



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

APPLIED THERMODYNAMICS LABORATORY								
IV Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC17	Core	L	T	P	C	CIA	SEE	Total
		-	-	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 45			Total Classes: 45			
Prerequisite: Materials and Solid Mechanics Laboratory								

I. COURSE OVERVIEW:

Applied thermodynamics laboratory is intended to study the working principle of internal combustion engines (both SI and CI engines), performance and characteristics in terms of heat balancing, economical speed variations, air fuel ratio influence on the engine to reinforce classroom theory by having the student perform required tests, analyze subsequent data, and present the results in a professionally prepared report.

II. COURSE OBJECTIVES:

The students will try to learn:

- I The obtain cycle timings of S.I and C.I engines and visualize the working of the models
- II The operating principle of C.I and S.I engines and to determine performance characteristics of engines.
- III The Performance test for 4-stroke SI engine and draw performance curves and Determine the volumetric efficiency and break thermal efficiency.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

- CO 1 Practice the various components and mechanisms of I. C. Engines to Appreciate the Mechanism of ports /Valves functioning in 2-stroke petrol /Diesel engine
- CO 2 Evaluate the performance characteristics of single cylinder petrol engine at different loads and single cylinder diesel engine at different loads and draw the heat balance sheet.
- CO 3 Analyze the method of finding the indicated power of individual cylinders of an engine by using morse test
- CO 4 Distinguish the performance characteristics of Multi cylinder engine for various operating conditions.
- CO 5 Apply the concepts of intercooling in multistage air compressor for minimum power input.
- CO 6 Determine the performance parameters of internal combustion engines under variable input conditions for optimum fuel consumption

IV. COURSE CONTENT

EXERCISES FOR APPLIED THERMODYNAMICS LABORATORY

Safety

Safety is a vital issue in all workplaces. Before using any equipment and machines or attempt practical work in a laboratory everyone must understand basic safety rules. These rules will help keep all safe in the laboratory.

Safety Rules

1. Always listen carefully to the teacher and follow instructions.
 2. When learning how to use a machine, listen very carefully to all the instructions given by the faculty / instructor. Ask questions, especially if you do not fully understand.
 3. Always wear an apron as it will protect your clothes and holds loose clothing such as ties in place.
 4. Wear good strong shoes.
 5. Bags should not be brought into a workshop as people can trip over them.
 6. Do not use a machine if you have not been shown how to operate it safely by the faculty / instructors
 7. Know where the emergency stop buttons are positioned in the laboratory. If you see an accident at the other side of the workshop you can use the emergency stop button to turn off all electrical power to machines.
 8. Always be patient, never rush in the laboratory.
 9. Always use a guard when working on a machine.
 10. Keep hands away from moving/rotating machinery.
 11. Use hand tools carefully, keeping both hands behind the cutting edge.
 12. Report any UNSAFE condition or acts to instructor.
 13. Report any damage to machines/equipment as this could cause an accident.
 14. Keep your work area clean.
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1. Getting Started Exercises

Introduction

The I.C. Engine laboratory is intended to study the working principle of IC engines (both SI and CI engines), performance and characteristics in terms of heat balancing, economical speed variations, air fuel ratio influence on the engine to reinforce classroom theory by having the student perform required tests, analyze subsequent data, and present the results in a professionally prepared report.

1.1 Plot the Valve timing diagram of an IC engine.

A valve timing diagram is a graphical representation of the exact moments, in the sequence of operations, at which the two valves (i.e. inlet and exhaust valves) open and close as well as the firing of the fuel.

Hint:

- Measure the radius of flywheel with thread.
- Check the Inlet valve and outlet valve from Figure 1.1.
- Observe the piston and cylinder movement from bottom dead center to top dead center.



Figure 1.1 Valve timing diagram

1.2 Plot the Valve timing diagram of a BMW engine.

The new BMW engine generation is mainly characterized by lower fuel consumption and fewer exhaust emission. To achieve low fuel consumption, a map-controlled oil pump, characteristic map thermostat and injection system with direct rail.

Try

1. Prepare the Valve timing diagram of a 4 Stroke four-cylinder petrol engine.
2. Plot the valve timing diagram of two-cylinder engine.
3. Plot the valve timing diagram of three-cylinder engine.
4. Prepare the Valve timing diagram of a 4 Stroke four-cylinder diesel engine.

2. Port timing diagram of IC engine

A two-stroke (or two-stroke cycle) engine is a type of internal combustion engine that completes a power cycle with two strokes (up and down movements) of the piston during one power cycle, this power cycle being completed in one revolution of the crankshaft.

2.1 Plot the port timing diagram for engine.

Hint:

- Check the Inlet port, outlet port and transfer port in the figure 2.1
- Observe the piston and cylinder movement from bottom dead center to top dead center.
- Observe the transfer port opening and closing.

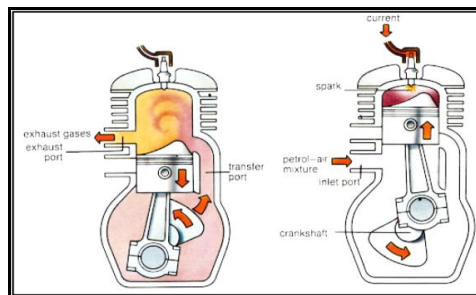


Figure 2.1 Two stroke petrol engine

2.2 Plot the port timing diagram of an activa engine.

The new activa engine generation is mainly characterized by lower fuel consumption and fewer exhaust emission. To achieve low fuel consumption, a map-controlled oil pump, characteristic map thermostat and injection system with direct rail.

Try

1. Prepare the port timing diagram of two-cylinder petrol engine.
2. Prepare the port timing diagram of three-cylinder petrol engine.

3. Two stroke SI engine

A two-stroke engine is a type of internal combustion engine that completes a power cycle with two strokes of the piston during only one crankshaft revolution. This is in contrast to a four-stroke engine that requires four strokes of the piston to complete a power cycle during two crankshaft revolutions.

3.1 Performance test on 2-S Petrol engine

Hints:

1. Ensure the petrol in the fuel in tank before starting.
2. Ensure the battery and spark plug.



Fig. 3.1, 2 Stroke Petrol Engine

3.2 Determine the efficiency of petrol engine

Try

1. Performance test on 2 stroke petrol engine using 2T oil.
2. Performance test on 2 stroke petrol engine by changing fin material.
3. Plot the thermal efficiency volumetric efficiency of 2 stroke petrol engine.

4. 4 Stroke petrol Engine

A two-stroke engine is a type of internal combustion engine that completes a power cycle with two strokes of the piston during only one crankshaft revolution. This is in contrast to a four-stroke engine that requires four strokes of the piston to complete a power cycle during two crankshaft revolutions.

4.1 Performance test on 4 stroke spark ignition engine Petrol engine.

Try

- 1) Ensure the petrol in the fuel in tank before starting.
- 2) Ensure the battery and spark plug.



Figure 4.1 Performance test of 4-S SI engine

4.2 Performance test on mechanical efficiency

Try

1. Performance test on 2 stroke petrol engine using 2T oil.
2. Performance test on 2 stroke petrol engine by changing fin material.

5. Morse test on a four- stroke Petrol engine

The purpose of morse test is to obtain the approximate Indicated Power of a Multi-cylinder Engine.

5.1 Performance of Morse Test on 4-cylinder 4-stroke petrol engine

Hint:

1. The first cylinder is put on to working condition by operating the lever and the engine allowed to run for some time.
2. The fuel level and lubricating oil level are checked.
3. The second cylinder is cut-off and the load at which speed is maintained at 1500 rpm is noted.



Figure 5.1 Morse test

5.2 Heat balance sheet of 4 stroke 4 cylinder petrol engine.

Try

1. Plot the chart between indicated power and brake power.
2. Determine the mechanical efficiency (η_m) of the engine.
3. Determine the firing order of 4-Cylinder petrol engine.

6. Heat balance for 4-stroke multi cylinder SI engine.

Heat balance sheet purpose to know the energy distribution that is how and where the input energy from the fuel is distributed.

6.1 Performance of on 4-cylinder 4-stroke diesel engine

Hints:

- i. Before starting engine check the fuel supply, lubrication oil, and availability of cooling water.
- ii. Engage the dynamometer after rated speed.
- iii. Disengage the dynamometer and stop the engine.



Figure 6.1 Heat Balance of 4-S Diesel Engine

6.2 Prepare balance sheet of 4 stroke diesel engine.

Try

1. Heat Balance sheet at engine rated speed 1000 RPM.
2. Heat Balance sheet at engine rated speed 1500 RPM.

7. Variable compression ratio engine

A variable compression ratio (VCR) engine is able to operate at different compression ratios, depending on the particular vehicle performance needs. The VCR engine is optimized for the full range of driving conditions, such as acceleration, speed, and load as shown in figure 7.1

7.1 Performance test on variable compression ratio engine

Hints:

- 1) Before starting engine check the fuel supply, lubrication oil, and availability of cooling water.
- 2) Engage the dynamometer after rated speed.
- 3) Disengage the dynamometer and stop the engine.



Figure 7.1 variable compression ratio engine diesel CI engine

7.2 Performance test on variable compression ratio engine with different compression ratio

Try

1. Adjust the cylinder to different head and find the efficiency of the engine.
2. Adjust the cylinder to (1, 2, 3) head and find the efficiency of the engine.

8. Reciprocating air compressor

An air compressor is a machine that takes ambient air from the surroundings and discharges it at a higher pressure. It is an application of a gas compressor and a pneumatic device that converts mechanical power.

8.1 Determine volumetric efficiency of an air compressor.

Hints:

- i) The apparatus consists of an two stage air compressors shown in figure 8.1.
- ii) The first stage air compressor and second stage air compressor is separated by intercooler.



Figure 8.1 Reciprocating air compressors

8.2 Determine isothermal efficiency of an air compressor.

Try

- 1) Performance volumetric Air compressor by opening the valve at different pressure bar.
- 2) Performance isothermal efficiency of two stage air compressor.

9. Assembling and dis Assembling IC engine

For disassembling the engine, it should be mounted in a suitable engine repair stand is not available, disassembling should be done in a careful manner to prevent accidents and damage to engine parts experimental setup, shown in figure 9.1.

9.1 Assembly and disassembly of an IC Engine

Hints:

- i) The system consists of number of engine part shown in Figure 9.1.

- ii) Drain the cooling system by opening the drain cock.
- iii) Disconnect the battery at the positive terminal to avoid the possibility of a short circuit.



Figure 9.1 Assembling and dis Assembling IC engine

9.2 Assembly of BMW engine

Try

- 1. Assembly and disassembly of BMW engine.
- 2. Assembly and disassembly of Maruti Omni engine.

10. Boilers

A boiler is a closed vessel in which water is heated to produce steam or hot water. The steam or hot water is then used for a variety of purposes, including heating buildings, generating electricity, and sterilizing equipment.

10.1 Study of Cochran Boiler for steam generation

Hint:

- 1) The apparatus consists of vertical, multi-tubular boiler equipped with numerous horizontal fire tubes shown in Figure 10.1.
- 2) These flue gases continue through the fire tubes.
- 3) Heat is transferred from the gases to the water within the fire tubes.
- 4) The flue gases subsequently exit through a firebox and are released into the atmosphere.

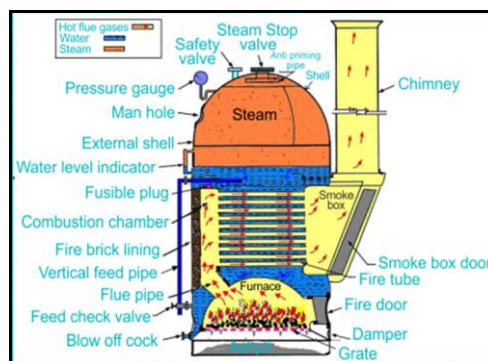


Figure: 10.1 Cochran Boiler

10.2 Study of Lancashire Boiler for steam generation

Try

- 1. Study of steam generation of cochran boiler by using super heater.
- 2. Study of steam generation of locomotive boiler by using super heater.

11. Boilers

A boiler is a closed vessel in which water is heated to produce steam or hot water. The steam or hot water is then used for a variety of purposes, including heating buildings, generating electricity, and sterilizing equipment.

11.1 Study of Locomotive Boiler for steam generation

A locomotive boiler has three main components: a double-walled firebox; a horizontal, cylindrical "boiler barrel" containing a large number of small flue-tubes; and a smokebox with chimney, for the exhaust gases.

Hint:

- 1) The apparatus consists of vertical, multi-tubular boiler equipped with numerous horizontal fire tubes shown in figure 10.1.
- 2) These flue gases continue through the fire tubes.
- 3) Heat is transferred from the gases to the water within the fire tubes.
- 4) The flue gases subsequently exit through a firebox and are released into the atmosphere.

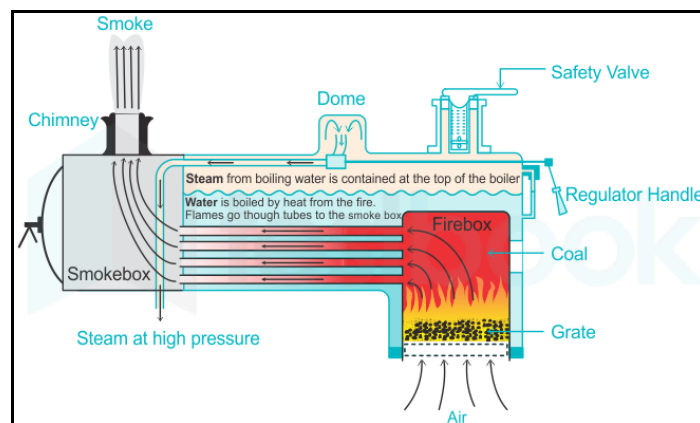


Figure: 11.1 Locomotive Boiler

Try

1. Study of steam generation of locomotive boiler by using super heater.
2. Study of steam generation of Cochran boiler by using super heater.

12. Mountings in boilers

The components which are fitted on the surface of the boiler for complete safety and control of steam generation process are known as boiler mountings. The following are the various important mountings of a boiler.

12.1 Mountings in boilers

Study the working function of mountings in boilers.

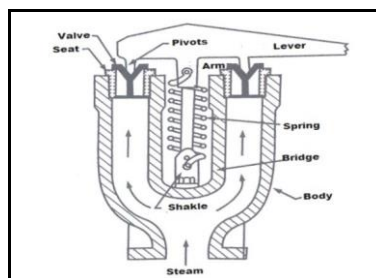


Figure: 12.1 Spring Loaded Safety valve

Hint:

- 1) The apparatus consists of various mounting shown in figure 12.1.
- 2) The spring loaded used in locomotive boiler.
- 3) The valve is loaded by means spring, instead of dead weight.

Try

1. Study the working of feed check valve.
2. Study the working of pressure gauge.

13. Accessories in boilers

The appliances installed to increase the efficiency of the boiler are known as the boiler accessories.

13.1 Study the working and function of Economizer in boilers

Economizer is a one type of heat exchange which exchanges some parts of the waste heat of flue gas to the feed water.

Hint:

- 1) Economizer is placed after the feed pump.
- 2) Priming problem in feed pump water into the boiler drum.

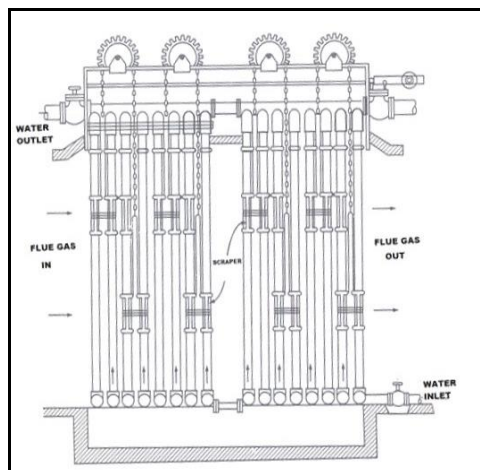


Figure: 13.1 Economizer

13.2 Study the working and function of economizer in steam power plant.

Economizer is a one type of heat exchange which exchanges some parts of the waste heat of flue gas to the feed water.

Try

1. Determine working of economizer in steam power plant.
2. Determine working of economizer to nuclear reactor.

14. Accessories in boilers

The appliances installed to increase the efficiency of the boiler are known as the boiler accessories.

14.1 Study the working and function of super heater in boilers.

A superheater is a vital part of a boiler system that is used to increase the overall efficiency of a thermal power plant. More specifically, it is a device which converts wet steam (saturated steam) into dry steam as dry steam contains more thermal energy.

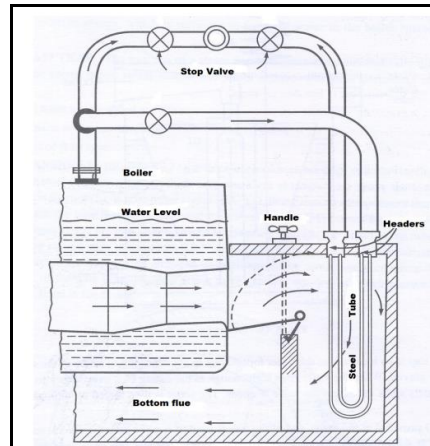


Figure 14.1 Super heater

Hint:

- 1) The apparatus consists of various accessories as shown in figure 14.1
- 2) The overheating of super heater tube is prevented by using a balanced damper which controls the flue gas.

14.2 Study the working and function of feed pump in boilers

The function of the feed pump is to pump the feed water to the boiler. The pumps may be rotary or reciprocating. The rotary pump is generally of high speed centrifugal type. They are driven by small steam turbine or by electric motor and are used when large quantity of water is to be supplied to boiler.

Try

1. Determine working of feed pump steam power plant.
2. Determine working of feed pump to nuclear reactor.

V. TEXT BOOKS:

1. V. Ganesan, "I.C. Engines", Tata McGraw-Hill, 3rd edition, 2011
2. B. John Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill, 2nd edition, 2011.

VI. REFERENCE BOOKS:

1. K. Rajput, "Thermal Engineering", Lakshmi Publications, 1st edition, 2011.

VII. ELECTRONICS RESOURCES:

1. <https://nptel.ac.in/courses/112102103/16>
2. <https://nptel.ac.in/courses/112107078/37>

VIII. MATERIALS ONLINE

1. Course template
2. Lab manual