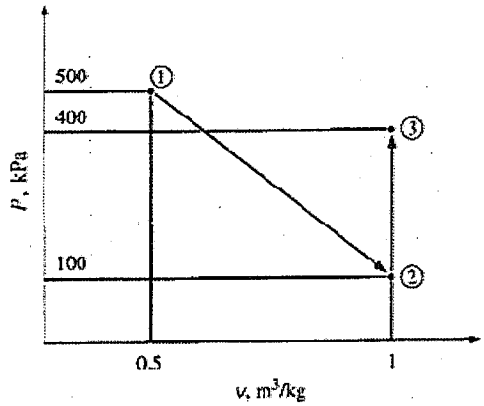
國立中山大學 101 學年度碩士暨碩士專班招生考試試題

科目：熱力及熱傳導、熱輻射學【機電系碩士班甲組】

題號：4096

Thermodynamics: (65%)

1. (10%, 每個子題5%) Calculate the work produced, in kJ/kg, (a) for the reversible process from state 1 to state 3 of a closed system and (b) for the reversible steady-flow process 1-3.



2. (10%) An open system is interactive with its surroundings through the mechanisms of mass, heat or work transfer. Please describe above what mechanisms can cause the changes of the energy, the entropy, and the exergy of a control volume, respectively?

3. (8%,每個子題 2%) A simple ideal Brayton cycle without regeneration is modified to incorporate multistage compression with intercooling and multistage expansion with reheating, without changing the pressure or temperature limits of the cycle. As a result of these two modifications,
   (a) Does the net work output increase, decrease, or remain the same?
   (b) Does the back work ratio increase, decrease, or remain the same?
   (c) Does the thermal efficiency increase, decrease, or remain the same?
   (d) Does the heat rejected increase, decrease, or remain the same?

4. (12%,每個子題 6%) Consider a simple ideal Rankine cycle (A) with fixed turbine inlet conditions. What is the effect of lowering the condenser pressure? (B) with fixed boiler and condenser pressure. What is the effect of superheating the steam to a higher temperature?

Pump work input:	(*a*) increases, (*b*) decreases, (*c*) remains the same
Turbine work output:	(*a*) increases, (*b*) decreases, (*c*) remains the same
Heat supplied:	(*a*) increases, (*b*) decreases, (*c*) remains the same
Heat rejected:	(*a*) increases, (*b*) decreases, (*c*) remains the same
Cycle efficiency:	(*a*) increases, (*b*) decreases, (*c*) remains the same
Moisture content at turbine exit:	(*a*) increases, (*b*) decreases, (*c*) remains the same

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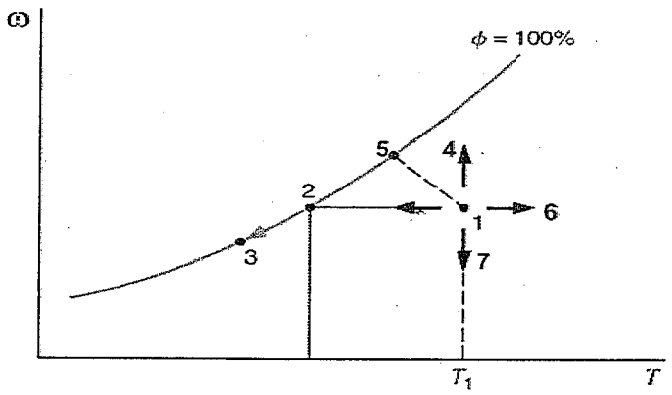
5. (10%) Show that the Joule-Thomson coefficient of an ideal gas is zero.
   [Note that $dh = c_p dT + [v - T(\partial v/\partial T)_P]\, dP$]

6. (10%,每個子題 2%) For an **ideal** vapor-compression refrigeration cycle:
   (a) Draw the T-s diagram for the cycle.
   (b) What are the four processes of the cycle?
   (c) Write down the energy balance for each process to show how you can calculate heat or work for each process of the cycle.
   (d) Which process provides refrigeration effect?
   (e) What is the COP for the refrigeration cycle? If the cycle is used as a heat pump, what is the COP?

7. (5%,每個子題 1%) In the psychrometric Chart, what are the paths for air, starting at state 1, go through the following devises
   (a) hair dryer
   (b) cooling tower
   (c) evaporator of an air-conditioner
   (d) condenser of an air-conditioner
   (e) electric heater



Heat Conduction and Radiation: (35%)

8. (6%,每個子題 3%) Write down the basic law for heat conduction? Why there is a negative sign in the law?

9. (8%,每個子題 4%) What is the Lumped-Capacitance-Method (LCM)? When the LCM is valid?

10. (6%) 冬天晚上發現地上的積水上結了一層薄冰,但大氣的溫度略高於 0 ℃,試以熱傳學解釋該現象之原因。

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11. (15%,每個子題 5%) Volumetric heat generation rate in a plane layer of coal (煤) of thickness L = 1 m is $\dot{q}$ =25 W/m^3. The top surface of the layer transfers heat by convection to ambient air for which h = 5 W/m^2 K and T_∞ = 25 ℃ while receiving solar irradiation in the amount G_s = 400 W/m^2. The solar absorptivity and emissivity of the surface are each $\alpha_s = \varepsilon = 0.95$. The bottom surface at x = 0 is insulated.
    (a) Write the steady-state form of the one dimensional (1-D) heat conduction equation for the layer of coal.
    (b) If the top surface temperature is T_s, derive the temperature distribution T(x) for the layer of coal by integrating the equation of (a).
    (c) Write the 1-D energy balance equation per unit area for the top surface of the coal and derive the equation ready for solving T_s. (Note that the equation should contain only T_s and numbers, no other symbols or variables. You don't need to solve out the value of T_s. The Stefan-Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ W/m^2 K^4)