

國立台灣科技大學九十八學年度碩士班招生試題

系所組別：機械工程系碩士班丙組

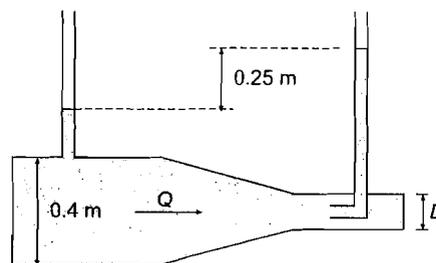
科目：熱力與流力

(總分為 100 分)

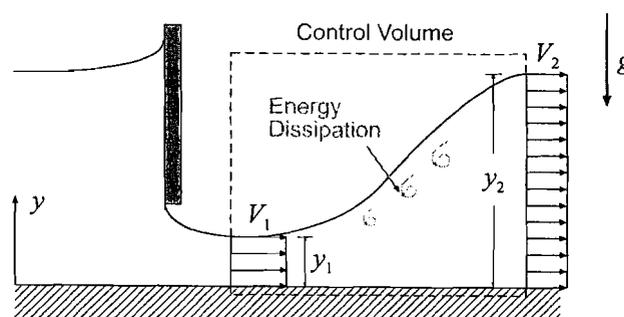
1. (20%) Answer the following questions briefly:

- Write down the basic assumptions for the derivation of steady Bernoulli's equation. (4%)
- Write down the definition of Reynolds number and describe briefly the major purpose of introducing this dimensionless number in fluid mechanics. (4%)
- Let \vec{u} be the velocity field of an incompressible fluid. Write down the corresponding continuity equation in its simplest form. (4%)
- Let $\vec{u} = y\hat{i} - x\hat{j}$ be the velocity field of a fluid flow, where \hat{i}, \hat{j} are the two unit basis vectors of the Cartesian coordinate system. Determine the expression of the corresponding streamlines. (4%)
- Briefly describe and explain the phenomena of Cavitation. (4%)

2. (10%) Water flows through the circular pipe contraction without any loss as shown in the figure below. For the given 0.25-m difference in the manometer level, determine the flowrate as a function of the diameter of the smaller pipe, D .



3. (20%) Hydraulic jump is an interesting phenomenon commonly seen in the steady discharge of a free-surface channel of rectangular cross section. See the figure shown below. Due to the strong energy dissipation, Bernoulli equation is not applicable in this case. To derive the condition for the occurrence of hydraulic jump, use the control volume given in the figure.



- Write down the mass conservation equation and the moment equation for the control volume. For a reasonable approximation, you may neglect the wall friction at the bottom of the channel. Gravity effect, however, can NOT be neglected in this case. (10%)
- Hydraulic jump occurs only if $\frac{y_2}{y_1} \geq 1$. Obtain the condition required for the occurrence of hydraulic jump. (10%)

國立台灣科技大學九十八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

Problem 4 (15分=(a) 8分+(b) 7分)

A refrigerator maintains the freezer compartment at -5°C when the air surrounding the refrigerator is at 22°C . The rate of heat transfer from the freezer compartment to the refrigerant is 8000 kJ/h and the power input required to operate the refrigerator is 3200 kJ/h . Determine (a) the coefficient of performance of the refrigerator and (b) compare with the coefficient of performance of a reversible refrigeration cycle operating between reservoirs at the same two temperatures.

Problem 5 (15分)

A piston-cylinder device contains 0.1 m^3 of nitrogen at 150 kPa , 25°C . The nitrogen is now compressed until the pressure is 1 MPa and the temperature is 150°C . During this compression process heat is transferred from the nitrogen, and the work done on the nitrogen is 20 kJ . Determine the amount of heat transfer.

$$(C_p = 1.041\text{ kJ/kg}\cdot\text{K}, C_v = 0.744\text{ kJ/kg}\cdot\text{K})$$

Problem 6 (20分=(a) 10分+(b) 10分)

Air is compressed by an adiabatic compressor from 100 kPa and 285 K to a pressure of 800 kPa at a steady rate of 0.25 kg/s . If the isentropic efficiency of the compressor is 85 percent, determine (a) the exit temperature of air and (b) the required power input to the compressor.



國立台灣科技大學九十八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

Ideal Gas Properties of Air for Problem 6

T(K), h and u(kJ/kg), s° (kJ/kg·K)											
T	h	u	s°	when $\Delta s = 0^{\circ}$		T	h	u	s°	when $\Delta s = 0$	
				p_r	v_r					p_r	v_r
200	199.97	142.56	1.29559	0.3363	1707.	450	451.80	322.62	2.11161	5.775	223.6
210	209.97	149.69	1.34444	0.3987	1512.	460	462.02	329.97	2.13407	6.245	211.4
220	219.97	156.82	1.39105	0.4690	1346.	470	472.24	337.32	2.15604	6.742	200.1
230	230.02	164.00	1.43557	0.5477	1205.	480	482.49	344.70	2.17760	7.268	189.5
240	240.02	171.13	1.47824	0.6355	1084.	490	492.74	352.08	2.19876	7.824	179.7
250	250.05	178.28	1.51917	0.7329	979.	500	503.02	359.49	2.21952	8.411	170.6
260	260.09	185.45	1.55848	0.8405	887.8	510	513.32	366.92	2.23993	9.031	162.1
270	270.11	192.60	1.59634	0.9590	808.0	520	523.63	374.36	2.25997	9.684	154.1
280	280.13	199.75	1.63279	1.0889	738.0	530	533.98	381.84	2.27967	10.37	146.7
285	285.14	203.33	1.65055	1.1584	706.1	540	544.35	389.34	2.29906	11.10	139.7
290	290.16	206.91	1.66802	1.2311	676.1	550	554.74	396.86	2.31809	11.86	133.1
295	295.17	210.49	1.68515	1.3068	647.9	560	565.17	404.42	2.33685	12.66	127.0
300	300.19	214.07	1.70203	1.3860	621.2	570	575.59	411.97	2.35531	13.50	121.2
305	305.22	217.67	1.71865	1.4686	596.0	580	586.04	419.55	2.37348	14.38	115.7
310	310.24	221.25	1.73498	1.5546	572.3	590	596.52	427.15	2.39140	15.31	110.6

11

