# 國立臺北科技大學 102 學年度碩士班招生考試

## 系所組別：1431 能源與冷凍空調工程系碩士班丙組

## 第二節　熱力學　試題（選考）



**注意事項：**

1. 本試題共六題，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、Two hydraulic piston/cylinders are connected with a line (as shown in Fig. 1). The master cylinder has an area of 5 cm2 creating a pressure of 1000 kPa. The slave cylinder has an area of 3 cm2. If 25 J is the work input to the master cylinder what is the force and displacement of each piston and the work out put of the slave cylinder piston? Assumpting that air is an ideal gas. The properties of air at room temperatures are R = 0.287 kJ/kg-K. (15 分)

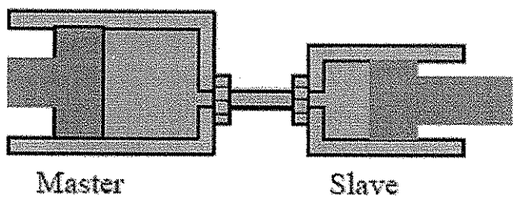


Fig. 1

二、A heat pump is driven by the work output of a heat engine as shown in Fig. 2. If we assume ideal devices find the ratio of the total power $\dot{Q}_{L1}+\dot{Q}_{H2}$ that heats the house to the power from the hot energy source $\dot{Q}_{H1}$ in terms of the temperatures. (15 分)

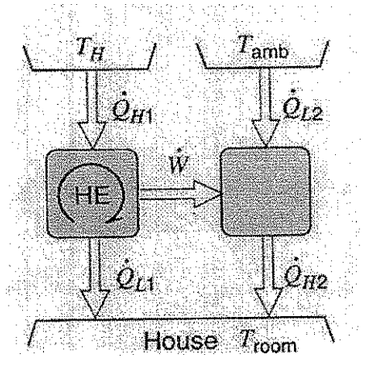


Fig. 2

三、One kg of air at 100 kPa is mixed with one kg air at 200 kPa, both at 300 K, in a rigid insulated tank. Find the final state (P, T) and the entropy generation in the process (gas constant of air $R_{air}$=0.287kJ/kg-K). (15 分)

注意：背面尚有試題

四、Two flows of air both at 200 kPa, one has 1 kg/s at 400 K and the other has 2 kg/s at 290 K. The two lines exchange energy through a number of ideal heat engines taking energy from the hot line and rejecting it to the colder line. The two flows then leave at the same temperature. Assume the whole setup is reversible and find the exit temperature and the total power out of the heat engines. (20 分)

五、Consider a Carnot cycle executed in a closed system with air as the working fluid. The maximum pressure in the cycle is 800 kPa while the maximum temperature is 750 K. If the entropy increase during the isothermal heat rejection process is 0.25 kJ/kg _ K and the net work output is 100kJ/kg, determine

1. the minimum pressure in the cycle； (7分)
2. the heat rejection from the cycle； (3分)
3. the thermal efficiency of the cycle；(4分)
4. If an actual heat engine cycle operates between the same temperature limits and produces 5200 kW of power for an air flow rate of 90 kg/s, determine the second law efficiency of this cycle. (6分)

Assumpting that air is an ideal gas with constant specific heats. The properties of air at room temperatures are R = 0.287 kJ/kg-K and k = 1.4.

六、A piston/cylinder contains 0.5 kg argon and 0.5 kg hydrogen at 300K, 100kpa. The mixture is compressed in an adiabatic process to 400 Kpa by an external force on the piston. Find the final temperature, the work and the heat transfer in the process. For the argon R=0.2081kJ/kg-K and $C_p$=0.52 kJ/kg-K, for the hydrogen R=4.1243 kJ/kg-K and $C_p$=14.209 kJ/kg-K. (15 分)

附表

***Ideal-Gas Properties of Air, Standard Entropy at 0.1-MPa (1-bar) Pressure***

| $T$ (K) | $u$ (kJ/kg) | $h$ (kJ/kg) | $s_T^0$ (kJ/kg-K) | $T$ (K) | $u$ (kJ/kg) | $h$ (kJ/kg) | $s_T^0$ (kJ/kg-K) |
|---|---|---|---|---|---|---|---|
| 200 | 142.77 | 200.17 | 6.46260 | 1100 | 845.45 | 1161.18 | 8.24449 |
| 220 | 157.07 | 220.22 | 6.55812 | 1150 | 889.21 | 1219.30 | 8.29616 |
| 240 | 171.38 | 240.27 | 6.64535 | 1200 | 933.37 | 1277.81 | 8.34596 |
| 260 | 185.70 | 260.32 | 6.72562 | 1250 | 977.89 | 1336.68 | 8.39402 |
| 280 | 200.02 | 280.39 | 6.79998 | 1300 | 1022.75 | 1395.89 | 8.44046 |
| 290 | 207.19 | 290.43 | 6.83521 | 1350 | 1067.94 | 1455.43 | 8.48539 |
| 298.15 | 213.04 | 298.62 | 6.86305 | 1400 | 1113.43 | 1515.27 | 8.52891 |
| 300 | 214.36 | 300.47 | 6.86926 | 1450 | 1159.20 | 1575.40 | 8.57111 |
| 320 | 228.73 | 320.58 | 6.93413 | 1500 | 1205.25 | 1635.80 | 8.61208 |
| 340 | 243.11 | 340.70 | 6.99515 | 1550 | 1251.55 | 1696.45 | 8.65185 |
| 360 | 257.53 | 360.86 | 7.05276 | 1600 | 1298.08 | 1757.33 | 8.69051 |
| 380 | 271.99 | 381.06 | 7.10735 | 1650 | 1344.83 | 1818.44 | 8.72811 |
| 400 | 286.49 | 401.30 | 7.15926 | 1700 | 1391.80 | 1879.76 | 8.76472 |
| 420 | 301.04 | 421.59 | 7.20875 | 1750 | 1438.97 | 1941.28 | 8.80039 |
| 440 | 315.64 | 441.93 | 7.25607 | 1800 | 1486.33 | 2002.99 | 8.83516 |
| 460 | 330.31 | 462.34 | 7.30142 | 1850 | 1533.87 | 2064.88 | 8.86908 |
| 480 | 345.04 | 482.81 | 7.34499 | 1900 | 1581.59 | 2126.95 | 8.90219 |
| 500 | 359.84 | 503.36 | 7.38692 | 1950 | 1629.47 | 2189.19 | 8.93452 |
| 520 | 374.73 | 523.98 | 7.42736 | 2000 | 1677.52 | 2251.58 | 8.96611 |
| 540 | 389.69 | 544.69 | 7.46642 | 2050 | 1725.71 | 2314.13 | 8.99699 |
| 560 | 404.74 | 565.47 | 7.50422 | 2100 | 1774.06 | 2376.82 | 9.02721 |
| 580 | 419.87 | 586.35 | 7.54084 | 2150 | 1822.54 | 2439.66 | 9.05678 |
| 600 | 435.10 | 607.32 | 7.57638 | 2200 | 1871.16 | 2502.63 | 9.08573 |
| 620 | 450.42 | 628.38 | 7.61090 | 2250 | 1919.91 | 2565.73 | 9.11409 |
| 640 | 465.83 | 649.53 | 7.64448 | 2300 | 1968.79 | 2628.96 | 9.14189 |
| 660 | 481.34 | 670.78 | 7.67717 | 2350 | 2017.79 | 2692.31 | 9.16913 |
| 680 | 496.94 | 692.12 | 7.70903 | 2400 | 2066.91 | 2755.78 | 9.19586 |
| 700 | 512.64 | 713.56 | 7.74010 | 2450 | 2116.14 | 2819.37 | 9.22208 |
| 720 | 528.44 | 735.10 | 7.77044 | 2500 | 2165.48 | 2883.06 | 9.24781 |
| 740 | 544.33 | 756.73 | 7.80008 | 2550 | 2214.93 | 2946.86 | 9.27308 |
| 760 | 560.32 | 778.46 | 7.82905 | 2600 | 2264.48 | 3010.76 | 9.29790 |
| 780 | 576.40 | 800.28 | 7.85740 | 2650 | 2314.13 | 3074.77 | 9.32228 |
| 800 | 592.58 | 822.20 | 7.88514 | 2700 | 2363.88 | 3138.87 | 9.34625 |
| 850 | 633.42 | 877.40 | 7.95207 | 2750 | 2413.73 | 3203.06 | 9.36980 |
| 900 | 674.82 | 933.15 | 8.01581 | 2800 | 2463.66 | 3267.35 | 9.39297 |
| 950 | 716.76 | 989.44 | 8.07667 | 2850 | 2513.69 | 3331.73 | 9.41576 |
| 1000 | 759.19 | 1046.22 | 8.13493 | 2900 | 2563.80 | 3396.19 | 9.43818 |
| 1050 | 802.10 | 1103.48 | 8.19081 | 2950 | 2613.99 | 3460.73 | 9.46025 |
| 1100 | 845.45 | 1161.18 | 8.24449 | 3000 | 2664.27 | 3525.36 | 9.48198 |