1. The thermal efficiency in the idea Rankine cycle is expressed as

   $\eta_{th} = W_{net} / Q_H$

   (a) From the mathematical viewpoint, how to improve the thermal efficiency, η_{th}?

   (b) And how to do it in engineering? (13%)

2. Why don't we only use the first law of thermodynamics to describe any process? (10%)

3. In Taiwan, the weather is hot and humid in summer. Please design a device to dehumidify and cool the air in a house. (Hint: use the psychrometric chart) (12%)

4. Fifty kilojoules of heat is to be transferred from a thermal-energy reservoir at a temperature of 550K to a heat engine that produces 10 KJ of work while rejecting heat to (a) a thermal-energy reservoir at 400K and (b) the environment at 298K. For each case, determine the thermal efficiency. Calculate the irreversibility and discuss its significance. (15%)

5. (a) What are c_p and c_v?

   (b) Derive the following expression.

   $$c_p - c_v = -\frac{T(\partial v/\partial T)_p^2}{(\partial v/\partial p)_T}$$

   (c) For a gas obeying the van der Waals equation of state,

   $$p = \frac{RT}{v-b} - \frac{a}{v^2}$$

   find the expression for $(c_p - c_v)$. (15%)

6. The first law of thermodynamics can be written as

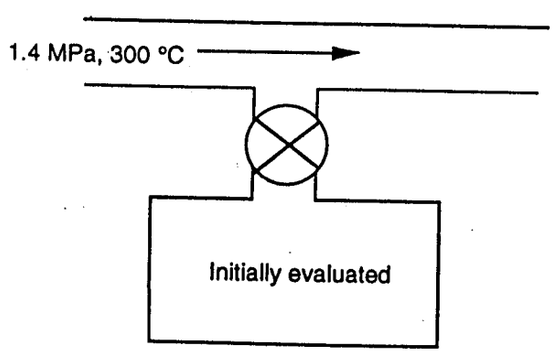
   $dU = \delta q - \delta w$

   (a) What are U, q and w?

   (b) What do the symbols "d" and "δ" mean?

   (c) Can we rewrite the equation as $dU = \delta q + \delta w$? Why? (14%)

7. Steam at a pressure of 1.4 MPa, 300°C, is flowing in a pipe (as shown in the following figure). Connected to this pipe through a valve is an evacuated tank. The valve is opened and the tank fills with steam until the pressure is 1.4 Mpa, and then the valve is closed. The process takes place adiabatically. Determine the final temperature of the steam. (14%)



P = 1.4 MPa		
Temp. (°C)	u (kJ/Kg)	h (kJ/Kg)
300	2785.2	3040.4
350	2869.2	3149.5
400	2952.5	3257.5
450	3121.1	3474.1

8. What's the difference between thermodynamics and heat transfer? (7%)