| 大葉大學九十學年度研究所碩士班招生考試試題紙 | | | |
|---|---|---|---|
| 系 所 組 別 | 考 試 科 目<br>（中 文 名 稱） | 考 試 日 期 | 備 註 |
| 機械工程系碩士班乙組 | 熱力及熱傳學 | 4 月 22 日 第 3 節 | 可帶計算機 |

註：考生可否攜帶計算機或其他資料作答，請在備註欄註明（如未註明，一律不准攜帶）

備註： (1)計算及證明題應詳列計算及證明步驟，否則一概不計分。

(2)本試卷共有六大題，含性質表(Table 1)共兩頁。作答應標示題號。

1. 解釋名詞(每小題 4%，計 20%)
   a. 試問用溫度計量測溫度是基於熱力學的那一個定律?試敘述該定律之內容。
   b. 對於由液體凝固時體積膨脹之純物質(例如水)，試繪出其相圖(phase diagram)並標示各相(phase)之區域及臨界點(critical point)。
   c. 試繪出 ideal air-standard Brayton cycle 的 *p-v* 圖及 *T-s* 圖，並標示各個過程(process)之名稱（如 $p$ = constant 或「等壓過程」)。
   d. 試寫出 entropy change 的定義式。
   e. 試繪出 ideal Rankine cycle 無過熱情形的 *T-s* 圖，並標示各個過程(process)之名稱。
2. (15%) A gas expands in a piston-cylinder assembly from $p_1 = 8.2$ bar, $V_1 = 0.0136\ \text{m}^3$ to $p_2 = 3.4$ bar in a process during which the relation between pressure and volume is $pV^{1.2} = constant$. The mass of the gas is 0.183 kg. If the specific internal energy of the gas *decreases* by 29.8 kJ/kg during the process, determine the heat transfer, in kJ. Kinetic and potential energy effects are negligible.
3. (20%) Steam enters the condenser of a vapor power plant at 0.1 bar with a quality of 0.95 and condensate exits at 0.1 bar and 45℃. Cooling water enters the condenser in a separate stream as a liquid at 20℃ and exits as a liquid at 35℃ with no change in pressure. Heat transfer from the outside of the condenser and changes in the kinetic and potential energies of the flowing streams can be ignored. For steady-state operation, determine
   (a) the ratio of the mass flow rate of the cooling water to the mass flow rate of the condensing stream.
   (b) the rate of energy transfer from the condensing steam to the cooling water, in kJ per kg of steam passing through the condenser.

   Table 1 (in the next page) and the following properties are given. For saturated water at 45℃, $h_f = 188.45$ kJ/kg. Specific heat for water is $c$ = 4.18 kJ/(kg・K).
4. (15%) An isolated system of total mass $m$ is formed by mixing two equal masses of the same liquid initially at the temperatures $T_1$ and $T_2$. Eventually, the system attains an equilibrium state. Each mass is incompressible with constant specific heat $c$.
   (a) What is the final temperature after mixing?
   (b) Show that the amount of entropy produced is

本試卷僅供參考

$$\sigma = mc \ln\left[\frac{T_1 + T_2}{2(T_1 T_2)^{1/2}}\right]$$

5. (15%) The hot combustion gases of a furnace are separated from the ambient air and its surroundings, which are at 25℃, by a brick wall 0.15 m thick. The brick has a thermal conductivity of 1.2 W/m · K and a surface emissivity of 0.8. Under steady-state conditions an outer surface temperature of 100℃ is measured. Free convection heat transfer to the air adjoining the surface is characterized by a convection coefficient of $h$ = 20 W/m$^2$ · K. What is the brick inner surface temperature? (*Hint*: Consider the outer surface of the brick wall as the system.)
6. (15%) Consider a steady tube flow with constant surface *heat flux* (i.e. $q_s''$ = constant) boundary condition and tube diameter $D$. The mean fluid temperature at the tube inlet ($x$ = 0) is $T_{m,i}$, where $x$ is measured along the tube (in the axial direction). Assume no shaft work is done by the fluid as it moves through the tube, and fluid kinetic and potential energy changes, as well as energy transfer by conduction in the axial direction, are negligible. Also assume constant $c_p$ for the fluid. Show that the fluid mean temperature varies along the tube in a linear manner as

$$T_m(x) = T_{m,i} + \frac{q_s'' \pi D}{\dot{m} c_p} x$$

本文件僅供參考

Table 1 Properties of Saturated Water (Liquid-Vapor): Pressure Table

| Press. bar | Temp. ℃ | Specific Volume m$^3$/kg | | Internal Energy kJ/kg | | Enthalpy kJ/kg | | |
|---|---|---|---|---|---|---|---|---|
| | | Sat. Liquid $v_f \times 10^3$ | Sat. Vapor $v_g$ | Sat. Liquid $u_f$ | Sat. Vapor $u_g$ | Sat. Liquid $h_f$ | Evap. $h_{fg}$ | Sat. Vapor $h_g$ |
| 0.04 | 28.96 | 1.0040 | 34.800 | 121.45 | 2415.2 | 121.46 | 2432.9 | 2554.4 |
| 0.10 | 45.81 | 1.0102 | 14.674 | 191.82 | 2437.9 | 191.83 | 2392.8 | 2584.7 |
| 0.20 | 60.06 | 1.0172 | 7.649 | 251.38 | 2456.7 | 251.40 | 2358.3 | 2609.7 |
| 1.00 | 99.63 | 1.0432 | 1.694 | 417.36 | 2506.1 | 417.46 | 2258.0 | 2675.5 |