國立臺北科技大學九十九學年度碩士班招生考試

系所組別：1330 車輛工程系碩士班丙組

第一節　熱力學　試題

注意事項：

1. 本試題共五題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、One kilogram of air is compressed slowly in a piston-cylinder assembly from 1 bar, 300°K, to a final pressure of 5 bars. During the process heat is exchanged with the surroundings at a rate sufficient to make the process isothermal. Determine (a) the change in internal energy of the air, (b) the work interaction, in kJ/kg, and (c) the quantity of heat transfer, in kJ/kg. (air, R=0.287 kJ/kg · °K) (20%：(a)6%、(b)7%、(c)7%)

二、Air initially at 1 bar and 300°K is compressed to 6 bars and 450°K. The power input to the air under steady-flow conditions is 6 kW, and a heat loss of 5 kJ/kg occurs during the process. If the changes in potential and kinetic energies are neglected, determine the mass flow rate, in kg/min. (air, C_{p0}=1.004 kJ/kg · °K) (20%)

三、A pressure vessel with a volume of 2 m^3 is filled with air at a pressure of 6 bars and a temperature of 250°C. Determine (a) the final temperature and (b) the percent of the mass left in the pressure vessel if gas is permitted to leave the pressure vessel under adiabatic conditions until the pressure drops to 1 bar. (air, k=1.4) (20%：(a)10%、(b)10%)

四、Consider 100 m^3 of an air-water vapor mixture at 0.1 MPa, 40°C, and 80% relative humidity. (a) Calculate the humidity ratio, dew point, mass of air, and mass of the vapor. (b) Calculate the amount of water condensed if the mixture is cooled to 5°C in a constant-pressure process. (air, R_{air}=0.287 kJ/kg · °K; vapor, R_{vapor}=0.4615 kJ/kg · °K; The table of thermodynamic properties of saturated water is listed in next page) (20%：(a)10%、(b)10%)

五、By considering a simple compressible substance in the absence of motion or gravitational effects, the first law for a change of state can be expressed as

$$\delta Q = \delta U + \delta W$$

(a)For a reversible process, please derive the Gibbs equations for a unit mass.

$$Tds = du + Pdv$$
$$Tds = dh - vdP \qquad (5\%)$$

(b)For an ideal gas with constant C_{p0}, C_{v0}, R and k, please derive the two corresponding equations of s_2-s_1=f(T_1, T_2, P_1, P_2, C_{p0}, R) and s_2-s_1=f(T_1, T_2, v_1, v_2, C_{v0}, R). (5%)

(c) By applying the above derived equations, please prove that the relation for an isentropic process is $P \cdot v^k$=constant. (10%)

TABLE B.1
Thermodynamic Properties of Water
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Saturated Water

		Specific Volume, m^3/kg			Internal Energy, kJ/kg		
Temp. (°C)	Press. (kPa)	Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Sat. Liquid u_f	Evap. u_{fg}	Sat. Vapor u_g
0.01	0.6113	0.001000	206.131	206.132	0	2375.33	2375.33
5	0.8721	0.001000	147.117	147.118	20.97	2361.27	2382.24
10	1.2276	0.001000	106.376	106.377	41.99	2347.16	2389.15
15	1.705	0.001001	77.924	77.925	62.98	2333.06	2396.04
20	2.339	0.001002	57.7887	57.7897	83.94	2318.98	2402.91
25	3.169	0.001003	43.3583	43.3593	104.86	2304.90	2409.76
30	4.246	0.001004	32.8922	32.8932	125.77	2290.81	2416.58
35	5.628	0.001006	25.2148	25.2158	146.65	2276.71	2423.36
40	7.384	0.001008	19.5219	19.5229	167.53	2262.57	2430.11
45	9.593	0.001010	15.2571	15.2581	188.41	2248.40	2436.81
50	12.350	0.001012	12.0308	12.0318	209.30	2234.17	2443.47
55	15.758	0.001015	9.56734	9.56835	230.19	2219.89	2450.08
60	19.941	0.001017	7.66969	7.67071	251.09	2205.54	2456.63
65	25.03	0.001020	6.19554	6.19656	272.00	2191.12	2463.12
70	31.19	0.001023	5.04114	5.04217	292.93	2176.62	2469.55
75	38.58	0.001026	4.13021	4.13123	313.87	2162.03	2475.91
80	47.39	0.001029	3.40612	3.40715	334.84	2147.36	2482.19
85	57.83	0.001032	2.82654	2.82757	355.82	2132.58	2488.40
90	70.14	0.001036	2.35953	2.36056	376.82	2117.70	2494.52
95	84.55	0.001040	1.98082	1.98186	397.86	2102.70	2500.56
100	101.3	0.001044	1.67185	1.67290	418.91	2087.58	2506.50
105	120.8	0.001047	1.41831	1.41936	440.00	2072.34	2512.34
110	143.3	0.001052	1.20909	1.21014	461.12	2056.96	2518.09
115	169.1	0.001056	1.03552	1.03658	482.28	2041.44	2523.72
120	198.5	0.001060	0.89080	0.89186	503.48	2025.76	2529.24
125	232.1	0.001065	0.76953	0.77059	524.72	2009.91	2534.63
130	270.1	0.001070	0.66744	0.66850	546.00	1993.90	2539.90
135	313.0	0.001075	0.58110	0.58217	567.34	1977.69	2545.03
140	361.3	0.001080	0.50777	0.50885	588.72	1961.30	2550.02
145	415.4	0.001085	0.44524	0.44632	610.16	1944.69	2554.86
150	475.9	0.001090	0.39169	0.39278	631.66	1927.87	2559.54
155	543.1	0.001096	0.34566	0.34676	653.23	1910.82	2564.04
160	617.8	0.001102	0.30596	0.30706	674.85	1893.52	2568.37
165	700.5	0.001108	0.27158	0.27269	696.55	1875.97	2572.51
170	791.7	0.001114	0.24171	0.24283	718.31	1858.14	2576.46
175	892.0	0.001121	0.21568	0.21680	740.16	1840.03	2580.19
180	1002.2	0.001127	0.19292	0.19405	762.08	1821.62	2583.70
185	1122.7	0.001134	0.17295	0.17409	784.08	1802.90	2586.98
190	1254.4	0.001141	0.15539	0.15654	806.17	1783.84	2590.01