Sub Code:RME302

Paper Id: 140302 Roll No:

**B. TECH**
**(SEM. III) THEORY EXAMINATION 2019-20**
**THERMODYNAMICS**

*Time: 3 Hours* *Total Marks: 70*

**Note:** Attempt all Sections. If require any missing data; then choose suitably.

**SECTION A**

**1. Attempt *all* questions in brief.** **2 x 7 = 14**

a. Differentiate microscopic and macroscopic point of view.
b. Define Joule – Thomson Co-efficient.
c. State Carnot theorem.
d. Distinguish between heat pump and refrigerator.
e. Distinguish between high grade energy and low grade energy?
f. What do you mean by dryness fraction?
g. State the assumption made in kinetic theory of gases?

**SECTION B**

**2. Attempt any *three* of the following:** **7 x 3 = 21**

**a)** At the beginning of the compression stroke of a two-cylinder internal combustion engine the air is at a pressure of 101.325 kPa. Compression reduces the volume to 1/5 of its original volume, and the law of compression is given by pv1.2 = constant. If the bore and stroke of each cylinder is 0.15 m and 0.25 m, respectively, determine the power absorbed in kW by compression strokes when the engine speed is such that each cylinder undergoes 500 compression strokes per minute.

**b)** A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine.

**c)** Steam flows through a small turbine at the rate of 5000 kg/h entering at 15 bar, 300°C and leaving at 0.1 bar with 4% moisture. The steam enters at 80 m/s at a point 2 in above the discharge and leaves at 40 m/s. Compute the shaft power assuming that the device is adiabatic but considering kinetic and potential energy changes. How much error would be made if these terms were neglected? Calculate the diameters of the inlet and discharge tubes.

**d)** Derive an expression for the COP of an ideal gas refrigeration cycle with a regenerative heat exchanger. Express the result in terms of the minimum gas temperature during heat rejection ($T_h$) maximum gas temperature during heat absorption ($T_l$) and pressure ratio for the cycle ($P_2P_1$).

**e)** Derive clausius-clapeyron equation.

**SECTION C**

**3. Attempt any *one* part of the following:** **7 x 1 = 7**

(a) A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3 m. The steam leaves the turbine at the following state: Pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW?

(b) A turbo compressor delivers 2.33 m3/s at 0.276 MPa, 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible.

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**4. Attempt any *one* part of the following: 7 x 1 = 7**

(a) A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a pump which extracts heat from the reservoir at 300 K at a rate twice that at which engine rejects heat to it. If the efficiency of the engine is 40% of the maximum possible the COP of the heat pump is 50% of the maximum possible, what is the temperature o reservoir to which the heat pump rejects heat? What is the rate of heat rejection from heat pump if the rate of heat supply to the engine is 50 kW?

(b) Calculate the entropy change of the universe as a result of the following processes: ( copper block of 600 g mass and with Cp of 150 J/K at 100°C is placed in a lake at 8°C The same block, at 8°C, is dropped from a height of 100 m into the lake. (c) Two blocks, at 100 and 0°C, are joined together.

**5. Attempt any *one* part of the following: 7 x 1 = 7**

(a) Two bodies of equal heat capacities C and temperatures T1 and T2 form an adiabatically closed system. What will the final temperature be if one lets this system come to equilibrium (a) freely? (b) Reversibly? (c) What is the maximum work which can be obtained from this system?

(b) Establish the inequality of Clausius and express Entropy change in irreversible process

**6. Attempt any *one* part of the following: 7 x 1 = 7**

(a) Steam from an engine exhaust at 1.25 bar flows steadily through an electric calorimeter and comes out at 1 bar, 130°C. The calorimeter has two 1 kW heaters and the flow is measured to be 3.4 kg in 5 min. Find the quality in the engine exhaust. For the same mass flow and pressures, what is the maximum moisture that can be determined if the outlet temperature is at least 105°C?

(b) A reversible polytropic process, begins with steam at p1 = 10 bar, t1 = 200°C, and ends with p2 = 1 bar. The exponent n has the value 1.15. Find the final specific volume, the final temperature, and the heat transferred per kg of fluid.

**7. Attempt any *one* part of the following: 7 x 1 = 7**

(a) Explain the vapour compression cycle with the help of T-s and p-h diagram.

(b) A vapour compression refrigeration system uses R-12 and operates between pressure limits of 0.745 and 0.15 MPa. The vapour entering the compressor has a temperature of – 10°C and the liquid leaving the condenser is at 28°C. A refrigerating load of 2 kW is required. Determine the COP and the swept volume of the compressor if it has a volumetric efficiency of 76% and runs at 600 rpm.