國立成功大學 109 學年度碩士班招生考試試題

系　　所：機械工程學系

考試科目：熱力學

考試日期：0210，節次：2

※ 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。

1. A mass-and atmosphere-loaded piston/cylinder contains 2 kg of water at 50°C, 200 kPa. Heat is added from a reservoir at 200°C to the water until it reaches 200°C. Find the work, heat transfer, and total entropy production for the system and surroundings. (15%)

2. A mass-and atmosphere-loaded piston/cylinder initially contains 0.5 kg of steam at 1.2 MPa, superheated by 112°C. Now, steam loses heat to the surroundings and the piston moves down hitting a set of stops at which point the cylinder contains saturated liquid water. The cooling continues until the cylinder contains water at 100°C. Determine
   (a) the initial temperature. (3%)
   (b) the specific volume of the steam by the time the piston first hits the stops. (3%)
   (c) the final pressure and the quality (if mixture). (6%)
   (d) the total heat transfer. (5%)
   (e) show the processes in a P-v diagram. Please draw the wet(vapor) dome and clearly mark each state. (3%)

3. A mass-and atmosphere-loaded piston/cylinder assembly contains 1 kg of water at 25°C, 200 kPa. A nozzle in a line to the cylinder is opened to enable a flow to the outside atmosphere at 100 kPa. The process continues until half the mass has flowed out. Assume there is no heat transfer and water temperature is constant. Find the exit velocity, total work done, and total entropy generation in the process. (15%)

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Property tables for problems 1, 2 and 3. If there is no appropriate table, please implement suitable approximation.

Saturated Water

T	P	v (m^3/kg)		u (kJ/kg)		h (kJ/kg)		s (kJ/kg-K)	
(°C)	(kPa)	v_f	v_g	u_f	u_g	h_f	h_g	s_f	s_g
25	**3.169**	**0.001003**	**43.3593**	**104.86**	**2409.76**	**104.87**	**2547.17**	**0.3673**	**8.5579**
50	**12.350**	**0.001012**	**12.0318**	**209.30**	**2443.47**	**209.31**	**2592.06**	**0.7037**	**8.0762**
75	**38.58**	**0.001026**	**4.13123**	**313.87**	**2475.91**	**313.91**	**2635.28**	**1.0514**	**7.6824**
100	**101.3**	**0.001044**	**1.67290**	**418.91**	**2506.50**	**419.02**	**2676.05**	**1.3068**	**7.3548**
188	**1200**	**0.001139**	**0.16333**	**797.27**	**2588.82**	**798.64**	**2784.82**	**2.2165**	**6.5233**

Superheated Vapor Water

T	P	v	u	h	s
(°C)	(kPa)	(m^3/kg)	(kJ/kg)	(kJ/kg)	(kJ/kg-K)
200	**200**	**1.08034**	**2654.39**	**2870.46**	**7.5066**
200	**1200**	**0.16930**	**2612.74**	**2815.90**	**6.5898**
250	**1200**	**0.19235**	**2704.20**	**2935.01**	**6.8293**
300	**1200**	**0.2138**	**2789.22**	**3045.80**	**7.0316**
350	**1200**	**0.23452**	**2872.16**	**3153.59**	**7.2120**

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4. (12%) Derive an expression for the enthalpy change in an isothermal process of a gas for which the equation of state is $P = \frac{RT}{(v-a)} - \frac{1}{v^2}$, where a is constant, and P, v, T, R are pressure, specific volume, temperature and gas constant, respectively.

5. The compression ratio in an air-standard Otto cycle is 10. At the beginning of the compression stroke, the pressure is 0.1 MPa and the temperature is 25 °C. The heat transfer to the air per cycle is 2000 kJ/kg air. Use 1.4 for specific heat ratio, 0.287 kJ/kg-K for gas constant and 0.717 kJ/kg-K for constant volume specific heat. Determine

(1) (8%) Sketch P-v and T-s diagrams of the cycle.

(2) (18%) The pressure and temperature at the end of each process of the cycle.

(3) (6%) The thermal efficiency.

(4) (6%) The mean effective pressure.