1. (10%) Work is done in compressing 2 kg of an ideal gas in a closed cylinder from a volume of $V_1 = 4 \ m^3$ to a volume of $V_2 = 1 \ m^3$. The initial pressure is 100 kPa. Calculate how much work is done (kJ) if
    (a) the process is isobaric?
    (b) the process is isothermal?
    (c) the process follows the relation $PV^{3/2}$ = constant?
    (d) Discuss on the results you obtained in parts (a)-(c).

2. (10%) Indicate whether the entropy of the control mass has increased, decreased, or remained constant when the following processes are complete. **Explain your answer.**
    (a) A frictionless piston slowly compresses a gas in an adiabatic cylinder.
    (b) A frictionless piston slowly compresses a gas in a diabatic (permits heat transfer) cylinder.
    (c) A cake of ice floating in water that is very near freezing increases in mass until all the water is frozen. (Take the control mass as the ice plus the water.)

3. (10%) A large coal fired power plant is being designed to produce 850 MW of power to drive its electrical generators. The plant engineer has testified that the plant will burn coal that produces a flame temperature of 1550°C, and that water is available for condenser cooling from a nearby river at a temperature of 27°C. Environmental restrictions allow the river to increase in temperature by no more than 2°C because of heat transfer from the plant. What is the minimum volumetric flow rate (m³/s) that the river must have in order to supply adequate plant cooling? For water at 27°C,

    $c_p = 4.18 \ kJ / kg \cdot K$, $v = 0.001003 (m^3 / kg)$.

4. (10%)
    (a) What is the difference between cogeneration and regeneration?
    (b) Describe three ways to increase the thermal efficiency of a Rankine cycle. Explain on a T-s diagram.
    (c) What are the differences between an Otto cycle and a Diesel cycle. Compare their performances.

5. (a) Prove that the specific heat at constant volume and constant pressure is the same for an incompressible substance, i.e. $c_p = c_v$. (5%)
    (b) From the first law of Thermodynamics, we have
    $$d E = \delta W + \delta Q$$
    for a closed system. Here, W and Q are path functions, but their addition is equivalent to a point function E. Why? (5%)

注意: 背面有試題

6. (a) Derive an expression for the thermal resistance through a hollow spherical shell of inside radius r_i and outside radius r_o having a thermal conductivity k. The inside and outside wall temperature are T_i and T_o, respectively.

   (b) A spherical tank, 1 m in diameter, is maintained at a temperature of 120°C and exposed to a convection environment. With h=25 W/m²°C and T_∞ = 15°C, what thickness of urethane foam should be added to ensure that the outer temperature of the insulation does not exceed 40°C ? What percentage reduction in heat loss results from installing this insulation ? The thermal conductivity of urethane foam is 0.018 W/m°C. (20%)

7. (a) Consider a steady, laminar, two-dimensional boundary layer flow in which the gravity force acts in the negative direction. Assume that the Boussinesq approximation is valid. The governing equation becomes

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = g\beta(T - T_\infty) + \nu\frac{\partial^2 u}{\partial y^2}$$

$$u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = \alpha\frac{\partial^2 T}{\partial y^2}$$

Obtain the dimensionless form of the governing equations in terms of the following dimensionless variables:

$x^* = x/L$, $y^* = y/L$, $u^* = u/u_0$, $v^* = v/u_0$, $T^* = (T-T_\infty)/(T_s - T_\infty)$,

where L is a characteristic length, u_0 is an arbitrary length, and T_∞ is the temperature of the quiescent fluid. Discuss the physical significance of Grashof number appearing in the dimensionless governing equation. (10%)

(c) A horizontal diameter pipe passing hot oil is to be used in the design of an industrial water heater. The water flows over the pipe with the velocity V.
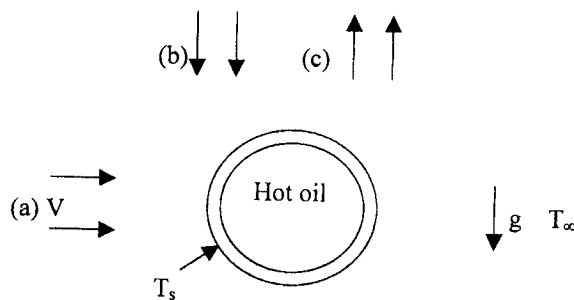
Discuss the condition that the forced, free, or mixed convection may be important. When the flow condition is mixed, investigate the flow direction on the heat transfer rate for (a) horizontal, (b) downward, and (c) upward flow. (10%)

8. (a) Describe the difference between a surface radiation emission and a volumetric radiation emission. (2%)

   (b) Describe the radiation characteristics of a blackbody. (5%)

   (c) What is the irradiation and radiosity? (3%)