Mechanical Engineering Science

Assignment questions/self study/Home work material:

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

1. Explain the difference between a closed system and an open system with practical engineering examples for each. Discuss how energy transfer occurs across their boundaries.
2. Explain under what conditions this process can be considered reversible.
3. Discuss the Zeroth Law of Thermodynamics and explain its significance in the definition and measurement of temperature.
4. A closed system undergoes a non-cyclic process where it absorbs 500 kJ of heat and does 300 kJ of work on the surroundings. Calculate the change in internal energy and interpret the result physically.
5. Analyze the limitations of the First Law of Thermodynamics with respect to determining the spontaneity of a thermodynamic process. How does the Second Law complement it?
6. Compare and contrast the Kelvin–Planck and Clausius statements of the Second Law of Thermodynamics, providing practical examples of devices that illustrate each statement.
7. Explain the concept of thermal energy reservoirs and their role in heat engines and reversed heat engines. How do these concepts affect the efficiency of thermodynamic cycles?
8. Discuss how fluid energy is converted into mechanical energy in this context.
9. Draw and explain the P-V diagrams for 4-stroke SI and CI engines. Highlight the key differences in their thermodynamic cycles and discuss their impact on engine efficiency and emissions.
10. Define the engine performance parameters such as indicated power, brake power, and thermal efficiency. How are these parameters experimentally determined in an IC engine?
11. Discuss the classification of internal combustion engines based on fuel type, ignition method, and operating cycle. Which classification has the greatest impact on vehicle emissions and why?
12. Describe the architecture of a hybrid electric vehicle (HEV) and explain how the power flows between the internal combustion engine and electric motor during acceleration and deceleration phases.
13. Analyze the advantages and disadvantages of electric vehicles compared to hybrid vehicles, considering factors such as environmental impact, cost, and infrastructure requirements.
14. Critically evaluate the role of regenerative braking in hybrid vehicles and how it improves overall energy efficiency. What are the limitations of this system?
15. The following readings were taken during the test of four stroke single cylinder petrol engine: Load on brake drum = 50 kg; Diameter of brake drum = 1,250 mm Spring balance reading = 7 kg; Engine speed = 450 rpm Fuel consumption = 4 kg/h; Calorific value of fuel = 43,000 kJ/kg Calculate: (i) indicated thermal efficiency, and (ii) brake thermal efficiency. Assume mechanical efficiency as 70%.

16. Following readings were taken during test of single cylinder four stroke engine: Cylinder diameter = 250 mm; stroke length = 400 mm; m.e.p. = 6.5 bar; engine speed = 250 rpm; net load on brake = 1,080 N; effective diameter of brake = 1.5 m; fuel used per hour = 10 kg; calorific value of fuel = 44,300 kJ/kg. Calculate: (i) indicated horse power, (ii) brake horse power, (iii) mechanical efficiency, and (iv) indicated thermal efficiency.
17. The following results refer to a test on CI engine: Indicated power = 37 kW; Frictional power = 6 kW; Brake specific fuel consumption = 0.28 kg/KWh; Calorific value of fuel = 44,300 kJ/kg Calculate: (i) mechanical efficiency, (ii) brake thermal efficiency, and (iii) indicated thermal efficiency.
18. Following observations were made during a trial on four stroke diesel engine. Cylinder diameter = 25 mm, stroke = 40 mm, speed = 250 rpm, brake load = 70 kg, brake drum diameter = 2 m, m.e.p. = 6 bar, diesel oil consumption = 0.1 m3/min., specific gravity of fuel = 0.78, C.V. = 43,900 kJ/kg. Determine (i) IP, (ii) BP, (iii) FP, (iv) mechanical efficiency, (v) brake thermal efficiency, and (vi) indicated thermal efficiency.