Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV • EXAMINATION – WINTER 2013

Subject Code: 141903 **Date: 19-12-2013**

Subject Name: Engineering Thermodynamics

Time: 02:30 pm to 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of steam tables and Molier chart is permitted**

Q.1 **(a)** Define following terms: state, path, process, isolated system, intensive property, quasi-static process, perfect gas. **07**

(b) A vessel of 2 m^3 volume contains hydrogen at atmospheric pressure and 27 °C temperature. An evacuating pump is connected to vessel and the evacuation process is continued till its pressure becomes 70 cm of Hg vacuum. Estimate the mass of hydrogen pumped out. Also determine the final pressure in the vessel if cooling is carried up to 10°C. Take atmospheric pressure as 76 cm of Hg and universal gas constant as 8.314 kJ/Kg K. **07**

Q.2 **(a)** In a gas turbine installation air is heated inside heat exchanger by 750 °C from ambient temperature of 27 °C. Hot air then enters into gas turbine with the velocity of 50 m/s and leaves at 600°C. Air leaving turbine enters a nozzle at 60 m/s velocity and leaves at temperature of 500°C. For unit mass flow rate of air determine the following assuming adiabatic expansion in turbine and nozzle, **07**

i. Heat transfer to air in heat exchanger
ii. Power output from turbine
iii. Velocity at exit of nozzle

Take C_p for air as 1.005 kJ/Kg K

(b) A rigid and insulated tank of 1 m^3 volume is divided by partition into two equal volume chambers having air at 0.5 M Pa, 27 °C, and 1 M Pa, 500 K. Determine final pressures and temperature if partition is removed. **07**

OR

(b) Distinguish between energy of non flow system and flow system. Deduce the steady flow energy equation for a reciprocating compressor. **07**

Q.3 **(a)** A reversible heat engine operates between two reservoirs at 600°C and 40°C. The engine drives a reversible refrigerator which operates between the same 40°C reservoir and reservoir at -18°C. The heat transfer at heat engine is 2100 kJ and there is a net work output of 370 kJ from the combined plant. Evaluate the heat transfer to refrigerator and net heat transfer to 40 °C reservoir. **07**

(b) In a steam turbine the steam enters at 50 bar, 600°C and 150 m/s and leaves as saturated vapour at 0.1 bar, 50 m/s. During the expansion work of 1000 kJ/kg is delivered. Determine the inlet steam availability, exit steam availability and irreversibility. Take dead state temperature as 15 °C. **07**

OR

Q.3 **(a)** Prove that violation of Kelvin-Plank statement leads to violation of Clausius statement. **07**

(b) Determine entropy change of universe if two copper blocks of 1 Kg and 0.5 kg at 150°C and 0°C are joined together. Specific heat for copper at 150°C and 0°C are 0.393kJ/Kg K and 0.381kJ/Kg K resply. **07**

Q.4 **(a)** Explain briefly Otto cycle with help of p-v and T-s diagram and derive an expression for ideal efficiency of Otto cycle. **07**

(b) Dry saturated steam at 10 bar is supplied to a prime mover and exhaust takes at 0.2 bar. Determine the Rankine efficiency, efficiency ratio, specific steam consumption if thermal efficiency is 20%, also determine percentage change in Rankine efficiency if steam is initially 90% dry. **07**

OR

Q.4 **(a)** Discuss the effect of pressure of steam at inlet to turbine, temperature at inlet to turbine and pressure at exit from turbine upon Rankine cycle performance. **07**

(b) An ideal diesel engine has a diameter 150 mm and stroke 200 mm. The clearance volume is 10% of the swept volume. Determine the compression ratio and air standard efficiency of the engine if cut off takes place at 6% of the stroke. **07**

Q.5 **(a)** Explain the following: Maxwell's equation, Helm-holtz and Gibbs function, Joule-Thomson coefficient. **07**

(b) With neat sketch explain construction and working of Junkers gas calorimeter. **07**

OR

Q.5 **(a)** Define the following: Avogadro's law, equation of state, law of corresponding states, Gibbs-Dalton law, **07**

(b) Explain the following: Enthalpy of formation, Enthalpy of reaction, Adiabatic flame temperature. **07**

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