Mechanical Engineering Science

QB

Unit: 1 – Principles of Thermodynamics, Fluid Energy, IC Engines and HEVs Dr. MBK

1. Define: (i) property, (ii) state, (iii) system, (iv) control volume, and (v) process.
2. Discuss the concept of thermal equilibrium and state zeroth law of thermodynamics.
3. What do you understand by quasi-static process? How it is achieved?
4. Differentiate among temperature, heat, and internal energy.
5. Discuss the thermodynamics system, surrounding, and universe. Also discuss the various types of system with suitable example.
6. State the zeroth law of thermodynamics and first law of thermodynamics.
7. State the Kelvin–Planck and Clausius statements of second law of thermodynamics.
8. Determine the work done in compressing 1 kg of air from a volume of 0.15 m3 at a pressure of 1 bar to a volume of 0.05 m3, when the compression is (i) isothermal, and (ii) adiabatic, take γ = 1.4.
9. Define a hydraulic machine. Give two examples.
10. What is the difference between a turbine and a pump in terms of energy conversion?
11. What causes the shaft of a hydraulic turbine to rotate?
12. What is the role of the generator in a hydroelectric power plant?
13. What are the different bases for classification of an internal combustion engine?
14. Give the detailed comparison of combustion phenomenon in CI and SI engine.
15. Describe the working of four strokes of a 4-stroke SI engine with a PV diagram.
16. Describe the working of four strokes of a 4-stroke CI engine with a PV diagram.
17. List and explain the function of any five major parts of an Internal Combustion (IC) engine.
18. Define the following engine performance parameters:
    Brake Power
    Indicated Power
    Mechanical Efficiency
19. A single cylinder engine operating at 2000 rpm develops a torque of 8 N-m. The indicated power of the engine is 2.0 kW. Find loss due to friction as the percentage of brake power.
20. A single cylinder engine running at 180 rpm develops a torque of 8 Nm. The indicated power of the engine 1.8 kW. Find the loss due to friction power as the percentage of brake power.
21. From a test on a four-stroke petrol engine, the following data is available: engine speed 1000 rpm, net brake torque 70 Nm, indicative mean effective pressure 10 bar, stroke 150 mm, bore 100 mm, rate of fuel consumption 2.57 kg/h, CV of petrol 41000 kJ/kg. Calculate the indicated thermal efficiency, brake thermal efficiency and mechanical efficiency.
22. The following data refers to a test on a single cylinder engine working on four stroke cycle:
    Diameter of brake drum = 60 cm
    Rope diameter = 3 cm
    Load on brake drum = 25 kg

Spring balance reading = 5 kg
Speed of engine = 400 rpm
Bore = 10 cm
Stroke = 15 cm
Indicated Power = 3.141 kW
Calculate (i) Brake Power (ii) Mechanical Efficiency

23. The following observations are taken during a trial on four stroke diesel engine. Cylinder diameter = 25 cm Stroke = 40 cm Speed = 250 rpm Brake load = 70 kg Brake drum diameter = 2m Diesel oil consumption = 0.1 litres/min Specific gravity of fuel = 0.78 Calorific value of fuel = 43900 kJ/kg Indicated Power = 24.54 kW Determine (i) Brake Power (ii) Mechanical efficiency (iii) Brake thermal efficiency (iv) Indicated thermal efficiency.
24. A four-cylinder four stroke petrol engine develops 30 kW at 2500 rpm. The mean effective pressure on each piston is 8 bar and mechanical efficiency is 80%. Calculate the diameter and stroke of each cylinder.
25. A diesel engine develops 5 kW. Its indicated thermal efficiency is 30% and mechanical efficiency is 75%. Estimate the fuel consumption of the engine in a) kg/hr and b) litres/hr. Also find ISFC and BSFC. Take CV of fuel = 42000 kJ/kg and specific gravity of fuel = 0.87.
26. A 4-cylinder, 4-stroke SI engine runs at 3000 rpm with a brake torque of 120 Nm. Calculate the brake power.
27. An engine develops an indicated power of 45 kW and a brake power of 40 kW. Calculate the mechanical efficiency.
28. List and explain any four major components of an Electric Vehicle.
29. Differentiate between EVs and HEVs in terms of energy source and emissions.
30. Explain the block diagram (architecture) of a Series Hybrid Electric Vehicle.
31. What are the advantages of Electric Vehicles over conventional petrol/diesel vehicles?
32. Explain the role of the battery management system (BMS) in EVs.
33. State and explain the three types of hybrid vehicle architectures.
34. Why do EVs have better energy efficiency than ICE vehicles?