NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR (HP)

DEPARTMENT OF MECHANICAL ENGINEERING

END SEMESTER EXAMINATION DEC 2020

Engineering Thermodynamics (ME-212)

Date: 09-12-2020, **Slot**: A (10:00 AM to 12:00 PM), Time: 2:00 hrs, **M.M.**: 50

Note: Attempt all the questions. Steam Table is allowed.

1. Two modes of energy transfer are work and heat. Does the mode of energy transfer depend on the choice of a system? Support your answer with the help of an example.   **2.5**

2. An anomalous behavior of water is observed on the phase diagram. That is, slope of the fusion curve is negative for water whereas for all other substances the fusion curve has a positive slope. Give two example where this anomalous behavior is found to be advantageous.   **2.5**

3. A steam turbine produces 500 MW of power. The inlet and outlet conditions of steam are as follows:

Parametrs	Inlet	Outlet
Pressure	12.5 MPa	10 kPa
Temperature	500°C	
Quality		0.85
Velocity	50 m/s	100 m/s

Heat transfer to the surroundings from the turbine surface is estimated as 10 MW. What is the mass flow rate of steam?   **5**

**4.** Compare Otto, Diesel and Dual cycles for the   **8**
  (a) Same compression ratio and heat input
  (b) Same maximum pressure and heat input
  (c) Same compression ratio and heat rejection
  (d) Same peak pressure, peak temperature and heat rejection

5. What approximations are involved in the Clapeyron-Clausius equation? A domestic pressure cooker is a common kitchen appliance which is usually used for cooking meat or pulses which are hard to boil at atmospheric pressure. The boiling point of water in the cooker increases because of the pressure developed by the steam. The cooker is provided with a lid which can be tightly sealed with the help of a gasket or O-ring. In view of the

safety in the kitchen, the pressure cooker is so designed that it maintains a constant pressure of 2 bar while it is in use. Assuming that no other data except the water boils at 100°C at 1 bar pressure with a latent heat of vapourization of 2256.94 kJ/kg, estimate the boiling point of water in the pressure cooker. **8**

6. A pressure vessel has a volume of 1 m³ and holds air at 1.5 Mpa and 177°C. The air is cooled to 27°C by heat transfer to the surrounding at 27°C. Calculate the availability in the initial and final states, Take $p_0 = 100\ kPa$. **8**

7. A resister (R) of 40 ohms is maintained at 27°C while a current (I) of 10 amperes is allowed to flow for one second (as shown in Figure below). Determine the entropy change of the resistor and the universe.

If the resistor initially at 27°C is now insulated and the same current is passed for the same time, determine the entropy change of the resistor and the universe. The specific heat of the resistor is 1 kJ/kgK and the mass of the resistor is 10 gram. **8**
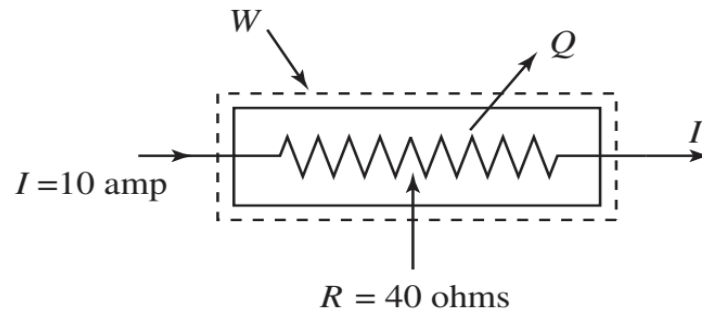
8. A reversible engine works between three thermal reservoirs, A, B and C. The engine absorbs an equal amount of heat from the reservoir A and B kept at temperature T_A and T_B, respectively and rejects heat to the thermal reservoir C kept at temperature T_C. The efficiency of the engine is α times the efficiency of the reversible engine, which works between two reservoirs A and C. Prove that: **8**

$$\frac{T_A}{T_B} = (2\alpha - 1) + 2(1 - \alpha)\frac{T_A}{T_C}$$

**END