AME 20231, Thermodynamics
Examination 2
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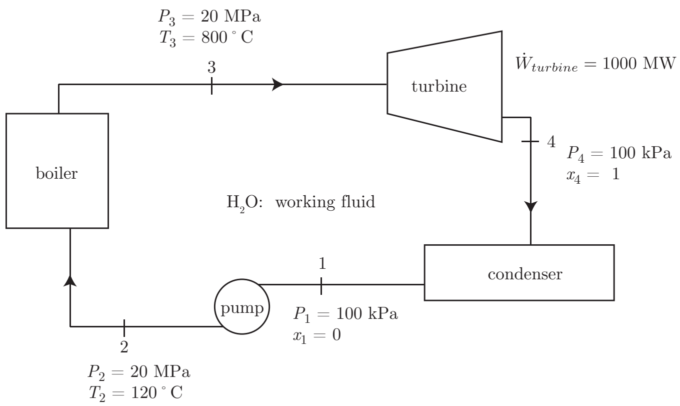
1. (40) Consider the Rankine cycle below. Find



   (a) the mass flow rate (kg/s),
   (b) the heat addition rate required by the boiler (kW),
   (c) the work rate required to power the pump (kW),
   (d) the thermal efficiency,
   (e) the thermal efficiency of a Carnot cycle operating between the same temperature limits,
   (f) a correctly oriented sketch, including the vapor dome and appropriate numerical values of P and v, of the cycle on a $P-v$ diagram,

2. (15) The gas N_2 is at $P_1 = 100$ kPa and $T_1 = 200$ K. It is heated isobarically to $T_2 = 300$ K. Estimate the thermal energy per unit mass required via three different assumptions:

   (a) calorically perfect ideal gas, (use Table A.5),
   (b) calorically imperfect ideal gas (use Table A.8),
   (c) non-ideal gas, (use Table B.6.2).

3. (30) A 1 kg sphere of gold is initially at $T(0) = 400$ K. It is in an environment with temperature $T_\infty = 300$ K. As done in class, one can approximate the temperature of the sphere as uniform throughout. The thermal energy flux from the sphere to the environment is well modeled by $\dot{Q} = -\mathsf{h}A(T - T_\infty)$, where $\mathsf{h} = 0.01$ kW/m^2/K is the convective heat transfer coefficient, A is the surface area, and T is the time–dependent temperature of gold. Find $T(t)$ and the time constant associated with the process. Find the total heat transferred to the environment Q.

4. (15) A Carnot freezer with desired interior temperature of 0°F is in a garage with temperature of 50°F. The freezer draws 300 W of electrical power from a wall outlet. Find the rate of thermal energy released to the garage from the freezer.