94 學年度 動力機械工程系 系（所） 甲 組碩士班入學考試

科目 熱流學（一） 科目代碼 1502 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

QUESTION 1 20%

A rigid storage tank contains air at the same temperature as the surround- dings (35°C). Suddenly it begins to rain, and the surrounding temperature drops to 25°C. The tank was initially at a pressure of 250 kPa, and the tank volume is $15\,m^3$. Please answer the questions as follows.

(A) What is the final temperature in the tank after the air cools in the tank to the temperature of the surroundings? (10%)

(B) How much heat transfer occurred to or from the air during the cooling? (10%)

($c_v = 0.718$ kJ/kgK for air)

QUESTION 2 15%

From the following two data points, estimate the temperature of the triple point of water. The triple point occurs where the lines for vapor-liquid and liquid-solid equilibrium meet on a P-T diagram.

Point A : solid-liquid at T = $-10\,°C$ and P_{sat} = 119 MPa

$$v_{sl} = -1.1\times10^{-4}\ m^3/kg,\quad h_{sl} = 333.5\,kJ/kg$$

Point B : liquid-vapor at P = 1 kPa and T = 7°C

$$h_{lg} = 2393\,kJ/kg$$

QUESTION 3 35%

Consider an ideal Otto cycle. The fuel-air mixture is compressed isentro- pically from state 1 (P = 1 atm, T = 300 K) to state 2. Heat of 1000 kJ/kg (q_{in}) is added to the mixture instantly at a fixed volume between states 2 and 3. Isentropic expansion follows from state 3 to state 4, before the constant-volume heat rejection between states 4 and 1. The compression ratio is 10. Constant C_p and C_v of the mixture are assumed to be 1.142 kJ/kg K and 0.855 kJ/kg K, respectively.

(A) Draw the *P-v* and *T-s* diagrams of this cycle. Also indicate in these diagrams the proper areas that correspond to the quantities of q_{in}, q_{out}, and w_{net}, respectively. (10%)

(B) Calculate the temperature and pressure of states 2, 3 and 4. (14%)

(C) If the compression process beginning from state 1 is irreversible, what will its end state (2′) be like? Compare the isentropic process 1-2 and the non-isentropic process 1-2′ on a *P-v* and a *T-s* diagram. You need to explain for the differences. (8%)

(D) What are the probable irreversible processes during process 1-2′ ? (3%)

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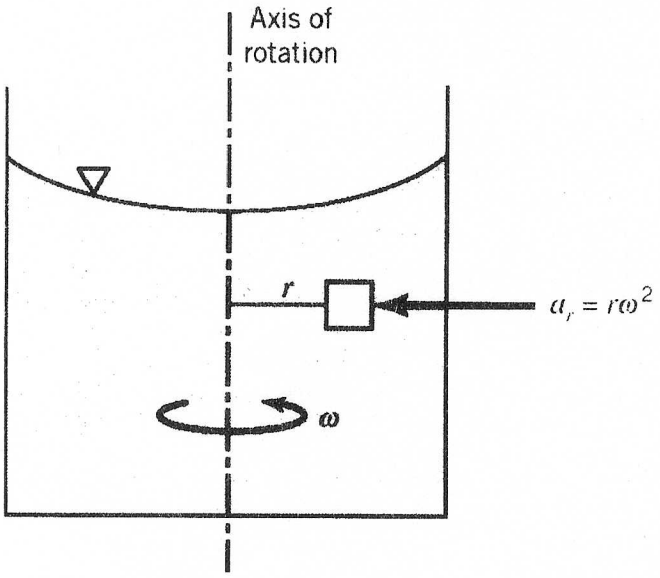
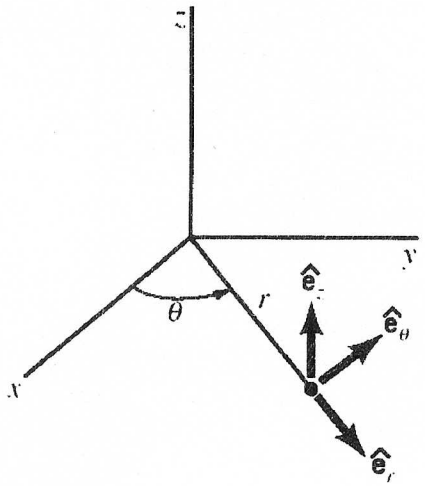
QUESTION 4 30%

(A) After an initial "start-up" transient, a fluid contained in a tank that rotates with a constant angular velocity about an axis as is shown in the following figure will rotate with the tank as a rigid body. You are asked to derive an expression describing how the pressure varies with the distance from the axis of rotation. (10%)





(B) Please identify the dimensionless number which is important in problems such as the flow of thin films of liquid, or in the formation of droplets or bubbles. Please explain its physical meaning. (5%)

(C) How do the rotation (or the rate of angular motion) and the rate of shearing strain (or the rate of angular deformation) of the fluid element relate to certain gradients in the flow field? (5%)

(D) A submarine moves through the seawater (specific gravity= 1.03) at a depth of 50 m with velocity V_0 = 5.0m/s as shown in the figure below. Determine the pressure at point (2). The initial position of the submarine is designated on the figure by the solid lines. The dashed lines are used to indicate the position at the instant when the submarine's nose, point (2), reaches point (1). Which coordinate system should be better used to solve the problem: a coordinate fixed to the ground or fixed on the submarine? Give the reason for making your choice. (10%)