

1. Answer the following : (30%)
 - (a) Why is the Carnot cycle not a realistic model for steam power plants ?
 - (b) What is the difference between a refrigerator and a heat pump ?
 - (c) In the absence of any friction and other irreversibilities, can a heat engine have an efficiency of 100% ? Explain.
 - (d) How to get the values of $s_g - s_f$ in the steam table ?
 - (e) Distinguish between the air standard cycle and the actual cycle ?
2. Air is compressed steadily by a reversible compressor from an inlet state of 100 Kpa and 300K to an exit pressure of 900Kpa. Determine the compressor work per unit mass for (a) isentropic compression with $k = 1.4$ (b) isothermal compression (c) ideal two-stage compression with intercooling with $n = 1.3$, $R = 0.287 \text{ kJ/kg}\cdot\text{K}$ (20%)
3. An initially evacuated tank is filled with an ideal gas. The inlet is controlled with the valve, and the inlet properties are constants at T_{in} and P_{in} . Determine the final tank temperature T_2 when the tank pressure is P_2 . Evaluate the entropy generation for the filling process. The process is adiabatic. (20%)

4. Answer as indicated:

- (a) An experiment was performed to determine the convection heat transfer coefficient associated with airflow over the surface of a thick steel casting ($k = 15 \text{ W/m}\cdot\text{K}$). Two thermocouples were inserted in the casting at distance of 10 and 20 mm from the surface along a hypothetical line normal to the surface. If the thermocouples measure temperatures of 50 and 35 °C in the steel when the air temperature is 100 °C, what is the convection heat transfer coefficient? (5%)
- (b) Consider a sphere and a cylinder of equal volume made of copper. Both the sphere and the cylinder are initially at the same temperature and are exposed to convection cooling in the same environment. The lumped capacitance analysis is assumed to be valid for both the sphere and the cylinder. Which do you think will cool faster? Justify your answer. (5%)
- (c) Hot water is cooled as it is forced to flow through the tubes exposed to atmospheric air. Fins are to be added in order to enhance heat transfer. Would you recommend attaching the fins inside or outside the tubes? Why? (5%)
- (d) What is thermal radiation? How does it differ from the other forms of electromagnetic radiation? (5%)
5. A long metallic rod of circular cross section with a diameter D is heat-treated by passing an electric current through the rod to provide uniform volumetric heat generation at a rate \dot{q} . The rod with an initial uniform temperature T_i is placed in a large chamber whose walls are maintained at the same temperature T_∞ as the enclosed air. Convection from the surface of the rod to the air is characterized by the heat transfer coefficient h . The rod has a surface emissivity of ϵ . Derive an equation that could be used to predict the transient temperature of the rod. List all the assumptions clearly. (10%)