MAE320-HW7A

The homework is due Monday, November 14, 2016. Each problem is worth the points indicated. Copying of the solution from another is not acceptable.

(1). Multiple choice (20 points)

1a). Which statement is invalid regarding the entropy generation ($S_{\text{gen}}$)?.
A). Entropy generation is always a positive quantity or zero.
B). The value of entropy generation depends on the process.
C). The value of entropy generation is zero during an internal reversible process.
D). Entropy generation is a property of a system.
E). None of the above

1b). The entropy of an isolated system increases during a process.
A). sometimes
B). always
C). never
D). may decrease
E). None of the above

1c). Which statement is invalid regarding the Clausius Inequality?
A). For any thermodynamic cycle (reversible or irreversible), \[ \oint \frac{\Delta Q}{T} \] is always less than or equal to zero.
B). The equality in the Clausius inequality holds for totally or just internally reversible cycles.
C). The Clausius Inequality Statement only reflects the first law of thermodynamics.
D). The Clausius Inequality Statement reflects the second law of thermodynamics.
E). None of the above

1d). Which statement is invalid regarding the entropy?
A) . Entropy is a property. Like all other properties, it has a fixed value at a fixed state.
B) . The entropy change of a system between two specified states is the same whether the process is reversible or irreversible.
C) . On a T-S diagram, the area under the process curve represents the heat transfer for an internally reversible process.
D) . Entropy is a path function; and the entropy change is dependent on the path of a process.
E) . None of the above

1e). If an adiabatic compressor undergoes an internally reversible process, we can conclude
A). It obviously is not an isentropic process.
B). Entropy generation ($S_{\text{gen}}$) is greater than zero.
C). Entropy generation ($S_{\text{gen}}$) is zero
D). Heat may transfer from the compressor to the surrounding.
E). The change in the entropy between the initial and the final state may not be zero.
1f). Which statement is invalid?
A). Entropy is a conserved property, and there exist a conservation of entropy principle.
B). Processes can occur in a certain direction only, not in any direction. A process must proceed in the direction that complies with the increase of entropy principle.
C). Entropy generation ($S_{gen}$) is a measure of the magnitudes of the irreversibilities during a process.
D). Entropy may be transferred by heat transfer and mass transfer.
E). None of the above

1g). Which statement is invalid?
A). The $T$-$s$ diagram serves as a valuable tool for visualizing the second law aspects of processes and cycles. An isentropic process appears as a vertical line segment on a $T$-$s$ diagram.
B). The $h$-$s$ diagram is useful analysis of adiabatic steady-flow devices, such as turbines, compressors and nozzles. The horizontal distance $\Delta s$ is a measure of irreversibilities associated with the process.
C). The $h$-$s$ diagram is useful analysis of adiabatic steady-flow devices. The vertical distance $\Delta h$ (between the inlet and the exit states) on an $h$-$s$ diagram is a measure of work.
D). From the microscopic viewpoint, entropy is a measure of molecular disorder or molecular randomness.
E). According to the third law of thermodynamics, a pure crystalline substance at absolute zero temperature is in perfect order. But its entropy never is zero.

2. An insulated rigid tank contains 10 kg water. Initially it is a saturated liquid-vapor mixture of water with a quality of 0.25 at pressure of 150 kPa. An electric heater inside is turned on and kept on until all the liquid vaporized. Determine the entropy change of the water during this process (10 points).

3. A reversible heat pump delivers heat at a rate of 300 kJ/s to warm a house maintained at 24 °C. The exterior air, which is at 7 °C, serves as the cool reservoir (9 points).
   (a) Draw a cartoon to illustrate the heat pump device
   (b) Calculate the rate of entropy change of the hot and cool reservoirs, respectively, as well as the entire heat pump system
   (c) Justify if this heat pump satisfies the increase of entropy principle

4. A rubber bag initially contains 2 kg of water at 160 °C and 10 bar. It undergoes an isothermal internally reversible expansion process during which 3000 kJ is received by heat transfer (24 points).
   (a) Determine the final pressure, in kPa
   (b) Calculate the work done during the process, in kJ
   (c) Draw a $T$-$s$ diagram, and locate the initial and final states in the $T$-$s$ diagram, label the temperatures and entropy at the initial and final states.
5. An insulated piston-cylinder system is initially filled with 0.07164 m³ of steam at 300 kPa and 200 °C. The steam is now compressed in an internal reversible manner until the pressure reaches 4.5 MPa.
   (a) Determine the specific entropy at the initial state (8 points)
   (b) Calculate the total work input during this process, in kJ (10 points).

6. Steam is expanded in an adiabatic turbine with a single inlet and a single outlet in an internally reversible manner. At the inlet, the steam is at 2 MPa and 360 °C. The steam pressure at the outlet is 100 kPa.
   (a) Find the specific entropy and quality of water at exit? (6 points)
   (b) Calculate the work per unit mass produced by the turbine (8 points).
   (c) Draw a T-s diagram, schematically locate the initial and final state in the T-s diagram and schematically show the process (5 points).