大葉大學 九十三 學年度 研究所碩士班 招生考試試題紙 共3頁 P3-1

系所別	組別	考試科目（中文名稱）	考試日期	節次	備註
機械工程研究所	乙組	流体力學或熱力學	3月28日	第二節 10:30~12:00	可使用不可程式計算機，答題應詳列步驟

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） 考生任選五題作答，六題(含)以上不計分

1) (20 %) A 50-kg iron block at 80°C is dropped into an insulated tank that contains 0.5 m^3 of liquid water with the specific volume of 0.001 m^3/kg. The specific heats of iron and liquid water are given as C_{iron}= 0.45 kJ/kg.°C and C_{water}=4.184 kJ/kg.°C. Determine the temperature when the thermal equilibrium is reached.

2) (20 %) Air at 100 kPa and 7 °C is steadily compressed to 600 kPa and 127 °C. The mass flow rate of the air is 0.02 kg/s with a heat loss of 16 kJ/kg during the process. Assuming the changes in kinetic and potential energies are negligible and the specific heat (C_p) of air is 1.005 kJ/kg.K, determine the work input to the compressor in kW.

3) (20 %) A 0.5 m^3 rigid tank contains refrigerant R-134a initially at 200 kPa and 40% quality. Heat is transferred to the refrigerant from a heat source until the pressure rises to 400kPa. Using the following thermodynamic data to determine the mass and the total entropy change of the refrigerant.

Property	v_f, m^3/kg	v_g, m^3/kg	s_f, kJ/(kg.K)	s_g kJ/(kg.K)
P= 200 kPa	0.0007532	0.0993	0.1481	0.9253
P= 400 kPa	0.0007904	0.0509	0.2399	0.9145

4) (20 %) Consider a steam power plant operating on the simple ideal Rankine cycle. The turbine and the pump are isentropic, and there are no pressure drops in the boiler and condenser. Steam leaves the condenser and goes into the pump as saturated liquid at the condenser pressure. Currently, Steam enters the turbine at 3 Mpa and 350 °C, and is condensed in the condenser at 75 kPa. Determine the steady-state thermal efficiency of the cycle.

P= 3 MPa, T= 350°C=> h= 3115.3 kJ/kg. s= 6.7428 kJ/kg.K

P= 75 KPa => h_f= 384.39 kJ/kg, h_{fg}= 2278.6 kJ/kg

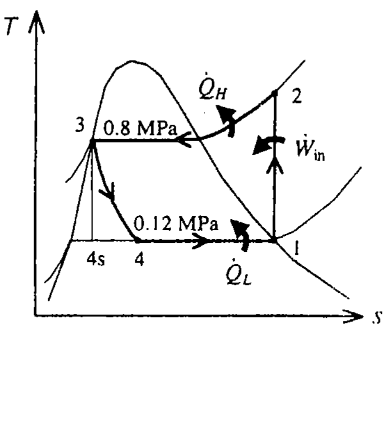
v_f= 0.001037 m^3/kg, s_f= 1.213 kJ/(kg.K), s_{fg}= 6.2434 kJ/(kg.K)

5) (20 %) A refrigerator uses refrigerant R-134a as the working fluid and operates on an ideal vapor-compression refrigeration cycle between 0.12 and 0.8 Mpa. The compression process is isentropic. The refrigerant enters the compressor as a saturated vapor, and leaves the condenser as saturated liquid. If the steady-state mass flow rate of the refrigerant is 0.05 kg/s, determine the COP_R of the refrigerator.

P= 120 KPa=> h_g= 233.86 kJ/kg, s_g= 0.9354 kJ/kg.K

P= 0.8 MPa, s_2=s_1 => h_2= 273.04 kJ/kg, T_2= 39.4 °C

P= 0.8 MPa => h_f= 93.42 kJ/kg



大葉大學 九十三 學年度 研究所碩士班 招生考試試題紙

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6.(20%)

Give the definitions of (a) Reynolds number; (b) Mach number; (c) Strouhal number; (d) Knudsen number. From the definition, derive the physical significance of each dimensionless number.

7.(20%)

The average wall heat flux, $\bar{q}_s$, for steady, incompressible external forced flow across a long cylinder depends on the upstream velocity V, the temperature difference ΔT between the wall surface and the upstream flow, the fluid viscosity, μ, the cylinder diameter, D, the fluid density, ρ, the fluid specific heat c_p and thermal conductivity k. Determine a set of dimensionless groups that can be used to correlate data. Please use D, μ, ΔT, k as repeating variables.

8.(20%)

A simple steady parallel-plate flow can be developed by fixing one plate and letting the other plate move with a constant velocity, U, as shown in Fig. 1. For this geometry the fluid particles move in the x direction parallel to the plates, and there is no velocity in the y and z direction. Furthermore, there would be no variation of u in the z direction for infinite plates. Determine the velocity distribution.

Note:

The continuity equation for incompressible fluids is

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

The Navier-Stokes equations are

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}\right)=-\frac{\partial p}{\partial x}+\rho g_x+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right)$$

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial y}+\rho g_y+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}+\frac{\partial^2 v}{\partial z^2}\right)$$

$$\rho\left(\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}\right)=-\frac{\partial p}{\partial z}+\rho g_z+\mu\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+\frac{\partial^2 w}{\partial z^2}\right)$$

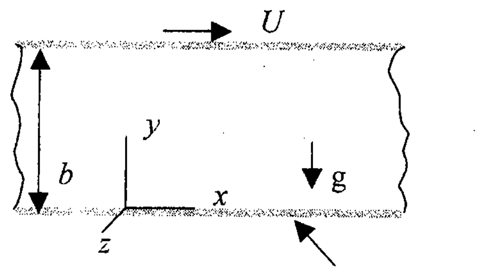

Fig. 1

9.(20%)

Consider the symmetrical flow of air around the cylinder. The control volume, excluding the cylinder, is shown in Fig. 2. The velocity distribution downstream of the cylinder is measured to be as shown. Determine (a) the mass flux across the surface BC; (b) the drag force per meter of length acting on the cylinder. Use ρ=1.23 kg/m^3.

Note

$$0=\frac{d}{dt}\int_{\text{c.v.}}\rho\, dV+\int_{\text{c.s.}}\rho\hat{n}\cdot\mathbf{V}\, dA$$

$$\Sigma\mathbf{F}=\frac{d}{dt}\int_{\text{c.v.}}\rho\mathbf{V}\, dV+\int_{\text{c.s.}}\rho\mathbf{V}(\mathbf{V}\cdot\hat{n})\, d\mathbf{A}$$

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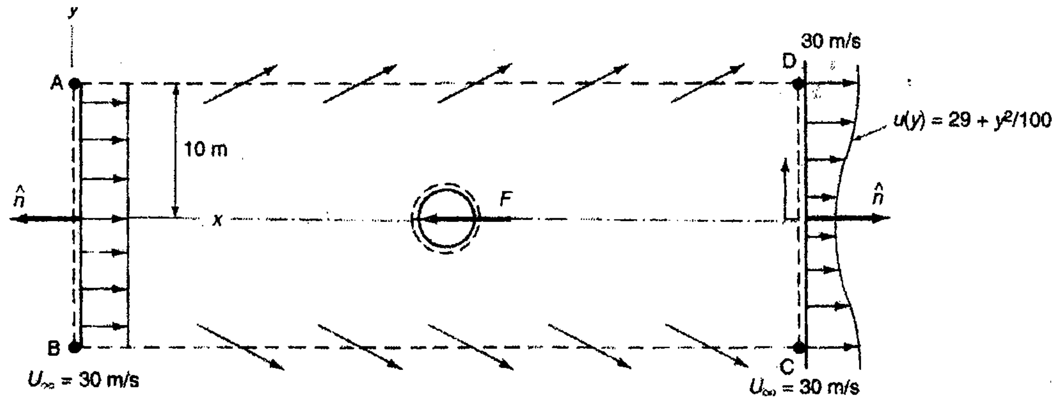

Fig. 2

10. (20%)

In Fig. 3, the rectangular water gate is hinged at point B and is 5ft wide and 10ft long. Please calculate the total force per unit length at the stop A with the negligible weight of water gate.

$\gamma_{H_2O} = 62.4 lbf/ft^3 = 9.81 kN/m^3$

$F_R = \gamma h_c A$, $y_R = \dfrac{I_{xc}}{y_c A} + y_c$, I_{xc} for a rectangular: $I_{xc} = \dfrac{1}{12} b a^3$

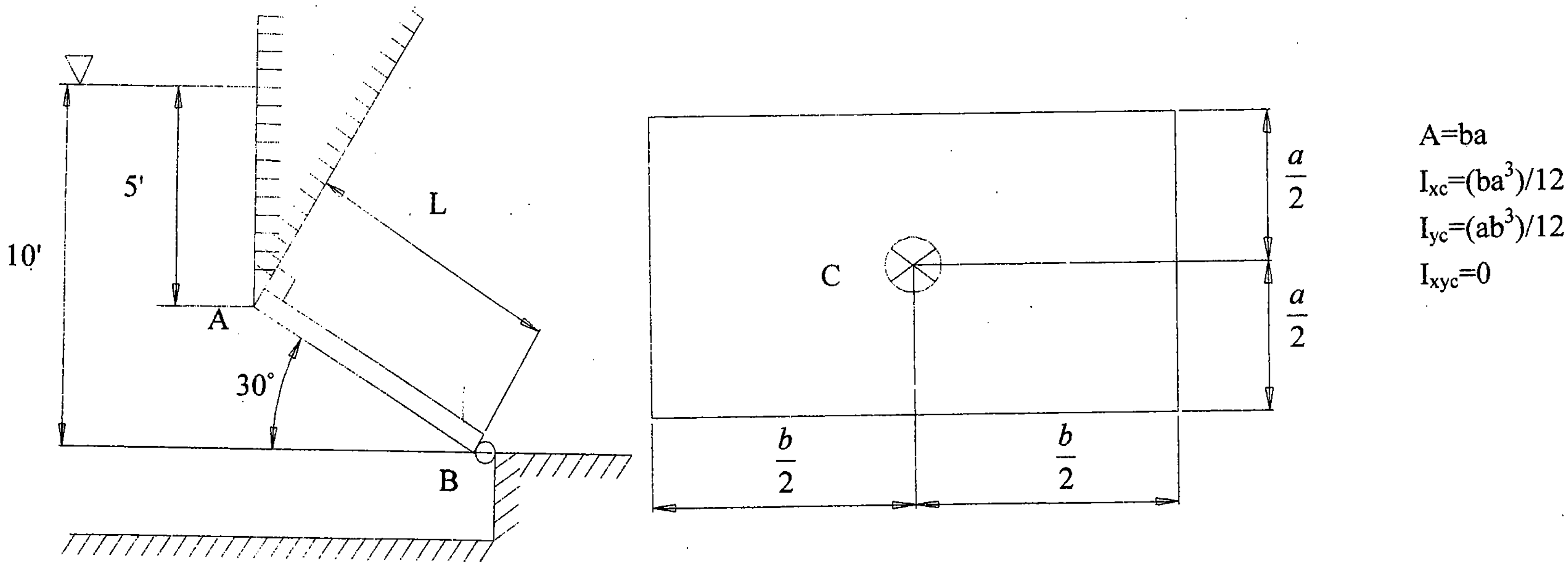

Fig. 3