SCHEME :K

Name :________________________
Roll No.:________ Year : 20 ___ 20 __
Exam Seat No. :___________________

LABORATORY MANUAL FOR
POWER PLANT ENGINEERING (315374)

MECHANICAL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous)(ISO21001:2018)(ISO/IEC27001:2013)

Maharashtra State
Board of Technical Education, Mumbai

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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.

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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

Power Plant Engineering (315374)

Semester – V

"K- SCHEME"

Diploma in Mechanical Engineering

Maharashtra State Board of Technical Education, Mumbai

(Autonomous) (ISO 21001:2018) (ISO/IEC 27001:2013)

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

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MAHARASHTRA STATE
BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms …………………………………… Roll No………………………of Fifth Semester of Diploma in …………………………………………………………of **Institute Name:** ……………………………………………………………….. (**Institute Code** :………………..) has completed the term work satisfactorily in course **Power Plant Engineering (315374)** for the academic year 20…… to 20…..... as prescribed in the curriculum.

Place: ………………. Enrollment No.: …………………

Date: …..................... Exam Seat No.: ………………....

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

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much-needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'K' Scheme curricula for engineering diploma programmes with National Education Policy 2020 (NEP-2020) 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.

A sound understanding of thermal power plants, fuels and their properties, industrial material handling systems, and mechanical equipment such as turbines, pumps, boilers, and ash handling systems is essential for engineers across all disciplines. Mastery of these foundational topics not only enhances technical competence but also fosters problem-solving abilities, creative thinking, and the spirit of teamwork, which are vital attributes in modern engineering practice.

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.

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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 Heating Ventilation Air Conditioning 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.

PO2. Problem analysis: Identify and analyze well-defined mechanical engineering problems using codified standard methods.

PO3. 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.

PO4. Engineering Tools, Experimentation and Testing: Apply modern mechanical engineering tools and appropriate technique to conduct standard tests and measurements.

PO5. Engineering practices for society, sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well defined engineering activities in diverse and multidisciplinary fields.

PO7. Life-long learning: Ability to analyze individual needs and engage in updating in the context of technological changes in mechanical engineering.

List of Industry Relevant Skills

These skills collectively prepare students for real-world challenges in power plant operation, maintenance, and environmental compliance, enabling them to contribute effectively to the energy and utility sector.

1. Compare and analyze properties of conventional power plant fuels to optimize efficiency and reduce emissions.
2. Measure and interpret feed water parameters (pH, conductivity, TDS) and maintain boiler water chemistry for safe operation.
3. Identify and maintain steam trap components (float and thermodynamic types) and understand steam-condensate system behavior.
4. Understand and maintain ash handling and dust collection systems, including the operation of Electrostatic Precipitators (ESPs).
5. Interpret layout diagrams of thermal and gas turbine power plants and demonstrate creativity through working/non-working models.
6. Follow preventive maintenance and safety protocols during practical’s involving water analysis, steam systems, and emission controls.

Practical- Course Outcome matrix

Course Outcomes (COs):

Students will be able to achieve & demonstrate the following COs on completion of course based learning;

- CO1. Choose appropriate fuel for power plant in given situation.
- CO2. Apply relevant knowledge & skills to maintain modern steam power plant efficiently and safely.
- CO3. Use knowledge & skills related to Gas Power Plant & Waste Heat Recovery properly in the given situation.
- CO4. Use suitable strategies to run nuclear power plants safely.
- CO5. Calculate economic parameters of various power plants.

S. No.	Laboratory Practical Titles	CO 1.	CO 2.	CO 3.	CO 4.	CO 5.
1	*Conventional Power Plant: Fuels and their properties.	√	-	-	-	-
2	*Find the feed water parameters.	-	√	-	-	-
3	Assembling and dismantling of Float and thermodynamic steam trap.	-	√	-	-	-
4	Ash handling system or electrostatic precipitator (ESP).	-	√	-	-	-
5	Layout model of gas turbine power plant.	-	-	√	-	-
6	*Cogeneration in the given thermal power plant	-	-	√	-	-
7	*Working of nuclear power plant.	-	-	-	√	-
8	Waste disposal model for nuclear waste.	-	-	-	√	-
9	Captive steam power plant with all technical specifications.	-	-	-	-	√
10	*Connected electricity load of anyone laboratory.	-	-	-	-	√
11	Modern steam power plant efficiency.	-	√	-	-	√

Guidelines to Teachers

1. **Teacher needs 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, student 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

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 09 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

Conventional Power Plant: Fuels and their Properties*

I. Practical Significance:

Understanding fuels and their properties helps diploma students analyse and improve power plant performance, troubleshoot issues, and support efficient, eco-friendly energy generation.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcome (CO)

CO4: Choose appropriate fuel for a power plant in a given situation.

IV. Laboratory Learning Outcome(s)

LLO 1.1 Select appropriate fuel for given conventional power plant based on properties of fuel.

V. Relative Affective Domain related Outcome(s)

- Work effectively in a team.
- Maintain tools, models, and equipment.
- Follow lab safety and ethical practices

VI. Minimum Theoretical Background with diagram

A. Types of Conventional Power Plants:

Thermal: Coal, oil, gas.

Nuclear: Uranium, plutonium.

B. Fuel Types and Features:

(i) Coal – High energy, high ash and emissions.

(ii) Fuel Oil – Easy handling, moderate emissions.

(iii) Natural Gas – Clean, efficient, needs pipeline.

(iv) Nuclear Fuels (U-235, Pu-239) – High energy, needs strict safety.

C. Fuel Properties:

(i) Calorific Value: Energy output per unit mass.

(ii) Moisture & Ash Content: Affect combustion and efficiency.

(iii) Volatile Matter & Fixed Carbon: Impact ignition and heat stability.

(iv) Density and Radioactivity: Affect storage, flow, and safety.

D. Fuel Selection Criteria

Selecting the appropriate fuel involves balancing several factors:

a) **Energy Content:** Fuels with higher calorific value produce more heat per unit mass.

b) **Availability and Cost:** Local availability reduces transportation costs; economic viability is key.

c) **Environmental Impact:** Emissions of CO_2, SO_x, NO_x, and particulate matter must be controlled.

d) **Handling and Storage:** Solid fuels require storage yards and ash disposal; liquid and gas fuels require tanks and pipelines; nuclear fuels need stringent safety measures.

e) **Plant Design Compatibility:** The fuel must be suitable for the plant's combustion system (e.g., pulverized coal boilers vs gas turbines).

VII. Experimental Setup

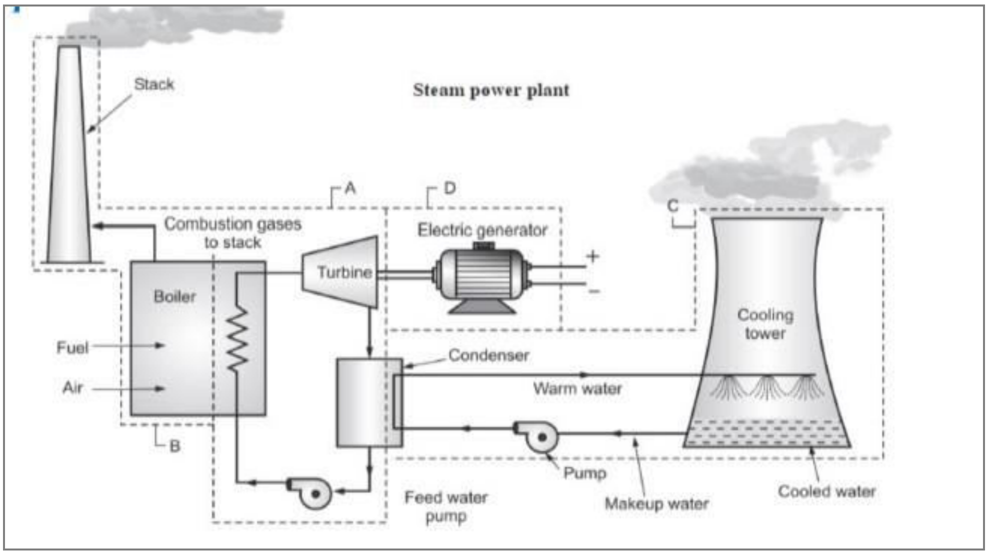

Fig 1: Basic Layout of Steam Power Plant

VIII. Required Resources:

S. No.	Name of Resource	Suggested Specification	Quantity
1	Video/PPT working of a steam power plant	Includes working principle and benefits	1
2	https://beeindia.gov.in/sites/default/files/2Ch1.pdf	--	--
3	Laser pointer for demonstration	For pointing out components in class	1

IX. Precautions to be Followed

1. Do not damage or mishandle physical models.
2. Maintain silence and attentiveness during video-based demonstration.

X. Procedure

1. Draw a schematic showing the boiler, turbine, condenser, generator, and cooling tower.
2. Label all components clearly to show steam and energy flow.
3. Define conventional fuels: coal, diesel, furnace oil, and natural gas.
4. List fuels with basic properties (calorific value, ash content, etc.).
5. Show that combustion of fuel releases heat energy.
6. Use heat to produce high-pressure steam in the boiler.
7. Direct steam to rotate the turbine connected to the generator.
8. Condense exhaust steam in the condenser using a cooling tower.
9. Highlight fuel selection factors: availability, cost, calorific value, ash content, pollution.
10. Show overall process: fuel → heat → steam → turbine → electricity.

XI. Observations

Aspect	Form	Calorific Value (MJ/kg)	Carbon Content	Ash Content	Moisture Content
Coal (Bituminous)					
Petroleum (Fuel Oil)					
Natural Gas					
Diesel					

XII. Results

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

XV. Practical Related Questions

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

1. Name any two conventional fuels used in thermal power plants.
2. Explain how the calorific value of a fuel affects the efficiency of a thermal power plant.
3. Compare coal and natural gas in terms of efficiency, environmental impact, and availability.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1) https://youtu.be/1gLsApOvzYQ
2) https://youtu.be/BYpfOKwlYS8
3) https://beeindia.gov.in/sites/default/files/2Ch1.pdf

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (10 Marks)	**(40%)**
1	Identification of Components	20%
2	Explanation using model/chart	20%
	Product Related (15 Marks)	**(60%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	30%
	Total	**100 %**

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

Practical No. 2

Find the feed water parameters.*

I. Practical Significance

The efficiency and longevity of boilers in thermal power plants depend significantly on the quality of feed water. Analysing feed water parameters helps prevent corrosion, scaling, and foaming, ensuring optimal plant performance.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge and skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcome (CO)

CO2: Apply relevant knowledge and skills to maintain modern steam power plant efficiently and safely.

IV. Laboratory Learning Outcome(s)

LLO 2.1: Use Digital pH meter and TDS meter.

LLO 2.2: Measure the parameters of feed water by using Digital pH meter and TDS meter.

V. Relative Affective Domain related Outcome(s)

- Work responsibly while handling lab equipment.
- Maintain proper data recording and observations
- Maintain tools, models, and equipment.
- Follow lab safety and ethical practices.

VI. Minimum Theoretical Background with diagram

Table 2.1: Feed Water Parameters

S.N.	Parameter	Significance
1	**pH Value**	Indicates acidity/basicity of water (ideal range: 8.5–9.5).
2	**Total Dissolved Solids (TDS)**	Measures dissolved salts; high values cause scaling.
3	**Hardness**	Caused by calcium and magnesium ions; responsible for scale.
4	**Conductivity**	Indicates the ability of water to conduct electricity (linked to TDS).
5	**Alkalinity**	High alkalinity may cause foaming in boilers.
6	**Silica Content**	Forms hard scale; must be minimized.

Table 2.2: Equipment Specifications

Equipment	Specifications / Details
pH Meter	Digital pH meter: pH Range-0-14pH, pH Resolution- 0.01pH, pH Accuracy-+0.002pH
Conductivity Meter	Type: Digital, bench-top or portable, Range: 0 to 200 mS/cm (auto-ranging), Accuracy: ±1% of reading
TDS Meter	TDS meter: TDS Measuring Range: 0-9990 PPM, Resolution: 1 PPM

	(10 PPM for 1000 to99990 PPM), Accuracy: ±2%, Temperature Measuring Range: 0° to 50°C
Hardness Test Kit	Material: Glass, Sizes: 50 ml to 1000 ml
Reagents	flame-resistant, chemical splash resistant
Beakers, Pipettes, etc	Digital pH meter: pH Range-0-14pH, pH Resolution- 0.01pH, pH Accuracy-+0.002pH
Safety kits / wear	Type: Digital, bench-top or portable, Range: 0 to 200 mS/cm (auto-ranging), Accuracy: ±1% of reading

VII. Experimental Setup

The experimental setup for analysing feed water parameters includes the following equipment arranged systematically on the laboratory workbench. The setup ensures accurate testing and safety during operation.

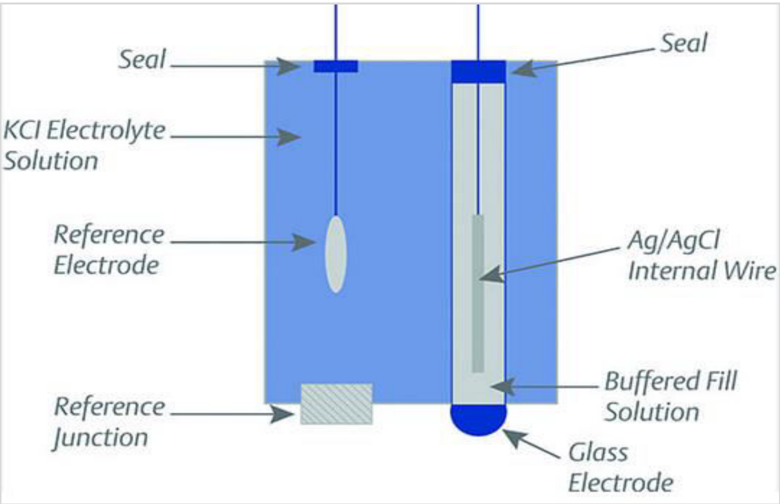

Fig. 2.1: TDS Measurement

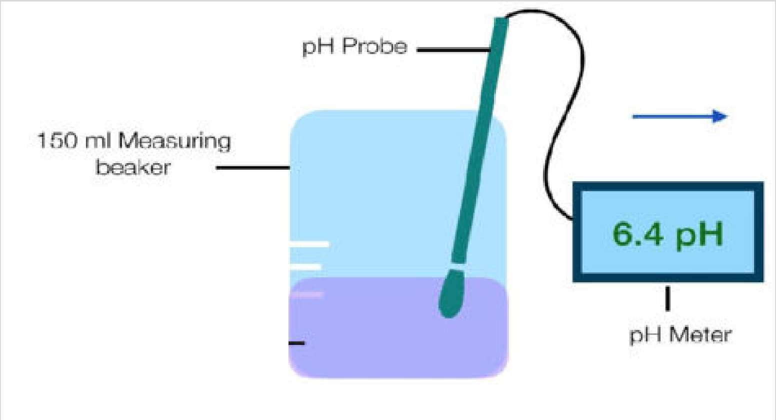

Fig. 2.2: pH Measurement

VIII. Required Resources

Equipment: pH Meter, Conductivity Meter, TDS Meter, Beakers, Pipettes, etc, Safety kits/wear;

https://archive.nptel.ac.in/courses/112/107/112107291/

IX. Precautions to be Followed

- Use fresh samples for testing.
- Handle acids and reagents with care.

X. Procedure

1. Collect the feed water sample in a clean container.
2. pH Measurement: Use calibrated pH meter; immerse electrode in sample.
3. TDS Test: Dip TDS meter into water; record value.
4. Conductivity Test: Use conductivity meter; wait for stable reading.
5. Hardness Test: Titrate sample with EDTA; note burette reading.
6. Record all observations in the table provided.

XI. Observations and Calculations

Equipment	Observations	Standard Value	Remarks
Conductivity			
TDS Meter			
Hardness			

XII. Results

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

XV. Practical Related Questions

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

1. List importance of hardness in boiler feed water.
2. Enlist effect of Low pH on boiler tubes.
3. Explain the relation between conductivity and TDS.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://youtu.be/a4meZbO-nr0
2. https://youtu.be/NtUboCva8fk
3. https://archive.nptel.ac.in/courses/112/107/112107291/
4. https://archive.nptel.ac.in/courses/103/107/103107211/
5. https://www.beeindia.gov.in/sites/default/files/2Ch2.pdf

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Identification of Components	20%
2	Explanation using model/chart	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total	**100 %**

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

Practical No. 3

Assembling and dismantling of Float and thermodynamic steam trap.

I. Practical Significance

Steam traps are critical in maintaining the efficiency of steam systems by removing condensate without losing steam. Understanding the assembly and dismantling of steam traps helps in routine maintenance and troubleshooting in thermal systems.

II. Industry/Employer Expected Outcome (s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcome (CO)

CO2: Apply relevant knowledge & skills to maintain modern steam power plant efficiently and safely.

IV. Laboratory Learning Outcome(s)

LLO 3.1: Dismantle Float and thermodynamic steam trap.
LLO 3.2: Check the status of components in the float and thermodynamic steam trap.
LLO 3.3: Assemble float and thermodynamic steam trap.

V. Relative Affective Domain related Outcome(s)

- Work responsibly while handling lab equipment.
- Maintain tools, models, and equipment.
- Follow lab safety and ethical practices.

VI. Minimum Theoretical Background with diagram

Float Steam Trap: Uses a float to open/close the discharge valve based on condensate level. Operates continuously. Suitable for processes requiring continuous condensate removal.
Thermodynamic Steam Trap: Works on the principle of steam pressure and velocity. Opens intermittently; best for high-pressure systems. Simple and rugged design.

VII. Experimental Setup:

A setup with mounted steam traps (cut section or working model) including: Pipe stands and mounting brackets, Float and thermodynamic traps (actual or models), Basic mechanical tools (spanner, wrench, screwdrivers, etc.) and Assembly diagram for reference.

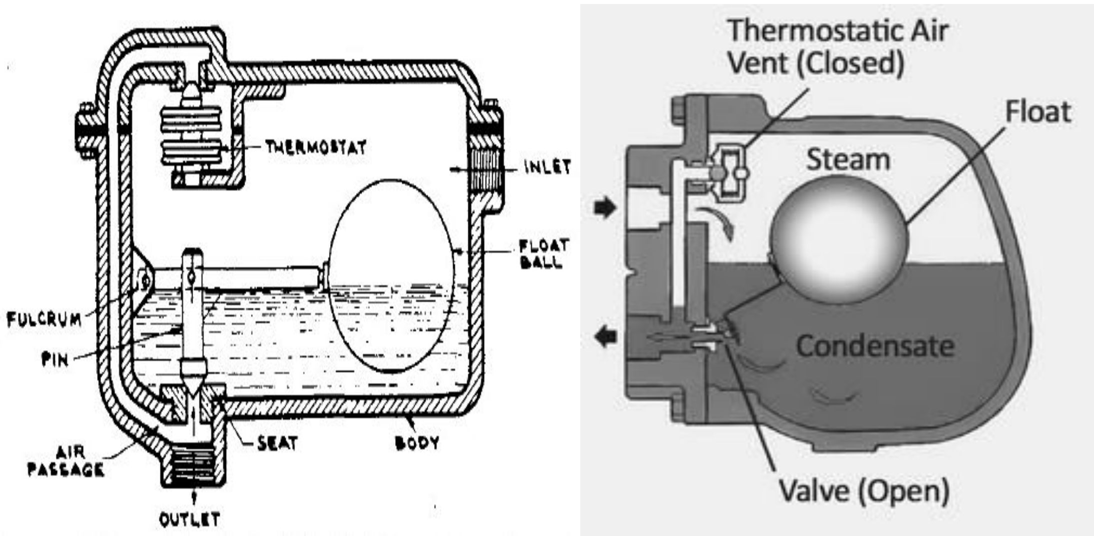

Fig. 3.1: Float and Thermodynamic Steam Trap

VIII. Required Resources

Equipment	Details
Float Steam Trap (Cut section/Working model)	Cast iron or stainless steel, cut-section
Thermodynamic Steam Trap	Stainless steel, compact body
Tool Kit	Adjustable spanner, screwdrivers, etc.
Lubricant/Sealant	Industrial grade
Personal Protective Equipment	Gloves, safety shoes, goggles
Equipment/Tools	Specifications

IX. Precautions to be Followed

1. Use tools properly to avoid damage to parts.
2. Do not over tighten fasteners during reassembly.
3. Follow standard safety protocols.

X. Procedure

1. Identify all components of the steam trap.
2. Carefully unscrew bolts and dismantle the trap.
3. Lay out parts sequentially and inspect for wear or damage.
4. Clean internal parts with a soft brush and lint-free cloth.
5. Reassemble the trap in correct order using reference diagrams.
6. Tighten all bolts to recommended torque.
7. Check for proper movement of float/disc.
8. Report any defects observed during inspection.

XI. Observations and Calculations

Name of component	Function	Observed Condition	Maintenance Type	Remarks
Condition of Gasket				
Movement of Float/Disc				
Condition of Seat & Valve				
Reassembly Tightness Check				

XII. Results

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

XV. Practical Related Questions

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

1. Enlist importance of steam traps in a steam distribution system.
2. Illustrate the importance of proper alignment during reassembly.
3. Illustrate the procedure of differentiating between steam and condensate by steam trap.
4. Describe the procedure to test a steam trap during the practical to check its proper working.

[Space for Answer]

References / Suggestions for Further Reading

1. https://www.engineeringtoolbox.com/steam-traps-d_797.html
2. https://youtu.be/w4MnNfUsBPU?si=GdyXH1aoWaaNHHda
3. https://youtu.be/HbuhjoN9xTU?si=rY_JkZkwxGxsTUdg
4. https://youtu.be/QqDDvQyfHXY?si=hr_08pZxjzOGf5iX

XVI. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Identification of Components	10%
2	Use of tools for assembly and disassembly	30%
3	Observation of different parts	20%
	Product Related (10 Marks)	**(40%)**
4	Interpretation of result	20%
5	Conclusions	10%
6	Practical related questions	10%
	Total	**100 %**

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

Practical No. 4

Ash handling system or electrostatic precipitator (ESP).

I. Practical Significance

Ash generated from combustion in thermal power plants must be removed efficiently to ensure smooth operation and environmental compliance. Ash handling systems and Electrostatic Precipitators (ESPs) help manage solid waste and minimize particulate emissions, contributing to cleaner and safer plant operations.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcome (CO)

CO2: Apply relevant knowledge & skills to maintain modern steam power plant efficiently and safely.

IV. Laboratory Learning Outcome(s)

LLO 4.1: Demonstrate the ash handling system using suitable media.

LLO 4.2: Prepare a layout comprising various components of the ash handling system.

V. Relative Affective Domain related Outcome(s)

- Work responsibly while handling lab equipment.
- Maintain proper data recording and observations.
- Maintain tools, models, and equipment.
- Follow lab safety and ethical practices.

V. Minimum Theoretical Background with diagram

A. Ash Handling System Types:

Ash is the residue left after combustion of coal in thermal power plants. Efficient ash handling is essential for smooth plant operation and to meet environmental regulations.

(i) Hydraulic System: Uses water to transport ash through pipelines.

(ii) Pneumatic System: Uses air pressure to convey ash to storage silos.

(iii) Mechanical System: Utilizes belt or chain conveyors to transport ash to disposal points.

B. Electrostatic Precipitator (ESP):

An ESP removes fine dust particles from flue gases before releasing them into the atmosphere. Flue gas flows through high-voltage electrodes, which electrically charge the dust particles. These charged particles are then attracted and collected on oppositely charged plates, which are cleaned regularly to remove the ash. An Electrostatic Precipitator is an air pollution control device that removes fine particulate matter (like ash, soot, or dust) from flue gases emitted by boilers, furnaces, or incinerators, primarily in thermal power plants and industrial setups.

Applications of ESP: In thermal power plants (to remove fly ash from boiler exhaust), in Cement Kilns, Steel Plants and waste incinerators.

VI. Basic Layout Diagram

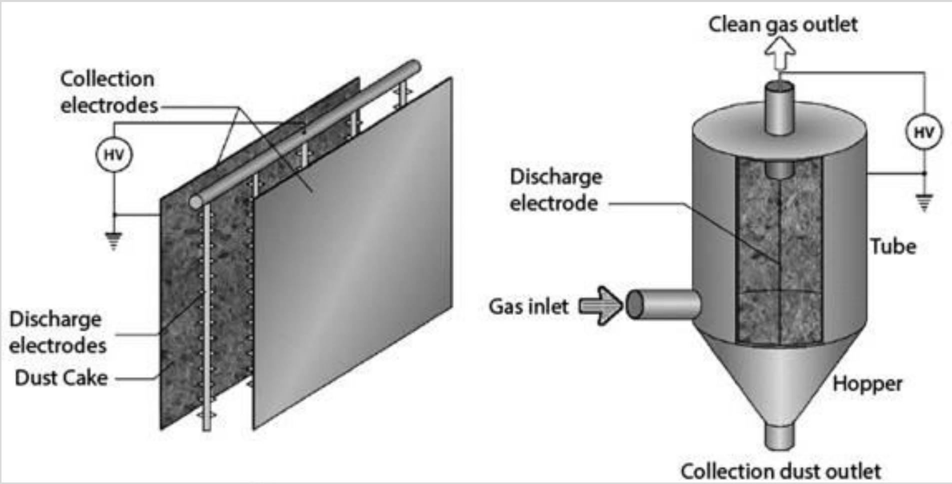

Fig. 4.1: Two types of electrostatic precipitator: (i) parallel-plate and (ii) tubular

VII. Experimental Setup

Includes model or Demonstrative prototype/Chart of:

1. ESP chamber with a sample power supply
2. Ash handling conveyor or pneumatic transport model
3. Layout chart of ash collection and ESP
4. https://youtu.be/6Mou__9adOc
5. https://youtu.be/wlPOMYxB64Q

IX. Required Resources

Equipment	Qty
ESP Model or Demonstrative prototype / Chart	1
Ash Handling System Model	1
Layout Charts	2

X. Precautions to be Followed

1. Use of Insulated Tools and Gloves.
2. Clear Signage and Labels.
3. Personal Protective Equipment (PPE).
4. Adhere strictly to lab safety guidelines.

XI. Procedure

1. Identify and label major components in both systems.
2. Observe working principles in simulation or demonstration.
3. Trace the flow of ash from the furnace to the disposal unit.
4. Record parameters such as airflow or voltage, if applicable.
5. Sketch the layout diagrams.
6. Discuss the advantages and environmental importance of the systems.

XII. Observations and Calculations

Name of component	Observed Value/Condition	Remarks
Type of Ash Handling System		
Layout Sketch Prepared		
Safety Observed During Operation		

XIII. Results

(Draw with block diagram path followed by ash in handling system)

XIV. Interpretation of Results

XV. XV. Conclusion and Recommendations

XVI. Practical Related Questions

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

1. State the effect of ash if is not removed properly from a boiler.
2. Name two common ash handling systems used in power plant.
3. "ESP helps in pollution control". Justify.
4. List components of ash handling systems.

[Space for Answer]

XVII. References / Suggestions for Further Reading

1. https://youtu.be/wzbtF8JKZF0
2. https://archive.nptel.ac.in/courses/112/107/112107291/

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (10 Marks)	**(40%)**
1	Identification of Components	20%
2	Collection of material from sources	20%
	Product Related (15 Marks)	**(60%)**
4	Interpretation of result	20%
5	Conclusions	20%
6	Practical related questions	20%
	Total	**100 %**

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

Practical No. 5

Layout Model of Gas Turbine Power Plant.

I. Practical Significance

Gas turbine power plants are valued for quick start-up and high power-to-weight ratio. Creating a layout model helps students grasp component functions and promotes creativity through the use of waste materials.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcome (CO)

CO3: Use knowledge and skills related to Gas Power Plant and Waste Heat Recovery properly in given situation.

IV. Laboratory Learning Outcome(s)

LLO 5.1: List the components of gas turbine power plant.

LLO 5.2: Prepare the model of gas turbine power plant using waste material in the institute.

V. Relative Affective Domain related Outcome(s)

- Work responsibly while handling lab equipment.
- Maintain proper data recording and observations.
- Maintain tools, models, and equipment.
- Follow lab safety and ethical practices

VI. Minimum Theoretical Background with diagram

Working Principle of Gas Turbine Power Plant:

Air is compressed in the compressor. Compressed air is mixed with fuel and ignited in the combustion chamber. High-pressure hot gases expand through the turbine, producing mechanical work. Mechanical work is used to drive the generator for electricity generation.

Major Components:

S.N.	Component	Function
1	Compressor	Compresses ambient air.
2	Combustion Chamber	Mixes compressed air with fuel and ignites it.
3	Gas Turbine	Extracts energy from hot gases.
4	Generator	Converts mechanical energy to electrical energy.
5	Air Intake and Exhaust	Supplies fresh air and releases exhaust gases.

VII. Experimental Setup:

The model may be prepared using; cardboard, plastic bottles, pipes, wires, old fans, and motors (waste material). Use a baseboard for mounting the components. Indicates the colour-coded arrows or labels for air, fuel, and exhaust flow paths. *(Standard Prototype Model for demonstration purpose.)*

VIII. Required Resources

Equipment	Quantity
Waste Material (Plastic, Cardboard, etc.)	For model making
Scissors, Glue, Cutter	Craft and assembly work
Colored Markers/Labels	For component labeling and flow direction
https://youtu.be/eeiu-wcyEbs https://youtu.be/GF-70yncAVY	--

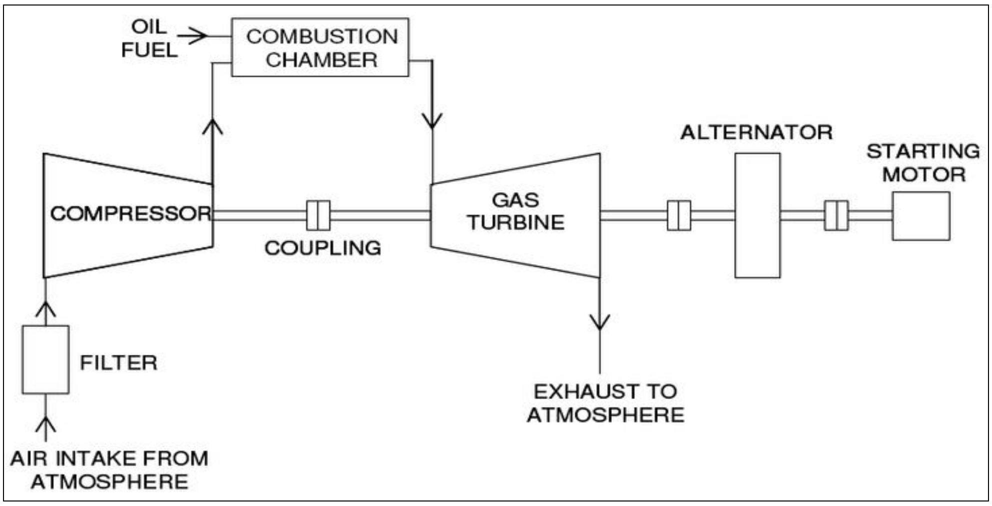

Fig. 5.1: Layout of Gas Turbine Power Plant

IX. Precautions to be Followed

1. Handle sharp tools (cutter, scissors) carefully.
2. Use glue and paints in a ventilated area.
3. Avoid connecting any electrical components without supervision.
4. Maintain a clean and safe working area.

X. Procedure

1. Identify and understand the function of each component.
2. Plan the layout on paper.
3. Gather waste materials for each component.
4. Assemble the model step by step.
5. Label all parts and indicate flow directions (air, fuel, exhaust).
6. Submit for instructor review and evaluation.

XI. Observations and Calculations

Name of component	Remark
Compressor	
Combustion Chamber	
Turbine	
Generator	
Air Intake/Exhaust	

XII. Results

Draw layout of Gas power plant.

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

XV. Practical Related Questions

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

1. List the major components of a gas turbine power plant.
2. Name any four gas power plant available in India with their capacity.
3. List fuels used for gas power plant.
4. Explain waste heat recovery system from gas power plant.

. **[Space for Answer]**

XVI. References / Suggestions for Further Reading

1. https://www.energyeducation.ca
2. IS:12855 – Indian Standard for Gas Turbine Performance

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Identification of Components	20%
2	Layout observation	10%
3	Drawing of Layout	30%
Product Related (10 Marks)		**(40%)**
4	Interpretation of result	10%
5	Conclusions	10%
6	Practical related questions	20%
	Total	**100 %**

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

Practical No.6

Demonstrate Cogeneration in the Given Thermal Power Plant.*

I. Practical Significance

Cogeneration, also known as Combined Heat and Power (CHP), refers to the simultaneous production of electricity and useful thermal energy from a single fuel source. It enhances the overall efficiency of thermal power plants by utilizing the waste heat for industrial processes, distinct heating, or other applications. This practical helps students understand the concept, benefits, and components involved in cogeneration.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcomes (COs)

CO3 - Use knowledge and skills related to Gas Power Plant and Waste Heat Recovery properly in given situation.

IV. Laboratory Learning Outcomes (LLOs)

LLO 6.1: Identify components of thermal power plant.
LLO 6.2: Demonstrate the working of cogeneration using suitable media.

V. Relative Affective Domain Outcomes

- Work effectively in a team.
- Maintain tools, models, and equipment.
- Follow lab safety and ethical practices.

VI. Minimum Theoretical Background with Diagram

Cogeneration, or Combined Heat and Power (CHP), is the simultaneous generation of electricity and useful heat from the same energy source. Unlike conventional power plants that waste a large amount of energy as heat, cogeneration systems capture and use this heat for productive purposes, increasing the overall efficiency of energy utilization.

In a typical thermal power generation system, only about 30–50% of the fuel energy is converted into electricity. The remaining 50–70% is lost as waste heat. Cogeneration theory is based on recovering this waste heat and using it for heating, drying, or other thermal applications. By utilizing both electricity and heat, cogeneration systems can achieve overall efficiencies up to 80–90%.

VII. Experimental Setup

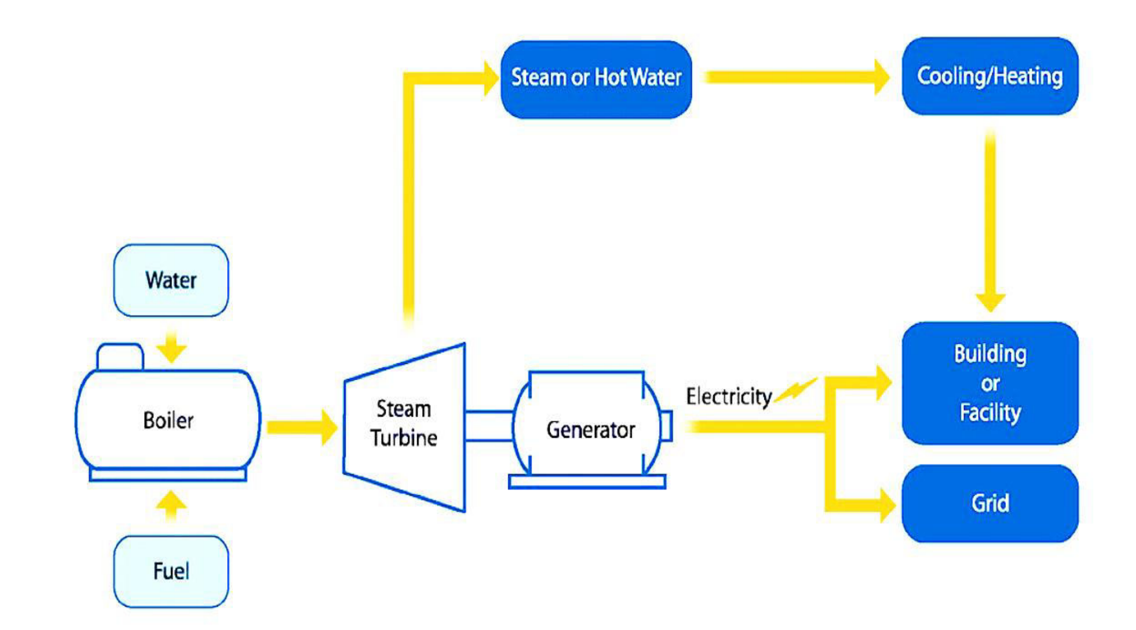

Fig. 6.1: Cogeneration System

VIII. Required Resources

S. No.	Name of Resource	Suggested Specification	Qty.
1	i) https://youtu.be/1kMT7BJ0d-8?si=Y9iexoUSXzrtCeot ii) https://www.youtube.com/watch?v=tARuhig03To iii) https://youtu.be/twkWCND0qWU *(Refer above link for demonstration)*	Show all major components such as Boiler, Steam turbine, Condenser, Pump, Generator etc.	1
2	i) PPT on Cogeneration Plant. ii) Model/Chart of cogeneration system in a thermal power plant	Includes working principle and benefits.	1

IX. Precautions to be Followed

1. Do not damage or mishandle physical models.
2. Maintain silence and attentiveness during video-based demonstration.

X. Procedure

1. Select the video link for observing working of Cogeneration plant.
2. Observe working of cogeneration plant.
3. Note down Component, application, capacity, fuel of cogeneration plant.
4. List different major component.

XI. Observations and Calculations

Component	Remark
Boiler	Type:
	Capacity
	Fuel Used
Steam Turbine	Type:
	Capacity
Pumps	Type:
	Capacity
Condenser	Type:
Heat Recovery Unit	
Generator	Make:

XII. Results

Draw the basic layout of Cogeneration plant.

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

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. Identify components of a given cogeneration system.
2. List any two fuels commonly used in cogeneration systems.
3. Compare conventional thermal power plant with cogeneration system on the basis of:
   (i) Efficiency (ii) Heat Wastage (iii) Fuel Used (iv) Pollution.
4. List different examples of industries using cogeneration.
5. List the various Control Devices used in cogeneration.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://youtu.be/1kMT7BJ0d-8?si=Y9iexoUSXzrtCeot
2. https://youtu.be/qG7SlVfAuPA
3. https://youtu.be/B1MkfNqUxMM
4. https://www.youtube.com/watch?v=tARuhig03To
5. https://youtu.be/CkiLHmU3ry4
6. https://youtu.be/twkWCND0qWU
7. https://youtu.be/9VC9OSZigto.
8. https://youtu.be/ell3ExEpzd8

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Identification of Components	20%
2	Explanation using model/chart	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	40%
4	Conclusions	10%
5	Practical related questions	10%
	Total	**100 %**

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

Practical No. 7

Demonstrate Working of Nuclear Power Plant.*

I. Practical Significance

Nuclear power plants play a vital role in meeting large-scale electricity demands through controlled nuclear fission. Understanding the construction and working of these plants is essential for diploma students to appreciate non-conventional power sources, safety features, and energy efficiency. This practical enable visualization and analysis using animations and model layouts.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcomes (COs)

CO4 - Use suitable strategies to run nuclear power plants safely.

IV. Laboratory Learning Outcomes (LLOs)

LLO 7.1: Identify the components of nuclear power plant.

LLO 7.2: Demonstrate construction & working of nuclear power plant using available animation.

LLO 7.3: Draw layout of nuclear power plant.

V. Relative Affective Domain Outcomes

- Follow ethical and safety norms in labs.
- Handle multimedia and physical models carefully.
- Collaborate as a team member in academic exercises.

VI. Minimum Theoretical Background

A nuclear power plant generates electricity using the heat produced by nuclear fission. In the nuclear reactor, fuel such as Uranium-235 or Plutonium-239 undergoes controlled fission, releasing a large amount of heat energy. This heat is transferred to a coolant (such as water or liquid sodium), which carries it to a steam generator. In the steam generator, this heat is used to convert water into high-pressure steam. The high-pressure steam then rotates a steam turbine, which is connected to a generator. As the turbine spins, the generator converts mechanical energy into electrical energy.

After passing through the turbine, the steam enters a condenser, where it is cooled and converted back into water. This water is reused in the system, forming a closed loop. Control rods are used to control the fission reaction by absorbing excess neutrons, and a moderator slows down the neutrons to sustain the chain reaction. The entire plant is enclosed in a containment structure for radiation protection and safety.

VII. Experimental Setup

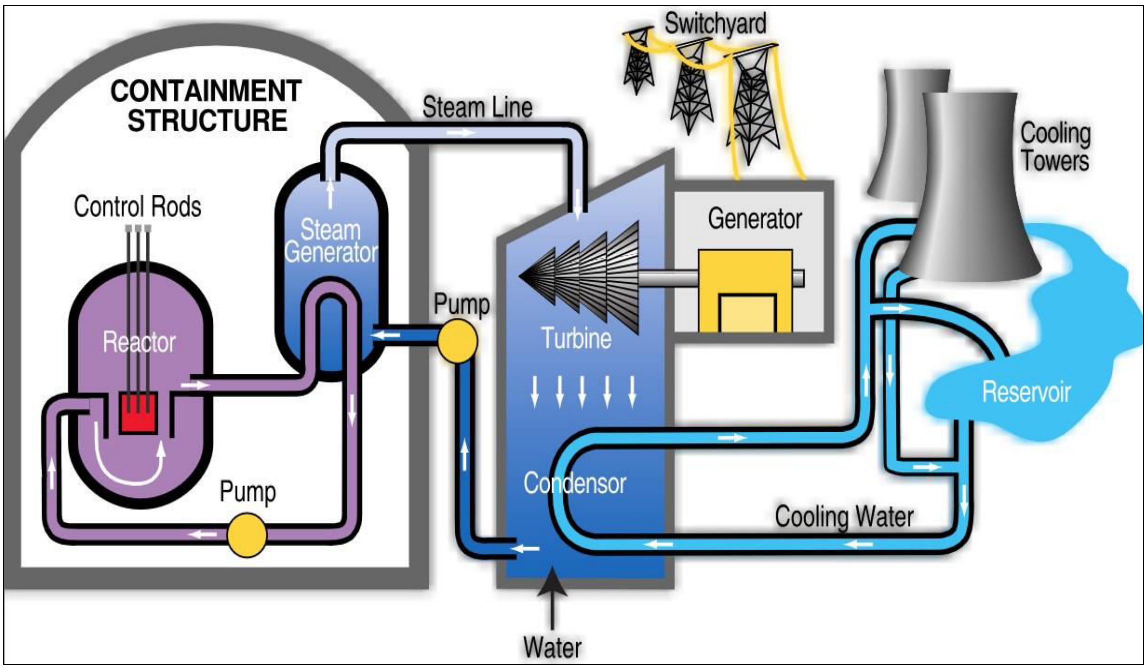

Fig.7.1: Working of Nuclear Power plant

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Resource	Description	Qty.
1	i. https://youtu.be/vggzl9OngaM ii. https://youtu.be/1U6Nzcv9Vws iii. https://youtu.be/xHA3rI6bwpI *(Refer above link for demonstration)*	Show all major components such as Reactor, Boiler, Control rods, Moderator etc. and it's working	1
2	Model/Chart of Nuclear Plant	If available, for physical demonstration	1

IX. Precautions to be Followed

1. Do not damage or mishandle physical models.
2. Maintain silence and attentiveness during video-based demonstration.

X. Procedure

1. Select the video link for observing working of Nuclear Power Plant.
2. Observe working of Nuclear Power Plant.
3. Note down Component, application, capacity, fuel, etc. of Nuclear Power Plant.
4. List different major component.
5. Highlight the safety features used in modern plants.

XI. Observations Table

Component	Type/Material/Function	Remark
Reactor Core		
Control Rods		
Moderator		
Coolant		
Heat Exchanger		
Steam Turbine		
Generator		
Condenser		
Cooling Tower		

XII. Results

Draw layout of nuclear power plant.

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

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. Compare a nuclear power plant with a thermal power plant in terms of Fuel used, fuel quantity, air pollution and waste disposal.
2. List important safety measures need for nuclear power plant.
3. Name any four nuclear power plants in India with their capacity.
4. Explain procedure for avoiding nuclear radiation from nuclear power plant.
5. Identify suitable coolants used in different types of nuclear reactors.

[Space for Answer]

XVI. References / Further Reading

1. https://youtu.be/xHA3rI6bwpI
2. https://youtu.be/1U6Nzcv9Vws
3. https://youtu.be/NgCb4Er9mew
4. https://youtu.be/CkiLHmU3ry4
5. https://youtu.be/twkWCND0qWU
6. https://youtu.be/vggzl9OngaM

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Observation media/model	20%
2	Neat labeled layout drawing	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	30%
	Total	**100 %**

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

Practical No. 8
Prepare the Waste disposal model for nuclear waste.

I. Practical Significance

Nuclear power generation results in radioactive waste, which poses long-term environmental and health hazards if not managed properly. Understanding the safe disposal methods and visualizing them through models fosters awareness about nuclear safety, sustainability, and waste management technologies.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcomes (COs)

CO4-Use suitable strategies to run nuclear power plants safely.

IV. Laboratory Learning Outcomes (LLOs)

LLO 8.1: Choose the waste disposal method for nuclear waste.

LLO 8.2: Prepare the model of waste disposal process for nuclear waste using waste material in the institute.

V. Relative Affective Domain Outcomes

- Follow sustainability practices (reuse/recycle).
- Follow safety norms while working with lab tools and materials.

VI. Minimum Theoretical Background

A nuclear waste disposal model is used to safely manage and dispose of radioactive waste generated from nuclear power plants, research centers, and medical facilities. This waste remains hazardous for thousands of years and must be handled carefully to protect humans and the environment.

A. Types of Nuclear Waste:

1. **Low-Level Waste (LLW):** Includes tools, filters, and clothing with low radiation. It is usually disposed of in near-surface landfills.
2. **Intermediate-Level Waste (ILW):** Contains higher radiation and may include reactor parts and chemical sludge. Requires proper shielding and underground storage.
3. **High-Level Waste (HLW):** Consists mainly of spent fuel. It is extremely radioactive and heat-producing, and requires long-term deep underground disposal.

B. Steps in Nuclear Waste Disposal:

1. **Collection:** Waste is collected at the place of generation, such as nuclear reactors or hospitals.
2. **Segregation:** Waste is separated based on its level of radioactivity.
3. **Treatment:** Some types of waste are solidified using processes like vitrification (turning into glass) or cementation.

4. Temporary Storage: Spent fuel is stored in cooling water pools or dry casks for a few years to reduce heat and radiation.

5. Final Disposal: Long-term disposal is done in deep geological repositories located hundreds of meters underground in stable rock formations. These facilities are designed to isolate the waste from the biosphere for thousands of years.

C. Types of Disposal:

(i) Near-Surface Disposal (for LLW)

(ii) Deep Geological Disposal (for HLW)

(iii) Dry Cask Storage (for spent fuels)

VII. Experimental Set up:

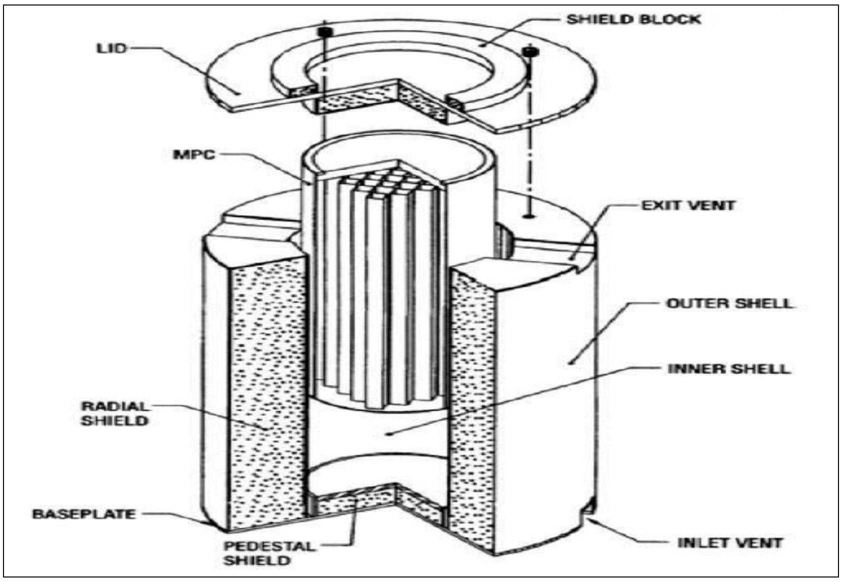

Fig. 8.1: Dry cask storage system

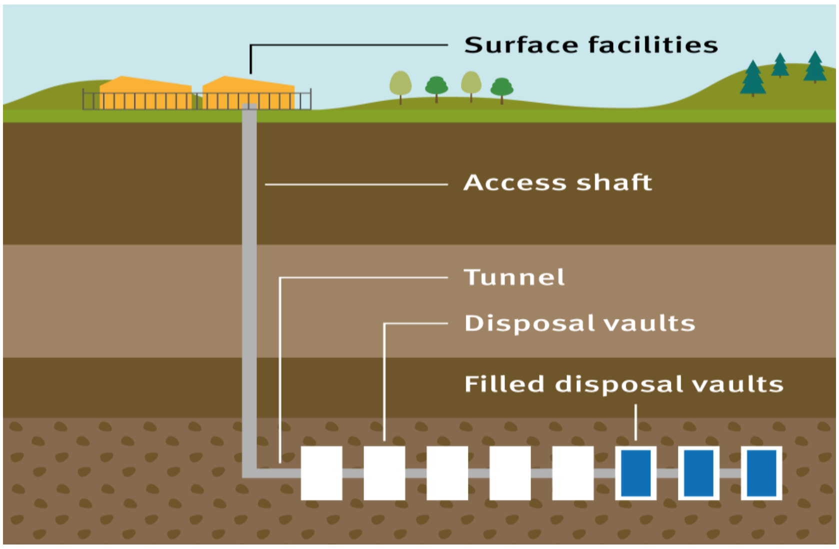

Fig. 8.2: Deep geological repository

VIII. Required Materials / Resources

S. No.	Material / Tool	Description/Source	Quantity
1	i. https://youtu.be/ew_ZaFuBoSs ii. https://youtu.be/rh6FeQWuhCs iii. https://youtu.be/BNZ0B2OmGTU iv. https://youtu.be/0gLia6uyzBU *(Refer above link for demonstration)*	Show the waste disposal methods through this link	--
2	Cardboard box/tubes	Recycled packaging	As needed
3	Plastic bottles/pipes	Waste bottles from lab/canteen	As needed
4	Glue, Fevicol, Tape	Stationery	1 each
5	Marker Pens, Labels	Stationery	1 set
6	Chart/printout for explanation	Internet/Reference book	Optional
7	Scissors/Cutter	Workshop/Stationery	1

IX. Precautions to be Followed

1. Maintain silence and attentiveness during video-based demonstration.
2. Use cutters and sharp objects carefully.
3. Avoid unnecessary wastage of reusable materials.
4. Maintain tidiness at your workbench.

X. Procedure

1. Select the video link for observing waste disposal of Nuclear Power Plant.
2. Observe the method of waste disposal of Nuclear Power Plant.
3. Note down the types of nuclear waste and disposal techniques.
4. Choose a disposal method appropriate for the selected waste type.
5. Design a basic layout of the model on paper.
6. Collect recyclable waste material from the institute.
7. Construct the model step-by-step, ensuring labelled sections.
8. Prepare a brief explanation of the working and safety features.
9. Present and demonstrate the model to the faculty.

XI. Observations :

Waste Type	Type of Disposal Method	Justification
LLW		
ILW		
HLW		

XII. Results

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

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. Classify nuclear waste into different categories.
2. List the main characteristics of high-level waste.
3. Suggest the materials that can be used to make a model of dry cask storage.
4. Draw a simple labeled diagram of a dry cask storage system.
5. Describe the purpose of waste storage in nuclear power plants.

[Space for Answer]

XVI. References / Further Reading

1. https://cryptome.wikileaks.org/eyeball/isfsi/isfsi-eyeball.htm
2. https://environmentagency.blog.gov.uk/2019/02/04/deep-thinking-regulating-geological-disposal/
3. https://youtu.be/zqv_J5EnA0s
4. https://youtu.be/ew_ZaFuBoSs
5. https://youtu.be/rh6FeQWuhCs
6. https://youtu.be/BNZ0B2OmGTU
7. https://youtu.be/0gLia6uyzBU
8. https://youtu.be/4j_wptct7kA?si=i_TlXdO8Lfbk3ty2
9. https://youtu.be/imsRLscqTW0

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Observation	30%
2	Teamwork and safety practices	10%
Product Related (15 Marks)		**(60%)**
3	Functionality and clarity of model	40%
4	Explanation and labeling	10%
5	Practical related questions	10%
	Total	**100 %**

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

Practical No. 9

Captive Steam Power Plant with All Technical Specifications.

I. Practical Significance

A captive power plant is a dedicated electricity generation system established by an industry to meet its own power needs, often using steam turbines. These plants improve reliability, reduce dependency on grid supply, and can be tailored to specific industrial load profiles. Understanding the layout, specifications, and operation of captive steam power plants is vital for diploma students specializing in power plant engineering.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcomes (COs)

CO5: Calculate economic parameters of various power plants.

IV. Laboratory Learning Outcomes (LLOs)

LLO 9.1: Demonstrate the working of captive power plant using media.
LLO 9.2: Identify the components of captive steam power plant.
LLO 9.3: Draw layout of a captive steam power plant.

V. Relative Affective Domain Outcomes

- Follow ethical lab practices.
- Maintain and organize lab resources.

VI. Minimum Theoretical Background

A captive steam power plant is a self-contained power generation system installed by an industry to meet its own electricity and steam requirements without relying on the public power grid. It typically includes a boiler, steam turbine, generator, and auxiliary equipment to produce both electrical energy and process steam, making it a cogeneration system. Such plants are commonly used in industries like textiles, chemicals, sugar, and paper, where continuous and reliable energy supply is essential. Captive plants improve overall efficiency, reduce energy costs, and ensure uninterrupted power for critical industrial operations, though they involve high initial investment and require skilled maintenance. It typically includes:

a. *Boiler* – generates high-pressure steam.
b. *Steam turbine* – converts steam energy to mechanical energy.
c. *Alternator/Generator* – converts mechanical energy to electrical energy.
d. *Condenser* – condenses exhaust steam from the turbine.
e. *Cooling Tower* – removes waste heat from condenser water.
f. *Deaerator and Feed Pump* – maintain water quality and flow.
g. *Control Room* – manages load sharing, fuel input, system protection.
h. *Captive plants* can range from 5 MW to 150 MW depending on load demand.

VII. Experimental Setup

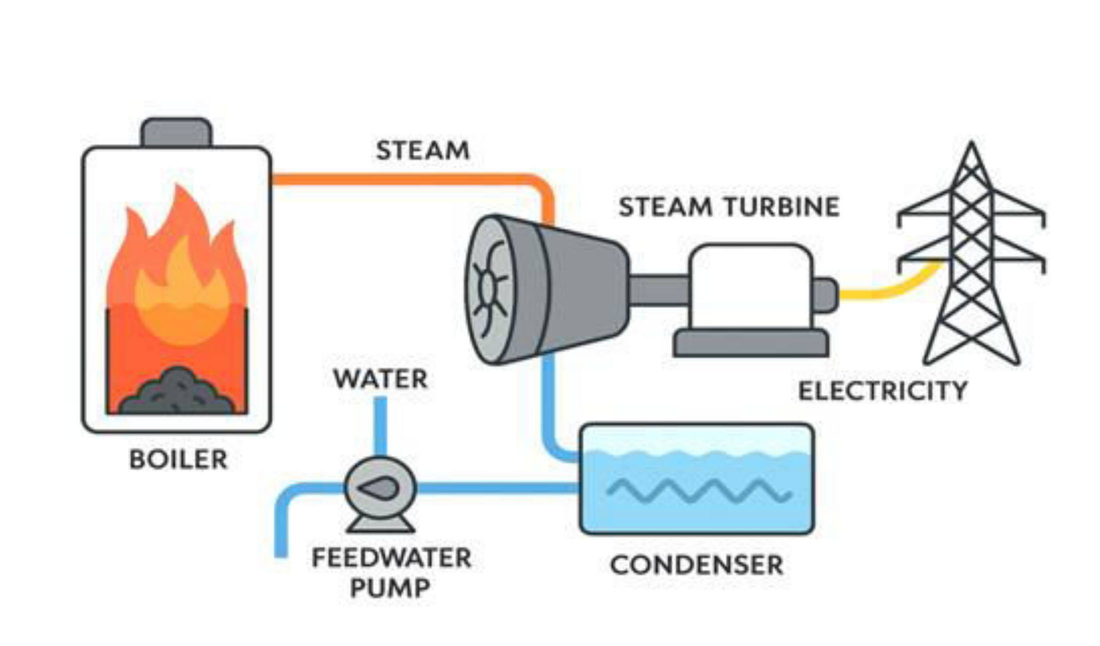

Fig.9.1: Captive Power Plant

VIII. Required Resources /Apparatus/Equipment with specification

S. No.	Name of Media/Model	Description	Quantity
1	i. https://youtu.be/UWesYFVE0sw ii. https://youtu.be/x8VcaRu4mYc	Captive steam power plant video Covers full layout and working with animation.	1
2	Chart/Model of power plant	Shows labelled components and steam flow	1
3	Whiteboard and markers	For explanation and Q&A	1 set
4	Graph paper and pencils	For layout drawing	Per student

IX. Precautions to be Followed

1. Do not mishandle display models or multimedia devices.
2. Draw diagrams neatly with proper labeling.
3. Use electrical tools safely if model is interactive.

X. Procedure

1. Watch the video of demonstration of a captive steam power plant.
2. Identify all the major components and note their functions.
3. Study technical specifications such as pressure, temperature, capacity, etc.

XI. Observations and Identification Table

Component	Function	Specification
Boiler		
Steam Turbine		
Generator		
Condenser		
Cooling Tower		
Feed Pump		

XII. Results

Draw layout of Captive Power Plant.

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

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 the auxiliary systems required in a captive power plant.
2) Name any two industries using captive steam power.
3) Write in details the specification of any two captive steam power plants.
4) Explain Captive Steam Power plant.
5) Describe the role of the feed water pump in the steam cycle.

[Space for Answer]

XVI. References / Further Reading

1. https://youtu.be/UWesYFVE0sw
2. https://youtu.be/hT45ESfFyaE
3. https://youtu.be/x8VcaRu4mYc

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Media Observation and Identification	20%
2	Drawing and labeling	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of results	20%
4	Technical conclusions	20%
5	Practical related questions	20%
	Total	**100 %**

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

Practical No. 10

Calculate the Connected Electricity Load of Any One Laboratory.*

I. Practical Significance

Electricity load estimation is fundamental for power planning, energy conservation, and selection of an appropriate power supply system. This practical introduces students to real-life load calculations and decision-making based on energy demands, helping them relate theoretical knowledge to practical implementation.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcomes (COs)

CO5 - Calculate economic parameters of various power plants.

IV. Laboratory Learning Outcomes (LLOs)

LLO 10.1: Calculate the connected electricity load of any one lab.

LLO 10.2: Suggest the type of power plant required on the basis of load and justify answer.

V. Relative Affective Domain Outcomes

- Work responsibly while handling lab equipment.
- Maintain proper data recording and calculations.
- Demonstrate awareness of energy efficiency and sustainability.

VI. Minimum Theoretical Background

a. **Connected Load:** Total wattage of all equipment that could be used simultaneously.

b. **Power (Watts**) = Voltage (V) × Current (A)

c. **For appliances:** Use Wattage × Quantity

d. Unit of load is typically kilowatts (kW)

e. Based on the load profile, the choice of power plant depends on:

(i) Base load (large, continuous use): Thermal/Nuclear/Hydro

(ii) Intermittent/small load: Solar/Diesel/Wind (captive or standalone)

VII. Experimental Setup

1. Choose any one laboratory (e.g., Electrical Lab, Computer Lab, Mechanical Lab, etc.).
2. Collect data on each electrical device used in the lab (fans, lights, computers, machines).
3. Use nameplate rating or a wattmeter if available.
4. Calculate total connected load.

VIII. Required Resources

S. No.	Name of Resource	Description	Qty.
1	Wattmeter/Clamp meter	To measure current and wattage.	1
2	Equipment specification	Nameplate data or manual.	As required
3	Calculator or spreadsheet	For load calculation.	1
4	Load estimation format	To record power ratings and quantity.	Per group

IX. Precautions to be Followed

1. Ensure equipment is switched off before checking ratings manually.
2. Use measurement tools as instructed.
3. Verify current rating, phase type, and power factor if applicable.

X. Procedure

1. Select any one lab for study.
2. List down all electrical equipment in use.
3. Note down their rated wattage and quantity.
4. Calculate the total connected load in watts and convert to kW.
5. Based on total load and type of usage, suggest the most suitable type of power plant.
6. Justify the selection based on efficiency, scale, and sustainability.

XI. Observation Table (Sample Format)

S. No.	Equipment Name	Power Rating (W)	Quantity	Total Load (W)
1	Tube Light			
2	Ceiling Fan			
3	Computer			
4	Printer			
5	UPS			
TOTAL CONNECTED LOAD				

Sample Calculation:

XII. Results/ sample calculation

XIII. Interpretation of Results

XIV. Conclusion and Recommendations

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 connected load.
2. Solar Power can meet the laboratory load with justification.
3. Name power plant is suitable for 1–5 kW load with suitable reason.
4. List different types of loads found in a laboratory.
5. Define the power factor.

[Space for Answer]

XVI. References / Further Reading

1. Power Station Engineering and Economy, by Bernhardt G A Sarotzki, William A Vopat ,Tata Mc Graw Hill 2001,ISBN-13 978-0070995734
2. https://mnre.gov.in
3. "How to calculate connected load – Electrical Engineering Basics" https://www.youtube.com/watch?v=IebflvdLVvM

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Data collection and accuracy	30%
2	Use of Measuring Equipment	30%
Product Related (10 Marks)		**(40%)**
3	Correct load calculation	20%
4	Justification of plant selection	10%
5	Practical related questions	10%
	Total	**100 %**

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

Practical No. 11

Determine the Efficiency of a Modern Steam Power Plant.

I. Practical Significance

Efficiency is a key performance metric in any steam power plant. Modern power plants strive to maximize energy conversion using optimized temperature, pressure, and turbine parameters. This practical introduces the use of EES (Engineering Equation Solver) or equivalent software to model basic thermodynamic cycles and evaluate plant efficiency.

II. Industry/Employer Expected Outcome(s)

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other industrial applications".

III. Course Level Learning Outcomes (COs)

CO2- Apply relevant knowledge & skills to maintain modern steam power plant efficiently and safely.

CO5 - Calculate economic parameters of various power plants.

IV. Laboratory Learning Outcomes (LLOs)

LLO 11.1: Use EES software or equivalent.

LLO 11.2: Select the working parameters of a given power plant.

LLO 11.3: Determine the efficiency of a steam power plant considering any two parameters using EES software.

V. Relative Affective Domain Outcomes

- Use licensed/ethical software properly.
- Maintain integrity while entering data and interpreting results.
- Work collaboratively and logically through simulation problems.

VI. Minimum Theoretical Background

The thermal efficiency of a Rankine cycle-based steam power plant is given by:

$$\eta = \frac{W_{net}}{Q_{in}} \times 100$$

Where;

$W_{net} = W_{turbine} - W_{pump}$

Q_{in}=heat added in boiler

Parameters required:

Boiler pressure (e.g., 100 bar)

Condenser pressure (e.g., 0.1 bar)

Superheated steam temperature (e.g., 540°C)

Mass flow rate (optional)

VII. Required Resources

S. No.	Software/Tool	Description	Quantity
1	EES Software (licensed/demo)	For thermodynamic cycle simulation.	1 per PC
2	System with Windows OS	To run EES.	1 per group
3	Reference data (steam tables)	For cross-verification.	Shared

VIII. Precautions to be Followed

1. Enter all parameters with correct units.
2. Check thermodynamic state at each point for physical feasibility.
3. Save your work regularly during simulation.

IX. Procedure

1. Launch the EES software.
2. Select working fluid:
3. Select two parameters (e.g., boiler pressure and condenser pressure).
4. Input the Rankine cycle state points:
   i. Inlet steam pressure & temperature
   ii. Condenser pressure
   iii. Assume isentropic expansion and pumping (if not specified)
5. Use built-in **enthalpy** and **entropy** functions to calculate:

$$W_{turbine}, W_{pump}, Q_{in}$$

6. Calculate the efficiency:

$$\eta = \frac{W_{net}}{Q_{in}} \times 100$$

7. Tabulate the result and interpret.

X. Observation Table

State Point	Pressure (bar)	Temperature (°C)	Enthalpy (kJ/kg)	Entropy (kJ/kg.k)
Boiler Out			h1 = _____	s1 = _____
Condenser In			h2 = _____	s2 = _____
Condenser Out			h3 = _____	s3 = _____
Boiler In			h4 = _____	s4 = _____

Calculated Efficiency: ___%

XI. Results

XII. Interpretation of Results

XII. Conclusion and Recommendations

XIII. 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 thermal efficiency in the context of a steam power plant.
2. State the key input parameters required for Rankine cycle simulation in EES.
3. State the importance of condenser pressure in Rankine cycle.
4. Compare actual cycle vs. ideal Rankine cycle using EES output on the basis of turbine work, Pump work, heat added, net work output and efficiency.
5. Suggest two methods to improve the efficiency of a modern steam power plant.

[Space for Answer]

XIV. References / Further Reading

1. www.fchart.com/ees
2. https://www.nptel.ac.in (Power Plant Engineering Modules)
3. Engineering Thermodynamics by P.K. Nag
4. YouTube: "EES Rankine Cycle Tutorial": https://youtu.be/GIDQzd60EC4

XV. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Correct EES model and syntax	10%
2	Use of Software	30%
Product Related (15 Marks)		**(60%)**
3	Correct efficiency calculation	40%
4	Valid conclusions and inferences	10%
5	Practical related questions	10%
	Total	**100 %**

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