

八十六學年度 工程與系統科學系(版) _____ 組碩士班研究生入學考試

科目 工程熱力學 科號 4012 共 六 頁第 一 頁 *請在試卷【答案卷】內作答

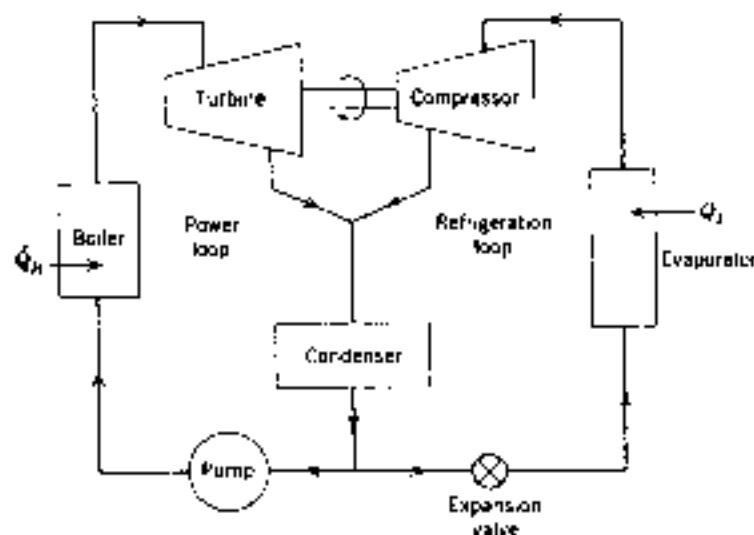
1. (a) Compressed water at 7 MPa and 250 °C enters a heated channel with an average velocity of 1 m/s. The channel is 1 cm in diameter and 1 m in length and uniformly heated with a heat flux of 1 MW/m². Determine the vapor quality at the channel exit. (see Appendix A for a partial steam table). (15%)
 - (b) A cup of hot water at 80 °C cools to ambient temperature, 25 °C. Calculate the net entropy change of the system (water + cup) plus surroundings for this process. Evaporation of water is assumed to be small and can be neglected. The cup is made of glass and its net weight is 200 g. The water weight is 500 g. The specific heats for the glass and water are 800 and 4200 J/kgK, respectively. The glass is in thermal equilibrium with water at any time. (10%)
 - (c) A mass of 1 kg of air contained in a cylinder at 2 MPa and 1200 K expands in a reversible adiabatic process to 200 kPa. Determine the work done during the process. Assume the air is an ideal gas and with constant specific heats. The gas constant and specific heat ratio for air is 0.287 and 1.4, respectively. (10%)
2. The rate of heat transfer to the surroundings from a person at rest is q J/s. An auditorium contains N people and there is an air conditioning system to maintain a constant temperature, T_0 .
 - (a) If the coefficient of performance of the air conditioning system is β , obtain an expression for the heat rejected by the system. (5%)
 - (b) If the heat rejected is used to produce warm water in a nearby barbershop, please determine the water flow rate if the temperature rise for the water is ΔT . The water specific heat is C . (10%)
 - (c) Suppose the air conditioning system fails, determine the averaged air temperature in the auditorium as a function of time. Assume the air mass in the auditorium is M and the constant volume specific heat for the air is C_v . (10%)

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3. It is proposed to build a 1000-MW electric power plant with steam as the working fluid. The condensers are to be cooled with sea water. The maximum steam temperature will be 550°C , and the pressure in the condensers will be 10 kPa.
- (a) As an engineering consultant, you are asked to estimate the minimum sea water flow rate if the temperature rise of sea water is limited to 10°C . The saturation steam temperature corresponding to 10 kPa is 46°C . The specific heat of sea water is 4200 J/kgK . (10%)
- (b) If the temperature rise is to be decreased to 8°C to reduce environmental impact, what kind of modification on the cooling system, other than increasing the sea water flow rate, would you suggest? (5%)
4. Consider an ideal dual-loop heat-powered refrigeration cycle using R-12 as the working fluid, as shown in the following. Saturated vapor at 105°C leaves the boiler and expands in the turbine to the condenser pressure. Saturated vapor at -15°C leaves the evaporator and is compressed to the condenser pressure. The ratio of flows through the two loops is such that the turbine produces just enough power to drive the compressor. The two exiting streams mix together and enter the condenser. Saturated liquid leaving the condenser at 45°C is then separated into two streams in the necessary proportions. Determine
- (a) The ratio of mass flow rate through the power loop to that through the refrigeration loop. (10%)
- (b) The performance of the cycle, in terms of the ratio \dot{Q}_l / \dot{Q}_{in} . (10%)
- (c) R-12 is harmful to the environment. What kind of substitute do you suggest? (5%)

(See Appendix B for properties)



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APPENDIX A

Saturated Steam: Pressure Table [SI Units]

| Press. MPa P | Temp. °C T | Specific Volume | | | | Internal Energy | | | | Enthalpy | | | | Entropy | | | |
|----------------------|--------------------|-----------------|----------|------------|--------|-----------------|--------|----------|----------|----------|--------|----------|----------|---------|-------|----------|----------|
| | | Sat. Liquid | | Sat. Vapor | | Liquid | | Vapor | | Liquid | | Vapor | | Liquid | | Vapor | |
| | | v_f | v_g | u_f | u_g | h_f | h_g | u_{fg} | u_{fg} | h_f | h_g | h_{fg} | h_{fg} | s_f | s_g | s_{fg} | s_{fg} |
| 3.5 | 242.60 | 0.001235 | 0.05707 | 1045.43 | 2603.7 | 1049.75 | 2803.4 | 1753.7 | 2725.3 | 2803.4 | 2.7253 | 3.4000 | 6.1253 | | | | |
| 4 | 250.40 | 0.001252 | 0.04978 | 1082.31 | 2602.3 | 1087.31 | 2801.4 | 1714.1 | 2796.4 | 2801.4 | 2.7964 | 3.2737 | 6.0701 | | | | |
| 5 | 263.99 | 0.001286 | 0.03944 | 1147.81 | 2597.1 | 1154.23 | 2794.3 | 1640.1 | 2920.2 | 2794.3 | 2.9202 | 3.0532 | 5.9734 | | | | |
| 6 | 275.64 | 0.001319 | 0.03244 | 1205.44 | 2589.7 | 1213.35 | 2784.3 | 1571.0 | 3026.7 | 2784.3 | 3.0267 | 2.8625 | 5.8892 | | | | |
| 7 | 285.88 | 0.001351 | 0.02737 | 1257.55 | 2580.5 | 1267.00 | 2772.1 | 1505.1 | 3121.1 | 2772.1 | 3.1211 | 2.6922 | 5.8133 | | | | |
| 8 | 295.06 | 0.001384 | 0.02352 | 1305.57 | 2569.8 | 1316.64 | 2758.0 | 1441.3 | 3206.8 | 2758.0 | 3.2068 | 2.5364 | 5.7432 | | | | |
| 9 | 303.40 | 0.001418 | 0.02048 | 1350.51 | 2557.8 | 1363.26 | 2742.1 | 1378.9 | 3285.8 | 2742.1 | 3.2858 | 2.3915 | 5.6772 | | | | |
| 10 | 311.06 | 0.001452 | 0.018026 | 1393.04 | 2544.4 | 1407.56 | 2724.7 | 1317.1 | 3359.6 | 2724.7 | 3.3596 | 2.2544 | 5.6141 | | | | |
| 11 | 318.15 | 0.001489 | 0.015987 | 1433.7 | 2529.8 | 1450.1 | 2705.6 | 1255.5 | 3429.5 | 2705.6 | 3.4295 | 2.1233 | 5.5527 | | | | |
| 12 | 324.75 | 0.001527 | 0.014263 | 1473.0 | 2513.7 | 1491.3 | 2684.9 | 1193.6 | 3496.2 | 2684.9 | 3.4962 | 1.9962 | 5.4924 | | | | |
| 13 | 330.93 | 0.001567 | 0.012780 | 1511.1 | 2496.1 | 1531.5 | 2662.2 | 1130.7 | 3560.6 | 2662.2 | 3.5606 | 1.8718 | 5.4323 | | | | |
| 14 | 336.75 | 0.001611 | 0.011485 | 1548.6 | 2476.8 | 1571.1 | 2637.6 | 1066.5 | 3623.2 | 2637.6 | 3.6232 | 1.7485 | 5.3717 | | | | |
| 15 | 342.24 | 0.001658 | 0.010337 | 1585.6 | 2455.5 | 1610.5 | 2610.5 | 1000.0 | 3684.8 | 2610.5 | 3.6848 | 1.6249 | 5.3098 | | | | |
| 16 | 347.44 | 0.001711 | 0.009306 | 1622.7 | 2431.7 | 1650.1 | 2580.6 | 930.6 | 3746.1 | 2580.6 | 3.7461 | 1.4994 | 5.2455 | | | | |
| 17 | 352.37 | 0.001770 | 0.008364 | 1660.2 | 2405.0 | 1690.3 | 2547.2 | 856.9 | 3807.9 | 2547.2 | 3.8079 | 1.3698 | 5.1777 | | | | |
| 18 | 357.06 | 0.001840 | 0.007489 | 1698.9 | 2374.3 | 1732.0 | 2509.1 | 777.1 | 3871.5 | 2509.1 | 3.8715 | 1.2329 | 5.1044 | | | | |
| 19 | 361.54 | 0.001924 | 0.006657 | 1739.9 | 2338.1 | 1776.5 | 2464.5 | 688.0 | 3938.8 | 2464.5 | 3.9388 | 1.0839 | 5.0228 | | | | |
| 20 | 365.81 | 0.002036 | 0.005834 | 1785.6 | 2293.0 | 1826.3 | 2409.7 | 583.4 | 4013.9 | 2409.7 | 4.0139 | 0.9130 | 4.9269 | | | | |
| 21 | 369.89 | 0.002207 | 0.004952 | 1842.1 | 2230.6 | 1888.4 | 2334.6 | 446.2 | 4107.5 | 2334.6 | 4.1075 | 0.6938 | 4.8013 | | | | |
| 22 | 373.80 | 0.002442 | 0.003568 | 1961.9 | 2087.1 | 2022.2 | 2165.6 | 143.4 | 4311.0 | 2165.6 | 4.3110 | 0.2216 | 4.5327 | | | | |
| 22.09 | 374.14 | 0.003155 | 0.003155 | 2029.6 | 0 | 2029.6 | 2029.6 | 0 | 4429.8 | 2029.6 | 4.4298 | 0 | 4.4298 | | | | |

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Appendix B

Thermodynamic Properties of Refrigerant-12 (Dichlorodifluoromethane)

Saturated R-12 (SI Units)

| Temp. °C | Abs. Press. MPa P | Specific Volume m ³ /kg | | | Enthalpy kJ/kg | | | Entropy kJ/kg K | | |
|-------------|----------------------------|---------------------------------------|--------------------------|---------------------------------|----------------------------------|--------------------------|---------------------------------|----------------------------------|--------------------------|---------------------------------|
| | | Sat. Liquid v _f | Evap. v _{fg} | Sat. Vapor v _g | Sat. Liquid h _f | Evap. h _{fg} | Sat. Vapor h _g | Sat. Liquid s _f | Evap. s _{fg} | Sat. Vapor s _g |
| -90 | 0.0028 | 0.009 608 | 4 414 937 | 4.415 545 | -43 243 | 189.618 | 146.375 | -0.2084 | 1.0352 | 0.8268 |
| -85 | 0.0042 | 0.009 612 | 3.036 704 | 3.037 316 | -38.968 | 187.608 | 148.640 | -0.1854 | 0.9970 | 0.8116 |
| -80 | 0.0062 | 0.009 617 | 2.137 728 | 2.138 345 | -34.688 | 185.612 | 150.924 | -0.1630 | 0.9609 | 0.7979 |
| -75 | 0.0088 | 0.009 622 | 1.537 030 | 1.537 651 | -30.401 | 183.625 | 153.224 | -0.1411 | 0.9266 | 0.7855 |
| -70 | 0.0123 | 0.009 627 | 1.126 654 | 1.127 280 | -26.107 | 181.640 | 155.536 | -0.1197 | 0.8940 | 0.7744 |
| -65 | 0.0168 | 0.009 632 | 0.840 534 | 0.841 166 | -21.793 | 179.651 | 157.857 | -0.0987 | 0.8630 | 0.7643 |
| -60 | 0.0226 | 0.009 637 | 0.637 274 | 0.637 910 | -17.469 | 177.653 | 160.184 | -0.0782 | 0.8334 | 0.7552 |
| -55 | 0.0300 | 0.009 642 | 0.490 358 | 0.491 000 | -13.129 | 175.641 | 162.512 | -0.0581 | 0.8051 | 0.7470 |
| -50 | 0.0391 | 0.009 648 | 0.382 457 | 0.383 105 | -8.772 | 173.611 | 164.840 | -0.0384 | 0.7779 | 0.7396 |
| -45 | 0.0504 | 0.009 654 | 0.302 029 | 0.302 682 | -4.396 | 171.558 | 167.163 | -0.0190 | 0.7519 | 0.7329 |
| -40 | 0.0642 | 0.009 659 | 0.241 251 | 0.241 910 | -0.000 | 169.479 | 169.479 | -0.0000 | 0.7269 | 0.7269 |
| -35 | 0.0807 | 0.009 666 | 0.194 732 | 0.195 398 | 4.416 | 167.368 | 171.784 | 0.0187 | 0.7027 | 0.7214 |
| -30 | 0.1004 | 0.009 672 | 0.158 703 | 0.159 375 | 8.854 | 165.222 | 174.076 | 0.0371 | 0.6795 | 0.7165 |
| -25 | 0.1237 | 0.009 679 | 0.130 487 | 0.131 166 | 13.315 | 163.037 | 176.357 | 0.0552 | 0.6570 | 0.7121 |
| -20 | 0.1509 | 0.009 685 | 0.108 162 | 0.108 847 | 17.800 | 160.810 | 178.610 | 0.0730 | 0.6352 | 0.7082 |
| -15 | 0.1826 | 0.009 693 | 0.090 126 | 0.091 018 | 22.312 | 158.534 | 180.846 | 0.0906 | 0.6141 | 0.7046 |
| -10 | 0.2191 | 0.009 700 | 0.075 946 | 0.076 646 | 26.851 | 156.207 | 183.058 | 0.1079 | 0.5936 | 0.7014 |
| -5 | 0.2610 | 0.009 708 | 0.064 255 | 0.064 963 | 31.420 | 153.823 | 185.243 | 0.1250 | 0.5736 | 0.6986 |
| 0 | 0.3086 | 0.009 716 | 0.054 673 | 0.055 389 | 36.022 | 151.376 | 187.397 | 0.1418 | 0.5542 | 0.6960 |
| 5 | 0.3626 | 0.009 724 | 0.046 761 | 0.047 485 | 40.659 | 148.859 | 189.518 | 0.1585 | 0.5351 | 0.6937 |
| 10 | 0.4233 | 0.009 733 | 0.040 180 | 0.040 914 | 45.337 | 146.265 | 191.602 | 0.1750 | 0.5165 | 0.6916 |
| 15 | 0.4914 | 0.009 743 | 0.034 671 | 0.035 413 | 50.058 | 143.586 | 193.644 | 0.1914 | 0.4983 | 0.6897 |
| 20 | 0.5673 | 0.009 752 | 0.030 028 | 0.030 780 | 54.828 | 140.812 | 195.641 | 0.2076 | 0.4803 | 0.6879 |
| 25 | 0.6516 | 0.009 763 | 0.026 091 | 0.026 854 | 59.653 | 137.933 | 197.586 | 0.2237 | 0.4626 | 0.6863 |
| 30 | 0.7449 | 0.009 774 | 0.022 734 | 0.023 508 | 64.539 | 134.936 | 199.475 | 0.2397 | 0.4451 | 0.6848 |
| 35 | 0.8477 | 0.009 786 | 0.019 855 | 0.020 641 | 69.494 | 131.805 | 201.299 | 0.2557 | 0.4277 | 0.6834 |
| 40 | 0.9607 | 0.009 798 | 0.017 373 | 0.018 171 | 74.527 | 128.525 | 203.051 | 0.2716 | 0.4104 | 0.6820 |
| 45 | 1.0843 | 0.009 811 | 0.015 220 | 0.016 032 | 79.647 | 125.074 | 204.722 | 0.2875 | 0.3931 | 0.6806 |
| 50 | 1.2193 | 0.009 826 | 0.013 344 | 0.014 170 | 84.868 | 121.430 | 206.298 | 0.3034 | 0.3758 | 0.6792 |
| 55 | 1.3663 | 0.009 841 | 0.011 701 | 0.012 542 | 90.201 | 117.565 | 207.766 | 0.3194 | 0.3582 | 0.6777 |
| 60 | 1.5259 | 0.009 858 | 0.010 253 | 0.011 111 | 95.665 | 113.443 | 209.109 | 0.3355 | 0.3405 | 0.6760 |
| 65 | 1.6988 | 0.009 877 | 0.008 971 | 0.009 847 | 101.279 | 109.024 | 210.303 | 0.3518 | 0.3224 | 0.6742 |
| 70 | 1.8858 | 0.009 897 | 0.007 828 | 0.008 725 | 107.067 | 104.255 | 211.321 | 0.3683 | 0.3038 | 0.6721 |
| 75 | 2.0874 | 0.009 920 | 0.006 802 | 0.007 723 | 113.058 | 99.068 | 212.126 | 0.3851 | 0.2845 | 0.6697 |
| 80 | 2.3046 | 0.009 946 | 0.005 875 | 0.006 821 | 119.291 | 93.373 | 212.665 | 0.4023 | 0.2644 | 0.6667 |
| 85 | 2.5380 | 0.009 976 | 0.005 029 | 0.006 005 | 125.818 | 87.047 | 212.865 | 0.4201 | 0.2430 | 0.6631 |
| 90 | 2.7885 | 0.010 012 | 0.004 246 | 0.005 258 | 132.708 | 79.907 | 212.614 | 0.4385 | 0.2200 | 0.6585 |
| 95 | 3.0569 | 0.010 056 | 0.003 508 | 0.004 563 | 140.068 | 71.658 | 211.726 | 0.4579 | 0.1946 | 0.6526 |
| 100 | 3.3440 | 0.010 113 | 0.002 790 | 0.003 903 | 148.076 | 61.768 | 209.843 | 0.4788 | 0.1655 | 0.6444 |
| 105 | 3.6509 | 0.010 197 | 0.002 045 | 0.003 242 | 157.085 | 49.014 | 206.099 | 0.5023 | 0.1296 | 0.6319 |
| 110 | 3.9784 | 0.010 364 | 0.001 098 | 0.002 462 | 168.059 | 28.425 | 196.484 | 0.5322 | 0.0742 | 0.6064 |
| 112 | 4.1155 | 0.010 792 | 0.000 005 | 0.001 797 | 174.920 | 0.151 | 175.071 | 0.5651 | 0.0004 | 0.5655 |

Source: Consistent with values presented in "Thermodynamic Properties of Freon-12," E. J. du Pont de Nemours and Company, Inc., 1956

國立清華大學 命題紙

八十六學年度工程系統科學系(所) 組碩士班研究生入學考試

科目 工程熱力學 科號 4012 共 六 頁第 五 頁 *請在試卷【答案卷】內作答

Superheated R-12 (SI Units)

| t °C | v m ³ /kg | h kJ/kg | s kJ/kg K | v m ³ /kg | h kJ/kg | s kJ/kg K | v m ³ /kg | h kJ/kg | s kJ/kg K |
|-----------------|---------------------------|--------------|----------------|---------------------------|--------------|----------------|---------------------------|--------------|----------------|
| 0.05 MPa | | | | | | | | | |
| 20 | 0.341 857 | 181.042 | 0.7912 | 0.167 701 | 179.861 | 0.7401 | | | |
| 40 | 0.356 227 | 186.757 | 0.8133 | 0.175 222 | 185.707 | 0.7628 | 0.114 716 | 184.619 | 0.7318 |
| 60 | 0.370 508 | 192.567 | 0.8350 | 0.182 647 | 191.628 | 0.7849 | 0.119 866 | 190.660 | 0.7543 |
| 80 | 0.384 716 | 198.471 | 0.8562 | 0.189 994 | 197.628 | 0.8064 | 0.124 932 | 196.762 | 0.7763 |
| 100 | 0.398 863 | 204.469 | 0.8770 | 0.197 277 | 203.707 | 0.8275 | 0.129 930 | 202.927 | 0.7977 |
| 120 | 0.412 959 | 210.557 | 0.8974 | 0.204 506 | 209.866 | 0.8482 | 0.134 873 | 209.160 | 0.8186 |
| 140 | 0.427 012 | 216.733 | 0.9175 | 0.211 691 | 216.104 | 0.8684 | 0.139 768 | 215.463 | 0.8390 |
| 160 | 0.441 030 | 222.997 | 0.9372 | 0.218 839 | 222.421 | 0.8883 | 0.144 625 | 221.835 | 0.8591 |
| 180 | 0.455 017 | 229.344 | 0.9565 | 0.225 955 | 228.815 | 0.9078 | 0.149 450 | 228.277 | 0.8787 |
| 200 | 0.468 978 | 235.774 | 0.9755 | 0.233 044 | 235.285 | 0.9269 | 0.154 247 | 234.789 | 0.8980 |
| 220 | 0.482 917 | 242.282 | 0.9942 | 0.240 111 | 241.829 | 0.9457 | 0.159 020 | 241.371 | 0.9169 |
| 240 | 0.496 838 | 248.868 | 1.0126 | 0.247 159 | 248.446 | 0.9642 | 0.163 774 | 248.020 | 0.9354 |
| 0.10 MPa | | | | | | | | | |
| 20 | 0.088 608 | 189.669 | 0.7320 | 0.069 752 | 188.644 | 0.7139 | 0.057 150 | 187.583 | 0.6984 |
| 40 | 0.097 550 | 195.878 | 0.7543 | 0.073 024 | 194.969 | 0.7366 | 0.059 984 | 194.034 | 0.7216 |
| 60 | 0.106 418 | 202.135 | 0.7760 | 0.076 218 | 201.322 | 0.7587 | 0.062 734 | 200.490 | 0.7440 |
| 80 | 0.110 228 | 208.446 | 0.7972 | 0.079 350 | 207.715 | 0.7801 | 0.065 418 | 206.969 | 0.7658 |
| 100 | 0.110 989 | 214.814 | 0.8178 | 0.082 431 | 214.153 | 0.8010 | 0.068 049 | 213.480 | 0.7869 |
| 120 | 0.107 710 | 221.243 | 0.8381 | 0.085 470 | 220.642 | 0.8214 | 0.070 635 | 220.030 | 0.8075 |
| 140 | 0.111 397 | 227.735 | 0.8578 | 0.088 474 | 227.185 | 0.8413 | 0.073 185 | 226.627 | 0.8276 |
| 160 | 0.115 055 | 234.291 | 0.8772 | 0.091 449 | 233.785 | 0.8608 | 0.075 705 | 233.273 | 0.8471 |
| 180 | 0.118 690 | 240.910 | 0.8962 | 0.094 398 | 240.443 | 0.8800 | 0.078 200 | 239.971 | 0.8663 |
| 200 | 0.122 304 | 247.593 | 0.9149 | 0.097 327 | 247.160 | 0.8987 | 0.080 673 | 246.723 | 0.8853 |
| 220 | 0.125 901 | 254.339 | 0.9332 | 0.100 238 | 253.936 | 0.9171 | 0.083 127 | 253.530 | 0.9038 |
| 240 | 0.129 483 | 261.147 | 0.9512 | 0.103 134 | 260.770 | 0.9352 | 0.085 566 | 260.391 | 0.9220 |
| 0.20 MPa | | | | | | | | | |
| 20 | 0.045 836 | 198.762 | 0.7199 | 0.035 646 | 196.935 | 0.6999 | | | |
| 40 | 0.047 971 | 205.428 | 0.7421 | 0.037 464 | 203.814 | 0.7230 | 0.030 422 | 202.116 | 0.7063 |
| 60 | 0.050 046 | 212.095 | 0.7639 | 0.039 214 | 210.656 | 0.7452 | 0.031 966 | 209.154 | 0.7291 |
| 80 | 0.052 072 | 218.779 | 0.7849 | 0.040 916 | 217.484 | 0.7667 | 0.033 450 | 216.141 | 0.7511 |
| 100 | 0.054 059 | 225.488 | 0.8054 | 0.042 565 | 224.315 | 0.7875 | 0.034 887 | 223.104 | 0.7723 |
| 120 | 0.056 014 | 232.230 | 0.8253 | 0.044 184 | 231.161 | 0.8077 | 0.036 285 | 230.062 | 0.7929 |
| 140 | 0.057 941 | 239.012 | 0.8448 | 0.045 774 | 238.031 | 0.8275 | 0.037 653 | 237.027 | 0.8129 |
| 160 | 0.059 846 | 245.837 | 0.8638 | 0.047 340 | 244.932 | 0.8467 | 0.038 995 | 244.009 | 0.8324 |
| 180 | 0.061 731 | 252.707 | 0.8825 | 0.048 886 | 251.869 | 0.8656 | 0.040 316 | 251.016 | 0.8514 |
| 200 | 0.063 600 | 259.624 | 0.9008 | 0.050 415 | 258.845 | 0.8840 | 0.041 619 | 258.053 | 0.8700 |
| 220 | 0.065 455 | 266.590 | 0.9187 | 0.051 929 | 265.862 | 0.9021 | 0.042 907 | 265.124 | 0.8882 |
| 240 | 0.067 298 | 273.605 | 0.9364 | 0.053 430 | 272.923 | 0.9198 | 0.044 181 | 272.231 | 0.9061 |
| 0.40 MPa | | | | | | | | | |
| 20 | 0.026 761 | 297.580 | 0.7148 | 0.022 850 | 295.924 | 0.7016 | 0.019 744 | 294.170 | 0.6982 |
| 40 | 0.028 100 | 214.745 | 0.7373 | 0.024 068 | 213.790 | 0.7248 | 0.020 912 | 211.765 | 0.7131 |
| 60 | 0.029 387 | 221.854 | 0.7590 | 0.025 247 | 220.558 | 0.7469 | 0.022 032 | 219.212 | 0.7358 |
| 80 | 0.030 632 | 228.931 | 0.7799 | 0.026 380 | 227.766 | 0.7682 | 0.023 062 | 226.564 | 0.7575 |
| 100 | 0.031 843 | 235.997 | 0.8002 | 0.027 477 | 234.941 | 0.7888 | 0.024 072 | 233.856 | 0.7785 |
| 120 | 0.033 027 | 243.066 | 0.8199 | 0.028 545 | 242.101 | 0.8088 | 0.025 051 | 241.113 | 0.7987 |
| 140 | 0.034 189 | 250.146 | 0.8392 | 0.029 588 | 249.260 | 0.8283 | 0.026 005 | 248.355 | 0.8184 |
| 160 | 0.035 332 | 257.247 | 0.8579 | 0.030 612 | 256.428 | 0.8472 | 0.026 937 | 255.593 | 0.8376 |
| 180 | 0.036 458 | 264.374 | 0.8763 | 0.031 619 | 263.613 | 0.8657 | 0.027 851 | 262.839 | 0.8562 |
| 200 | 0.037 572 | 271.531 | 0.8943 | 0.032 612 | 270.820 | 0.8838 | 0.028 751 | 270.100 | 0.8745 |
| 220 | 0.038 673 | 278.720 | 0.9119 | 0.033 592 | 278.055 | 0.9016 | 0.029 639 | 277.381 | 0.8925 |
| 240 | 0.039 764 | 285.946 | 0.9292 | 0.034 563 | 285.320 | 0.9189 | 0.030 515 | 284.687 | 0.9098 |

(Continued)

八十六學年度工程與系統科學系(所) 組碩士班研究生入學考試

科目 工程熱力學 科號 4012 共 六 頁第 六 頁 *請在試卷【答案卷】內作答

(Continued) Superheated R-12 (SI Units)

| Temp °C | v m ³ /kg | h kJ/kg | s kJ/kg K | v m ³ /kg | h kJ/kg | s kJ/kg K | v m ³ /kg | h kJ/kg | s kJ/kg K |
|-----------------|---------------------------|--------------|-----------------|---------------------------|--------------|-----------------|---------------------------|--------------|----------------|
| 1.00 MPa | | | 1.20 MPa | | | 1.40 MPa | | | |
| 50.0 | 0.018 366 | 210.162 | 0.7021 | 0.014 483 | 206.661 | 0.6812 | | | |
| 60.0 | 0.019 410 | 217.810 | 0.7254 | 0.015 463 | 214.805 | 0.7060 | 0.012 579 | 211.457 | 0.6876 |
| 70.0 | 0.020 397 | 225.319 | 0.7476 | 0.016 368 | 222.687 | 0.7293 | 0.013 448 | 219.822 | 0.7123 |
| 80.0 | 0.021 341 | 232.739 | 0.7689 | 0.017 221 | 230.398 | 0.7514 | 0.014 247 | 227.891 | 0.7355 |
| 90.0 | 0.022 251 | 240.101 | 0.7895 | 0.018 032 | 237.995 | 0.7727 | 0.014 997 | 235.766 | 0.7575 |
| 100.0 | 0.023 133 | 247.430 | 0.8094 | 0.018 812 | 245.518 | 0.7931 | 0.015 710 | 243.512 | 0.7785 |
| 110.0 | 0.023 993 | 254.743 | 0.8287 | 0.019 567 | 252.993 | 0.8129 | 0.016 393 | 251.170 | 0.7988 |
| 120.0 | 0.024 835 | 262.053 | 0.8475 | 0.020 301 | 260.441 | 0.8320 | 0.017 053 | 258.770 | 0.8183 |
| 130.0 | 0.025 661 | 269.369 | 0.8654 | 0.021 018 | 267.875 | 0.8507 | 0.017 695 | 266.334 | 0.8373 |
| 140.0 | 0.026 474 | 276.699 | 0.8839 | 0.021 721 | 275.307 | 0.8689 | 0.018 321 | 273.877 | 0.8558 |
| 150.0 | 0.027 275 | 284.047 | 0.9015 | 0.022 412 | 282.745 | 0.8867 | 0.018 934 | 281.411 | 0.8738 |
| 160.0 | 0.028 068 | 291.419 | 0.9187 | 0.023 093 | 290.195 | 0.9041 | 0.019 535 | 288.946 | 0.8914 |
| 1.60 MPa | | | 1.80 MPa | | | 2.00 MPa | | | |
| 70.0 | 0.011 208 | 216.650 | 0.6959 | 0.009 406 | 213.049 | 0.6794 | | | |
| 80.0 | 0.011 984 | 225.177 | 0.7204 | 0.010 187 | 222.198 | 0.7057 | 0.008 704 | 218.859 | 0.6989 |
| 90.0 | 0.012 698 | 233.390 | 0.7437 | 0.010 884 | 230.835 | 0.7298 | 0.009 406 | 228.056 | 0.7166 |
| 100.0 | 0.013 366 | 241.397 | 0.7651 | 0.011 526 | 239.155 | 0.7524 | 0.010 035 | 236.760 | 0.7402 |
| 110.0 | 0.014 000 | 249.264 | 0.7859 | 0.012 126 | 247.264 | 0.7739 | 0.010 615 | 245.154 | 0.7624 |
| 120.0 | 0.014 608 | 257.035 | 0.8059 | 0.012 697 | 255.228 | 0.7944 | 0.011 159 | 253.341 | 0.7835 |
| 130.0 | 0.015 195 | 264.742 | 0.8253 | 0.013 244 | 263.094 | 0.8141 | 0.011 676 | 261.384 | 0.8017 |
| 140.0 | 0.015 765 | 272.406 | 0.8440 | 0.013 772 | 270.891 | 0.8332 | 0.012 172 | 269.327 | 0.8232 |
| 150.0 | 0.016 320 | 280.044 | 0.8627 | 0.014 284 | 278.642 | 0.8518 | 0.012 651 | 277.201 | 0.8420 |
| 160.0 | 0.016 864 | 287.669 | 0.8801 | 0.014 784 | 286.364 | 0.8698 | 0.013 116 | 285.027 | 0.8603 |
| 170.0 | 0.017 398 | 295.290 | 0.8975 | 0.015 272 | 294.069 | 0.8874 | 0.013 570 | 292.822 | 0.8781 |
| 180.0 | 0.017 923 | 302.914 | 0.9145 | 0.015 752 | 301.767 | 0.9046 | 0.014 013 | 300.598 | 0.8955 |
| 2.50 MPa | | | 3.00 MPa | | | 3.50 MPa | | | |
| 90.0 | 0.006 595 | 219.562 | 0.6823 | | | | | | |
| 100.0 | 0.007 264 | 229.852 | 0.7103 | 0.005 231 | 220.529 | 0.6770 | | | |
| 110.0 | 0.007 837 | 239.271 | 0.7352 | 0.005 846 | 232.068 | 0.7075 | 0.004 324 | 222.121 | 0.6750 |
| 120.0 | 0.008 351 | 248.192 | 0.7582 | 0.006 419 | 242.208 | 0.7336 | 0.004 959 | 234.875 | 0.7078 |
| 130.0 | 0.008 827 | 256.794 | 0.7798 | 0.006 947 | 251.632 | 0.7573 | 0.005 456 | 245.661 | 0.7349 |
| 140.0 | 0.009 273 | 265.180 | 0.8003 | 0.007 313 | 260.620 | 0.7793 | 0.005 884 | 255.524 | 0.7593 |
| 150.0 | 0.009 697 | 273.414 | 0.8200 | 0.007 709 | 269.319 | 0.8001 | 0.006 270 | 264.846 | 0.7814 |
| 160.0 | 0.010 104 | 281.546 | 0.8390 | 0.008 083 | 277.817 | 0.8200 | 0.006 626 | 273.817 | 0.8023 |
| 170.0 | 0.010 497 | 289.589 | 0.8574 | 0.008 439 | 286.171 | 0.8391 | 0.006 961 | 282.545 | 0.8222 |
| 180.0 | 0.010 879 | 297.583 | 0.8752 | 0.008 782 | 294.422 | 0.8575 | 0.007 279 | 291.100 | 0.8413 |
| 190.0 | 0.011 250 | 305.540 | 0.8926 | 0.009 114 | 302.597 | 0.8753 | 0.007 584 | 299.528 | 0.8597 |
| 200.0 | 0.011 614 | 313.472 | 0.9095 | 0.009 436 | 310.718 | 0.8927 | 0.007 878 | 307.864 | 0.8775 |
| 4.80 MPa | | | 5.80 MPa | | | 6.80 MPa | | | |
| 120.0 | 0.003 736 | 224.863 | 0.6771 | | | | | | |
| 130.0 | 0.004 325 | 238.443 | 0.7111 | | | | | | |
| 140.0 | 0.004 781 | 249.703 | 0.7386 | | | | | | |
| 150.0 | 0.005 172 | 259.904 | 0.7630 | | | | | | |
| 160.0 | 0.005 523 | 269.492 | 0.7854 | | | | | | |
| 170.0 | 0.005 845 | 278.684 | 0.8063 | | | | | | |
| 180.0 | 0.006 147 | 287.602 | 0.8262 | | | | | | |
| 190.0 | 0.006 434 | 296.326 | 0.8453 | | | | | | |
| 200.0 | 0.006 708 | 304.906 | 0.8636 | | | | | | |
| 210.0 | 0.006 972 | 313.380 | 0.8813 | | | | | | |
| 220.0 | 0.007 228 | 321.774 | 0.8985 | | | | | | |
| 230.0 | 0.007 477 | 330.108 | 0.9152 | | | | | | |