

**MEMS 0051 - Introduction to Thermodynamics**  
**Quiz #5**

Name: Solutions

## Problem 1

Calculate the correct performance metric ( $\eta$ ,  $\beta$  or  $\beta'$ ) for a device that requires a power input of 500 [kW] and supplies 1,250 [kW] of thermal energy to a high-temperature reservoir while removing 750 [kW] of thermal energy from the low-temperature reservoir. Heat pump:

$$\beta' = \frac{Q_H}{W} = \frac{1,250 \text{ [kW]}}{500 \text{ [kW]}} = 2.5$$

## Problem 2

Do the following systems violate the 2<sup>nd</sup> Law of Thermodynamics (yes or no):

- (a) A system that transfers heat from a low-temperature to a high-temperature reservoir while simultaneously producing power: Yes
- (b) A system that takes heat from a high-temperature reservoir, produces power, but does not reject heat to a low-temperature reservoir: Yes
- (c) A system where a heat engine takes heat from a high-temperature reservoir, produces work while rejecting heat to a low-temperature reservoir, and said work is used to run a refrigerator that takes heat from a low-temperature reservoir and transfers it to a high-temperature reservoir: No

## Problem 3

Using your tables, determine the change of enthalpy for the following:

- (a) Carbon dioxide heated from 200 [K] to 2,000 [K]  
Using Table A.8 on page 765

$$\Delta h = (2,290.51 - 135.28) \text{ [kJ/kg]} = 2,155.23 \text{ [kJ/kg]}$$

- (b) Liquid water at 2,500 [kPa] heated from 20°C to 105°C Using the saturated water temperature tables on page 777

$$\Delta h = (440.13 - 83.94) \text{ [kJ/kg]} = 356.19 \text{ [kJ/kg]}$$