所別：能源工程研究所碩士班 科目：熱力學

Symbol:

T= temperature, s= entropy, P= pressure, v= volume, c_P= constant pressure specific heat, c_v= constant volume specific heat, R= universal gas constant.

1. (10%) The property entropy is defined as $dS = \left(\frac{\delta Q}{T}\right)_{\text{int rev}}$. Consider a cycle that is made up of two processes: process 1-2, which is arbitrary (reversible or irreversible), and process 2-1, which is internally reversible. From the Clausius inequality ($\oint \frac{\delta Q}{T} \le 0$), show that the entropy change of a closed system during an irreversible process is greater than the integral of $\frac{\delta Q}{T}$ evaluated for that process, and $\Delta S_{sys} = S_2 - S_1 = \int_1^2 \frac{\delta Q}{T} + S_{gen}$, where S_{gen} represents the entropy generation.

2. (10%) What are the characteristics of all heat engines? Draw the schematic of a steam power plant and explain why it is a heat engine.

3. (10%) When the changes in kinetic and potential energies are negligible, the compressor work for an internally reversible process, the compressor work is given by $w_{rev,in} = \int_1^2 v dP$, where P is the pressure and v is the specific volume. Discuss the effect of the specific volume on the work input and the work output. Explain how cooling the gas during a compression process reduces the power consumption.

4. Consider an ideal Brayton refrigeration cycle.
   (a) Plot the T-s and P-v diagram. (8%)
   (b) escribe the characteristics of each process (i.e., mechanism, change of thermodynamic properties, T, s, P, v) (12%)

5. Assuming the equation of state for a real gas had the form of $P(v - a/T)=RT$ where a=constant, find
   (a) dh between P_1 and P_2 at an isothermal temperature T_1. (10%)
   (b) $c_P - c_v$ in terms of R, P and T. (10%)
   The equation of enthalpy change (dh) and c_P-c_v is given for your reference:

$$dh = c_P dT + [v - T\left(\frac{\partial v}{\partial T}\right)_P]dP; \quad c_P - c_v = -T\left(\frac{\partial v}{\partial T}\right)_P^2 \left(\frac{\partial P}{\partial v}\right)_P$$

6. (10%) In an ideal Brayton cycle, what advantages can be obtained by using intercooling, reheating, or regeneration? Please discuss.

7. (10%) Explain the following terms:
   (a) Dew-point temperature.
   (b) Joule-Thomson Coefficient.
   (c) Adiabatic flame temperature.

8. (10%) Answer the following questions.
   (a) How does the presence of moisture in air affect the outcome of a combustion process?
   (b) How does the presence of N_2 in air affect the outcome of a combustion process?
   (c) In determining chemical equilibrium, the criterion is usually expressed in terms of the Gibbs function instead of entropy. Why?