used in industries-

- Conveyors
- Industrial trucks (Fork-lift trucks)
- Cranes and hoists.
- Robots.
- Containers. etc.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

List different types of material handling equipment's used in industries.

State functions and application of each material handling equipment in industries.

III. Course Level Learning Outcome (CO)

COa. - Understand working of various material lifting machines and conveyors.

COc. - Use of various material lifting machines and conveyors..

IV. Laboratory Learning Outcome(s)

Use of lifting machines and conveyors for given application.

V. Relative Affective Domain related Outcome(s)-

- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

A) **Conveyors**- These are the equipment's which carries or conveys materials from one point to another. Its types include belt type, apron type, roller type or computer controlled conveyors.

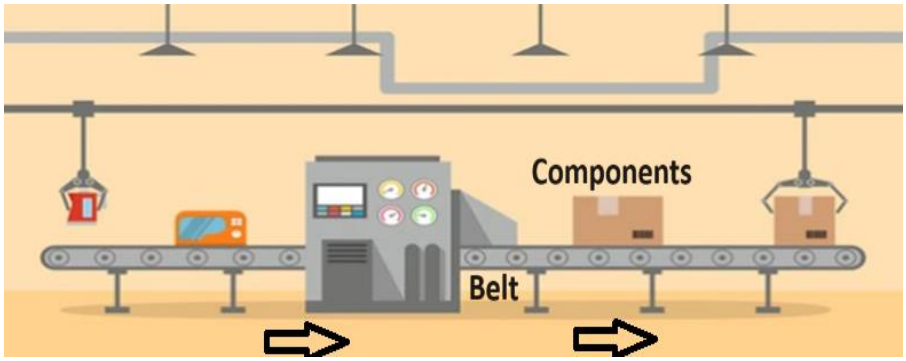


Fig.1.Layout of belt-conveyor system

Fig.2- Layout of roller conveyor system
(https://www.nai-group.com/conveyor-system-technology-trends/)

B) Lifting Machines-

i)Fork-Lift Truck- Its source of power is diesel/petrol engine or battery driven motor.
The operation and of lifting forks are through hydraulic power pack.The body of the truck is built heavy to withstand the lifting loads.These trucks are very feasible material handling devices.

Fig.3. Fork-lift truck.

ii) Cranes and hoists- Industrial cranes are the material handling devices used to lift boxed or palletized products to high storage levels.Cranes are self propelled manually or semi automatically operated through the material handling paths in the industry.

Hoists are the devices used for raising or lowering a load suspended from a hook on the end of chain or wire rope. A hoist may be fixed or stationary base mounted or travelling type.

Fig.4. Industrial cranes.

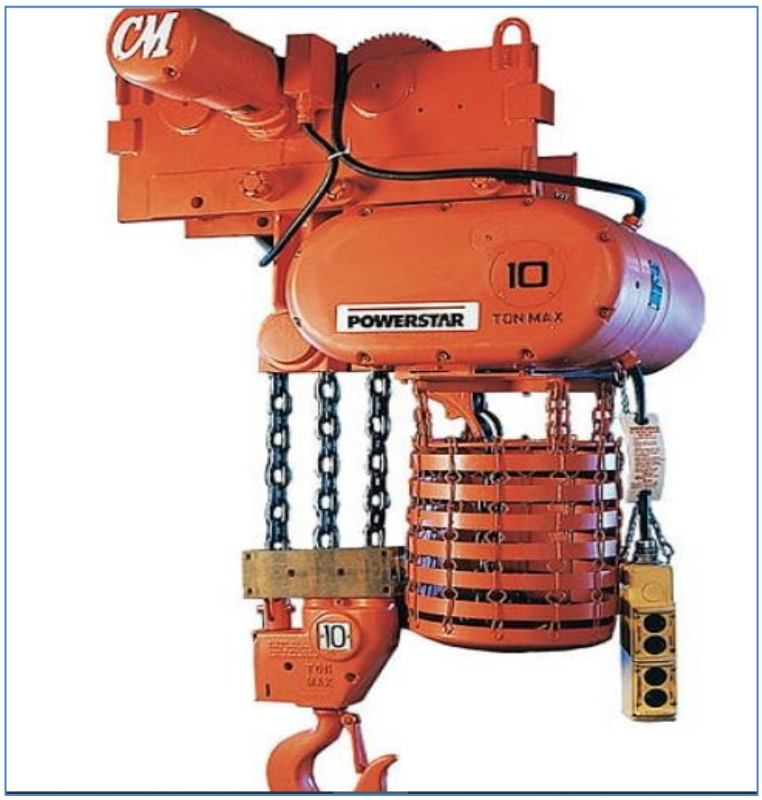
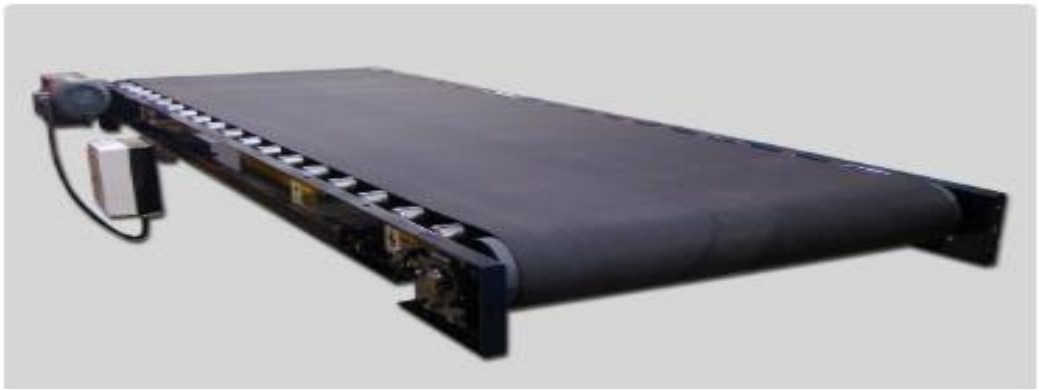


Fig 5. Power hoist.
(Source: https://www.shannahancrane.com/cm-powerstar-electric-chain-hoist)

VII. Experimental setup (Model)-

Name of Equipment 1) ----------

(Name the components)



Belt Conveyor
(Source: https://omni.com/products/belt-conveyor/)

Name of Equipment 2) ----------

(Name the components)

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Models/Charts of conveyor system.	Simple Models/ Charts of conveyor system showing all important parts	01
2	Models/Charts of lifting machines.	Simple Models/Charts of lifting machines showing all	01

		important parts (Cranes-Applied Mechanics Lab)	

IX. Precautions to be Followed

- Avoid improper handling of experimental models and charts.
- Use safety shoes.
- Use tools safely.

X. Procedure

1.Explain different types of material handling equipment's used in industry.
2.Explain the difference between types of material handling devices along with applications.
3.Explain the main components of a conveyor system/lifting machine.
4.Explain functions of each component of conveyor system/lifting machine.
5.Demonstrate working of conveyor system/lifting machine using chart.
6.Demonstrate working of conveyor system/lifting machine using model.

XI. Observations and calculations

Equipment Type	Name the component	Shape/Location	Function
Conveyor System/Lifting Machine.			

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Collect specifications of hoists and cranes used in different applications.
2. State four differences between conveyors and cranes used as material handling devices in industries.
3. State the necessity of material handling in modern industries.
4. State the principles of material handling.
5. Draw neat labeled sketch of Belt and roller conveyor system.
6. Visit nearby industry to prepare list of material handling systems.

[Space for Answer]

XVI. References / Suggestions for Further Reading

- https://www.designedconveyor.com/resource/
- https://www.kokeinc.com/general/4-types-materials-handling-equipment/

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the Set up/models	10%
	Observations /Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	Total	100 %

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

Practical No. 11
Demonstrate working of overhead crane used in Industry

I. Practical Significance

Overhead cranes are also called as bridge cranes mounted on I section beams at considerable heights below the roof of the plant or factory. It is used for heavy loads for a. Lifting b. Lowering c. Move horizontally along a rail or beam safely. It is very important material handling equipment's used in industries for movement of raw materials from their native places to the points of use in manufacturing, movement of semi-finished products through different manufacturing processes and loading and unloading of raw materials and finished products from transportation vehicles.

The well-designed layout of material handling system by overhead cranes in heavy industries can improve customer service, lower costs and reduce the risk of accidents and damage. Overhead cranes play a critical role in several industries such as manufacturing, steel production, mining, oil and gas, chemicals and recycling. These industries rely heavily on overhead cranes for lifting and transporting heavy loads, enabling them to maintain high productivity and performance.

Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

List different types of overhead cranes used in industries.

State functions and application of overhead cranes as material handling equipment in industries.

II. Course Level Learning Outcome (CO)

COa.- Understand working of overhead cranes used in industries.

COc.- Use of various overhead cranes in different types of industries.

III. Laboratory Learning Outcome(s)

Use of overhead crane for given application.

IV. Relative Affective Domain related Outcome(s)-

- Maintain tools and equipment.
- Follow ethical Practices

.

V. Minimum Theoretical Background with diagram (if required)

C) **Overhead Crane**- These cranes can greatly improve production and efficiency in industry. Choosing the right overhead crane can make work much easier in different types of industries. It mainly consists of three Components like Bridge, Hoist mechanism and Control system for required movements. Electric Overhead Travelling crane (EOT) is most common overhead crane.

Types of Overhead cranes-

1) Gantry Crane.
2) Jib Crane.
3) Bridge Crane.
4) Workstation Crane.
5) Monorail Crane.

Fig.1.Gantry Crane

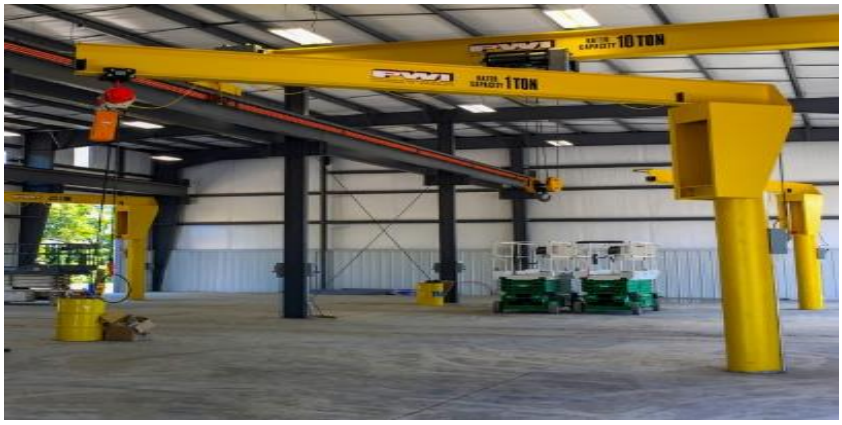


Fig.2- Jib Crane.
(Source: https://pwiworks.com/what-is-jib-crane/)

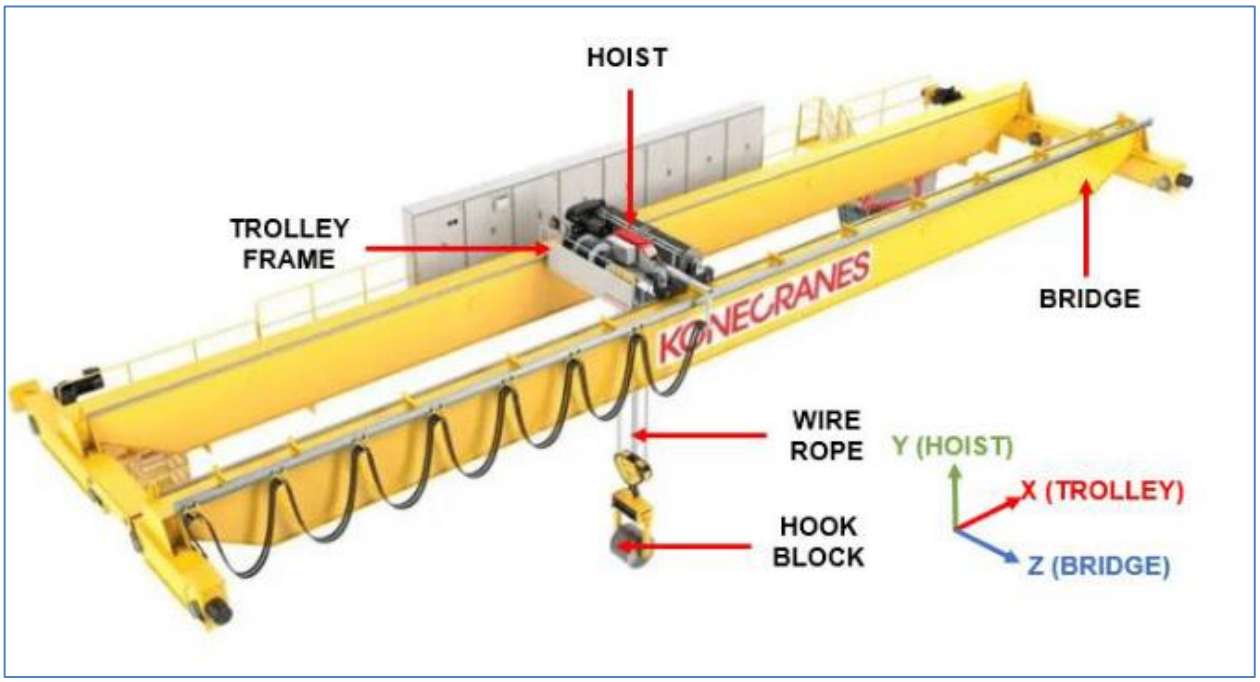
Fig.3. Bridge Crane
(Source: https://pwiworks.com/8-types-of-overhead-cranes/)

Fig.4.Workstation Crane.

Fig.5 Monorail Crane.
(Source:https://www.cranesandhoists.in/latest-update/monorail-cranes-monorail-cra/12)

VI. Experimental setup (Model)-

Name of Equipment 1) ----------



VII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Models/Charts of overhead crane system.	Simple Models/ Charts of overhead crane system showing all important parts	01
2	PPT's and videos showing working of overhead cranes in industries.	PPT's and videos showing construction, working and functions of all parts of overhead cranes used in modern industries	02

VIII. Precautions to be Followed

- Avoid improper handling of experimental models and charts.
- Use safety shoes.
- Use tools safely.

IX. Procedure

1.Explain different types of overhead cranes used in industry.
2.Explain the difference between types of overhead cranes along with applications.
3.Explain the main components of overhead crane system.
4.Explain functions of each component of overhead crane system.

5.Demonstrate working of overhead crane system using charts.
6.Demonstrate working of overhead crane system using simple models.

X. Observations and calculations

Equipment Type	Name the component	Shape/Location	Function
Overhead Crane System	Bridge		
	Trolley Frame		
	Hoist		
	Wire Rope		
	Hook Block		

XI. Results

XII. Interpretation of Results

XIII. Conclusions and Recommendation

XIV. 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.Collect specifications of overhead cranes used in different applications.

2.State four features and applications of overhead cranes used as material handling devices in industries.

3.State the necessity of overhead cranes in modern industries.

4.Collect the information about any overhead crane used in nearby workshop/Industry.

5.Explain the construction and working of Bridge type of overhead crane system.

6.List safety precautions while using Overhead cranes.

[Space for Answer]

XV. References / Suggestions for Further Reading

- https://www.konecranes.com/en-in/equipment/overhead-cranes.
- https://www.americancrane.com/overhead-cranes/

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the Set up/measuring Instruments	10%
	Observation/Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No.12
Demonstrate working of Hydraulic Power Plant

I. Practical Significance

The purpose of hydroelectric power plant is to provide power from water flowing under pressure. It has two forms of energy, kinetic energy and potential energy. Kinetic energy depends upon the mass velocity of flow while the potential energy exists as a result of difference in water level below two points. The turbine converts potential and kinetic energy possessed by water in to mechanical energy. Thus the turbine is a prime mover which when coupled to a generator produces electricity.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

- Observe working of Hydraulic Power Plant and identify components.

III. Course Level Learning Outcome (CO)

CO c.- Understand working of Hydraulic Power Plant

IV. Laboratory Learning Outcome(s)

- Observe working of Hydraulic Power Plant

V. Relative Affective Domain related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

- Know the construction and working of Hydroelectric Power Plant.
- Knowledge about Dam
- Identify water Turbine
- Identify recommended tools.

The hydraulic power plant is located at dam site with huge amount of water stored and water turbines are used for power generation. The turbines are classified as impulse turbine and reaction turbines. Pelton wheel, Francis turbine and Kaplan turbine are commonly used water turbines in hydraulic power plants

VII. Experimental setup

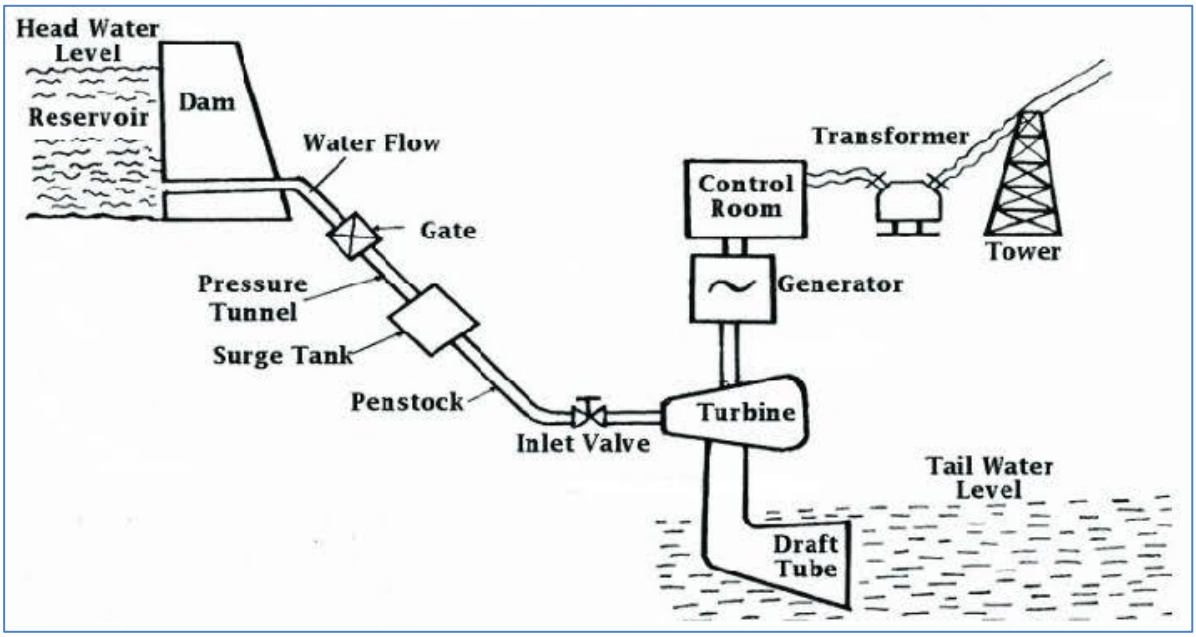


Fig.1 Layout of Hydraulic Power Plant

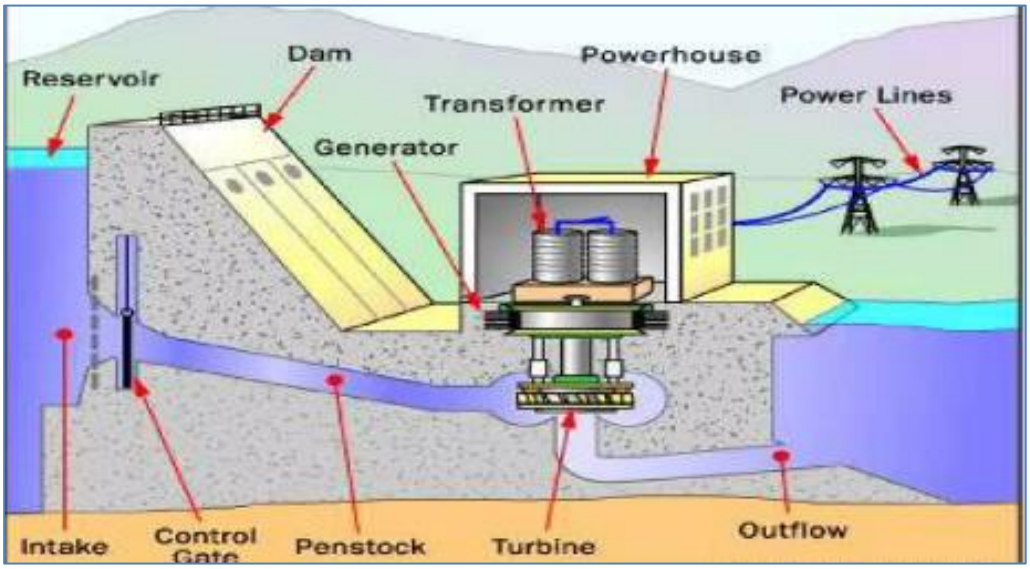


Fig.2 Elements of Hydraulic Power Plant
(Source:https://www.micro-hydro-power.com/how-hydropower-plants-work.htm)

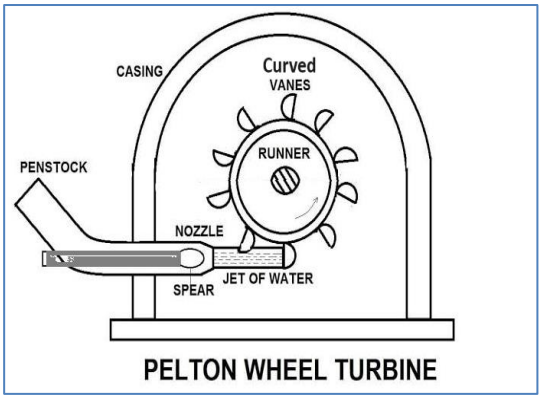


Fig.3 Pelton wheel turbine sketch and set up

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Hydraulic Power Plant	Model, Set up of turbine available in Fluid Mechanics lab.	1
2	Hydraulic Power Plant	Chart	1

IX. Precautions to be Followed

Avoid improper handling of Centrifugal Pump Model.

X. Procedure

1. Identify and locate the components.
2. Locate the penstock, nozzle and turbine different parts of hydraulic power plant
3. Observe and trace the path of water

XI. Observations and calculations

Sr. No.	Particulars	Remark (Functions /Type)
1	Dam	
2	Penstock	

3	Nozzle	
4	Turbine	
5	Control gate	

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Draw a layout of hydraulic power plant on graph paper
2. List the major hydraulic power plant in India with their capacity.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1.https://www.youtube.com/watch?v=-hooifWJ1jY
2.Hydroelectric power plant Animation (youtube.com)

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the measuring Instruments	20%
	Calculation of final readings	00%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No.13
Identify different components of Centrifugal Pump

I. Practical Significance

A Pump is generally used to induce flow or raise the pressure of a liquid. Centrifugal pumps are a category of Dynamic pumps. The working principle of centrifugal pumps involves imparting energy to the liquid by means of a centrifugal force developed by the rotation of an impeller that has several blades or vanes.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

List different components of Centrifugal Pumps.

III. Course Level Learning Outcome (CO)

COa.- Understand working of Thermal Power Plant.

COc.- Use of Hydraulic turbine and Hydraulic pumps.

IV. Laboratory Learning Outcome(s)

Use of centrifugal pump for given application

V. Relative Affective Domain related Outcome(s)-

- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

Centrifugal force is the tendency of an object moving in a circle to travel away from center of a circle. The centrifugal pump is commonly used water lifting purpose in domestic applications/agriculture sector.

VII. Experimental setup

Fig.1 Centrifugal Pump

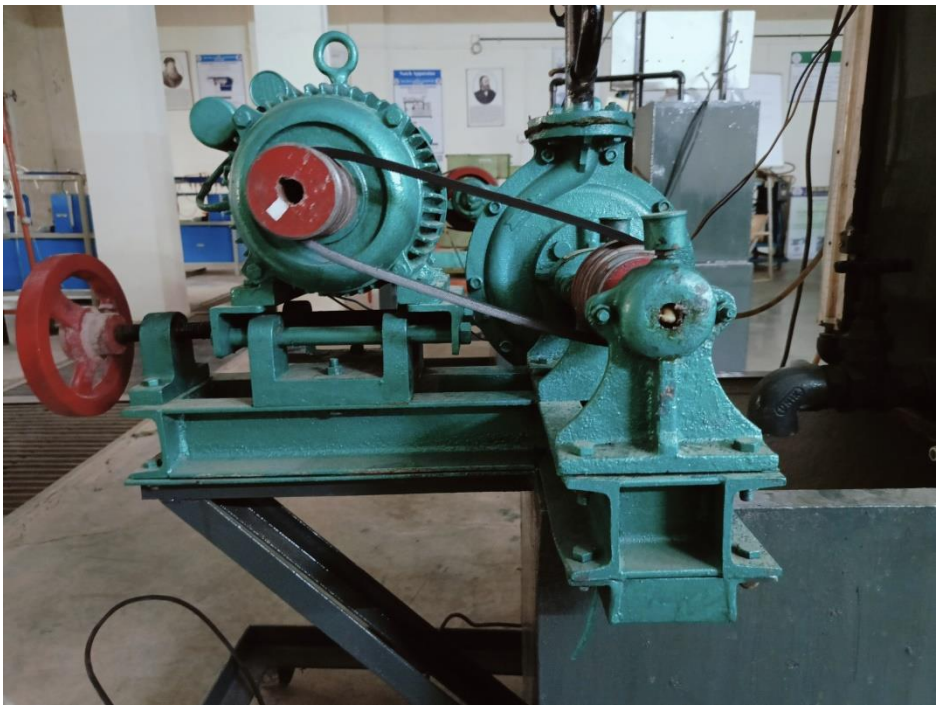


Fig.2 Setup of Centrifugal pump

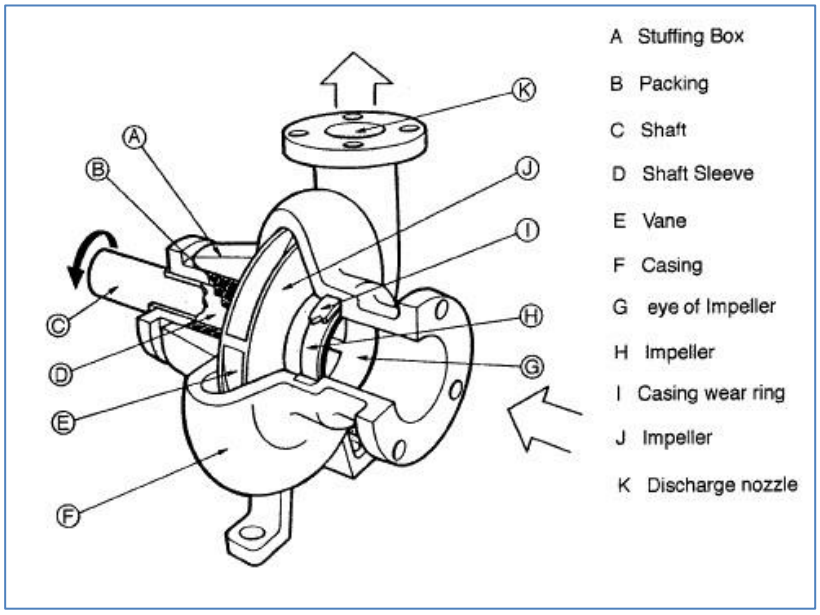


Fig.3 Components of Centrifugal Pump


Fig.4 Casing and Impeller of Centrifulgal Pump

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
	Centrifugal Pump	Actual set up/ Model of Centrifugal Pump showing all important parts	01
	Centrifugal Pump	Chart of Centrifugal Pump showing all important parts	01

IX. Precautions to be Followed

Avoid improper handling of Centrifugal Pump set up/ Model.

X. Procedure

1) Explain construction of Centrifugal Pump
2) Explain working principle Centrifugal Pump
3) Explain the main components of a Centrifugal Pump
4) Explain functions of each component of Centrifugal Pump
5) Demonstrate working of Centrifugal Pump using model
6) Demonstrate working of Centrifugal Pump using chart
7) Explain the applications of Centrifugal Pump

XI. Observations and calculations

Type of Pump	Name the components	Function
Centrifugal Pump		

Type of Pump	Name the components	Function

XII. Results

Interpretation of Results

Conclusions and Recommendation

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. Draw labeled sketch of a Centrifugal Pump on graph paper.
2. Write specification of Centrifugal Pump used in sugar industry/pharmaceutical industry/hydraulic power plant.
3. State necessity of Centrifugal Pump in hydraulic power plant.
4. Collect specification leaflets of centrifugal pump from local suppliers

[Space for Answer]

XIII. References / Suggestions for Further Reading

- Main Parts of a Centrifugal Pump | Description of Components | nuclear-power.com
- https://www.youtube.com/watch?v=BaEHVpKc-1Q

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the models/set up	20%
	Observations of set up and models	00%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No.14
Identify different components of Reciprocating Pump

I. Practical Significance

Reciprocating pump is a positive plunger pump. They are used widely in lifting water from ground to the storage tanks in residential areas. They develop high pressures but has limited use. Reciprocating pump consists of "suction stroke" and a "delivery stroke". Suction stroke is the place where the water is sucked in from the ground and delivery stroke is the place where the sucked water is delivered to the required place.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

List different components of Reciprocating Pumps.

State functions of each component of a Reciprocating Pump

III. Course Level Learning Outcome (CO)

COa.- Understand working of Thermal Power Plant.

COc.- Use of Hydraulic turbine and Hydraulic pumps.

IV. Laboratory Learning Outcome(s)

Use of Reciprocating Pump for given application

V. Relative Affective Domain related Outcome(s)-

- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

Reciprocating motion, also called reciprocation, is a repetitive up-and-down or back-and-forth linear motion. It is found in a wide range of mechanisms, including reciprocating engines and pumps. It is commonly used at service station for high pressure jet of water used for washing of vehicles.

VII. Experimental setup

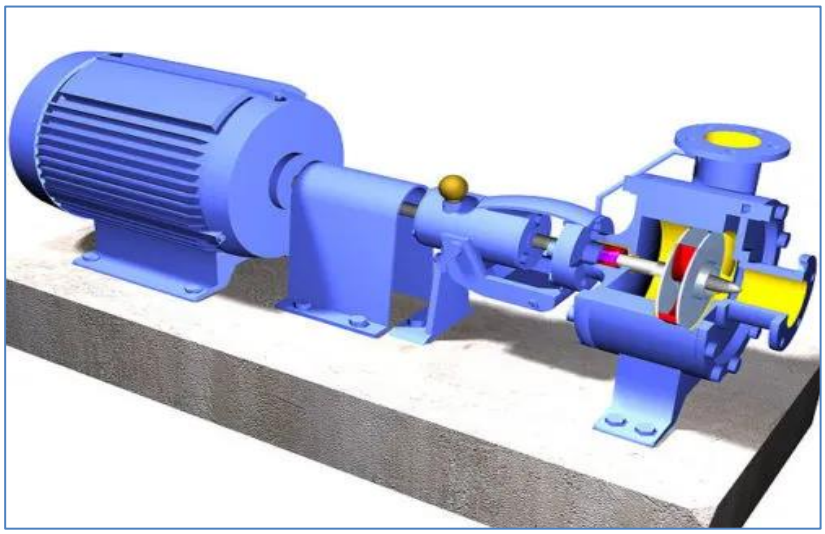


Fig.1 Reciprocating Pump
(https://commons.wikimedia.org/wiki/File:Centrifugal_Pump.svg)

Fig.2 Set up of Reciprocation pump

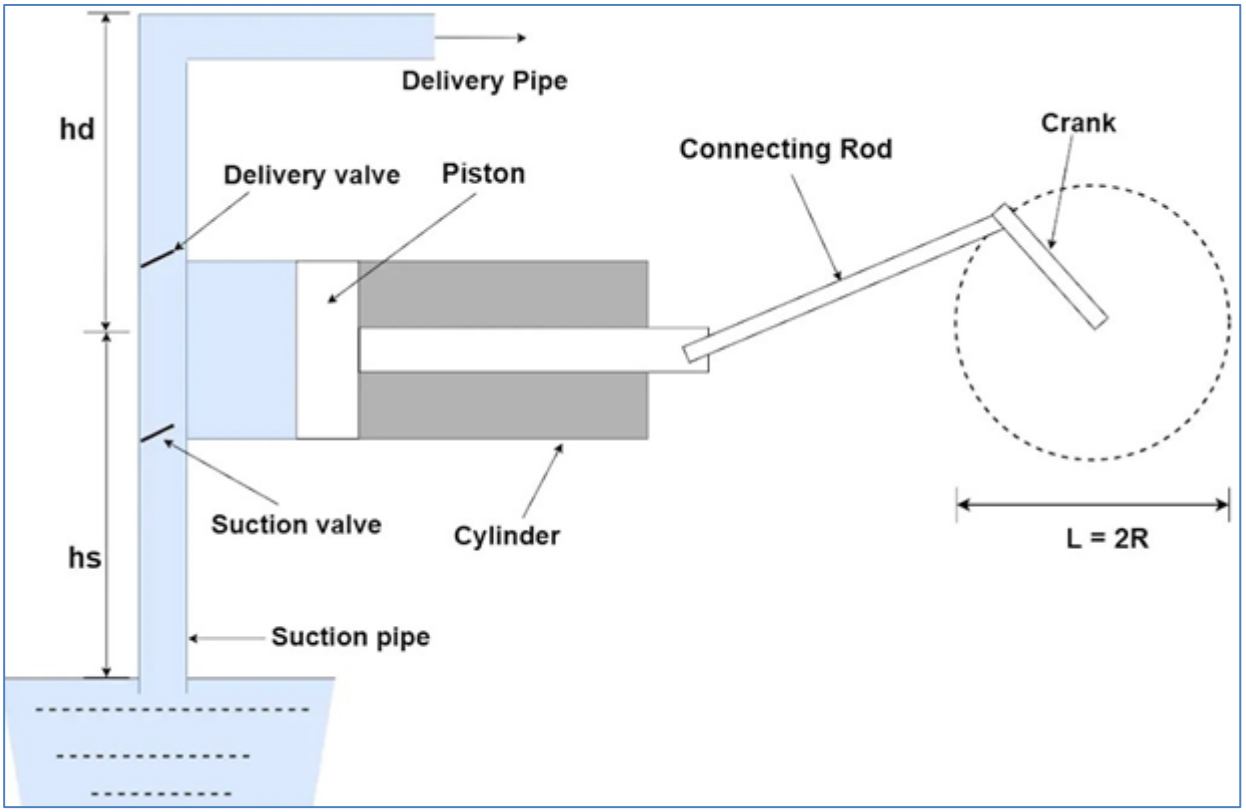


Fig.3 Layout of Reciprocating Pump

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
	Reciprocating Pump	Model of Reciprocating Pump showing all important parts	01
	Reciprocating Pump	Chart of Reciprocating Pump showing all important parts	01

IX. Precautions to be Followed

Avoid improper handling of Reciprocating pump model.

X. Procedure

1. Explain working principle Reciprocating
2. Explain the main components of a Reciprocating pump
3. Explain functions of each component of Reciprocating ump
4. Demonstrate working of Reciprocating Pump using model/Set up
5. Demonstrate working of Reciprocating Pump using chart
6. Explain the applications of Reciprocating Pump

XI. Observations

Type of Pump	Name the components	Function
Reciprocating Pump		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Draw a labeled sketch of Reciprocating Pump on graph paper
2. Write specification of Reciprocating Pump used in sugar industry/pharmaceutical industry/hydraulic power plant.
3. State necessity of Reciprocating Pump in hydraulic power plant.
4. Differentiate between Centrifugal Pump and Reciprocating Pump.

[Space for Answer]

XVI. References / Suggestions for Further Reading

- https://clubtechnical.com/comparison-between-centrifugal-pump-and-reciprocating-pump
- https://www.youtube.com/watch?v=41vb6T42_Tk

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the models/set up	20%
	Observations of set up and models	00%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No.15
Measure Pressure, temperature of air compressor at different points

I. Practical Significance

The air compressor is a machine which uses a drive motor to power the device, which sucks in successive volumes of air from the atmosphere, compresses (squeezes) each volume of air in the limited space to increase the pressure, resulting in a smaller amount, and then transfers the air high pressure in the receiver tank. This high pressure air is removed from the receiving tank for the different application. When certain amount of constant discharge of air is displaced, then it is called as a positive displacement air compressor.

Air compressors have many uses, including: supplying high-pressure clean air to fill gas cylinders, supplying moderate-pressure clean air to a submerged surface supplied diver, supplying moderate-pressure clean air for driving some office and school building pneumatic HVAC control system valves, supplying a large amount of moderate-pressure air to power pneumatic tools, such as jackhammers, filling high pressure air tanks (HPA), for filling tires, and to produce large volumes of moderate- pressure air for large-scale industrial processes (such as oxidation for petroleum coking or cement plant bag house purge systems)

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

Measure Pressure, temperature of air compressor at different points

III. Course Level Learning Outcome (CO)

COd.-Understand working of Air compressor and Refrigeration system

IV. Laboratory Learning Outcome(s)

Use temperature and pressure measuring devices

V. Relative Affective Domain related Outcome(s)-

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

VI. Minimum Theoretical Background with diagram (if required)

The air is compressed by reciprocating motion of piston and cylinder similar to manual operated pump used to fill air in tube of bicycle or vehicle tyre.

The reciprocating compressor is single or double acting as per stages of compression. The pressure is measured by Bourdon type pressure gauge and mercury manometer.

The temperature is measured by thermometer, thermocouple and digital temperature indicator. The speed of compressor shaft can be measured by contact based mechanical tachometer.

VII. Experimental setup

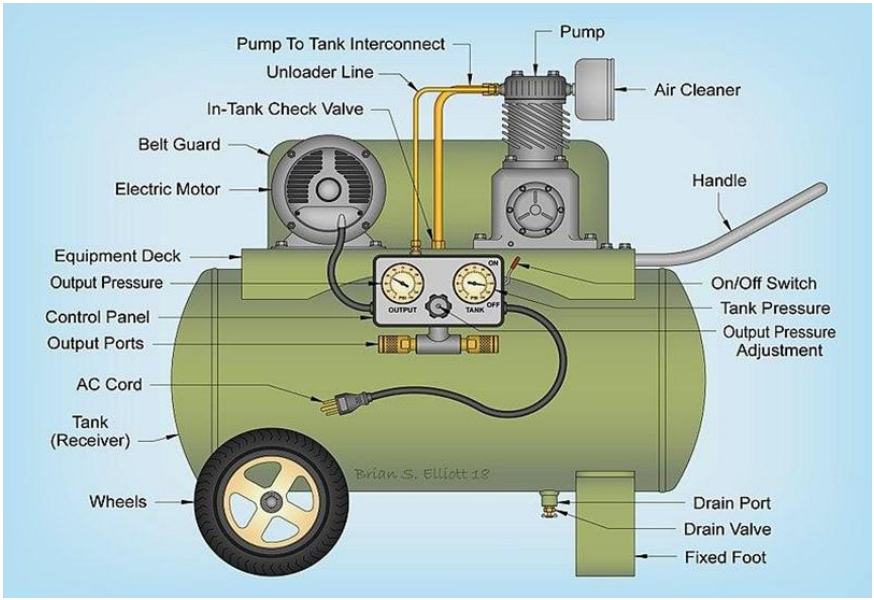


Fig.1 Technical Illustration of a single-stage air compressor

(Source:https://blog.exair.com/2022/11/10/basics-of-air-compressors/)

Fig.2 Typical experimental set up of two stage Reciprocating air compressor test rig

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification		Quantity
		Pressure Gauge	Range from 0-10Kg/cm^2	
		Water Manometer	U-shaped glass tube	
		Air box	-----	

1	Two stage single acting reciprocating air compressor	Orifice plate	Diameter size from 6-30mm	1
		Air receiver tank	160 Lit	
		Thermometer/Thermocouple	Mercury in glass type/ Type K	
		Digital Temperature indicator	Pt100RTDs Milli volt And 4-20 range current	
		Tachometer	Speed up to 3000 rpm	
2	Electric Motor	Speed up to 1200rpm		1

IX. Precautions to be Followed

1. Avoid improper handling of two stage air compressor.
2. Maintain the proper level of lubricating oil up to red mark
3. Checking for oil and air leaks.

X. Procedure

1. Fill the manometer with water up to half level.
2. Keep delivery valve and manometer cock on suction line in closed position.
3. Start the compressor and open the manometer cock. Then, let the air pressure build-up in the tank.
4. Maintain pressure of air inside the tank constant, by adjusting delivery valve. Note this delivery pressure reading by pressure gauge mounted on tank.
5. With the same delivery pressure, note down water manometer reading, intake pressure, intermediate pressure, delivery pressure, intake temperature, temperatures before and after intercooler and delivery temperature.

XI. Observations and calculations

Sr. No.	Particulars	Notations	Unit	Reading
1	Intake Pressure (gauge)	$P_{1(\text{gauge})}$	Kg / cm^2	
	Intake Pressure (absolute) $P_{1(abs)}=P_{(atm)}+P_{1(gauge)}$ =(……)+(……X 0.9806)	P_1	bar	
	Intercooler/Intermediate pressure (gauge)	$P_{2(\text{gauge})}$	Kg / cm^2	

2	Intermediate Pressure (absolute) $P_{2\,(abs)}=P_{(atm)}+P_{2(gauge)}$ =(……)+(……X 0.9806)	P_2	bar	
3	Delivery pressure (gauge)	$P_{3(gauge)}$	Kg / cm^2	
	Delivery pressure (absolute) $P_{3\,(abs)}=P_{(atm)}+P_{3(gauge)}$ =(……)+(……X 0.9806)	P_3	bar	
4	Intake temperature	t_1	^0c	
		$T_1 = t_1 + 273$	^0K	
5	Temperature before intercooler	t_2	^0c	
		$T_2 = t_2 + 273$	^0K	
6	Temperature after intercooler	$t_{2'}$	^0c	
		$T_{2'} = t_{2'} + 273$	^0K	
7	Delivery temperature	t_3	^0c	
		$T_3 = t_3 + 273$	^0K	
8	Motor speed	N_1	rpm	
9	Manometer reading (as per procedure it should be at Sr.no.1) in table	h_1	mm	
		h_2	mm	

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Draw a block diagram of a two stage reciprocating air compressor on graph paper
2. Write specification of Motor used for the practical.
3. State practical applications of compressed air.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1.www.youtube.com/watch?v=rtrOcFq6QSs
2.www.youtube.com/watch?v=bJluUxA7aaY
3.www.youtube.com/watch?v=doDVrnV69CM
4.www.youtube.com/watch?v=rtrOcFq6QSs
5.www.youtube.com/watch?v=bJluUxA7aaY
6.www.youtube.com/watch?v=doDVrnV69CM

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the measuring Instruments	20%
	Calculation of final readings	00%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No.16

Calculate speed ratio of Belt Drive used in Air compressor and Driven Motor

I. Practical Significance

Power transfer from primary mover to any mechanism which gives some useful outcome is one of the most common works done in mechanically engineered products.

In order to transfer power form primary mover to any mechanism products like gears, belts, rope and chains are used.

These products transfer power from one place to another and also can provide mechanical advantages in terms of increase speed or torque at output.

From the above mention products belts are one which can be used to transfer power from primary mover to mechanism when primary mover and mechanism is far apart and light weight power transfer mechanism is required.

Belts have the ability to effectively transfer power even when primary power and mechanism are even meters away from each other.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1.Calculate speed ratio of given compressor

2.Calculate velocity ratio of given compressor

III. Course Level Learning Outcome (CO)

COd.-Understand working of Air compressor and Refrigeration system

IV. Laboratory Learning Outcome(s)

Calculate velocity ratio of given compressor

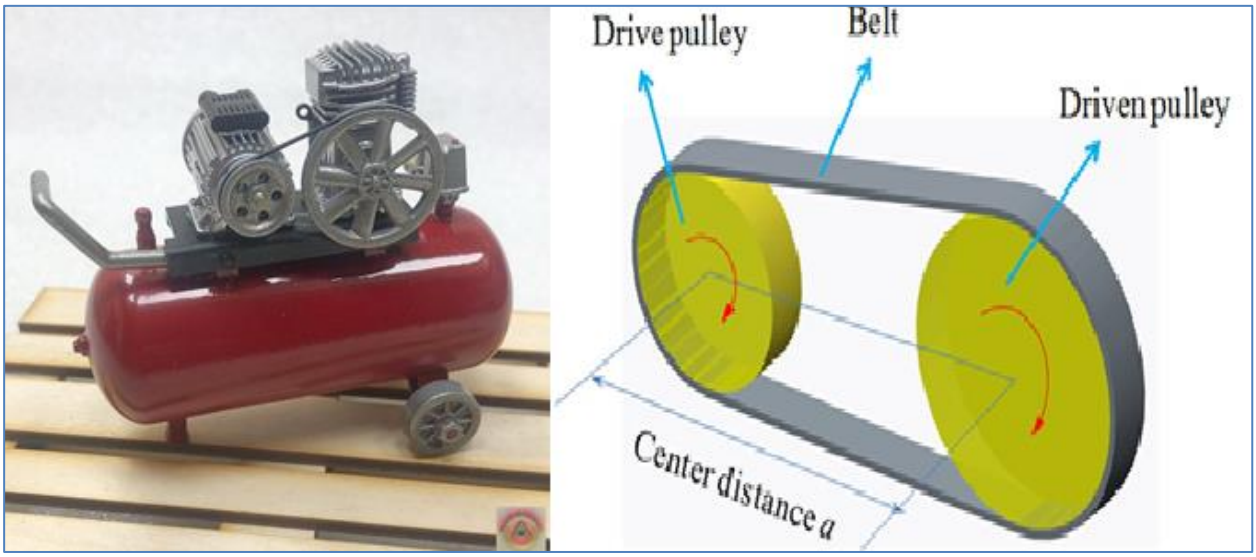
V. Relative Affective Domain related Outcome(s)-

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

VI. Minimum Theoretical Background with diagram (if required)

To transmit power from one shaft to another, Pulleys are mounted on the shaft. The Pulleys are connected by endless belt passing over the pulleys. The connecting belt is kept in tension so that motion of pulley is transferred to other without slip. The speed of driven shaft can be varied by varying the diameters of two pulleys.

VII. Experimental setup



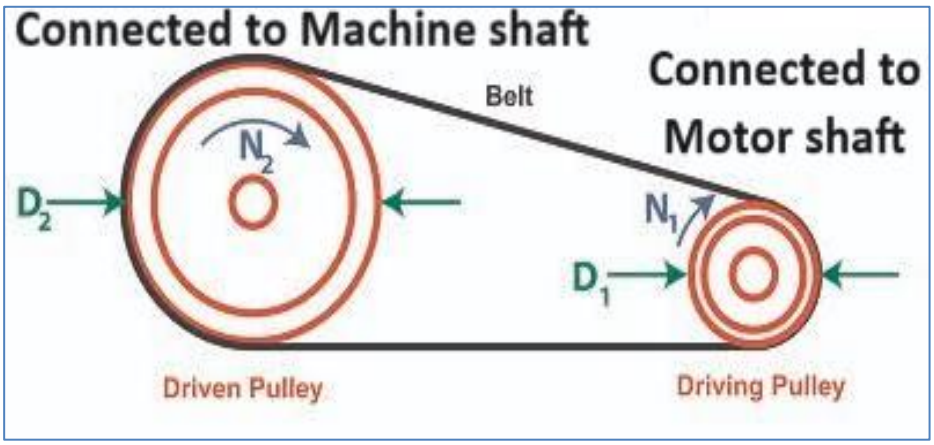


Fig.1 Schematic structure of Belt Drive

Fig 2. Analogue and Digital tachometer

(Source:https://www.instrumentchoice.com.au/fluke-931-contact-and-non-contact-dual-purpose-tachometers)

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Two stage single acting reciprocating air compressor	Belt drive provided for motor and compressor shafts	**1**
2	Electric Motor	Speed up to 1400 rpm	1
3	Mechanical Digital tachometer (speed measurement)	Range 0-5000 rpm	1
4	Steel rule (pulley diameter measurement)	0- 350 mm	1

IX. Precautions to be Followed

1. Avoid improper handling of two stage air compressor.
2. Maintain the proper level of lubricating oil up to red mark
3. Do not wear loose clothes during observation of rotating parts/pulleys
3. Checking for oil and air leaks.

X. Procedure

1. Ensure proper electric supply to it.
2. Switch on the machine.
3. Observe power transmission from driving to driven shaft/drum.
4. Measure the speed of the driving shaft using a digital (or analogue) tachometer.
5. Note the reading.
6. Measure the speed of the driven shaft in the same manner.
7. Switch off the machine.
8. Measure the diameters (radius) of the driving and driven pulley

XI. Observations and calculations

Speed of pulley		**Diameter of Pulley**		**Velocity Ratio**
Driver (N1 rpm)	Driven (N2 rpm)	Driver (D1 mm)	Driven (D2 mm)	(N1/N2)

Calculate speed ratio using formula:

Speed Ratio = N1/N2= D2/D1

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Define Belt Drive.
2. Write specification of Motor used for the practical.
3. List various types of belts used in belt drive mechanisms.
4. Calculate speed of driven pulley if Driver pulley of 40 mm diameter rotating with 400 rpm is connected with Driven pulley of 20 mm diameter by belt drive.
5. Write any two practical applications of belt drive (hint: Visit machine shop/ Fluid mechanics Laboratory/ Nearby floor mill)

[Space for Answer]

XVI. References / Suggestions for Further Reading

1.https://www.youtube.com/watch?v=NPjenJmlGbQ
2.https://www.youtube.com/watch?v=Jq35SP5lQOs

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the measuring Instruments	20%
	Calculation of final readings	00%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No.17
Demonstrate working of Household Refrigerator for identifying different components and type

I. Practical Significance

Household refrigerator is an appliance that is used for the short-term preservation of food products in the home by means of refrigeration. A domestic refrigerator is a metal cabinet with a built-in hermetically sealed refrigerating unit when the hot gas in the coils of the condenser meets the cooler air temperature of the kitchen, it becomes a liquid. Now in liquid form at high pressure, the refrigerant cools down as it flows through the expansion valve into the evaporator coils inside the freezer and the fridge.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

Identify different components of household refrigerator and type.

III. Course Level Learning Outcome (CO)

COd.- Understand working of Air compressor and refrigeration system

IV. Laboratory Learning Outcome(s)

Identify different components of household refrigerator

V. Relative Affective Domain related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

The process of removing heat from an enclosed place that has to be cooled is known as refrigeration. Refrigerant undergoes numerous state changes as it passes through the compressor, condenser, expansion valve, and evaporator—the four basic components of a compression refrigeration system.

VII. Experimental setup

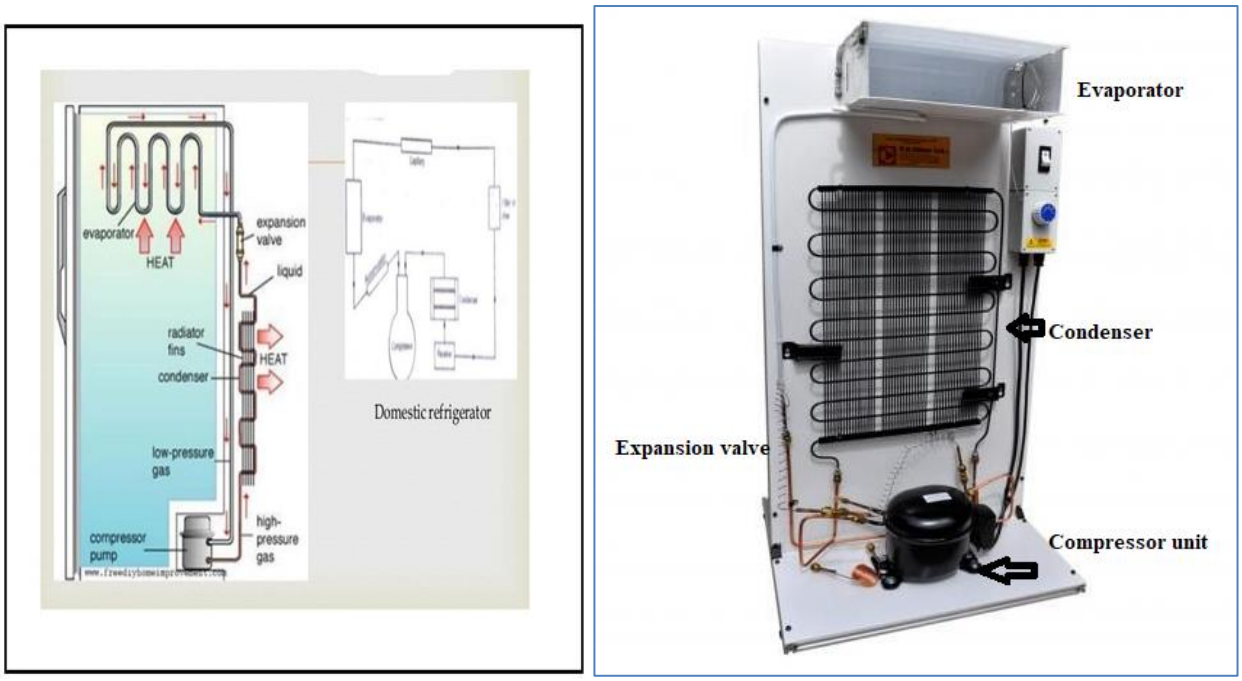


Fig.1 Household refrigerator unit

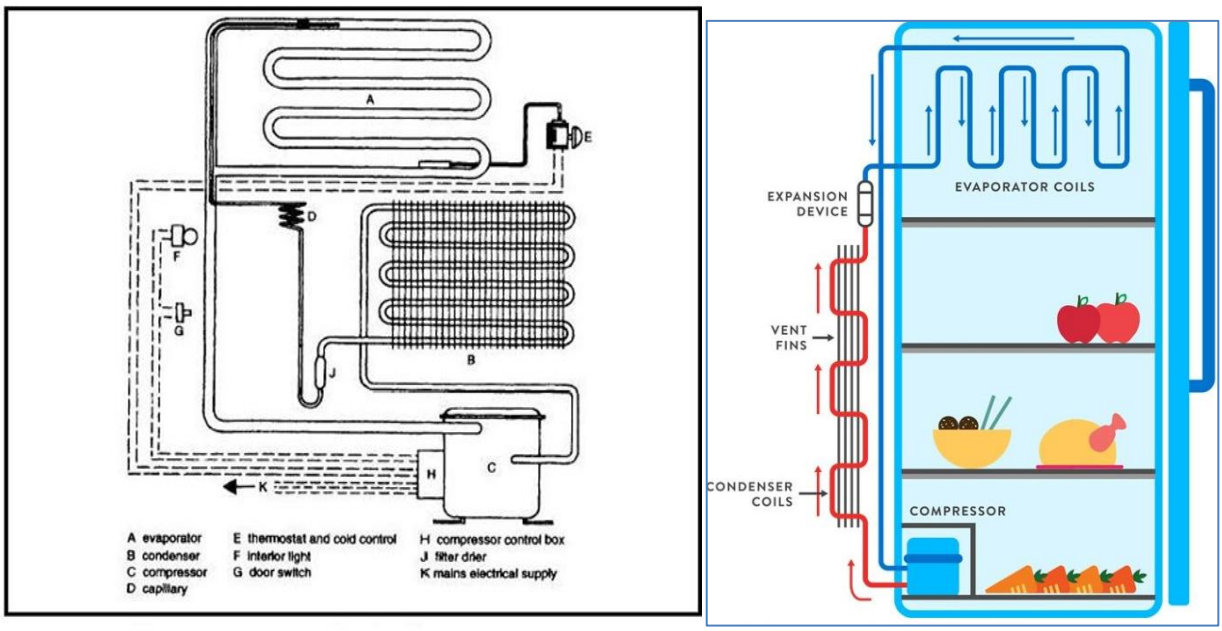


Fig.2 Line Diagram of Household refrigerator

(Sourcehttps://hometechgrow.com/working-principle-and-benefits-room-air-conditioners/)

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Domestic Refrigerator	Capacity – 165 lit.	1
		Refrigerant –R 134a	

IX. Precautions to be Followed

1. Ensure that refrigerator is connected to with proper electric power supply.
2. Ensure that refrigerator door is tightly closed.
3. Inspect that there is proper distance between refrigerator and wall.
4 Avoid improper handling of domestic refrigerator.

X. Procedure

1.Identify and locate the components.

2. Locate the refrigerant tubes connecting different parts and trace the path of refrigerant.

3.Observe and trace the path of refrigerant.

XI. Observations and calculations

Sr. No.	Particulars	Remark (Functions /Type)
1	Compressor	
2	Condenser	
3	Evaporator	
4	Thermostat valve	
5	Expansion valve	

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Draw a layout of household refrigerator on graph paper
2. Collect the names of Indian manufacturers of household refrigerator along with their range of capacity in TR.
3. Select the capacity of refrigerator for a. medical store b. Small pan shop c. Hotel

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=h5wQoA15OnQ
2. https://www.youtube.com/watch?v=L5jQqmaFKOE
3. https://www.youtube.com/watch?v=TPabv9iDENc

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the Models/set up	20%
	Observations of models/set up	00%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	Total	100 %

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

Practical No.18
Demonstrate working of Window air conditioner for identifying different components

I. Practical Significance

Window air conditioning unit is a factory assembled air conditioning unit. Casing of the unit is divided into indoor portion and outdoor portion. Indoor portion which faces the room consists of evaporator, blower, filter and control unit. Outdoor portion consists of compressor, condenser and its fan. The main components of a water cooler and window/split air conditioning units are the compressor, the condenser, the expansion valve and the evaporator.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

- Identify different components of Window air conditioner

III. Course Level Learning Outcome (CO)

COd.- Understand working of Air compressor and refrigeration system

IV. Laboratory Learning Outcome(s)

List different components of Window air conditioner

V. Relative Affective Domain related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

- Know the construction and working of refrigeration system.
- Identify various subassemblies of refrigeration system.
- Identify various sub-assemblies of water cooler and window/split air conditioning units
- Identify recommended tools.

An air conditioner works by actually removing heat and humidity from the inside air to create cool air within your house or other enclosed space. A condenser, compressor, expansion valve, and evaporator function together to minimize air temperature in an air conditioner as per vapour compression cycle.

VII. Experimental setup

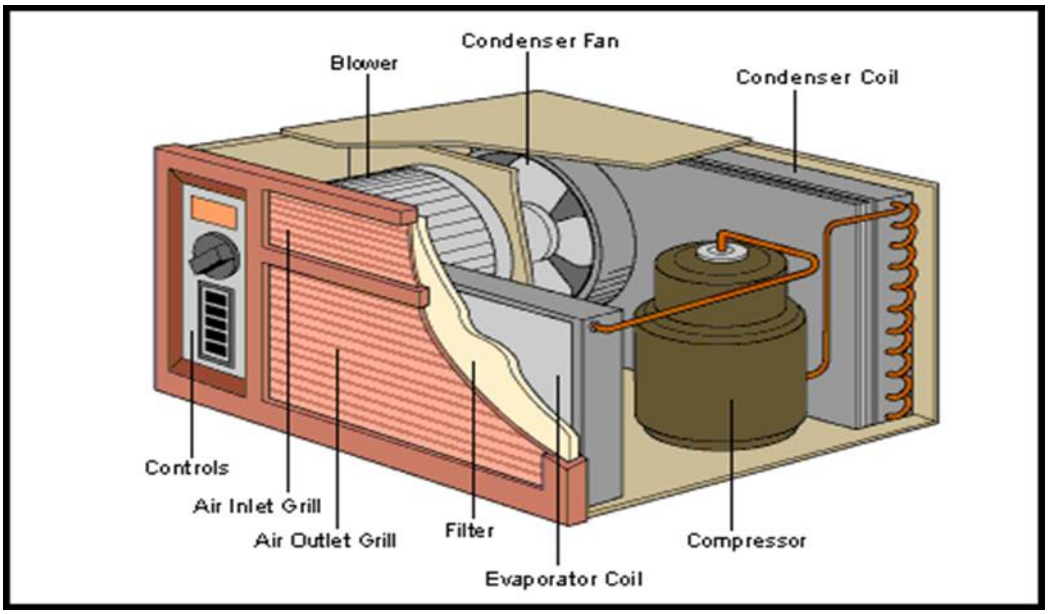


Fig.1 Window Air conditioner unit
(Source:https://hometechgrow.com/working-principle-and-benefits-room-air-conditioners/)

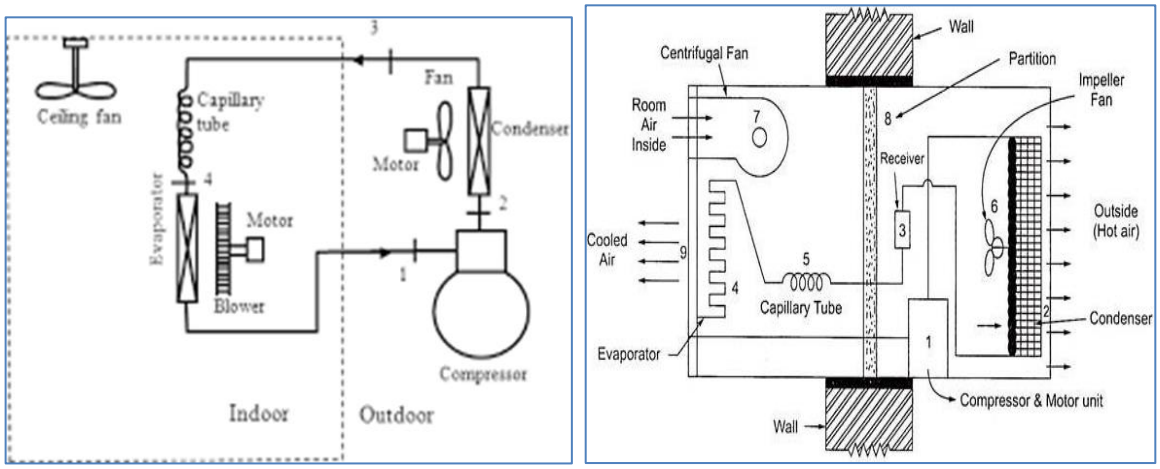


Fig.2 Circuit Diagram and sketch of Window Air conditioner

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Window/Split air conditioning	Models or actual set up As per standard	1
2	Industrial Visit	Visit to Air conditioner service stations	1

IX. Precautions to be Followed

1. Avoid improper handling of window/split air conditioning units.
2. Do not release Refrigerants (harmful substances) into the atmosphere
3. Unplug window/split air conditioning units before touching to any component
4. Ensure that window/split air conditioning units is connected with proper electric power supply.

X. Procedure

1. Visually inspect unit
2. Removal of loose parts of storage container of your system
3. Inspect electrical wiring and components
4. Visually inspect unit
5. Removal of loose parts of storage container of your system
6. Inspect electrical wiring and components
7. Observe the Cut unit of the Compressor
8. Observe the Cut unit of the Condenser
9. Observe the Expansion unit
10. Observe the Cut unit of the Evaporator
11. Observe the Thermostatic switch
12. Observe the drier
13. Observe the OLP
14. Observe the cabinet with PUF insulation
15. Observe the Blower
16. Observe the Fan motor

XI. Observations and calculations

Sr. No.	Particulars	Remark
1	Compressor	Capacity -
		Make-
		Type-
2	Condenser	Capacity -
		Type-
		No. of coils-
3	Expansion valve	Name-
		Type-
		Make-

Sr. No.	Particulars	Remark
4	Evaporator	Type-
		No. of coils-
5	Thermostatic switch	Type -
6	Drier	Type -
7	OLP	Capacity(volt)-
		Capacity(current)-
8	Blower	Type-
9	Fan Motor	Capacity -
		Type-
10	Cabinet	Inside Panel -
		Outside Panel -

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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. Draw a layout of Window Air conditioner on graph paper
2. Collect the names of Indian manufacturers of window air conditioners along with their range of capacity in TR.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=qBbND6UcjOs
2. https://www.youtube.com/watch?v=NzCj_BPKv0U
3. https://www.youtube.com/watch?v=cDl90FQo-I8

XVII Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the Models/set up/measuring Instruments	10%
	Observations Models/set up/measuring Instruments	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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

Practical No. 19
Collect information of water lifting systems in ancient India relation with hydraulic pump (IKS)

I. Practical Significance

Water is major source for agriculture and traditionally pulley system is used which involves pulling up water from a well or other such source to irrigate the land. According to power sources water lifts can be classified as manual, animal and power operated devices.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

3. Identify the type of system used in ancient period.
4. Select the appropriate water lifting system for different applications.

III. Course Level Learning Outcome (CO)

COd.- Understand ancient water pumping system for various applications

IV. Laboratory Learning Outcome(s)

Collect information of water lifting system in ancient India.(IKS)

V. Relative Affective Domain related Outcome(s)-

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

VI. Minimum Theoretical Background with diagram (if required)

Ancient time following method were used

1. Swing basket:. The device consists of a basket made from the cheap materials like woven bamboo strips, leather, or iron sheet to which four ropes are attached.

2. Counterpoise lift. It is also known as **dhenki or picattach**. It is generally used for lifting of water from unlined wells, stream or pond for irrigating small fields. It consists of a lever rod supported at a suitable point on a vertical post about which it can swing in vertical direction.

3.Paddle wheel. It is also known as **Chakram** and is mostly used in costal regions for irrigating paddy fields. It consists of small paddles mounted radially to a horizontal shaft, which moves in close fitting concave trough, thereby pushing water ahead of them.

4.Persian wheel: It is also known as Raha. It is used to lift water from a depth up to 20m. The efficiency of the device is considerably reduced after 7.5m. The device consists of endless chain of buckets made of GI sheet having capacity from 8-15 litres. The chain of bucket is mounted on a drum and is submerged in the water to sufficient depth.

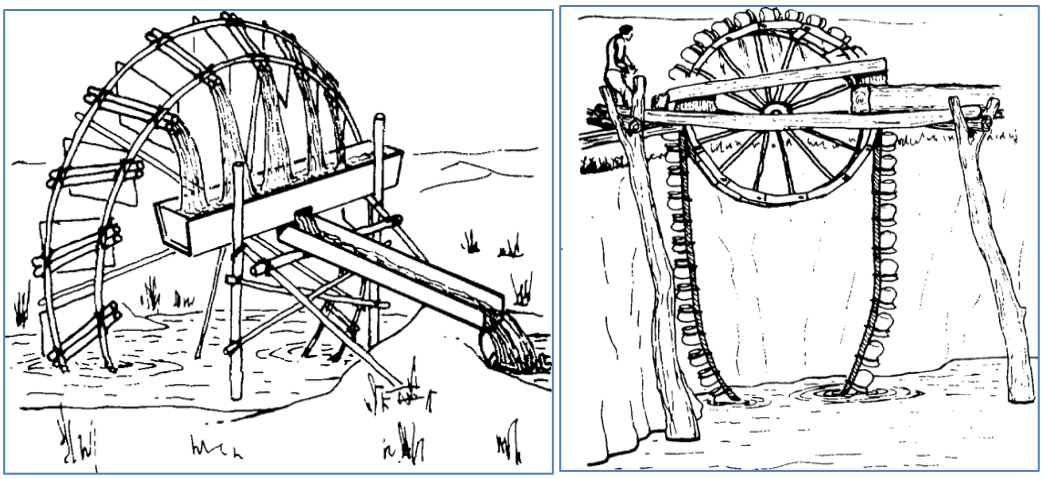
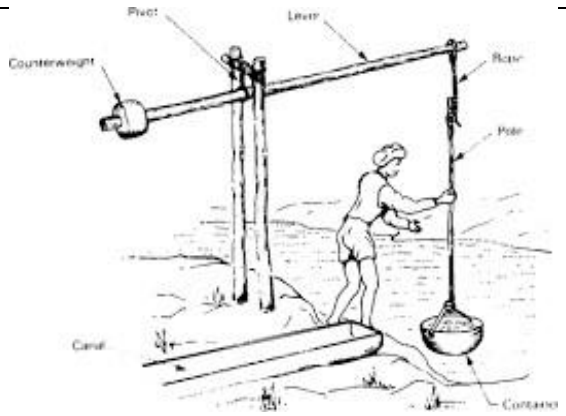


Fig.1 Traditional water lifting systems
(Source:https://akvopedia.org/s_wiki/index.php?title=Bucket_elevators,_Persian_wheels_)

Table 1. Similarity and Comparison of Ancient and Recent technologies of water lifting systems

Point	Ancient system	Recent technologies
Similarity		
Mechanism	Rotary motion of wheel or lever mechanism	Rotary or reciprocating motion
Water carrying component	Cylindrical Drums or bucket or traditional pots	Impeller blades , cylinder and piston
Differences		
Source of power	Mechanical or manual or use of Animals	Electrical or engine operated
Use of materials	Local wooden/bamboo parts, metal drums, buckets	Cast iron casing, impeller, metal pipes
Applications	Farming and irrigation	Farming, irrigation and industrial use

VII. A) Experimental setup no.1 (Any working model having belt drive)

Type	Sketch	Set up/models
Counter poise lift		Prepare model to show concept of water lifting by Counterpoise lift Or use display chart

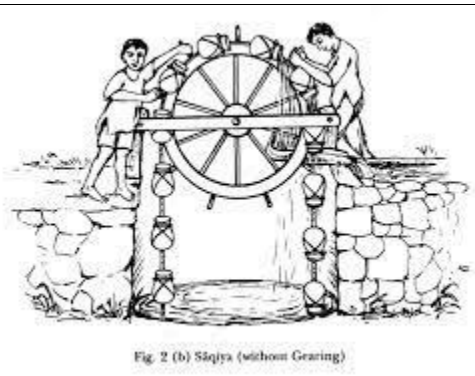
Dhenkli or Shaduf	 Fig. 2 (b) Sāqiya (without Gearing)	Prepare model to show concept of water lifting by Dhenkli or Shaduf or use display chart
Persian wheel		Prepare model to show concept of water lifting by Persian wheel or use display chart

Fig.1 Practical set up/models of Ancient water lifting systems

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Charts of **Rahat, Persian wheel**	Models/ charts showing construction and working	01
2	Charts /models of **pulley and rope**	Models/ charts showing construction and working	01
3	Charts /models of **Swing basket**	Models/ charts showing construction and working	01

IX. Precautions to be Followed

1. Avoid improper handling models/charts
2. Maintain proper distance from working models.
3. Use safety shoes.
4. Use tools safely.

X. Procedure

1. Explain working principle of Rahat, Persian wheel, swing basket, peddle wheel
2. Explain the concept of traditional system of water lifting
3. Explain the main components of traditional system of water lifting
4. Explain functions and working of components of traditional system of water lifting

XI. Observation Tables-

(Visit to nearby villages to collect information if possible)

Sr No.	Type of system	Components	Function
1	Rahat		
2	Pulley system		
3	Persian wheel		
4	Swing basket		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. 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 difference between Rahat and Persian wheel

2.Write specification of different components Persian wheel

3.List various types of traditional water lifting systems for irrigation

[Space for Answer]

XVI. References / Suggestions for Further Reading

Chadas : https://www.youtube.com/watch?v=uTrajIJ79ME
Persian wheel : https://www.youtube.com/watch?v=7Xyv1AmMCZw
Dhenkli : https://www.youtube.com/watch?v=5RQU2V1CCAk

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(20%)**
	Handling of the Models/Set up	10%
	Observations/ Calculation of final readings	10%
Product Related (10 Marks)		**(80%)**
	Interpretation of result	40%
	Conclusions	20%
	Practical related questions	20%
	T**otal**	100 %

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