國立台灣科技大學九十五學年度碩士班招生試題
系所組別：機械工程系碩士班丙組
科　　目：熱力學

總分100分. 所有答案必須寫於答案卷上. 寫於試題上者不予計分

Problem 1. 是 非 題: (共 10 題，每題 2 分，答錯倒扣 0.5 分)　　20%

( ) 1. For a close system undergoes a cycle, the net amount of work always equals the net amount of heat transfer.

( ) 2. The amount of heat transfer of a closed system undergoing any process between two different states is not unique.

( ) 3. During a steady-flow process, the volume flow rate entering a control volume always equals the volume flow rate leaving the control volume.

( ) 4. The boundary work for a steady-flow process always equals zero.

( ) 5. For an ideal gas, the following properties: enthalpy, internal energy, specific heat and pressure, are function of temperature only.

( ) 6. The following equation can only be applied to reversible process for ideal gas with constant C_p.

$$s_2 - s_1 = C_p \ln\frac{T_2}{T_1} - R\ln\frac{P_2}{P_1}$$

( ) 7. If a fluid has a very large Prandtl number and flows over a flat plate, the thickness of thermal boundary layer is much larger than the thickness of velocity boundary layer at the same location.

( ) 8. A unit mass of an ideal gas at temperature T undergoes a reversible isothermal process from volume V_1 to volume V_2 while loosing heat to the surroundings at temperature T in the amount of q. If the gas constant of the gas is R, the entropy change of the gas Δs during this process is $\Delta s = R\ln(V_2/V_1)$

( ) 9. A system undergoes a process between two fixed states first in a reversible manner and then in an irreversible manner, $\Delta s_{irrev} = \left(\int_1^2 \frac{\delta Q}{T}\right)_{rev}$.

( ) 10. Isothermal, internally reversible process is necessarily isentropic.

Problem 2. 20%

An air compressor is designed to compress atmospheric air steadily to a pressure of 1MPa. The atmospheric air is assumed to at 100 kPa and $25^{\circ}C$. The heat loss rate to the environment is anticipated to be about equal to 10 percent of the power input to the compressor. The air enters at 50 m/s where the inlet area is $9\times10^{-3} m^2$ and leaves at 120 m/s through an area $5\times10^{-4} m^2$. Determine the exit temperature and the power input to the compressor.

(For air, R = 0.287 kJ/kg·K, C_p = 1.005 kJ/kg·K)

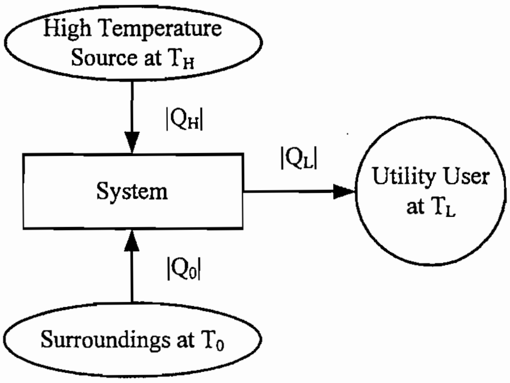
Problem 3. 20%

A 100-kg iron block at $80^{\circ}C$ is dropped into an insulated tank that contains 0.5 m^3 of liquid water at $25^{\circ}C$. Determine the temperature when thermal equilibrium is reached.

(For iron, specific heat C = 0.45 kJ/kg·K. For liquid water, specific heat C = 4.18 kJ/kg·K.)

Problem 4 20%

A system undergoes a cycle while receiving $|Q_0|$ from the surroundings at temperature T_0, $|Q_H|$ from a high temperature source at temperature T_H as shown schematically below. The system delivers energy $|Q_L|$ to a utility user at temperature T_L. Determine the *maximum* theoretical value of $|Q_L|$ when T_H = 1500 K, T_0 = 300 K, T_L = 600 K, and $|Q_H|$ = 30 kJ.



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Problem 5 **20%**

A heater embedded in a solid surface is cooled by a two-dimensional impinging jet of water as indicated below. The heater temperature T_h is 60°C and the impinging jet free stream temperature T_∞ and velocity U_∞ are 20°C and 0.1 m/s, respectively. For these circumstances, analysis indicates that the thermal boundary layer thickness δ_t is given by the relation

$$\delta_t = 11.8 L \, Pr^{-1/3} \, Re_L^{-1/2}$$

where $Pr = \mu C_p/k$ is the fluid Prandtl number and $Re_L = \rho U_\infty L/\mu$. For the conditioner indicated in the figure, experiments indicate that the heat flux from the heater to the fluid q'' is 10 kW/m^2.

(a) Using the information given, derive an approximate relation for the Nusselt number $Nu_L = q''L/(T_h - T_\infty)k$ as a function of Pr and Re_L.

(b) Use the relation derived in (a) to predict q'' if U_∞ is increased to 0.2 m/s.