

# ENSC 461

## Assignment #7 (Non-Reacting Mixtures and HVAC)

Assignment date:

Due date:

### Problem 1:

A system consists, initially of  $n_A$  moles of gas A at pressure  $P$  and temperature  $T$  and  $n_B$  moles of gas B separate from gas A but at the same pressure and temperature. The gases are allowed to mix with no heat or work interactions with the surroundings. The final equilibrium pressure and temperature are  $P$  and  $T$ , respectively, and the mixing occurs with no change in total volume.

- Assuming ideal gas behavior, obtain an expression for the entropy produced in terms of  $R$ ,  $n_A$ , and  $n_B$ .
- Using the result of part a), demonstrate that the entropy produced has a positive value.
- Would entropy be produced when samples of the same gas at the same temperature and pressure mix? Explain.

### Problem 2:

Air at 35°C, 1 atm, and 10% relative humidity enters an evaporative cooler operating at steady-state. The volumetric flow rate of the incoming air is 50 m<sup>3</sup>/min. Liquid water at 20°C enters the cooler and fully evaporates. Moist air exits the cooler at 25°C, and 1 atm. If there is no significant heat transfer between the device and its surroundings, show the process on a psychrometric chart and determine:

- The rate at which liquid enters the cooler, in kg/min.
- The relative humidity at the exit.
- The rate of exergy destruction, in kJ/min, for  $T_0 = 20^\circ\text{C}$ .

Neglect potential and kinetic energy effects. Calculate properties of the moist air using: a) the relationships derived in the class, b) the psychrometric chart. Compare the two sets.