Basic Mechanical Engineering Unit–5 Notes Reciprocating Machines

UNIT–5 TOPICS

• Working Principle of Steam Engine
• Carnot Cycle
• Otto Cycle
• Diesel Cycle
• Dual Cycle
• P-V and T-S Diagrams
• Efficiency of Cycles
• Two Stroke Petrol Engine
• Four Stroke Petrol Engine
• Two Stroke Diesel Engine
• Four Stroke Diesel Engine
• Working Principle of Compressor

1. INTRODUCTION TO RECIPROCATING MACHINES

Reciprocating machines are machines in which piston moves back and forth inside cylinder.

Applications:
• Automobiles
• Power plants
• Air compressors
• Pumps

2. STEAM ENGINE

Steam engine converts heat energy of steam into mechanical energy.

Main Parts:
• Cylinder
• Piston
• Connecting rod
• Crankshaft
• Valve mechanism

Working Principle:
Steam enters cylinder and pushes piston. Reciprocating motion of piston is converted into rotary motion by crankshaft.

Applications:
• Railway locomotives
• Industrial machinery

3. CARNOT CYCLE

Carnot cycle is ideal thermodynamic cycle having maximum efficiency.

Processes of Carnot Cycle:

1. Isothermal expansion
2. Adiabatic expansion
3. Isothermal compression
4. Adiabatic compression

Efficiency of Carnot Cycle:

$\eta = 1 - (T■ / T■)$

Where:
T■ = source temperature
T■ = sink temperature

Importance:
It represents maximum possible efficiency of heat engine.

4. OTTO CYCLE

Otto cycle is air standard cycle for petrol engines.

Processes:
1. Adiabatic compression
2. Constant volume heat addition
3. Adiabatic expansion
4. Constant volume heat rejection

Efficiency:

$\eta = 1 - (1 / r^{(\gamma-1)})$

Where:
r = compression ratio
γ = specific heat ratio

Applications:
• Petrol engines

5. DIESEL CYCLE

Diesel cycle is air standard cycle for diesel engines.

Processes:
1. Adiabatic compression
2. Constant pressure heat addition
3. Adiabatic expansion
4. Constant volume heat rejection

Applications:
• Diesel engines
• Heavy vehicles

6. DUAL CYCLE

Dual cycle is combination of Otto and Diesel cycles.

Heat is supplied partly at constant volume and partly at constant pressure.

Applications:
• Modern internal combustion engines

7. P-V AND T-S DIAGRAMS

P-V Diagram:
Shows relationship between pressure and volume.

T-S Diagram:
Shows relationship between temperature and entropy.

These diagrams are used to analyze thermodynamic cycles.

8. TWO STROKE PETROL ENGINE

In two stroke engine, one power stroke is obtained in every revolution of crankshaft.

Working:
1. Compression and suction
2. Power and exhaust

Advantages:
• Simple construction
• Lightweight

Disadvantages:
• Lower efficiency
• More fuel consumption

Applications:
• Scooters
• Small motorcycles

9. FOUR STROKE PETROL ENGINE

One power stroke is obtained in two revolutions of crankshaft.

Strokes:
1. Suction stroke
2. Compression stroke
3. Power stroke
4. Exhaust stroke

Advantages:
• High efficiency
• Less fuel consumption

Applications:
• Cars
• Bikes

10. TWO STROKE DIESEL ENGINE

Works similar to two stroke petrol engine but uses diesel fuel.

Applications:
• Marine engines
• Heavy machinery

11. FOUR STROKE DIESEL ENGINE

Works similar to four stroke petrol engine but uses compression ignition.

Applications:
• Trucks
• Buses
• Generators

12. COMPRESSOR

Compressor is machine used to increase pressure of gas.

Working Principle:

Mechanical energy is converted into pressure energy of gas.

Types of Compressors:
• Reciprocating compressor
• Rotary compressor

Applications:
• Refrigeration
• Pneumatic tools
• Air conditioning systems

MOST IMPORTANT 14 MARK QUESTIONS

1. Explain working principle of steam engine with neat diagram.

2. Explain Carnot cycle with P-V and T-S diagrams.

3. Explain Otto cycle with efficiency derivation.

4. Explain Diesel cycle with neat diagrams.

5. Explain Dual cycle and its applications.

6. Explain P-V and T-S diagrams of thermodynamic cycles.

7. Explain working of two stroke petrol engine.

8. Explain working of four stroke petrol engine.

9. Explain working of two stroke diesel engine.

10. Explain working of four stroke diesel engine.

11. Differentiate two stroke and four stroke engines.

12. Explain working principle of compressor.

IMPORTANT 7 MARK QUESTIONS

1. Define reciprocating machines.

2. Explain Carnot cycle efficiency.

3. Explain Otto cycle applications.

4. Explain Diesel cycle.

5. Explain Dual cycle.

6. Explain compressor applications.

7. Explain P-V diagram.

IMPORTANT NUMERICALS

1. Carnot cycle efficiency numerical.

2. Otto cycle efficiency problems.

3. Compression ratio numerical.

4. Work done in thermodynamic cycles.

EXAM TIPS

- Draw neat engine diagrams carefully.
- Practice P-V and T-S diagrams daily.
- Learn cycle processes properly.
- Revise engine working principles regularly.
- Focus on efficiency formulas.