國立成功大學 105 學年度碩士班招生考試試題

系　　所：工程科學系

考試科目：熱力學

考試日期：0228，節次：1

※考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

I. Multiple-choice questions (單選題) (24%)

1. Which one is a path function? (A) enthalpy, (B) pressure, (C) work, (D) state variable, (E) None of above.
2. The work can be expressed as ${}_1W_2 = \int_1^2 PdV$. If PV = constant, the expression of ${}_1W_2$ be rewritten as (A) ${}_1W_2 = P(V_2 - V_1)$, (B) ${}_1W_2 = V(P_2 - P_1)$, (C) ${}_1W_2 = P_2V_2 - P_1V_1$, (D) ${}_1W_2 = P_1V_1 \ln(V_2 / V_1)$, (E) None of above.
3. Which one of the following statements is incorrect? (A) A phase is defined as a quantity of matter that is homogeneous throughout, (B) An intensive property depends on the mass, (C) The path of the succession of states through which the system passes is called process, (D) Energy has been defined as the capability to produce an effect, (E) None of above.
4. Which one of the following statements is correct? (A) Pressure is defined as the tangential component of force per unit area, (B) The zeroth law of thermodynamic states that the heat transferred from high temperature to low temperature, (C) A pure substance is one that has a heterogeneous and invariable chemical composition, (D) For an ideal gas, the compressibility factor, Z, is equal to zero, (E) None of above.
5. A mass of 200 g of saturated liquid water is completely vaporized at a constant pressure of 100 kPa, whose v_g and v_f are 1.6941 and 0.001043 m^3/kg, respectively. What is the volume change? (A) 0.3386 m^3, (B) 0.4589 m^3, (C) 0.2020 m^3, (D) 1.6932 m^3, (E) None of above.
6. Following the last question (i.e., Quest 5.), at 100 kPa, h_{fg} = 2257.5 kJ/kg. What is the amount of energy transferred to the water? (A) 225.8 kJ, (B) 765.2 kJ, (C) 451.5 kJ, (D) 112.9 kJ, (E) None of above.

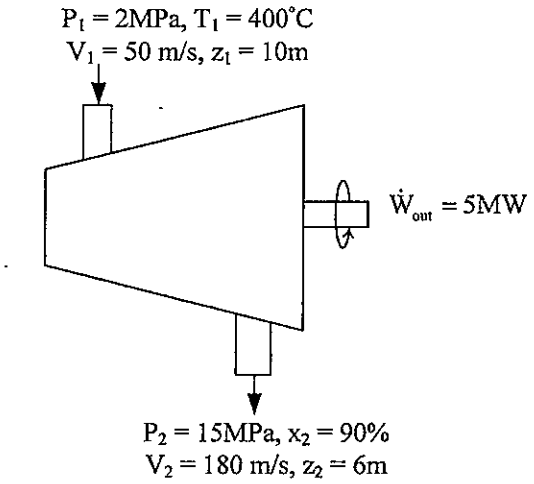
II. A rigid tank is divided into two equal parts by a partition. Initially, one side of the tank contains 5 kg of water at 200 kPa and 25°C, and the other side is evacuated. The partition is then removed, and the water expands into the entire tank. The water is allowed to exchange heat with the surroundings until the temperature in the tank returns to the initial value of 25°C. Determine (a) the volume of the tank, (b) the final pressure, and (c) the heat transfer for this process. At 25°C, v_g = 43.340 m^3/kg, v_f = 0.001003 m^3/kg, u_f = 104.83 kJ/kg, u_{fg} = 2304.3 kJ/kg, and the saturated pressure is 3.1698 kPa. At 200 kPa and 25°C, the specific volume, v_1, is about equal to 0.001 m^3/kg and the internal energy, u_1, is about equal to u_f. (19%)

III. The power output of an adiabatic steam turbine is 5 MW, and the inlet and the exit conditions of the steam are indicated in the following figure. (19%)

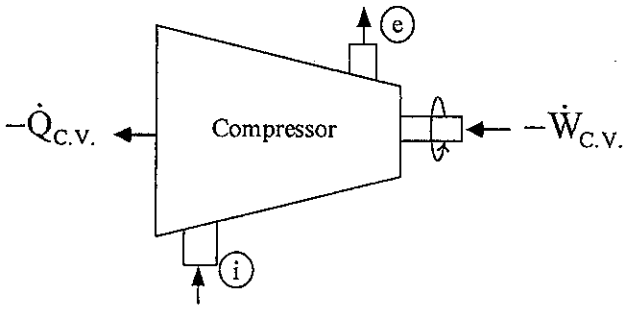
(a) Calculate Δh, Δke and Δpe, where $\Delta h = h_2 - h_1$, $\Delta ke = \left(V_2^2 - V_1^2\right)/2$ and $\Delta pe = g(z_2 - z_1)$. At P_1 = 2MPa and T_1 = 400°C, h_1 = 3248.4 kJ/kg. At P_2 = 15kPa, h_f = 225.94 kJ/kg and h_{fg} = 2372.3 kJ/kg.

(b) Determine the work done per unit mass of the steam flowing through the turbine.

(c) Calculate the mass flow rate of the stream.



IV. Consider an air compressor that receives ambient air at 100 kPa and 25°C. It compresses air to a pressure of 1 MPa, where it exits at a temperature of 540K. Since the air and compressor housing are hotter than the ambient surroundings, 50 kJ per kilogram air flowing through the compressor are lost. Find the reversible work and the irreversibility in the process. (18%)



Hint:

$h_i = 298.6$ kJ/kg, $h_e = 544.7$ kJ/kg, $R = 0.287$ kJ/(kg·K)

$s^0_{T_i} = 6.8631\,\text{kJ}/(\text{kg}\cdot\text{K}), s^0_{T_e} = 7.4664\,\text{kJ}/(\text{kg}\cdot\text{K})$

V. Explain the following terms: (20%)

(1) Pure substance
(2) Triple point
(3) Allotropic transformation
(4) Specific heat at constant volume
(5) Kelvin-Planck statement