

BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIRST YEAR FIRST SEMESTER
EXAMINATION 2025

Thermodynamics and Heat Power

Time: - 3 hours

Full Marks: -100

Answer any *five* questions

*All parts of the same question must be answered together
Data, consistent with the problem may be assumed if necessary*

1. Answer the following questions: 20
 - a) Define the following terms: Thermodynamic system, Phase, Compression ratio.
 - b) What is a heat engine? How does it differ from a heat pump?
 - c) State and explain the Zeroth law of thermodynamics.
 - d) What do you mean by clearance and stroke volumes of an IC engine?

2. a) Differentiate between 4-stroke and 2-stroke engines. 8
 b) A four stroke SI engine at full load delivers 50 kW. It requires 8.5 kW to rotate it without load at the same speed. Find its mechanical efficiency at full load, half load and quarter load. Also find out the volume of the fuel consumed per second at full load if the brake thermal efficiency is 25%, given that calorific value of the fuel is 42 MJ/kg and specific gravity of fuel 0.75. Estimate the indicated thermal efficiency. 12

3. a) What are the modes in which energy is stored in a system? Show that stored energy is a property of a system. 10
 b) A mass of 5.0 kg gas expands within a flexible container so that the p - v relationship is of the form $pv^{1.4} = \text{const}$. The initial pressure is 1000 kPa and the initial volume is 1.0 m^3 . The final pressure is 5.0 kPa. If specific internal energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction. 10

4. a) Derive a mathematical expression of the steady flow energy equation with relevant parameters. 8
 b) A certain water heater operates under steady flow conditions receiving 4.2 kg/s of water at 75°C temperature, enthalpy 313.93 kJ/kg. The water is heated by mixing with steam which is supplied to the heater at temperature 100.2°C and enthalpy 2676 kJ/kg. The mixture leaves the heater as liquid water at temperature 100°C and enthalpy 419 kJ/kg. How much steam must be supplied to the heater per hour? 10

5. a) State and explain the Kelvin-Planck statement of the 2nd law of thermodynamics. 5
 b) Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 100 K, respectively. Engine A receives 1680 kJ of heat from the high-temperature reservoir and rejects heat to the Carnot engine B . Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir. If engines A and B have equal thermal efficiencies, determine (i) the heat rejected by engine B , (ii) the temperature at which heat is rejected by engine A , and (iii) the work done during the process by engines A and B respectively. If engines A and B deliver equal work, determine (iv) the amount of heat taken in by engine B , and (v) the efficiencies of engines A and B . 15

[Turn over

6. a) What is the function of a *Feed check valve* and *Man hole* in a fire tube boiler? 4
b) Sketch and label a fire tube boiler. 10
c) State advantages of water tube boiler over fire tube boiler. 6
7. Write short note on the followings (*any four*): 20
a) Heat pump, b) Control volume, c) Free expansion, d) Diesel cycle, e) Thermodynamic property.