

Mechanical Engineering Department
MEL 140: Engineering Thermodynamics

Time : 2hrs

MAJOR TEST (May 2007)

Max Points 70

Solve Q. No 1 and any 3 question more. Symbols have their usual meaning.

Q.1 Explain precisely (any two)

- (a) Caratheodory's formulation of the concept of entropy.
- (b) the difference between the "first-law" and the "second-law" efficiencies of typical processes.
- (c) The definitions of dew point temperature, relative humidity and specific humidity of moist air.
- (d) Insights from thermodynamics into the concept of "development". [10]

Q2. A window air conditioner produces 3kW of cooling effect maintaining a room at 25° C when the outdoor temperature is 45 ° C. Its evaporator temperature is 10 ° C and the condenser temperature is 55 ° C. If it consumes 1.5 kW of electric power estimate the entropy generation due to

- (a) internal irreversibilities
- (b) external irreversibilities [20]

Q3. The equation of state of a certain gas is $P(v-b) = RT$ where b is a constant. If its constant volume specific heat C_v is also constant, show that for a reversible adiabatic process $P(v-b)^r = \text{constant}$ where $r = 1 + R/C_v$.

[20]

Q4. A Paramagnetic solid obeying Curie- Weiss equation of state, viz.

$$M V/H^* = C/(T-T_0)$$

is magnetized in a reversible isothermal process at 600K till its field strength becomes 10^7 amp/m.

Calculate the temperature drop that would occur if this solid is demagnetized isentropically

Given constants of Curie-Weiss eq.

$$C = 2 \times 10^{-4} \text{ m}^3 \text{ K/kg } T_0 = 300\text{K}$$

Specific heat $C_m = 0.6 \text{ kJ/kg K}$

$$\mu_0 = 4 \pi \times 10^{-7} \text{ N/amp}^2$$

[20]

Q5. A soldering iron is being preheated prior to use. It draws a current of 0.5 amp when connected to mains at 220V. Its mass is 100gms and specific heat 0.5 kJ/kg. What shall

be its temperature after one minute? Assume the rate of heat transfer from its surface, when at temperature T , to the surroundings at 30°C is given by the relation

$$Q = 2(T-30) \text{ Watts}$$

What is the exergy of the soldering iron at that temperature and the exergetic efficiency of the heating process. [20]

Q6. A thermal power plant is operating on a Rankine cycle, the condenser pressure being 5kPa and the boiler pressure being 10MPa . The steam temperature at turbine inlet is 600°C , the isentropic efficiency of the turbine is 85% and the steam mass flow rate is 100kg/s . Determine.

- (a) The "quality" of steam at turbine exit
- (b) The condensate pump work

[20]