Tutorial

1. 0.5 kg of air is compressed reversibly and adiabatically from 80 kPa, 60 ºC to 0.4 MPa, and is then expanded at constant pressure to the original volume. Sketch these processes on the P-V and T-S planes. Compute the heat transfer and work transfer for the whole path.
   Take R = 0.287 kJ/kg · K and γ = 1.4

2. A mass of air is initially at 260 ºC and 700 kPa, and occupies 0.028 m^3. The air is expanded at constant pressure to 0.084 m^3. A polytropic process with n = 1.50 is then carried out, followed by a constant temperature process which completes the cycle. All the processes are reversible. (a) Sketch these processes on the P-V and T-S planes. (b) Find the heat received and heat rejected in the cycle. (c) Find the efficiency of the cycle.
   Take C_v = 0.718 kJ/kg · K and γ = 1.4

3. A mass of 0.25 kg of an ideal gas has a pressure of 300 kPa, a temperature of 80 ºC, and a volume of 0.07 m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 300 kPa and final volume of 0.1 m^3, during which the work done on the gas is 25 kJ. Evaluate C_p and C_v of the gas and the increase in entropy of the gas.

4. 3 kg of air at 150 kPa and 300 K is compressed reversibly and adiabatically until its pressure becomes 3 times the original pressure. It is expanded at constant pressure and finally cooled at constant volume to return to its original conditions. (a) Draw the P-V and T-S diagrams. (b) Calculate the rate of heat transfer. (c) Calculate the work done
   Take γ = 1.4, C_v = 0.718 kJ/kg · K

5. In a Carnot cycle, 2 kg of air at 2.75 MN/m^2 and 400 °C is first expanded isothermally to 2 times of its initial volume and then further expanded reversibly and adiabatically to 4 times of its initial volume. Isothermal compression followed by reversible adiabatic compression returns the air to its original state. (a) Draw the P –V diagram. (b) Calculate the final pressure, volume and temperature. (c) Calculate the work done per cycle
   Take R = 0.287 kJ/kg K and γ = 1.4

6. A quantity of air at a temperature and pressure of 20 °C, 1 bar, occupies a volume of 0.04 m^3. An adiabatic and reversible compression to 5 bar is followed by heat addition at constant volume until the temperature is 300 °C. Finally, a polytropic process restores the fluid back to its original condition. (a) Sketch the cycle on a P-V diagram (b) Calculate the mass of the gas, (c) Find the polytropic index. (d) Calculate the net work done on or by the gas during the complete cycle.
   Take R = 0.287 kJ/kg K and γ = 1.4

7. A cylinder contains 1 kg of air at a pressure and temperature of 1.5 bar and 20 °C respectively. The air is compressed according to the process law $PV^{1.3}$ = Constant until the volume is halved. The gas is then heated isochorically until the pressure is 5.9 bar. Finally a polytropic expansion process restores the air to its original condition. The characteristic gas constant and specific heat capacity at constant pressure may be taken as 0.287 kJ/kg·K and 1.005 kJ/kg·K, respectively. (a) Sketch the sequence of events on a PV diagram. (b) Calculate the work done during the compression process. (c) Calculate the polytropic index of the expansion process. (d) Calculate the change in entropy during the isochoric process.