1. For air, the constant pressure specific heat as a function of temperature is given by

\[ \bar{c}_p(T) = \bar{a} + \bar{b}T + \bar{c}T^2 + \bar{d}T^3 \]

where \( T \) is in K and \( \bar{c}_p \) is in kJ/(kmol K). The coefficients are:

\[
\begin{align*}
\bar{a} &= 28.11 \\
\bar{b} &= 0.1967 \times 10^{-2} \\
\bar{c} &= 0.4802 \times 10^{-5} \\
\bar{d} &= -1.966 \times 10^{-9}
\end{align*}
\]

(a) Plot \( c_p \) versus \( T \) for \( T \) from 273 to 2000 K. Note: \( c_p = \bar{c}_p/MW \) and \( MW = 28.97 \) kg/kmol. Use a software package to create the graph.

(b) Is the approximation that \( c_p = 1.004 \) kJ/(kg K) valid? If so, when? Prepare a table and discuss the percent error for various temperatures.

2. Air, an ideal gas, originally at 500 K is compressed reversibly in a piston from 1 MPa to 5 MPa. Consider the following cases:

(a) The process is isothermal.

(b) The process is adiabatic.

For each case, sketch the process on a \( P_v \)- and \( T_s \)-diagram and calculate the work and the heat transfer per unit mass. State any assumptions that you make.

3. Superheated steam at 10 MPa and 600°C leaves a steam-generating unit and enters a well-insulated turbine. Consider the following cases:

(a) The steam expands isentropically to a pressure of 1 MPa.

(b) The steam exits the turbine at 1 MPa and 300°C.

(c) The steam expands isentropically to a pressure of 10 kPa.

For each case, sketch the process on a \( T_s \)-diagram, calculate the specific work, and discuss any other interesting pieces of information. It may be necessary to make some additional assumptions. If so, state those assumptions.

Due: 30 August 2017