國立成功大學

111學年度碩士班招生考試試題

編　號：120

系　所：工程科學系

科　目：熱力學

日　期：0220

節　次：第 1 節

備　註：可使用計算機

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

第 1 至 3 題為選擇題及繪圖題，第 4 題為計算題，第 5 題為繪圖及說明。

1. Superheated water vapor at 1 MPa, 1 kg and 300 °C is allowed to cool at **constant volume** until the pressure drops to 500 kPa. **(25%)**
   At the final state, determine
   (1) the temperature (°C) (a)137.5, (b) 147.9, (c) 151.8, (d) 155.5, (e) 158.8, (f) 161.9.
   (2) the quality (%) (a)52.8, (b) 56.7, (c) 60.6, (d) 64.8, (e) 68.7, (f) 72.9.
   (3) internal energy (kJ/kg) (a) 1960, (b) 1970, (c) 1980, (d) 1990, (e) 2000, (f) 2010.
   (4) water cooled energy (kJ) (a) 807, (b) 812, (c) 820, (d) 828, (e) 834, (f) 840.
   (5) Draw the process on a P-v diagram with respect to saturation lines.

2. As Fig. 1, air at 100 kPa and 25°C enters an adiabatic diffuser steadily with velocity of 200 m/s and leaves with a low velocity at a pressure of 120 kPa. The exit area of the diffuser is 6 times the inlet area.　(The property of air is R = 0.287 kJ/kg·K) **(25%)**
   Determine
   (1) the specific volume of inlet (v_1, m³/kg) (a) 0.86, (b) 0.90, (c) 0.94, (d) 0.98, (e) 1.02, (f) 1.06.
   (2) the mass flow rate of the air (kg/s) (a) 54.2, (b) 58.5, (c) 62.3, (d) 65.7, (e) 68.5, (f) 71.2.
   (3) the exit Enthalpy (h_2, kJ/kg) (a) 278.6, (b) 285.5, (c) 292.4, (d) 297.4, (e) 312.3, (f) 318.2.
   (4) the exit temperature (K) (a) 300, (b) 305, (c) 312, (d) 318, (e) 323, (f) 330.
   (5) the exit velocity of the air (m/s) (a) 22.3 (b) 25.8, (c) 27.6, (d) 29.7, (e) 31.2, (f) 33.5.

3. As Fig. 2, an isentropic steam turbine processes 2 kg/s of steam at 3 MPa, which is exhausted at 200 kPa and 150°C. 20 percent of this flow is diverted for feed water heating at 400 kPa. **(20%)**
   Determine
   (1) the process entropy (kJ/kg·K) (a) 7.127, (b)7.281, (c) 7.508, (d)7.710, (e) 7.894, (f)8.224.
   (2) the enter 1 enthalpy (h_1, kJ/kg) (a) 3425, (b) 3450, (c) 3462, (d) 3481, (e) 3494, (f) 3502
   (3) the exit 2 enthalpy (h_2, kJ/kg) (a) 2870, (b) 2885, (c) 2900, (d) 2915, (e) 2950, (f) 2945.
   (4) the power produced by turbine (kW) (a) 1392 (b) 1400, (c) 1421, (d) 1445, (e) 1458, (f) 1472.

4. As Fig. 3, Air at 350 K and 150 kPa steadily flows into a hair dryer having electrical work input of 1000 W. Because of the size of the air intake, the inlet velocity of the air is negligible. The air mass flow rate and velocity at the hair dryer exit are 0.1 kg/s and 15 m/s, respectively. The flow process is both constant pressure and adiabatic. (a) Determine the air temperature at the hair dryer exit, in °C. (b) Determine the air volume flow rate at the hair dryer exit, in m³/s. (The property of air is R = 0.287 kJ/kg·K; c_p = 1.005 kJ/ kg·K) . **(20%)**

5. Please draw the reversed Carnot cycle process and indicate the title of each process. (such as: which process is reversible isothermal compression?) **(10%)**
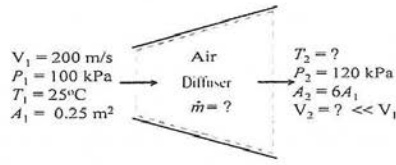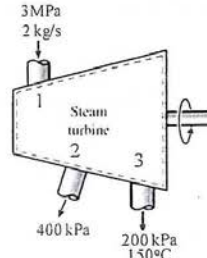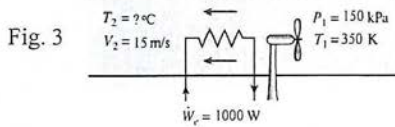
Figures and Tables

Fig. 1

$V_1 = 200$ m/s
$P_1 = 100$ kPa
$T_1 = 25$ºC
$A_1 = 0.25$ m²

Air Diffuser
$\dot{m} = ?$

$T_2 = ?$
$P_2 = 120$ kPa
$A_2 = 6A_1$
$V_2 = ? \ll V_1$

Fig. 2

3MPa
2 kg/s

Steam turbine

400 kPa

200 kPa
150ºC

Fig. 3

$T_2 = ?$ ºC
$V_2 = 15$ m/s

$P_1 = 150$ kPa
$T_1 = 350$ K

$\dot{W}_e = 1000$ W

TABLE A–5

Saturated water—Pressure table

		Specific volume, m³/kg		Internal energy, kJ/kg			Enthalpy, kJ/kg		
Press., P kPa	Sat. temp., T_{sat} °C	Sat. liquid, v_f	Sat. vapor, v_g	Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g
450	147.90	0.001088	0.41392	622.65	1934.5	2557.1	623.14	2120.3	2743.4
500	151.83	0.001093	0.37483	639.54	1921.2	2560.7	640.09	2108.0	2748.1
550	155.46	0.001097	0.34261	655.16	1908.8	2563.9	655.77	2096.6	2752.4
600	158.83	0.001101	0.31560	669.72	1897.1	2566.8	670.38	2085.8	2756.2
650	161.98	0.001104	0.29260	683.37	1886.1	2569.4	684.08	2075.5	2759.6

TABLE A–6

Superheated water

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K
	P = 0.20 MPa (120.21°C)				P = 0.40 MPa (143.61°C)				P = 3.00 MPa (233.85°C)			
Sat.	0.88578	2529.1	2706.3	7.1270	0.46242	2553.1	2738.1	6.8955	0.06667	2603.2	2803.2	6.1856
150	0.95986	2577.1	2769.1	7.2810	0.47088	2564.4	2752.8	6.9306				
200	1.08049	2654.6	2870.7	7.5081	0.53434	2647.2	2860.9	7.1723				
250	1.19890	2731.4	2971.2	7.7100	0.59520	2726.4	2964.5	7.3804	0.07063	2644.7	2856.5	6.2893
300	1.31623	2808.8	3072.1	7.8941	0.65489	2805.1	3067.1	7.5677	0.08118	2750.8	2994.3	6.5412
400	1.54934	2967.2	3277.0	8.2236	0.77265	2964.9	3273.9	7.9003	0.09938	2933.6	3231.7	6.9235
500	1.78142	3131.4	3487.1	8.5153	0.88936	3129.8	3485.5	8.1933	0.11620	3108.6	3457.2	7.2359
600	2.01302	3302.2	3704.8	8.7793	1.00558	3301.0	3703.3	8.4580	0.13245	3285.5	3682.8	7.5103

TABLE A–6

Superheated water (Continued)

T C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K
	P = 1.80 MPa (179.88°C)			
Sat.	0.19437	2582.8	2777.1	6.3350
200	0.20602	2622.3	2828.3	6.6956
250	0.23275	2710.4	2943.1	6.9265
300	0.25799	2793.7	3051.6	7.1246
350	0.28250	2875.7	3158.2	7.3029
400	0.30661	2957.9	3264.5	7.4670

TABLE A–17

Ideal gas properties of air

T K	h kJ/kg	P_r	u kJ/kg	v_r	s kJ/kg·K
295	295.17	1.3068	210.49	647.9	1.68515
298	298.18	1.3543	212.64	631.9	1.69528
300	300.19	1.3860	214.07	621.2	1.70203
315	315.27	1.6442	224.85	549.8	1.75106
320	320.29	1.7375	228.42	528.6	1.76690
325	325.31	1.8345	232.02	508.4	1.78249