Homework Assignment #3 : due Oct. 13
(a subset of these problems will be selected for grading)

1 Electric power is to be generated by installing a hydraulic turbine-generator at a site 160 m below the free surface of a large water reservoir that can supply water at a rate of 3500 kg/s steadily. Determine the power generation potential. (2-12)

2. Two sites are being considered for wind power generation. In the first site, the wind blows steadily at 7 m/s for 3000 hours per year, whereas in the second site the wind blows at 10 m/s for 2000 hours per year. Assuming the wind velocity is negligible at other times for simplicity, determine which is a better site for wind power generation. Hint: Note that the mass flow rate of air is proportional to wind velocity. (2-15) PARTIAL ANSWER: $E_{\text{max},1} = 643 \text{ kWh/yr}$.

3. A water pump increases the water pressure from 10 psia to 50psia. Determine the power input required in hp, to pump 1.2 ft³/s of water. Does the water temperature at the inlet have any significant effect on the required flow power? – (2-46E). Answer. 12.6 hp

4. The water in a large lake is to be used to generate electricity by the installation of a hydraulic turbine-generator at a location where the depth of the water is 50 m. Water is to be supplied at a rate of 5000 kg/s. If the electric power generated is measured to be 1862 kW and the generator efficiency is 95%, determine (a) the overall efficiency of the turbine-generator, (b) the mechanical efficiency of the turbine, and (c) the shaft power supplied by the turbine to the generator. (2-68). PARTIAL ANSWER: (b) mechanical efficiency of turbine = 0.80.
5 Calculate the total work, in kJ, produced by the isothermal process shown in the figure when the system consists of 3 kg of oxygen. (4-6) HINTS: be careful about sign convention. Note you can treat oxygen as an ideal gas to relate the specific volumes to each other.

6. A frictionless piston-cylinder device initially contains 50 L of saturated liquid refrigerant-134a. The piston is free to move, and its mass is such that it maintains a pressure of 500 kPa on the refrigerant. The refrigerant is now heated until its temperature rises to 70 °C. Calculate the work done during this process. (4-11) - ANSWER: 1600 kJ

7. 1 kg of water that is initially at 90 °C with a quality of 10 % occupies a spring-loaded piston-cylinder device such as that in the figure (see book or on-line lecture videos for this figure). This device is now heated until the pressure rises to 800 kPa and the temperature is 250 °C. Determine the total work produced during this process in kJ. (4-25) - ANSWER: 24.5 kJ

8. Saturated water vapor at 200 °C is isothermally condensed to a saturated liquid in a piston-cylinder device. Calculate the heat transfer and the work done during this process in kJ/kg. (4-34) ANSWERS: 1940 kJ/kg, 196 kJ/kg.
9. A 3 ft³ adiabatic rigid container is divided into two equal volumes by a thin membrane as shown in the figure. Initially, one of these chambers is filled with air at 100 psia and 100 °F while the other chamber is evacuated. Determine the internal energy change of the air when the membrane is ruptured. Also, determine the final air pressure in the container. (4-70E)

10. Air is contained in a cylinder device fitted with a piston-cylinder. The piston initially rests on a set of stops, and a pressure of 300 kPa is required to move the piston. Initially the air is at 100 kPa and 27 °C and occupies a volume of 0.4 m³. Determine the amount of heat transferred to the air in kJ while increasing the temperature to 1200 K. Assume air has constant specific heats evaluated at 300 K. (4-81). ANSWER 340 kJ.