Assignment 6

1. A rigid tank of volume 1.0 m³ contains dry saturated steam initially at 200°C. Due to heat transfer to the environment, the steam temperature drops to 100°C. The temperature of the environment is 300 K.
   a) Calculate the amount of heat transfer involved.
   b) Calculate the amount of thermodynamic lost work involved.

2. A rigid container encloses 1500 lbm of air at 15 psia and 500°R. We wish to increase the temperature to 540 R. Assume ideal-gas behaviour and C_v = 0.171 Btu/lbm °R.
   a) Determine the requirement of energy input to the air for such a change of state.
   b) Determine the entropy creation in the universe if the change of state is accomplished by using energy from a heat reservoir at 300°F alone.
   c) Determine the entropy creation in the universe if the change of state is accomplished by using energy from a work reservoir alone.

3. Twenty kilograms of liquid-vapour mixture of H_2O initially at 100°C and at quality of 60% are being cooled quasi-statically until they are 100% saturated liquid at 100°C. They can exchange heat with the environment at 25°C only.
   a) Determine the amount of heat transfer for the fluid.
   b) Show that the heat-transfer process is irreversible.

4. Two kilograms of nitrogen gas, confined inside a cylinder equipped with a piston, undergoes a change of state quasi-statically from 300 K and 101.325 kPa to a final state of 300 K and 20,000 kPa. Heat transfer can occur between the nitrogen gas and a heat reservoir at 300 K.
   a) Determine the total amount of work transfer for the nitrogen gas.
   b) Determine the total amount of heat transfer for the nitrogen gas.
   c) Show that the process is both internally reversible as well as externally reversible.

5. A piece of metal (specific heat capacity, c = 0.4kJ/(Kg.K)) is being colled from 200C to 100C. Heat removed from metal (differentially) is fed to a heat engine operating with the environment as the heat sink. Environment pressure & Temperature are 101.235 kPa, and 300K respectively. Calculate the following:
   a) Heat removed from themetal in kJ/Kg.
   b) The change in availability of the metal. (change in availability is defined as maximum work delivered (per unit mass) by system while changing its state from initial to final)
   c) The useful work output of the engine when it is reversible.
   d) Lost work, if engine is irreversible with useful work output is 10 kJ/kg.

6. Prove that at constant temperature and pressure, a process (state change) is feasible only if $\Delta G_{T,P} \leq 0$. (Hint: Any process/state change is feasible if $\Delta S_{isolated} \geq 0$.)