

BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIRST YEAR FIRST SEMESTER
EXAMINATION 2023

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 terms: Thermodynamic Property, Process and Cycle.
 - b) What is enthalpy? Why does the enthalpy of an ideal gas depend only on temperature?
 - c) What is a Carnot cycle? Plot the Carnot cycle on T-s plane.
 - d) Prove that $pv^\gamma = \text{const.}$ for a reversible adiabatic process.
 - e) What do you understand by entropy principle?

- 2 a) Explain with neat sketches the working of a 4-stroke SI engine. 10
 - b) In an air standard Diesel cycle, the compression ratio is 16 and at the beginning of isentropic compression, the temperature is 15°C and pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C . Calculate (a) the cut-off ratio, (b) the heat supplied per kg of air, (c) the cycle efficiency. 10

- 3 a) When is work said to be done by a system? Establish the mathematical expression of displacement work for a reversible process. 10
 - b) 1kg of air in a piston-cylinder arrangement at 50°C , 1000 kPa is expanded in a reversible isobaric process to 140°C . Find the work done, change in internal energy and heat transfer during this process. Also plot the above process on $P-v$, $P-T$, and $T-v$ planes. Assume for air $R= 0.287$ KJ/Kg K and $C_v= 0.718$ KJ/Kg K. 10

- 4 a) Derive an expression of energy equation for a steady flow system. 10
 - b) In a steady flow apparatus, 135KJ of work is done by each Kg of fluid. The specific volume of the fluid, pressure, and velocity at the inlet are $0.37 \text{ m}^3/\text{Kg}$, 600KPa, and 16 m/s. The inlet is 32m above the floor and the discharge pipe is at floor level. The discharge conditions are $0.62 \text{ m}^3/\text{Kg}$, 100KPa, and 270 m/s. The total heat gain between the inlet and discharge is 9KJ/Kg of fluid. In flowing through this apparatus, does the specific internal energy increase or decrease and by how much? 10

- 5 a) What is PMM2? Why is it impossible? 5
 - b) State and explain the second law of thermodynamics. 5
 - c) A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes in Q_1 heat units at T_1 and rejects Q_2 at T_2 . The heat pump abstracts Q_4 from the sink at T_4 and discharges Q_3 at T_3 . Develop the expression $Q_4/Q_1 = T_4(T_1 - T_2)/T_1(T_3 - T_4)$. 10

[Turn over

- 6 a) What is entropy? Prove that entropy is a property of a system. 10
b) A block of iron weighing 100kg and having a temperature of 100°C is immersed in 50 kg of water at a temperature of 20°C. What will be the change of entropy of the combined system of iron and water? Specific heats of iron and water are 0.45 and 4.18 kJ/kgK respectively. 10
7. Write short notes on the following (*any four*): 20
a) Thermodynamic systems, b) Entropy principle, c) Thermal energy reservoir, d) Irreversibility, f) Zeroth law of thermodynamics