大葉大學 九十四 學年度 研究所碩士班 招生考試試題紙 共2頁, 第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27日	第2節 10:30~12:00	可攜帶不可程式計算機

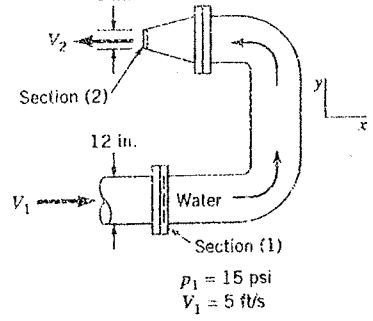
註：考生可否攜帶計算機或其他資料作答，請在備註欄註明（如未註明，一律不准攜帶）

請考生特別注意：請由以下題目中任選 5 題作答(答題數不可超過 5 題，第 6 題(含)以上不予計分)。並請詳列計算步驟，否則一概不計分。

1. (20%) Answer the following questions.
   (a) (5%) What is a "fluid"? Give word statement. Do not give any example.
   (b) (6%) Write the Navier-Stokes equation in vector form for Newtonian fluid with constant viscosity, assuming gravitational force is the only body force. Write also the x-component of the equation in Cartesian coordinates.
   (c) (9%) Give a schematic diagram of a Pitot tube, and derive from which a formula for the calculation of flow velocity based on the measured data.

2. (20%) The velocity potential for a given irrotational, two-dimensional flow field is $\phi = \left(\frac{5}{3}\right)x^3 - 5xy^2$.
   (a) Determine the velocity components u and v. (b) Show that the differential form of the continuity equation is satisfied. (c) Determine the corresponding stream function.

3. (20%) Determine the magnitude and direction of the x and y components of the anchoring force required to hold in place the horizontal 180° elbow and nozzle combination shown in the figure to the right. Neglect gravity and use $\rho = 1.94$ slugs/ft^3 for water density.



4. (20%) For the fluid flow in a smooth tube, the pressure drop per unit tube length (Δp_ℓ) can be expressed in the following function form： $\Delta p_\ell = f(D, \rho, \mu, V)$ ，where D is the inner diameter of the tube, ρ is the fluid density, μ is the dynamic viscosity of the fluid, V is the averaged flow velocity. Use the *MLT* dimensional system in the following analysis. (a) List the *MLT* dimensions of the above five variables, (b) Write the *MLT* dimensional matrix for the above five variables and show that the rank of the dimensional matrix is 3, (c)Choose D 、ρ 、V as the repeating variables and use the Buckingham Pi theorem to find appropriate dimensionless products (Pi terms)。

5. (20%) Consider the laminar flow of an incompressible fluid past a flat plate at $y = 0$. The boundary layer velocity profile is approximated as $u = Uy/\delta$ for $0 \le y \le \delta$ and $u = U$ for $y > \delta$. (a) Determine the momentum thickness. (b) Determine the wall shear stress by using the momentum integral equation.

6. (20%) Nitrogen gas contained in a piston-cylinder device is compressed from 0.5 to 0.1 m^3. During the process, the pressure and volume are related by $PV^2 = a$, where $a = 6$ kPa·m^6. Please determine the work done on the nitrogen gas during this process?

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7. (20%) A piston-cylinder device contains 5 kg of refrigerant-134a at 1.2 MPa and 100 °C. Initially, the enthalpy (h) and internal energy (u) of the refrigerant are 332.47 and 305.54 kJ/kg, respectively. The refrigerant is now cooled at constant pressure until it exists as a saturated liquid-vapor mixture with a quality of 60%. Determine the amount of heat loss and show the process on a T-v diagram with respect to saturated lines.

Saturated refrigerant-134a: Pressure table

Pressure (MPa)	Internal Energy, kJ/kg		Enthalpy, kJ/kg	
	Sat. liquid, u_f	Sat. vapor, u_g	Sat. liquid, h_f	Sat. vapor, h_g
1.0	104.42	247.77	105.29	267.97
1.2	114.69	251.03	115.76	270.99
1.4	123.98	253.74	125.26	273.40

8. (20%) A heat engine operates between two reservoirs at 800 and 20 °C. One-half of the work output of the heat engine is used to drive a Carnot heat pump that removes heat from the cold surroundings at 2 °C and transfers it to a house maintained at 22 °C. If the house is losing heat at a rate of 62000 kJ/h, determine the minimum rate of heat supply to the heat engine required to keep the house at 22 °C.

9. (20%) Air enters the compressor of a gas-turbine plant at ambient conditions of 100 kPa and 27 °C with a low velocity and exists at 1 MPa and 347 °C with a velocity of 90 m/s. The compressor is cooled at a rate of 1500 kJ/min, and the power input to the compressor is 250 kW. Determine the mass flow rate of air through the compressor.

Table: Ideal-gas properties of air

Temperature (K)	Enthalpy (h), kJ/kg	Internal Energy (u), kJ/kg
300	300.19	214.07
320	320.29	228.42
600	607.02	434.78
620	628.07	450.09

10. (20%) Consider a steam power plant operating on the simple ideal Rankine cycle. The steam enters the turbine at 3 MPa and 350 °C and is condensed in the condenser at a pressure of 75 kPa. The enthalpy (h) and specific volume (v) of the water at the pump inlet are 384.39 kJ/kg and 0.001037 m^3/kg, respectively. The enthalpy (h) and entropy (s) of the steam at the turbine inlet are 3115.3 kJ/kg and 6.7428 kJ/kg·K, respectively. Determine the thermal efficiency of this cycle.

Saturated water: Pressure table

Pressure (kPa)	Enthalpy, kJ/kg		Entropy, kJ/kg·K	
	Sat. liquid, h_f	Sat. vapor, h_g	Sat. liquid, s_f	Sat. vapor, s_g
50	340.49	2645.9	1.0910	7.5939
75	384.39	2663.0	1.2130	7.4564
100	417.46	2675.5	1.3026	7.3594