Teaching and Learning Objectives of Lecture 26 – 30

1. Given a steady-state, closed device that may exchange heat with the surroundings at known temperatures, apply the rate-form of the entropy balance and the energy balance to determine the *best* possible performance for the device, *e.g.* the *minimum* net work input or the *maximum* net work output. You should be able to prove to yourself that this condition *always* occurs when the device operates in an internally reversible fashion, *i.e.* when the rate of entropy production is zero.

2. Define the isentropic efficiency of various steady-state devices as a measure of departure of actual device performance from the best-case scenario.

3. Given a steady-state device and its isentropic efficiency, determine the properties of the exit state.

4. Given a steady-state, closed system or a closed system that executes a cycle and exchanges energy by heat transfer with the surroundings at known temperatures,
   (a) determine if the device is a heat engine (power cycle) or a refrigeration/heat pump cycle
   (b) determine the appropriate *measure of performance* for the cycle
   - for a heat engine (power cycle)—the *thermal efficiency*
     $\eta = \dot{W}_{\text{net,out}} \big/ \dot{Q}_{\text{in @ } T_{\text{Hot}}}$
   - for a refrigerator—the *coefficient of performance for a refrigerator*
     $\text{COP}_{\text{Ref}} = \dot{Q}_{\text{in @ } T_{\text{Cold}}} \big/ \dot{W}_{\text{net,in}}$
   - for a heat pump—the *coefficient of performance for a heat pump*
     $\text{COP}_{\text{HP}} = \dot{Q}_{\text{out @ } T_{\text{Hot}}} \big/ \dot{W}_{\text{net,in}}$

   (c) determine the entropy production rate for the device.