

國立中正大學

113 學年度碩士班招生考試

試題

[第 1 節]

科目名稱	熱力學
系所組別	機械工程學系-丙組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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[20%]

1. Propane contained in a piston-cylinder assembly, initially at 30 °C, 1 bar, and a volume of 0.2 m³. The propane undergoes a process to a final pressure of 4 bar, during which the pressure-volume relationship is $pV^{1.1} = \text{constant}$. For the propane, if kinetic and potential energy effects can be ignored, evaluate

[10%] (1) the work, in kJ

[10%] (2) the heat transfer, in kJ.

Properties of Superheated Propane

T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K
$p = 1.0 \text{ bar} = 0.1 \text{ MPa}$ ($T_{\text{sat}} = -42.38^\circ\text{C}$)					$p = 4.0 \text{ bar} = 0.4 \text{ MPa}$ ($T_{\text{sat}} = -5.46^\circ\text{C}$)				
Sat.	0.4185	378.5	420.3	1.822	Sat.	0.1137	418.0	463.5	1.751
-50					0	0.1169	426.1	472.9	1.786
-40	0.4234	381.5	423.8	1.837	10	0.1227	441.2	490.3	1.848
-30	0.4439	394.2	438.6	1.899	20	0.1283	456.6	507.9	1.909
-20	0.4641	407.3	453.7	1.960	30	0.1338	472.2	525.7	1.969
-10	0.4842	420.7	469.1	2.019	40	0.1392	488.1	543.8	2.027
0	0.5040	434.4	484.8	2.078	50	0.1445	504.4	562.2	2.085
10	0.5238	448.6	501.0	2.136	60	0.1498	521.1	581.0	2.143
20	0.5434	463.3	517.6	2.194	70	0.1550	538.1	600.1	2.199
30	0.5629	478.2	534.5	2.251	80	0.1601	555.7	619.7	2.255
40	0.5824	493.7	551.9	2.307	90	0.1652	573.5	639.6	2.311
50	0.6018	509.5	569.7	2.363	100	0.1703	591.8	659.9	2.366
60	0.6211	525.8	587.9	2.419	110	0.1754	610.4	680.6	2.421

[30%]

2. Nitrogen enters a well-insulated diffuser operating at a steady state at 0.656 bar, 300 K with a velocity of 282 m/s. The inlet area is $4.8 \times 10^{-3} \text{ m}^2$. At the diffuser exit, the pressure is 0.9 bar and the velocity is 130 m/s. The nitrogen behaves as an ideal gas with a constant $c_p = 1.04 \text{ kJ/kg-K}$. If the potential energy effect can be neglected, determine

[10%] (1) the exit temperature, in K.

[10%] (2) the exit area, in m^2 .

[10%] (3) For a control volume enclosing the diffuser, determine the entropy production, in kJ/K per kg of nitrogen flowing.

(Note: For an ideal gas, $s(T_2, p_2) - s(T_1, p_1) = \int_{T_1}^{T_2} c_p(T) \frac{dT}{T} - R \ln \left(\frac{p_2}{p_1} \right)$)

[20%]

3. Saturated water vapor at 8 bar enters an insulated turbine and exits as 1 bar. The turbine generates a work of 320 kJ/kg.

[5%] (1) Sketch a temperature-entropy (T - s) diagram for the process.

[5%] (2) Determine the temperature of steam at the exit.

[5%] (3) Determine the isentropic efficiency of the turbine.

[5%] (4) Determine the entropy production for the process.

[15%]

4. Sketch diagrams and describe each process in details.

[3%] (1) Sketch a pressure-specific volume (p - v) diagram for an Otto cycle.

[3%] (2) Sketch a pressure-specific volume (p - v) diagram for a diesel cycle.

[3%] (3) Sketch a pressure-specific volume (p - v) diagram for an ideal Brayton cycle.

[3%] (4) Sketch a temperature-entropy (T - s) diagram for an ideal Rankine cycle.

[3%] (5) Sketch a temperature-entropy (T - s) diagram for an ideal vapor-compression refrigeration cycle.

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[15%]

5. A large room contains moist air at 30°C, 100 kPa. The partial pressure of water vapor is 1.5 kPa.

[3%] (1) Determine the relative humidity.

[3%] (2) Determine the humidity ratio.

[4%] (3) Determine the dew point temperature, in °C.

[5%] (4) If the moist air initially in a closed tank is heated to 80°C, determine the relative humidity.

Properties of Saturated Water (Liquid-Vapor)

Temp. °C	Press. bar	Specific Volume m ³ /kg		Internal Energy kJ/kg		Enthalpy kJ/kg		Entropy kJ/kg · K	
		Sat. Liquid $v_f \times 10^3$	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g
10	0.01228	1.0004	106.379	42.00	2389.2	42.01	2519.8	0.1510	8.9008
11	0.01312	1.0004	99.857	46.20	2390.5	46.20	2521.6	0.1658	8.8765
12	0.01402	1.0005	93.784	50.41	2391.9	50.41	2523.4	0.1806	8.8524
13	0.01497	1.0007	88.124	54.60	2393.3	54.60	2525.3	0.1953	8.8285
14	0.01598	1.0008	82.848	58.79	2394.7	58.80	2527.1	0.2099	8.8048
15	0.01705	1.0009	77.926	62.99	2396.1	62.99	2528.9	0.2245	8.7814
30	0.04246	1.0043	32.894	125.78	2416.6	125.79	2556.3	0.4369	8.4533
31	0.04496	1.0046	31.165	129.96	2418.0	129.97	2558.1	0.4507	8.4329
32	0.04759	1.0050	29.540	134.14	2419.3	134.15	2559.9	0.4644	8.4127
33	0.05034	1.0053	28.011	138.32	2420.7	138.33	2561.7	0.4781	8.3927
34	0.05324	1.0056	26.571	142.50	2422.0	142.50	2563.5	0.4917	8.3728
35	0.05628	1.0060	25.216	146.67	2423.4	146.68	2565.3	0.5053	8.3531
75	.3858	1.0259	4.131	313.90	2475.9	313.93	2635.3	1.0155	7.6824
80	.4739	1.0291	3.407	334.86	2482.2	334.91	2643.7	1.0753	7.6122
85	.5783	1.0325	2.828	355.84	2488.4	355.90	2651.9	1.1343	7.5445
90	.7014	1.0360	2.361	376.85	2494.5	376.92	2660.1	1.1925	7.4791
95	.8455	1.0397	1.982	397.88	2500.6	397.96	2668.1	1.2500	7.4159
99.63	1.00	1.0432	1.694	417.36	2506.1	417.46	2675.5	1.3026	7.3594
120.2	2.00	1.0605	0.8857	504.49	2529.5	504.70	2706.7	1.5301	7.1271
133.6	3.00	1.0732	0.6058	561.15	2543.6	561.47	2725.3	1.6718	6.9919
143.6	4.00	1.0836	0.4625	604.31	2553.6	604.74	2738.6	1.7766	6.8959
151.9	5.00	1.0926	0.3749	639.68	2561.2	640.23	2748.7	1.8607	6.8212
158.9	6.00	1.1006	0.3157	669.90	2567.4	670.56	2756.8	1.9312	6.7600
165.0	7.00	1.1080	0.2729	696.44	2572.5	697.22	2763.5	1.9922	6.7080
170.4	8.00	1.1148	0.2404	720.22	2576.8	721.11	2769.1	2.0462	6.6628
175.4	9.00	1.1212	0.2150	741.83	2580.5	742.83	2773.9	2.0946	6.6226