

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2023****Subject Code:3142004****Date:17-07-2023****Subject Name: Engineering Thermodynamics****Time: 10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.
5. Use of Steam Table is permissible.

- Q.1** (a) What do you understand by path function and point function? What are exact and inexact differentials? **03**
- (b) With examples explain intensive and extensive properties. **04**
- (c) Show that the efficiency of all reversible heat engines operating between the same temperature level is same. **07**
- Q.2** (a) What is Avogadro's law? **03**
- (b) Write down two statements of second law of thermodynamics (Kelvin-Planck statement and Clausius statement) **04**
- (c) Derive equation of Carnot cycle $\eta_{cycle} = \frac{W_{net}}{Q_1} = \frac{T_1 - T_2}{T_1}$ **07**
- OR**
- (c) In a gas turbine the gas enters at the rate of 5 kg/s with a velocity of 50 m/s and enthalpy of 900 kJ/kg and leaves the turbine with a velocity of 150 m/s and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surroundings is 25 kJ/kg. Assume for gas $R = 0.285$ kJ/kg K and $C_p = 1.004$ kJ/kg K and the inlet conditions to be at 100 kPa and 27 °C. Determine the power output of the turbine and the diameter of the inlet pipe. **07**
- Q.3** (a) What is available energy and unavailable energy? **03**
- (b) Show that entropy is a property of a system. **04**
- (c) Establish the inequality of Clausius. **07**
- OR**
- Q.3** (a) What is the critical state? Explain critical pressure, temperature and volume of water. **03**
- (b) What is the mass of air contained in a room 6 m x 9 m x 4 m if the pressure is 101.325 kPa and temperature is 25 °C? **04**
- (c) With neat diagram explain the functions of four basic components of steam power plant. **07**
- Q.4** (a) What are PMM1 and PMM2? Why they are impossible? **03**
- (b) Why is Carnot cycle not practicable for a steam power plant? **04**
- (c) What is spark ignition engine? What is the air standard cycle of such engine? What are its four processes? **07**
- OR**
- Q.4** (a) What is the characteristic gas constant? **03**
- (b) A refrigeration plant for a food store operates as a reversed Carnot heat engine cycle. The store is to be maintained at a temperature of -5 °C and the heat transfer from the store to the cycle is at the rate of 5 kW. **04**

If heat is transferred from the cycle to the atmosphere at a temperature of 25 °C, calculate the power required to drive the plant.

- (c) For the same compression ratio and heat rejection, which cycle is most efficient: Otto, diesel or dual? Explain with p-v and T-s diagram. **07**

Q.5 (a) State and explain the Gibbs-Dalton law of partial pressures. **03**

(b) Explain the law of corresponding states. **04**

(c) A certain gas has $C_p = 1.968$ and $C_v = 1.507$ kJ/kg K. Find its molecular weight and the gas constant. A constant volume chamber of 0.3 m³ capacity contains 2 kg of this gas at 5 °C. Heat is transferred to the gas until the temperature is 100 °C. Find the work done, the heat transferred and the change in internal energy, enthalpy and entropy. **07**

OR

Q.5 (a) Explain throttling process with proper diagram and example. **03**

(b) Write Van der Waals equation and mention significance of constants 'a' and 'b'. **04**

(c) Derive the efficiency equation for Brayton cycle **07**

$$\eta_{Brayton} = 1 - \frac{1}{r_p^{(\gamma-1)/\gamma}}$$
