國立臺北科技大學 101 學年度碩士班招生考試

系所組別：1203 製造科技研究所

第二節　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。

● The conservation equations of mass and energy are given below:

$$\sum_i \dot{m} - \sum_e \dot{m} = \frac{dm_{sys}}{dt}$$

$$\dot{Q} - \dot{W} + \sum_i \dot{m}(h + e_k + e_p) - \sum_e \dot{m}(h + e_k + e_p) = \frac{dE_{sys}}{dt}$$

$$s_2 - s_1 = s_2^0 - s_1^0 - R\ln\left(\frac{P_2}{P_1}\right); \quad \text{where,} \quad s^0 \equiv \int_0^T C_p \frac{dT}{T}$$

1. (25%) A closed system initially contains 1 kg of water-vapor mixture with quality 0.8 at 10MPa. The process of constant volume occurs until pressure is 100kPa. Then the heat is added at constant-pressure process until the state is saturated vapor. Another process of constant volume occurs until pressure is 10MPa. Finally, the heat is released at constant-pressure process when the quality is equal to the initial state. Please draw these processes on T-v and P-v diagrams, respectively. How can you find the total heat released from the system and total work done by the system after completing all those processes?

2. (25%) A steam turbine is used to steadily operate an R-134a centrifugal compressor as shown in Fig. 1. The inlet and exit states of the turbine are $P_i = 10MPa$, $T_i = 650$ ℃, $x_e = 0.96$ and $P_e = 10kPa$. The mass flow rate of the steam is 10 kg/s. The inlet and exit states of the compressor are $x_i = 1.0$, $P_i = 120kPa$, and $P_e = 800kPa$, $T_e = 40$ ℃. Assuming both the turbine and compressor are adiabatic devices, please describe how you determine the work done by the turbine and the mass flow rate of refrigerant through the compressor.
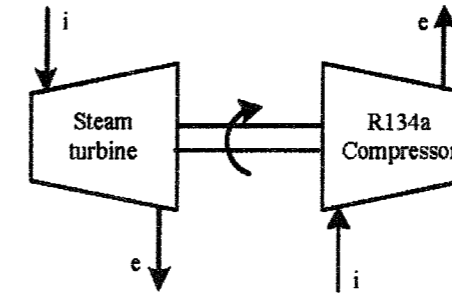

Fig. 1

3. (25%) In an ideal Brayton cycle with ideal intercooling and reheating, air enters the first-stage compressor at 37℃ and 100kPa. Both turbine stages and both compressor stages have pressure ratios of 3.0, and air enters the first-stage turbine with a temperature of 827℃. Please draw the T-s and P-v diagrams for all processes of the cycle. Please also describe how you calculate the power output per unit mass of the high-pressure turbine.

4. (25%) An simple ideal Rankine cycle uses water as working fluid, which critical state has pressure of 22.1 MPa and temperature of 647K (374℃). The temperatures of high-temperature reservoir and low temperature reservoir are 700K and 280K, respectively. The system flow rate is 80 kg/s. The state at turbine inlet is 10 MPa of saturated vapor. The state at pump inlet is 0.01 MPa saturated liquid. Please identify the system irreversibility on T-s diagram. Also describe how you determine the thermal efficiency in terms of enthalpy.