國立臺北科技大學103學年度碩士班招生考試

系所組別：1203 製造科技研究所

第三節　熱力學　試題（選考）

注意事項：

1. 本試題共 4 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

Note: If you think the conditions given are not enough for you to use, make your own reasonable assumption(s). The conservation equations of mass and energy and some possibly used equations are given below for your need:

- The conservation equations of mass and energy:

$$\sum_{inlet} \dot{m} - \sum_{exit} \dot{m} = \frac{dm_{sys}}{dt}$$

$$\dot{Q} - \dot{W} + \sum_{inlet} \dot{m}h - \sum_{exit} \dot{m}h = \frac{dU_{sys}}{dt}$$

- The equation of irreversibility:

$$\dot{I} = T_0\left(\frac{dS}{dt}\right)_{tot} = T_0\left(\sum_{exit} \dot{m}s - \sum_{inlet} \dot{m}s + \frac{dS_{sys}}{dt} - \sum_k \frac{\dot{Q}_k}{T_k}\right)$$

- Other possibly used equations:

$$ds = \left(\delta q / T\right)_{rev} \quad \text{for reversible process}$$

$$Tds = dh - vdp \qquad h = u + pv \qquad dh = CpdT + \frac{\partial h}{\partial p}dp$$

For ideal gas, $u = u(T)$, $\quad pv = RT$, $\quad s^0 = \int_0^T Cp\frac{dT}{T}$

1. (20%) What's Carnot cycle? If this engine is a Carnot engine, find out its efficiency and irreversibility. How and why you employ the concept of Carnot cycle to the improvement for Brayton and Rankine cycles by the use of reheating processes? You can also employ the *T-s* diagram to interpret or explain it. Both Brayton and Rankine cycles are composed of 2 isentropic processes and 2 constant-pressure processes.

2. (30%) A power cycle operates as shown in Fig. A, in which T_H= 1000°C and $T_L = T_0$= 0°C. Determine the following:
   (a) If this engine is an ideal simple Brayton cycle, how you find out the efficiency and irreversibility per unit mass? It has compression ratio 9 and air inlet to the compressor is 1atm; the highest and the lowest operation temperatures are 900°C and 30°C, respectively. It is assumed that the specific heat *Cp* is a constant of 1.0 kJ/kg-K and the gas constant has the value of $R=0.25\ Cp$.
   (15%)
   (b) Draw the above Carnot cycle and Brayton cycle in the *T-s* diagram for comparison. (15%)

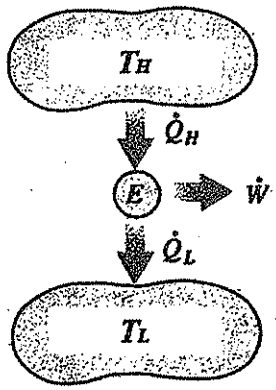

Fig. A: T_H and T_L represent the temperature of heat source and heat sink

3. (30%) An ideal simple Rankine cycle is used as the engine as shown in Fig. A. In which, T_H=300°C and T_L=70°C. Supposed that it has the turbine inlet temperature equaling to T_H and pump inlet temperature equaling to T_L with saturated liquid. Determine the following:
   (a) If you do not have steam tables, **describe** how you find out the maximum efficiency and the associate irreversibility for this Rankine cycle. (15%)
   (b) Draw the above Carnot cycle and Rankine cycle in the *T-s* diagram for comparison. (15%)

注意：背面尚有試題

4. (20%) Steam steadily enters an adiabatic turbine, as shown in Fig. B, at a rate of 10 kg/s at 3.5 MPa and 350°C. At a point where the steam is at 1 MPa and 250°C, 15% of the total mass flow is extracted for some other heating purpose. The rest of the steam expands further and is exhausted from the turbine at 30 kPa with a quality of 90%. **Describe** how you determine the turbine's power output.

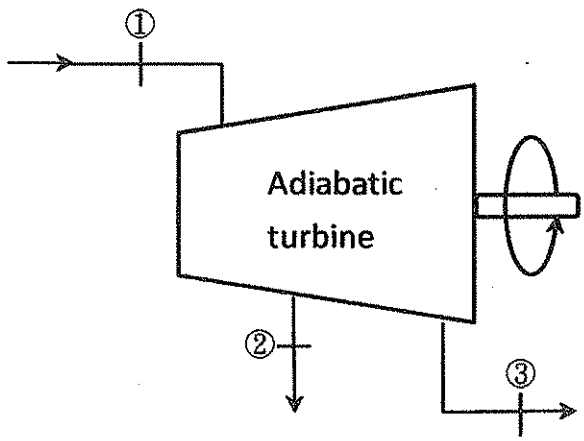

Fig. B