

國立臺灣科技大學101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：熱力與流力

(總分為100分)

1. (10%) The gage fluid in the manometer has a specific gravity of 3.46. Pipes A and B both contain water. As shown in Figure 1, the differential reading of the manometer is originally 0.2 m. If the pressure in pipe A is decreased by 2000 Pa and the pressure in pipe B increases by 1000 Pa, determine the new differential reading of the manometer (10%).

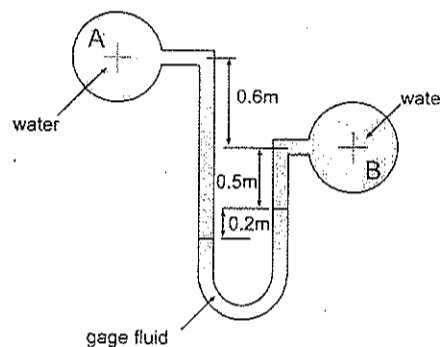


Figure 1: The original differential reading of the manometer is 0.2 m.

2. (10%) Water flows steadily from a huge, closed tank as shown in Figure 2. The deflection in the mercury manometer is 4.0 cm and viscous effects are negligible. (a) Determine the volume flowrate (5%). (b) Determine the air pressure (gauge pressure) in the closed tank. (5%)

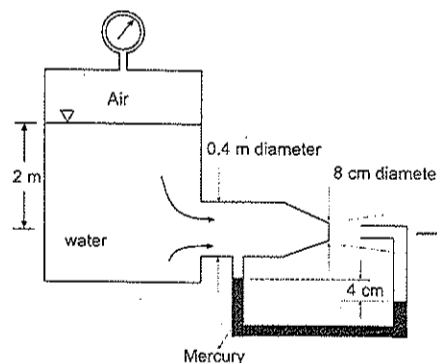


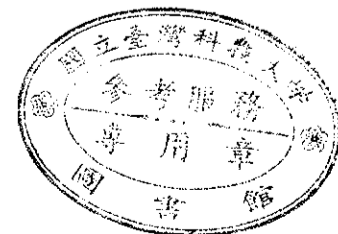
Figure 2: Jet from a pressurized tank.

3. (20%) Let $(u(x, y), v(x, y))$ be the velocity field of a two dimensional incompressible fluid flow without source/sink point in the area of interest. The fluid is newtonian and its viscosity is μ . It is also known that $u(x, y) = x + y$ and the shear stress $\tau_{xy} = 2\mu$. Find $v(x, y)$ first (10%). Obtain the general equation for the streamlines of the flow field (10%).
4. (10%) Water ($\rho = 1000 \text{ kg/m}^3$ and $\mu = 1.12 \times 10^{-3} \text{ N}\cdot\text{s/m}^2$) flows steadily through a circular pipe (cast iron pipe, roughness = 0.26 mm) with a diameter of 1 cm and a volume flow rate of $7.854 \times 10^{-3} \text{ liter/s}$. The pipe is 120 m long. Neglect the entrance effect and minor losses. Calculate the pressure differential between the inlet and outlet ports (5%). Find the power required to drive the fluid flow (5%).

Useful Formulae:

$$\frac{1}{\sqrt{f}} = -2.0 \log \left(\frac{\epsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}} \right)$$

$$f = \frac{64}{Re}$$



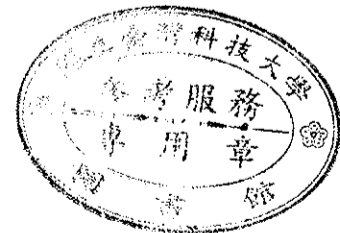
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5. (10%) Nitrogen gas is compressed from 80 kPa and 27°C to 480 kPa by a compressor. Determine the compressor work per unit mass flow of nitrogen for assuming the compression process to be an ideal two-stage polytropic with $n=1.3$. Note that gas constant and ratio of specific heat of nitrogen are $R=0.297$ kJ/kg·K and $C_p/C_v=1.4$.
6. (20%) True or False (Please write down your answers on the answer sheet; two points for each problem) 請將是非題答案書寫於答案紙內，於試題作答不予計分。
- () 1. A container with a higher temperature owns more amount of heat than the amount of heat in a same container with a lower temperature
- () 2. Some properties of ideal gases, such as internal energy, enthalpy, and entropy are functions of temperature only.
- () 3. Except for the vicinity of triple point, superheated vapor for any substance can be approximated by ideal-gas equation to obtain a good result.
- () 4. Compressibility factor, Z , is a measure of deviation from ideal-gas behavior. Also, its value is always greater than 1.
- () 5. Temperature of an ideal gas will decrease when it undergoes a steady-flow throttling process.
- () 6. A system undergoes a process between two fixed states first in a reversible manner and then in an irreversible manner. Then $\Delta S_{\text{irrev}} = \left(\int_1^2 \frac{\delta Q}{T} \right)_{\text{rev}}$.
- () 7. A new temperature scale is defined as
Boiling point: 250 degrees and Ice point: -250 degrees.
 Then the temperature reading for 50°C under this new temperature scale is 100 degrees.
- () 8. In a steady flow irreversible process, the total entropy of a system can increase, decrease, or remain constant.
- () 9. For a steady-state steady-flow system with a non-ideal gas as the working fluid, its internal energy, specific heat, and specific volume are unchanged if it undergoes a cyclic process..
- () 10. The isentropic process of an incompressible substance is also isothermal.



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7. (20%) Single-Choice (Please write down your answers on the answer sheet; four points for each problem) 請將選擇題答案書寫於答案紙內，於試題作答不予計分。

- () 1. The work energy required to accelerate an 800-kg car from rest to 90 km/h is
(a) 100 kJ, (b) 125 kJ, (c) 250 kJ, (d) 375 kJ, (e) None of the above.
- () 2. A 2-m³ rigid tank contains nitrogen gas at 500 kPa and 300 K. Now the gas is compressed isothermally to a volume of 0.2 m³. The work done on the gas during this compression process is
(a) 575.6 kJ, (b) 1151.3 kJ, (c) 1726.9 kJ, (d) 2302.6 kJ, (e) 2878.2 kJ.
Note that gas constant and ratio of specific heat of nitrogen are $R=0.297$ kJ/kg·K and $C_p/C_v=1.4$.
- () 3. Two Carnot heat engines are operating in series such that the heat sink of the first engine serves as the heat source of the second one. If the source temperature of the first engine is 1,280 K and the sink temperature of the second engine is 500 K and the thermal efficiencies of both engines are the same, the temperature of the intermediate reservoirs is (a) 625 K, (b) 800 K, (c) 860 K, (d) 453 K, (e) 758 K.
- () 4. An ideal gas ($\kappa = 1.667$) with constant specific heat is compressed from 150 kPa and 25°C to a pressure of 700 kPa adiabatically. The lowest temperature of this ideal gas after compression is (a) 25 °C, (b) 46 °C, (c) 117 °C, (d) 279 °C, (e) 472 °C.
- () 5. Consider a Carnot refrigerator and a Carnot heat pump operating between the same two thermal energy reservoirs. If the COP of the heat pump is 3.25, the COP of the refrigerator is (a) 4.0, (b) 0.25, (c) 1.25, (d) 0.8, (e) 2.25.

