Final Exam 10.2.2011

Paper copy of "Appendix: Property Tables and Charts" and a collection of mathematical formulas on a sheet of A4 is allowed to the exam.

NOTE! Return the question paper and your formula collection with your answers.

1. Explain why the Carnot vapour power cycle is not suitable model for the simple vapour power plant.

2. On the basis of a cold-air-standard analysis, show that the thermal efficiency of an ideal regenerative gas turbine can be expressed as

$$\eta = 1 - \left(\frac{T_1}{T_3}\right)(r)^{(k-1)/k},$$

   where r is the compressor pressure ratio, and T_1 and T_3 denote the temperatures at the compressor and turbine inlets, respectively.

3. An actual vapor-compression refrigeration cycle differs from the ideal one in several ways, owing mostly to the irreversibilities that occur in various components.

   (a) Account for the entropy increase or decrease during a compression process in the actual cycle.

   (b) Does the ideal vapor-compression refrigeration cycle involve any internal irreversibilities? And if so, where?

   Show the T-s diagrams for the ideal and the actual vapor-compression cycles, respectively, relative to saturation lines.

   Hint! *Account for* requires an answer that gives the reasons for the subject of the question.

4. Explain the difference between the higher heating value and the lower heating value. Determine the higher heating value (HHV) at standard reference state for landfill gas that has the following volumetric analysis: 54 percent CH_4, 42 percent CO_2, 1 percent O_2 and 3 percent N_2.

5. Define the meaning of a term 'water-source heat pump'. Compare the COP of a water-source heat pump and an air-source heat pump used to keep a space at 25°C.