



جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة الفرات الأوسط التقنية
الكلية التقنية الهندسية / النجف



قسم هندسة تقنيات السيارات

المرحلة الأولى

أسئلة الفصل الأول للعام الدراسي

٢٠١٥-٢٠١٦

شعبة صيانة الجوانب و الإطارات



Subject: Thermodynamic
Time: 2 hours

Class: 1st year
Date: 21 / 2 / 2016

Notes// 1. Please read the questions carefully, 2. Answer all question

Useful data: (The acceleration of gravity is: $g = 9.81 \text{ m/s}^2$, density of mercury (Hg): $\rho_{\text{Hg}} = 13595 \text{ kg/m}^3$, For ideal gas: the constant gas of air is : $R = 0.287 \text{ kJ/kg} \cdot \text{K}$)

Q1\\ Multiple Choice: Identify the choice that best answers of the following questions. (20%)

1. The measured temperature of a system is 25°C. Its exact absolute temperature in K is:

- A) 303.15K B) 293.15 K C) 186.15 K D) 298.15 K

2. In a closed thermodynamic system there is:

- A) only mass transfer B) only energy transfer
C) both mass and energy transfer D) none of the above

3. Convert 101.3 kPa of atmospheric pressure to absolute millimeters of mercury:

- A) 720 mm of Hg B) 740 mm of Hg C) 760 mm of Hg D) 770 mm of Hg

4. Which of the following is not an intensive property?

- A) pressure B) density C) temperature D) volume

5. In general compressed liquid is characterized by:

- A) $P_{\text{given}} > P_{\text{sat}}$ at a given T
B) $u_{\text{given}} > u_f$ at a given T or P
C) $P_{\text{given}} < P_{\text{sat}}$ at a given T
D) $h_{\text{given}} > h_f$ at a given T or P

6. For an ideal gas, according to Boyle's law:

- A) $p \cdot v = \text{constant}$, if T is kept constant.
B) $p/T = \text{constant}$, if v is kept constant.
C) $v/T = \text{constant}$, if p is kept constant.
D) $T/p = \text{constant}$, if v is kept constant.

7. Estimate the entropy of refrigerant -134a at $T = 40^\circ\text{C}$, and $P = 180 \text{ kPa}$:

- A) 1.9518 kJ/kg.K B) 1.5236 kJ/kg.K C) 1.5127 kJ/kg.K D) 1.0975 kJ/kg.K

8. Two identical boxes X and Y each contain an ideal gas, The ratio of $\frac{P_X}{P_Y}$ is:

Container X
Volume, V
Temperature, T
2N moles
Pressure, P_X

Container Y
Volume, V/3
Temperature, 2T
N moles
Pressure, P_Y

- A) 2/3 B) 3/2 C) 1/3 D) 3

9. Thermodynamic system may be defined as a quantity of matter upon which attention is focused for study if:

- A) it is only bounded by real surface.
B) the boundary surfaces are constant in shape and volume.
C) it is not bounded by imaginary surface.
D) it is bounded by either real surfaces or imaginary surfaces irrespective of shape or volume.

10. The quality of saturated refrigerant -134a at 200 kPa and $v = 0.0849 \text{ m}^3/\text{kg}$ is nearest:

- A) 65% B) 75% C) 85% D) 95%



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Q2. A//

(10 %)

In a condenser, the vacuum is found to be 145 mm of mercury and the barometer reads the atmospheric 735 mm of mercury. Find the absolute pressure in a condenser in (kPa).

Q2. B//

(10 %)

A pressure vessel with a volume of 0.003 m^3 contains 0.01 kg of an ideal gas. Initially, the absolute pressure and temperature of the gas are 5 bar and 120°C respectively. The gas is undergone an expansion process to a pressure and volume of 1 bar and 0.02 m^3 respectively. Determine the molecular mass and the temperature of the gas at the final condition.

**Q3. ** Complete the following table for water:

(20%)

NO.	T ($^\circ \text{C}$)	P (kPa)	h (kJ/kg)	x =..., if applicable	Phase Description,
1		2000	908.47		
2	115		1875.8		
3		2750			Saturated vapor
4		1400	3921.7		
5	160	15000			

**Q4. ** 1 kg of air in a closed tank initially at 25°C and 1 bar undergoes a cyclic process consisting of the following processes:

Process (1-2): constant volume heating to a pressure of 2 bar

Process (2-3): constant temperature expansion

Process (3-1): constant pressure compression. Assuming the air as an ideal gas: (a) Sketch the processes on a (p-u) diagram and (b) determine the temperature at state 2 and the volume at state 3.

(20%)

**Q5. ** Superheated water at 3 MPa and 600°C is allowed to cool at constant volume until the temperature drops to 120°C . At the final state, (a) the pressure (b) the quality, and (c) the enthalpy, also show the process on a T-v diagram with respect to saturation lines.

(20%)

~~~~~ With Best Wishes ~~~~~

Lecture\ Salah M.S.

Head of Dept.



Subject: Thermodynamic  
Time: 2 hours

Class: 1<sup>st</sup> year  
Date: 21 / 2 / 2016

Notes// 1. Please read the questions carefully, 2. Answer all question

TABLE A-4

Saturated water—Temperature table

| Temp.,<br>$T$ °C | Sat.<br>press.,<br>$P_{sat}$ kPa | Specific volume,<br>$m^3/kg$ |                         | Internal energy,<br>kJ/kg |                    |                         | Enthalpy,<br>kJ/kg       |                    |                         | Entropy,<br>kJ/kg·K      |                    |                         |
|------------------|----------------------------------|------------------------------|-------------------------|---------------------------|--------------------|-------------------------|--------------------------|--------------------|-------------------------|--------------------------|--------------------|-------------------------|
|                  |                                  | Sat.<br>liquid,<br>$v_f$     | Sat.<br>vapor,<br>$v_g$ | Sat.<br>liquid,<br>$u_f$  | Evap.,<br>$u_{fg}$ | Sat.<br>vapor,<br>$u_g$ | Sat.<br>liquid,<br>$h_f$ | Evap.,<br>$h_{fg}$ | Sat.<br>vapor,<br>$h_g$ | Sat.<br>liquid,<br>$s_f$ | Evap.,<br>$s_{fg}$ | Sat.<br>vapor,<br>$s_g$ |
| 0.01             | 0.6117                           | 0.001000                     | 206.00                  | 0.000                     | 2374.9             | 2374.9                  | 0.001                    | 2500.9             | 2500.9                  | 0.0000                   | 9.1556             | 9.1556                  |
| 5                | 0.8725                           | 0.001000                     | 147.03                  | 21.019                    | 2360.8             | 2381.8                  | 21.020                   | 2489.1             | 2510.1                  | 0.0763                   | 8.9487             | 9.0249                  |
| 10               | 1.2281                           | 0.001000                     | 106.32                  | 42.020                    | 2346.6             | 2388.7                  | 42.022                   | 2477.2             | 2519.2                  | 0.1511                   | 8.7488             | 8.8999                  |
| 15               | 1.7057                           | 0.001001                     | 77.885                  | 62.980                    | 2332.5             | 2395.5                  | 62.982                   | 2465.4             | 2528.3                  | 0.2245                   | 8.5559             | 8.7803                  |
| 20               | 2.3392                           | 0.001002                     | 57.762                  | 83.913                    | 2318.4             | 2402.3                  | 83.915                   | 2453.5             | 2537.4                  | 0.2965                   | 8.3696             | 8.6661                  |
| 25               | 3.1698                           | 0.001003                     | 43.340                  | 104.83                    | 2304.3             | 2409.1                  | 104.83                   | 2441.7             | 2546.5                  | 0.3672                   | 8.1895             | 8.5567                  |
| 30               | 4.2469                           | 0.001004                     | 32.879                  | 125.73                    | 2290.2             | 2415.9                  | 125.74                   | 2429.8             | 2555.6                  | 0.4368                   | 8.0152             | 8.4520                  |
| 35               | 5.6291                           | 0.001006                     | 25.205                  | 146.63                    | 2276.0             | 2422.7                  | 146.64                   | 2417.9             | 2564.6                  | 0.5051                   | 7.8466             | 8.3517                  |
| 40               | 7.3851                           | 0.001008                     | 19.515                  | 167.53                    | 2261.9             | 2429.4                  | 167.53                   | 2406.0             | 2573.5                  | 0.5724                   | 7.6832             | 8.2556                  |
| 45               | 9.5953                           | 0.001010                     | 15.251                  | 188.43                    | 2247.7             | 2436.1                  | 188.44                   | 2394.0             | 2582.4                  | 0.6386                   | 7.5247             | 8.1633                  |
| 50               | 12.349                           | 0.001012                     | 11.158                  | 209.10                    | 2233.6             | 2442.7                  | 209.10                   | 2381.2             | 2591.3                  | 0.7038                   | 7.3711             | 8.0749                  |
| 55               | 15.755                           | 0.001014                     | 8.1493                  | 229.93                    | 2219.5             | 2449.4                  | 229.93                   | 2368.4             | 2600.3                  | 0.7681                   | 7.2238             | 7.9919                  |
| 60               | 19.947                           | 0.001016                     | 5.9823                  | 250.10                    | 2205.4             | 2456.0                  | 250.10                   | 2355.6             | 2609.3                  | 0.8315                   | 7.0822             | 7.9137                  |
| 65               | 25.033                           | 0.001018                     | 4.3511                  | 270.82                    | 2191.3             | 2462.7                  | 270.82                   | 2342.8             | 2618.3                  | 0.8938                   | 6.9411             | 7.8349                  |
| 70               | 31.193                           | 0.001020                     | 3.1573                  | 291.20                    | 2177.2             | 2469.4                  | 291.20                   | 2330.0             | 2627.3                  | 0.9551                   | 6.8000             | 7.7561                  |
| 75               | 38.597                           | 0.001026                     | 2.2810                  | 311.99                    | 2163.1             | 2475.3                  | 311.99                   | 2317.2             | 2636.3                  | 1.0158                   | 6.6585             | 7.6812                  |
| 80               | 47.416                           | 0.001029                     | 1.6123                  | 334.97                    | 2149.0             | 2481.6                  | 334.97                   | 2304.3             | 2645.3                  | 1.0756                   | 6.5165             | 7.6111                  |
| 85               | 57.868                           | 0.001032                     | 1.1480                  | 355.96                    | 2134.9             | 2487.8                  | 355.96                   | 2291.5             | 2654.3                  | 1.1346                   | 6.3745             | 7.5435                  |
| 90               | 70.183                           | 0.001036                     | 0.8353                  | 376.97                    | 2120.8             | 2494.0                  | 376.97                   | 2278.6             | 2663.3                  | 1.1929                   | 6.2325             | 7.4782                  |
| 95               | 84.609                           | 0.001040                     | 0.6148                  | 398.00                    | 2106.7             | 2500.1                  | 398.00                   | 2265.7             | 2672.3                  | 1.2504                   | 6.0905             | 7.4151                  |
| 100              | 101.42                           | 0.001043                     | 0.4620                  | 419.06                    | 2092.6             | 2506.0                  | 419.06                   | 2252.8             | 2681.3                  | 1.3072                   | 5.9479             | 7.3542                  |
| 105              | 120.90                           | 0.001047                     | 0.3393                  | 440.15                    | 2078.5             | 2511.9                  | 440.15                   | 2240.0             | 2690.3                  | 1.3634                   | 5.8053             | 7.2952                  |
| 110              | 143.38                           | 0.001052                     | 0.2478                  | 461.27                    | 2064.4             | 2517.7                  | 461.27                   | 2227.2             | 2699.3                  | 1.4188                   | 5.6627             | 7.2382                  |
| 115              | 169.18                           | 0.001056                     | 0.1807                  | 482.42                    | 2050.3             | 2523.3                  | 482.42                   | 2214.4             | 2708.3                  | 1.4737                   | 5.5201             | 7.1829                  |
| 120              | 198.67                           | 0.001060                     | 0.1318                  | 503.60                    | 2036.2             | 2528.9                  | 503.60                   | 2201.6             | 2717.3                  | 1.5279                   | 5.3775             | 7.1292                  |
| 125              | 232.23                           | 0.001065                     | 0.0993                  | 524.83                    | 2022.1             | 2534.3                  | 524.83                   | 2188.8             | 2726.3                  | 1.5816                   | 5.2349             | 7.0771                  |
| 130              | 270.28                           | 0.001070                     | 0.0736                  | 546.10                    | 2008.0             | 2539.5                  | 546.10                   | 2176.0             | 2735.3                  | 1.6346                   | 5.0923             | 7.0265                  |
| 135              | 313.22                           | 0.001075                     | 0.0548                  | 567.41                    | 1993.9             | 2544.7                  | 567.41                   | 2163.2             | 2744.3                  | 1.6872                   | 4.9497             | 6.9773                  |
| 140              | 361.53                           | 0.001080                     | 0.0408                  | 588.77                    | 1979.8             | 2549.6                  | 588.77                   | 2150.4             | 2753.3                  | 1.7392                   | 4.8071             | 6.9294                  |
| 145              | 415.58                           | 0.001085                     | 0.0306                  | 610.19                    | 1965.7             | 2554.4                  | 610.19                   | 2137.6             | 2762.3                  | 1.7908                   | 4.6645             | 6.8827                  |
| 150              | 476.16                           | 0.001091                     | 0.0228                  | 631.66                    | 1951.6             | 2559.1                  | 631.66                   | 2124.8             | 2771.3                  | 1.8418                   | 4.5219             | 6.8371                  |
| 155              | 543.49                           | 0.001096                     | 0.0171                  | 653.19                    | 1937.5             | 2563.5                  | 653.19                   | 2112.0             | 2780.3                  | 1.8924                   | 4.3793             | 6.7927                  |
| 160              | 618.23                           | 0.001102                     | 0.0128                  | 674.79                    | 1923.4             | 2567.8                  | 674.79                   | 2100.0             | 2789.3                  | 1.9426                   | 4.2367             | 6.7492                  |
| 165              | 700.93                           | 0.001108                     | 0.0096                  | 696.46                    | 1909.3             | 2571.9                  | 696.46                   | 2088.0             | 2798.3                  | 1.9923                   | 4.0941             | 6.7067                  |
| 170              | 792.18                           | 0.001114                     | 0.0072                  | 718.20                    | 1895.2             | 2575.7                  | 718.20                   | 2076.0             | 2807.3                  | 2.0417                   | 3.9515             | 6.6650                  |
| 175              | 892.60                           | 0.001121                     | 0.0054                  | 740.02                    | 1881.1             | 2579.4                  | 740.02                   | 2064.0             | 2816.3                  | 2.0906                   | 3.8089             | 6.6242                  |
| 180              | 1002.8                           | 0.001127                     | 0.0041                  | 761.92                    | 1867.0             | 2583.0                  | 761.92                   | 2052.0             | 2825.3                  | 2.1392                   | 3.6663             | 6.5841                  |
| 185              | 1123.5                           | 0.001134                     | 0.0030                  | 783.91                    | 1852.9             | 2586.6                  | 783.91                   | 2040.0             | 2834.3                  | 2.1875                   | 3.5237             | 6.5447                  |
| 190              | 1255.2                           | 0.001141                     | 0.0022                  | 806.00                    | 1838.8             | 2590.0                  | 806.00                   | 2028.0             | 2843.3                  | 2.2355                   | 3.3811             | 6.5059                  |
| 195              | 1398.8                           | 0.001149                     | 0.0016                  | 828.18                    | 1824.7             | 2593.7                  | 828.18                   | 2016.0             | 2852.3                  | 2.2831                   | 3.2385             | 6.4678                  |
| 200              | 1554.9                           | 0.001157                     | 0.0012                  | 850.46                    | 1810.6             | 2597.2                  | 850.46                   | 2004.0             | 2861.3                  | 2.3305                   | 3.0959             | 6.4302                  |

TABLE A-5

Saturated water—Pressure table

| Press.,<br>$P$ kPa | Sat.<br>temp.,<br>$T_{sat}$ °C | Specific volume,<br>$m^3/kg$ |                         | Internal energy,<br>kJ/kg |                    |                         | Enthalpy,<br>kJ/kg       |                    |                         | Entropy,<br>kJ/kg·K      |                    |                         |
|--------------------|--------------------------------|------------------------------|-------------------------|---------------------------|--------------------|-------------------------|--------------------------|--------------------|-------------------------|--------------------------|--------------------|-------------------------|
|                    |                                | Sat.<br>liquid,<br>$v_f$     | Sat.<br>vapor,<br>$v_g$ | Sat.<br>liquid,<br>$u_f$  | Evap.,<br>$u_{fg}$ | Sat.<br>vapor,<br>$u_g$ | Sat.<br>liquid,<br>$h_f$ | Evap.,<br>$h_{fg}$ | Sat.<br>vapor,<br>$h_g$ | Sat.<br>liquid,<br>$s_f$ | Evap.,<br>$s_{fg}$ | Sat.<br>vapor,<br>$s_g$ |
| 1.0                | 6.97                           | 0.001000                     | 129.19                  | 29.302                    | 2355.2             | 2384.5                  | 29.303                   | 2484.4             | 2513.7                  | 0.1059                   | 8.8690             | 8.9749                  |
| 1.5                | 13.02                          | 0.001001                     | 87.964                  | 54.686                    | 2338.1             | 2392.8                  | 54.688                   | 2470.1             | 2524.7                  | 0.1956                   | 8.6314             | 8.8270                  |
| 2.0                | 17.50                          | 0.001001                     | 66.990                  | 73.431                    | 2325.5             | 2398.9                  | 73.433                   | 2459.5             | 2532.9                  | 0.2606                   | 8.4621             | 8.7227                  |
| 2.5                | 21.08                          | 0.001002                     | 54.242                  | 88.422                    | 2315.4             | 2403.8                  | 88.424                   | 2451.0             | 2539.4                  | 0.3118                   | 8.3302             | 8.6421                  |
| 3.0                | 24.08                          | 0.001003                     | 45.654                  | 100.98                    | 2306.9             | 2407.9                  | 100.98                   | 2443.9             | 2544.8                  | 0.3543                   | 8.2222             | 8.5765                  |
| 4.0                | 28.96                          | 0.001004                     | 34.791                  | 121.39                    | 2293.1             | 2414.5                  | 121.39                   | 2432.3             | 2553.7                  | 0.4224                   | 8.0510             | 8.4734                  |
| 5.0                | 32.87                          | 0.001005                     | 28.185                  | 137.75                    | 2282.1             | 2419.8                  | 137.75                   | 2423.0             | 2560.7                  | 0.4762                   | 7.9176             | 8.3938                  |
| 7.5                | 40.29                          | 0.001008                     | 19.233                  | 168.74                    | 2261.1             | 2429.8                  | 168.75                   | 2405.3             | 2574.0                  | 0.5763                   | 7.6738             | 8.2501                  |
| 10                 | 45.81                          | 0.001010                     | 14.670                  | 191.79                    | 2245.4             | 2437.2                  | 191.81                   | 2392.1             | 2583.9                  | 0.6492                   | 7.4996             | 8.1488                  |
| 15                 | 53.97                          | 0.001014                     | 10.020                  | 225.93                    | 2222.1             | 2448.0                  | 225.94                   | 2372.3             | 2598.3                  | 0.7549                   | 7.2522             | 8.0071                  |
| 20                 | 60.06                          | 0.001017                     | 7.6481                  | 251.40                    | 2204.6             | 2456.0                  | 251.42                   | 2357.5             | 2608.9                  | 0.8320                   | 7.0762             | 7.9073                  |
| 25                 | 64.96                          | 0.001020                     | 6.2034                  | 271.93                    | 2190.4             | 2462.4                  | 271.96                   | 2345.5             | 2617.5                  | 0.8932                   | 6.9370             | 7.8302                  |
| 30                 | 69.09                          | 0.001022                     | 5.2287                  | 289.24                    | 2178.5             | 2467.7                  | 289.27                   | 2335.3             | 2624.6                  | 0.9441                   | 6.8234             | 7.7675                  |
| 40                 | 75.86                          | 0.001026                     | 3.9933                  | 317.58                    | 2158.8             | 2476.3                  | 317.62                   | 2318.4             | 2636.1                  | 1.0261                   | 6.6430             | 7.6691                  |
| 50                 | 81.32                          | 0.001030                     | 3.2403                  | 340.49                    | 2142.7             | 2483.2                  | 340.54                   | 2304.7             | 2645.2                  | 1.0912                   | 6.5019             | 7.5931                  |



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TABLE A-5

Saturated water—Pressure table (Concluded)

| Press.,<br>P kPa | Sat.<br>temp.,<br>T <sub>sat</sub> °C | Specific volume,<br>m <sup>3</sup> /kg |                                  | Internal energy,<br>kJ/kg         |                           |                                  | Enthalpy,<br>kJ/kg                |                           |                                  | Entropy,<br>kJ/kg·K               |                           |                                  |
|------------------|---------------------------------------|----------------------------------------|----------------------------------|-----------------------------------|---------------------------|----------------------------------|-----------------------------------|---------------------------|----------------------------------|-----------------------------------|---------------------------|----------------------------------|
|                  |                                       | Sat.<br>liquid,<br>v <sub>f</sub>      | Sat.<br>vapor,<br>v <sub>g</sub> | Sat.<br>liquid,<br>u <sub>f</sub> | Evap.,<br>u <sub>fg</sub> | Sat.<br>vapor,<br>u <sub>g</sub> | Sat.<br>liquid,<br>h <sub>f</sub> | Evap.,<br>h <sub>fg</sub> | Sat.<br>vapor,<br>h <sub>g</sub> | Sat.<br>liquid,<br>s <sub>f</sub> | Evap.,<br>s <sub>fg</sub> | Sat.<br>vapor,<br>s <sub>g</sub> |
| 800              | 170.41                                | 0.001115                               | 0.24035                          | 719.97                            | 1856.1                    | 2576.0                           | 720.87                            | 2047.5                    | 2768.3                           | 2.0457                            | 4.6160                    | 6.6616                           |
| 850              | 172.94                                | 0.001118                               | 0.22690                          | 731.00                            | 1846.9                    | 2577.9                           | 731.95                            | 2038.8                    | 2770.8                           | 2.0705                            | 4.5705                    | 6.6409                           |
| 900              | 175.35                                | 0.001121                               | 0.21489                          | 741.55                            | 1838.1                    | 2579.6                           | 742.56                            | 2030.5                    | 2773.0                           | 2.0941                            | 4.5273                    | 6.6213                           |
| 950              | 177.66                                | 0.001124                               | 0.20411                          | 751.67                            | 1829.6                    | 2581.3                           | 752.74                            | 2022.4                    | 2775.2                           | 2.1166                            | 4.4862                    | 6.6027                           |
| 1000             | 179.88                                | 0.001127                               | 0.19436                          | 761.39                            | 1821.4                    | 2582.8                           | 762.51                            | 2014.6                    | 2777.1                           | 2.1381                            | 4.4470                    | 6.5850                           |
| 1100             | 184.06                                | 0.001133                               | 0.17745                          | 779.78                            | 1805.7                    | 2585.5                           | 781.03                            | 1999.6                    | 2780.7                           | 2.1785                            | 4.3735                    | 6.5520                           |
| 1200             | 187.96                                | 0.001138                               | 0.16326                          | 796.96                            | 1790.9                    | 2587.8                           | 798.33                            | 1985.4                    | 2783.8                           | 2.2159                            | 4.3058                    | 6.5217                           |
| 1300             | 191.60                                | 0.001144                               | 0.15119                          | 813.10                            | 1776.8                    | 2589.9                           | 814.59                            | 1971.9                    | 2786.5                           | 2.2508                            | 4.2428                    | 6.4935                           |
| 1400             | 195.04                                | 0.001149                               | 0.14078                          | 828.35                            | 1763.4                    | 2591.8                           | 829.96                            | 1958.9                    | 2788.9                           | 2.2835                            | 4.1840                    | 6.4675                           |
| 1500             | 198.29                                | 0.001154                               | 0.13171                          | 842.82                            | 1750.6                    | 2593.4                           | 844.55                            | 1946.4                    | 2791.0                           | 2.3143                            | 4.1287                    | 6.4430                           |
| 1750             | 205.72                                | 0.001166                               | 0.11344                          | 876.12                            | 1720.6                    | 2596.7                           | 878.16                            | 1917.1                    | 2795.2                           | 2.3844                            | 4.0033                    | 6.3877                           |
| 2000             | 212.38                                | 0.001177                               | 0.099587                         | 906.12                            | 1693.0                    | 2599.1                           | 908.47                            | 1889.8                    | 2798.3                           | 2.4467                            | 3.8923                    | 6.3390                           |
| 2250             | 218.41                                | 0.001187                               | 0.088717                         | 933.54                            | 1667.3                    | 2600.9                           | 936.21                            | 1864.3                    | 2800.5                           | 2.5029                            | 3.7926                    | 6.2954                           |
| 2500             | 223.95                                | 0.001197                               | 0.079952                         | 958.87                            | 1643.2                    | 2602.1                           | 961.87                            | 1840.1                    | 2801.9                           | 2.5542                            | 3.7016                    | 6.2558                           |
| 3000             | 233.85                                | 0.001217                               | 0.066667                         | 1004.6                            | 1598.5                    | 2603.2                           | 1008.3                            | 1794.9                    | 2803.2                           | 2.6454                            | 3.5402                    | 6.1856                           |
| 3500             | 242.56                                | 0.001235                               | 0.057061                         | 1045.4                            | 1557.6                    | 2603.0                           | 1049.7                            | 1753.0                    | 2802.7                           | 2.7253                            | 3.3991                    | 6.1244                           |
| 4000             | 250.35                                | 0.001252                               | 0.049779                         | 1082.4                            | 1519.3                    | 2601.7                           | 1087.4                            | 1713.5                    | 2800.8                           | 2.7966                            | 3.2731                    | 6.0696                           |
| 5000             | 263.94                                | 0.001286                               | 0.039448                         | 1148.1                            | 1448.9                    | 2597.0                           | 1154.5                            | 1639.7                    | 2794.2                           | 2.9207                            | 3.0530                    | 5.9737                           |
| 6000             | 275.59                                | 0.001319                               | 0.032449                         | 1205.8                            | 1384.1                    | 2589.9                           | 1213.8                            | 1570.9                    | 2784.6                           | 3.0275                            | 2.8627                    | 5.8902                           |
| 8000             | 295.01                                | 0.001384                               | 0.023525                         | 1306.0                            | 1264.5                    | 2570.5                           | 1317.1                            | 1441.6                    | 2758.7                           | 3.2077                            | 2.5373                    | 5.7450                           |
| 9000             | 303.35                                | 0.001418                               | 0.020489                         | 1350.9                            | 1207.6                    | 2558.5                           | 1363.7                            | 1379.3                    | 2742.9                           | 3.2866                            | 2.3925                    | 5.6791                           |
| 10,000           | 311.00                                | 0.001452                               | 0.018028                         | 1393.3                            | 1151.8                    | 2545.2                           | 1407.8                            | 1317.6                    | 2725.5                           | 3.3603                            | 2.2556                    | 5.6159                           |
| 11,000           | 318.08                                | 0.001488                               | 0.015988                         | 1433.9                            | 1096.6                    | 2530.4                           | 1450.2                            | 1256.1                    | 2706.3                           | 3.4299                            | 2.1248                    | 5.5544                           |
| 12,000           | 324.68                                | 0.001526                               | 0.014264                         | 1473.0                            | 1041.3                    | 2514.3                           | 1491.3                            | 1194.1                    | 2685.4                           | 3.4964                            | 1.9975                    | 5.4939                           |
| 13,000           | 330.85                                | 0.001566                               | 0.012781                         | 1511.0                            | 985.5                     | 2496.6                           | 1531.4                            | 1131.3                    | 2662.7                           | 3.5606                            | 1.8730                    | 5.4336                           |
| 14,000           | 336.67                                | 0.001610                               | 0.011487                         | 1548.4                            | 928.7                     | 2477.1                           | 1571.0                            | 1067.0                    | 2637.9                           | 3.6232                            | 1.7497                    | 5.3728                           |
| 15,000           | 342.16                                | 0.001657                               | 0.010341                         | 1585.5                            | 870.3                     | 2455.7                           | 1610.3                            | 1000.5                    | 2610.8                           | 3.6848                            | 1.6261                    | 5.3108                           |
| 16,000           | 347.36                                | 0.001710                               | 0.009312                         | 1622.6                            | 809.4                     | 2432.0                           | 1649.9                            | 931.1                     | 2581.0                           | 3.7461                            | 1.5005                    | 5.2466                           |
| 17,000           | 352.29                                | 0.001770                               | 0.008374                         | 1660.2                            | 745.1                     | 2405.4                           | 1690.3                            | 857.4                     | 2547.7                           | 3.8082                            | 1.3709                    | 5.1791                           |

TABLE A-6

Superheated water

| Superheated water                     |                         |            |            |              |                         |            |            |              |                         |            |            |              |
|---------------------------------------|-------------------------|------------|------------|--------------|-------------------------|------------|------------|--------------|-------------------------|------------|------------|--------------|
| T<br>°C                               | v<br>m <sup>3</sup> /kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K | v<br>m <sup>3</sup> /kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K | v<br>m <sup>3</sup> /kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K |
| * P = 0.01 MPa (45.81°C) <sup>a</sup> |                         |            |            |              | P = 0.05 MPa (81.32°C)  |            |            |              | P = 0.10 MPa (99.61°C)  |            |            |              |
| Sat. <sup>1</sup>                     | 14.670                  | 2437.2     | 2583.9     | 8.1488       | 3.2403                  | 2483.2     | 2645.2     | 7.5931       | 1.6941                  | 2505.6     | 2675.0     | 7.3589       |
| 50                                    | 14.867                  | 2443.3     | 2592.0     | 8.1741       |                         |            |            |              |                         |            |            |              |
| 100                                   | 17.196                  | 2515.5     | 2687.5     | 8.4489       | 3.4187                  | 2511.5     | 2682.4     | 7.6953       | 1.6959                  | 2506.2     | 2675.8     | 7.3611       |
| 150                                   | 19.513                  | 2587.9     | 2783.0     | 8.6893       | 3.8897                  | 2585.7     | 2780.2     | 7.9413       | 1.9367                  | 2582.9     | 2776.6     | 7.6148       |
| 200                                   | 21.826                  | 2661.4     | 2879.6     | 8.9049       | 4.3562                  | 2660.0     | 2877.8     | 8.1592       | 2.1724                  | 2658.2     | 2875.5     | 7.8356       |
| 250                                   | 24.136                  | 2736.1     | 2977.5     | 9.1015       | 4.8206                  | 2735.1     | 2976.2     | 8.3568       | 2.4062                  | 2733.9     | 2974.5     | 8.0346       |
| 300                                   | 26.446                  | 2812.3     | 3076.7     | 9.2827       | 5.2841                  | 2811.6     | 3075.8     | 8.5387       | 2.6389                  | 2810.7     | 3074.5     | 8.2172       |
| 400                                   | 31.063                  | 2969.3     | 3280.0     | 9.6094       | 6.2094                  | 2968.9     | 3279.3     | 8.8659       | 3.1027                  | 2968.3     | 3278.6     | 8.5452       |
| 500                                   | 35.680                  | 3132.9     | 3489.7     | 9.8998       | 7.1338                  | 3132.6     | 3489.3     | 9.1566       | 3.5655                  | 3132.2     | 3488.7     | 8.8362       |
| 600                                   | 40.296                  | 3303.3     | 3706.3     | 10.1631      | 8.0577                  | 3303.1     | 3706.0     | 9.4201       | 4.0279                  | 3302.8     | 3705.6     | 9.0999       |
| 700                                   | 44.911                  | 3480.8     | 3929.9     | 10.4056      | 8.9813                  | 3480.6     | 3929.7     | 9.6626       | 4.4900                  | 3480.4     | 3929.4     | 9.3424       |
| 800                                   | 49.527                  | 3665.4     | 4160.6     | 10.6312      | 9.9047                  | 3665.2     | 4160.4     | 9.8883       | 4.9519                  | 3665.0     | 4160.2     | 9.5682       |
| 900                                   | 54.143                  | 3856.9     | 4398.3     | 10.8429      | 10.8280                 | 3856.8     | 4398.2     | 10.1000      | 5.4137                  | 3856.7     | 4398.0     | 9.7800       |
| 1000                                  | 58.758                  | 4055.3     | 4642.8     | 11.0429      | 11.7513                 | 4055.2     | 4642.7     | 10.3000      | 5.8755                  | 4055.0     | 4642.6     | 9.9800       |
| 1100                                  | 63.373                  | 4260.0     | 4893.8     | 11.2326      | 12.6745                 | 4259.9     | 4893.7     | 10.4897      | 6.3372                  | 4259.8     | 4893.6     | 10.1698      |
| 1200                                  | 67.989                  | 4470.9     | 5150.8     | 11.4132      | 13.5977                 | 4470.8     | 5150.7     | 10.6704      | 6.7988                  | 4470.7     | 5150.6     | 10.3504      |
| 1300                                  | 72.604                  | 4687.4     | 5413.4     | 11.5857      | 14.5209                 | 4687.3     | 5413.3     | 10.8429      | 7.2605                  | 4687.2     | 5413.3     | 10.5229      |

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Subject: Thermodynamic  
Time: 2 hours

Notes// 1. Please read the questions carefully, 2. Answer all question

TABLE A-7

| Compressed liquid water               |           |         |         |                 | $v$                                    | $u$     | $h$     | $s$             | $v$                                    | $u$     | $h$     | $s$             |
|---------------------------------------|-----------|---------|---------|-----------------|----------------------------------------|---------|---------|-----------------|----------------------------------------|---------|---------|-----------------|
| $T$                                   | $v$       | $u$     | $h$     | $s$             | $m^3/kg$                               | $kJ/kg$ | $kJ/kg$ | $kJ/kg \cdot K$ | $m^3/kg$                               | $kJ/kg$ | $kJ/kg$ | $kJ/kg \cdot K$ |
| $^{\circ}C$                           | $m^3/kg$  | $kJ/kg$ | $kJ/kg$ | $kJ/kg \cdot K$ | $P = 10 \text{ MPa (311.00}^{\circ}C)$ |         |         |                 | $P = 15 \text{ MPa (342.16}^{\circ}C)$ |         |         |                 |
| $P = 5 \text{ MPa (263.94}^{\circ}C)$ |           |         |         |                 |                                        |         |         |                 |                                        |         |         |                 |
| Sat.                                  | 0.0012862 | 1148.1  | 1154.5  | 2.9207          | 0.0014522                              | 1393.3  | 1407.9  | 3.3603          | 0.0016572                              | 1585.5  | 1610.3  | 3.6848          |
| 0                                     | 0.0009977 | 0.04    | 5.03    | 0.0001          | 0.0009952                              | 0.12    | 10.07   | 0.0003          | 0.0009928                              | 0.18    | 15.07   | 0.0004          |
| 20                                    | 0.0009996 | 83.61   | 88.61   | 0.2954          | 0.0009973                              | 83.31   | 93.28   | 0.2943          | 0.0009951                              | 83.01   | 97.93   | 0.2932          |
| 40                                    | 0.0010037 | 166.92  | 171.95  | 0.5705          | 0.0010035                              | 166.33  | 176.37  | 0.5685          | 0.0010013                              | 165.75  | 180.77  | 0.5666          |
| 60                                    | 0.0010149 | 250.29  | 255.36  | 0.8287          | 0.0010127                              | 249.43  | 259.55  | 0.8260          | 0.0010105                              | 248.58  | 263.74  | 0.8234          |
| 80                                    | 0.0010267 | 333.82  | 338.96  | 1.0723          | 0.0010244                              | 332.69  | 342.94  | 1.0691          | 0.0010221                              | 331.59  | 346.92  | 1.0659          |
| 100                                   | 0.0010410 | 417.65  | 422.85  | 1.3034          | 0.0010385                              | 416.23  | 426.62  | 1.2996          | 0.0010361                              | 414.85  | 430.39  | 1.2958          |
| 120                                   | 0.0010576 | 501.91  | 507.19  | 1.5236          | 0.0010549                              | 500.18  | 510.73  | 1.5191          | 0.0010522                              | 498.50  | 514.28  | 1.5148          |
| 140                                   | 0.0010769 | 585.80  | 592.18  | 1.7344          | 0.0010738                              | 584.72  | 595.45  | 1.7293          | 0.0010708                              | 582.69  | 598.75  | 1.7243          |
| 160                                   | 0.0010988 | 672.55  | 678.04  | 1.9374          | 0.0010954                              | 670.06  | 681.01  | 1.9316          | 0.0010920                              | 667.63  | 684.01  | 1.9259          |
| 180                                   | 0.0011240 | 759.47  | 765.09  | 2.1338          | 0.0011200                              | 756.48  | 767.68  | 2.1271          | 0.0011160                              | 753.58  | 770.32  | 2.1206          |
| 200                                   | 0.0011531 | 847.92  | 853.68  | 2.3251          | 0.0011482                              | 844.32  | 855.80  | 2.3174          | 0.0011435                              | 840.84  | 858.00  | 2.3100          |
| 220                                   | 0.0011868 | 938.39  | 944.32  | 2.5127          | 0.0011809                              | 934.01  | 945.82  | 2.5037          | 0.0011752                              | 929.81  | 947.43  | 2.4951          |
| 240                                   | 0.0012268 | 1031.5  | 1037.7  | 2.6983          | 0.0012192                              | 1026.2  | 1038.3  | 2.6876          | 0.0012121                              | 1021.0  | 1039.2  | 2.6774          |
| 260                                   | 0.0012755 | 1128.5  | 1134.9  | 2.8841          | 0.0012653                              | 1121.6  | 1134.3  | 2.8710          | 0.0012560                              | 1115.1  | 1134.0  | 2.8585          |

Saturated refrigerant-134a

TABLE A-11

Saturated refrigerant-134a—Temperature table

| Temp., $^{\circ}C$ | Sat. press., $P_{sat}$ kPa | Specific volume, $m^3/kg$ |                   | Internal energy, $kJ/kg$ |                 |                   | Enthalpy, $kJ/kg$  |                 |                   | Entropy, $kJ/kg \cdot K$ |                 |                   |
|--------------------|----------------------------|---------------------------|-------------------|--------------------------|-----------------|-------------------|--------------------|-----------------|-------------------|--------------------------|-----------------|-------------------|
|                    |                            | Sat. liquid, $v_f$        | Sat. vapor, $v_g$ | Sat. liquid, $u_f$       | Evap., $u_{fg}$ | Sat. vapor, $u_g$ | Sat. liquid, $h_f$ | Evap., $h_{fg}$ | Sat. vapor, $h_g$ | Sat. liquid, $s_f$       | Evap., $s_{fg}$ | Sat. vapor, $s_g$ |
| -40                | 51.25                      | 0.0007054                 | 0.36081           | -0.036                   | 207.40          | 207.37            | 0.000              | 225.86          | 225.86            | 0.00000                  | 0.96866         | 0.96866           |
| -38                | 56.86                      | 0.0007083                 | 0.32732           | 2.475                    | 206.04          | 208.51            | 2.515              | 224.61          | 227.12            | 0.01072                  | 0.95511         | 0.96584           |
| -36                | 62.95                      | 0.0007112                 | 0.29751           | 4.992                    | 204.67          | 209.66            | 5.037              | 223.35          | 228.39            | 0.02138                  | 0.94176         | 0.96315           |
| -34                | 69.56                      | 0.0007142                 | 0.27090           | 7.517                    | 203.29          | 210.81            | 7.566              | 222.09          | 229.65            | 0.03199                  | 0.92859         | 0.96058           |
| -32                | 76.71                      | 0.0007172                 | 0.24711           | 10.05                    | 201.91          | 211.96            | 10.10              | 220.81          | 230.91            | 0.04253                  | 0.91560         | 0.95813           |
| -30                | 84.43                      | 0.0007203                 | 0.22580           | 12.59                    | 200.52          | 213.11            | 12.65              | 219.52          | 232.17            | 0.05301                  | 0.90278         | 0.95579           |
| -28                | 92.76                      | 0.0007234                 | 0.20666           | 15.13                    | 199.12          | 214.25            | 15.20              | 218.22          | 233.43            | 0.06344                  | 0.89012         | 0.95356           |
| -26                | 101.73                     | 0.0007265                 | 0.18946           | 17.69                    | 197.72          | 215.40            | 17.76              | 216.92          | 234.68            | 0.07382                  | 0.87762         | 0.95144           |
| -24                | 111.37                     | 0.0007297                 | 0.17395           | 20.25                    | 196.30          | 216.55            | 20.33              | 215.59          | 235.92            | 0.08414                  | 0.86527         | 0.94941           |
| -22                | 121.72                     | 0.0007329                 | 0.15995           | 22.82                    | 194.88          | 217.70            | 22.91              | 214.26          | 237.17            | 0.09441                  | 0.85307         | 0.94748           |
| 80                 | 2635.3                     | 0.0010772                 | 0.006436          | 171.40                   | 92.23           | 263.63            | 174.24             | 106.35          | 280.59            | 0.58800                  | 0.30111         | 0.88912           |
| 85                 | 2928.2                     | 0.0011270                 | 0.005486          | 180.77                   | 82.67           | 263.44            | 184.07             | 95.44           | 279.51            | 0.61473                  | 0.26644         | 0.88117           |
| 90                 | 3246.9                     | 0.0011932                 | 0.004599          | 190.89                   | 71.29           | 262.18            | 194.76             | 82.35           | 277.11            | 0.64336                  | 0.22674         | 0.87010           |
| 95                 | 3594.1                     | 0.0012933                 | 0.003726          | 202.40                   | 56.47           | 258.87            | 207.05             | 65.21           | 272.26            | 0.67578                  | 0.17711         | 0.85289           |
| 100                | 3975.1                     | 0.0015269                 | 0.002630          | 218.72                   | 29.19           | 247.91            | 224.79             | 33.58           | 258.37            | 0.72217                  | 0.08999         | 0.81215           |



Subject: Thermodynamic  
 Time: 2 hours

Class: 1<sup>st</sup> year  
 Date: 21 / 2 / 2016

*Notes// 1. Please read the questions carefully, 2. Answer all question*

TABLE A-6

Superheated water (Concluded)

| T<br>°C                 | v<br>m <sup>3</sup> /kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K | v<br>m <sup>3</sup> /kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K | v<br>m <sup>3</sup> /kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K |
|-------------------------|-------------------------|------------|------------|--------------|-------------------------|------------|------------|--------------|-------------------------|------------|------------|--------------|
| P = 1.00 MPa (179.88°C) |                         |            |            |              | P = 1.20 MPa (187.96°C) |            |            |              | P = 1.40 MPa (195.04°C) |            |            |              |
| Sat.                    | 0.19437                 | 2582.8     | 2777.1     | 6.5850       | 0.16326                 | 2587.8     | 2783.8     | 6.5217       | 0.14078                 | 2591.8     | 2788.9     | 6.4675       |
| 200                     | 0.20602                 | 2622.3     | 2828.3     | 6.6956       | 0.16934                 | 2612.9     | 2816.1     | 6.5909       | 0.14303                 | 2602.7     | 2803.0     | 6.4975       |
| 250                     | 0.23275                 | 2710.4     | 2943.1     | 6.9265       | 0.19241                 | 2704.7     | 2935.6     | 6.8313       | 0.16356                 | 2698.9     | 2927.9     | 6.7488       |
| 300                     | 0.25799                 | 2793.7     | 3051.6     | 7.1246       | 0.21386                 | 2789.7     | 3046.3     | 7.0335       | 0.18233                 | 2785.7     | 3040.9     | 6.9553       |
| 350                     | 0.28260                 | 2875.7     | 3158.2     | 7.3029       | 0.23455                 | 2872.7     | 3154.2     | 7.2139       | 0.20029                 | 2869.7     | 3150.1     | 7.1379       |
| 400                     | 0.30661                 | 2957.9     | 3264.5     | 7.4670       | 0.25482                 | 2955.5     | 3261.3     | 7.3793       | 0.21782                 | 2953.1     | 3258.1*    | 7.3046       |
| 500                     | 0.35411                 | 3125.0     | 3479.1     | 7.7642       | 0.29464                 | 3123.4     | 3477.0     | 7.6779       | 0.25216                 | 3121.8     | 3474.8     | 7.6047       |
| 600                     | 0.40111                 | 3297.5     | 3698.6     | 8.0311       | 0.33395                 | 3296.3     | 3697.0     | 7.9466       | 0.28597                 | 3295.1     | 3695.5     | 7.8730       |
| 700                     | 0.44783                 | 3476.3     | 3924.1     | 8.2755       | 0.37297                 | 3475.3     | 3922.9     | 8.1904       | 0.31951                 | 3474.4     | 3921.7     | 8.1183       |
| 800                     | 0.49438                 | 3661.7     | 4156.1     | 8.5024       | 0.41184                 | 3661.0     | 4155.2     | 8.4176       | 0.35288                 | 3660.3     | 4154.3     | 8.3458       |
| 900                     | 0.54083                 | 3853.9     | 4394.8     | 8.7150       | 0.45059                 | 3853.3     | 4394.0     | 8.6303       | 0.38614                 | 3852.7     | 4393.3     | 8.5587       |
| 1000                    | 0.58721                 | 4052.7     | 4640.0     | 8.9155       | 0.48928                 | 4052.2     | 4639.4     | 8.8310       | 0.41933                 | 4051.7     | 4638.8     | 8.7595       |
| 1100                    | 0.63354                 | 4257.9     | 4891.4     | 9.1057       | 0.52792                 | 4257.5     | 4891.0     | 9.0212       | 0.45247                 | 4257.0     | 4890.5     | 8.9497       |
| 1200                    | 0.67983                 | 4469.0     | 5148.9     | 9.2866       | 0.56652                 | 4468.7     | 5148.5     | 9.2022       | 0.48558                 | 4468.3     | 5148.1     | 9.1308       |
| 1300                    | 0.72510                 | 4685.8     | 5411.9     | 9.4593       | 0.60509                 | 4685.5     | 5411.6     | 9.3750       | 0.51866                 | 4685.1     | 5411.3     | 9.3036       |
| P = 1.60 MPa (201.37°C) |                         |            |            |              | P = 1.80 MPa (207.11°C) |            |            |              | P = 2.00 MPa (212.38°C) |            |            |              |
| Sat.                    | 0.12374                 | 2594.8     | 2792.8     | 6.4200       | 0.11037                 | 2597.3     | 2795.9     | 6.3775       | 0.09959                 | 2599.1     | 2798.3     | 6.3390       |
| 225                     | 0.13293                 | 2645.1     | 2857.8     | 6.5537       | 0.11678                 | 2637.0     | 2847.2     | 6.4825       | 0.10381                 | 2628.5     | 2836.1     | 6.4160       |
| 250                     | 0.14190                 | 2692.9     | 2919.9     | 6.6753       | 0.12502                 | 2686.7     | 2911.7     | 6.6088       | 0.11150                 | 2680.3     | 2903.3     | 6.5475       |
| 300                     | 0.15866                 | 2781.6     | 3035.4     | 6.8864       | 0.14025                 | 2777.4     | 3029.9     | 6.8246       | 0.12551                 | 2773.2     | 3024.2     | 6.7684       |
| 350                     | 0.17459                 | 2866.6     | 3146.0     | 7.0713       | 0.15460                 | 2863.6     | 3141.9     | 7.0120       | 0.13860                 | 2860.5     | 3137.7     | 6.9583       |
| 400                     | 0.19007                 | 2950.8     | 3254.9     | 7.2394       | 0.16849                 | 2948.3     | 3251.6     | 7.1814       | 0.15122                 | 2945.9     | 3248.4     | 7.1292       |
| 500                     | 0.22029                 | 3120.1     | 3472.6     | 7.5410       | 0.19551                 | 3118.5     | 3470.4     | 7.4845       | 0.17568                 | 3116.9     | 3468.3     | 7.4337       |
| 600                     | 0.24999                 | 3293.9     | 3693.9     | 7.8101       | 0.22200                 | 3292.7     | 3692.3     | 7.7543       | 0.19962                 | 3291.5     | 3690.7     | 7.7043       |
| 700                     | 0.27941                 | 3473.5     | 3920.5     | 8.0558       | 0.24822                 | 3472.6     | 3919.4     | 8.0005       | 0.22326                 | 3471.7     | 3918.2     | 7.9509       |
| 800                     | 0.30865                 | 3659.5     | 4153.4     | 8.2834       | 0.27426                 | 3658.8     | 4152.4     | 8.2284       | 0.24674                 | 3658.0     | 4151.5     | 8.1791       |
| 900                     | 0.33780                 | 3852.1     | 4392.6     | 8.4965       | 0.30020                 | 3851.5     | 4391.9     | 8.4417       | 0.27012                 | 3850.9     | 4391.1     | 8.3925       |
| 1000                    | 0.36687                 | 4051.2     | 4638.2     | 8.6974       | 0.32606                 | 4050.7     | 4637.6     | 8.6427       | 0.29342                 | 4050.2     | 4637.1     | 8.5936       |
| 1100                    | 0.39589                 | 4256.6     | 4890.0     | 8.8878       | 0.35188                 | 4256.2     | 4889.6     | 8.8331       | 0.31667                 | 4255.7     | 4889.1     | 8.7842       |
| 1200                    | 0.42488                 | 4467.9     | 5147.7     | 9.0689       | 0.37766                 | 4467.6     | 5147.3     | 9.0143       | 0.33989                 | 4467.2     | 5147.0     | 8.9654       |
| 1300                    | 0.45383                 | 4684.8     | 5410.9     | 9.2418       | 0.40341                 | 4684.5     | 5410.6     | 9.1872       | 0.36308                 | 4684.2     | 5410.3     | 9.1384       |
| P = 2.50 MPa (223.95°C) |                         |            |            |              | P = 3.00 MPa (233.85°C) |            |            |              | P = 3.50 MPa (242.56°C) |            |            |              |
| Sat.                    | 0.07995                 | 2602.1     | 2801.9     | 6.2558       | 0.06667                 | 2603.2     | 2803.2     | 6.1856       | 0.05706                 | 2603.0     | 2802.7     | 6.1244       |
| 225                     | 0.08026                 | 2604.8     | 2805.5     | 6.2629       | 0.07063                 | 2644.7     | 2856.5     | 6.2893       | 0.05876                 | 2624.0     | 2829.7     | 6.1764       |
| 250                     | 0.08705                 | 2663.3     | 2880.9     | 6.4107       | 0.08118                 | 2750.8     | 2994.3     | 6.5412       | 0.06845                 | 2738.8     | 2978.4     | 6.4484       |
| 300                     | 0.09894                 | 2762.2     | 3009.6     | 6.6459       | 0.09056                 | 2844.4     | 3116.1     | 6.7450       | 0.07680                 | 2836.0     | 3104.9     | 6.6601       |
| 350                     | 0.10979                 | 2852.5     | 3127.0     | 6.8424       | 0.09938                 | 2933.5     | 3231.7     | 6.9235       | 0.08456                 | 2927.2     | 3223.2     | 6.8428       |
| 400                     | 0.12012                 | 2939.8     | 3240.1     | 7.0170       | 0.10789                 | 3021.2     | 3344.9     | 7.0856       | 0.09198                 | 3016.1     | 3338.1     | 7.0074       |
| 450                     | 0.13015                 | 3026.2     | 3351.6     | 7.1768       | 0.11620                 | 3108.6     | 3457.2     | 7.2359       | 0.09919                 | 3104.5     | 3451.7     | 7.1593       |
| 500                     | 0.13999                 | 3112.8     | 3462.8     | 7.3254       | 0.12445                 | 3195.5     | 3570.2     | 7.3813       | 0.10640                 | 3192.9     | 3548.9     | 7.3112       |
| 600                     | 0.15931                 | 3288.5     | 3686.8     | 7.5979       | 0.14841                 | 3467.0     | 3912.2     | 7.7590       | 0.12702                 | 3464.7     | 3909.3     | 7.6855       |
| 700                     | 0.17835                 | 3469.3     | 3915.2     | 7.8455       | 0.16420                 | 3654.3     | 4146.9     | 7.9885       | 0.14061                 | 3652.5     | 4144.6     | 7.9156       |
| 800                     | 0.19722                 | 3656.2     | 4149.2     | 8.0744       | 0.17988                 | 3847.9     | 4387.5     | 8.2028       | 0.15410                 | 3846.4     | 4385.7     | 8.1304       |
| 900                     | 0.21597                 | 3849.4     | 4389.3     | 8.2882       | 0.19549                 | 4047.7     | 4634.2     | 8.4045       | 0.16751                 | 4046.4     | 4632.7     | 8.3324       |
| 1000                    | 0.23466                 | 4049.0     | 4635.6     | 8.4897       | 0.21105                 | 4253.6     | 4886.7     | 8.5955       | 0.18087                 | 4252.5     | 4885.6     | 8.5236       |
| 1100                    | 0.25330                 | 4254.7     | 4887.9     | 8.6804       | 0.22658                 | 4465.3     | 5145.1     | 8.7771       | 0.19420                 | 4464.4     | 5144.1     | 8.7053       |
| 1200                    | 0.27190                 | 4466.3     | 5146.0     | 8.8618       | 0.24207                 | 4682.6     | 5408.8     | 8.9502       | 0.20750                 | 4681.8     | 5408.0     | 8.8786       |
| 1300                    | 0.29048                 | 4683.4     | 5409.5     | 9.0349       |                         |            |            |              |                         |            |            |              |



Subject: Thermodynamic  
Time: 2 hours

Class: 1<sup>st</sup> year  
Date: 21 / 2 / 2016

*Notes// 1. Please read the questions carefully, 2. Answer all question*

TABLE A-12

Saturated refrigerant-134a—Pressure table

| Press.,<br>P kPa | Sat.<br>temp.,<br>$T_{sat}$ °C | Specific volume,<br>$m^3/kg$ |                         | Internal energy,<br>kJ/kg |                    |                         | Enthalpy,<br>kJ/kg       |                    |                         | Entropy,<br>kJ/kg·K      |                    |                         |
|------------------|--------------------------------|------------------------------|-------------------------|---------------------------|--------------------|-------------------------|--------------------------|--------------------|-------------------------|--------------------------|--------------------|-------------------------|
|                  |                                | Sat.<br>liquid,<br>$v_f$     | Sat.<br>vapor,<br>$v_g$ | Sat.<br>liquid,<br>$u_f$  | Evap.,<br>$u_{fg}$ | Sat.<br>vapor,<br>$u_g$ | Sat.<br>liquid,<br>$h_f$ | Evap.,<br>$h_{fg}$ | Sat.<br>vapor,<br>$h_g$ | Sat.<br>liquid,<br>$s_f$ | Evap.,<br>$s_{fg}$ | Sat.<br>vapor,<br>$s_g$ |
| 60               | -36.95                         | 0.0007098                    | 0.31121                 | 3.798                     | 205.32             | 209.12                  | 3.841                    | 223.95             | 227.79                  | 0.01634                  | 0.94807            | 0.96441                 |
| 70               | -33.87                         | 0.0007144                    | 0.26929                 | 7.680                     | 203.20             | 210.88                  | 7.730                    | 222.00             | 229.73                  | 0.03267                  | 0.92775            | 0.96042                 |
| 80               | -31.13                         | 0.0007185                    | 0.23753                 | 11.15                     | 201.30             | 212.46                  | 11.21                    | 220.25             | 231.46                  | 0.04711                  | 0.90999            | 0.95710                 |
| 90               | -28.65                         | 0.0007223                    | 0.21263                 | 14.31                     | 199.57             | 213.88                  | 14.37                    | 218.65             | 233.02                  | 0.06008                  | 0.89419            | 0.95427                 |
| 100              | -26.37                         | 0.0007259                    | 0.19254                 | 17.21                     | 197.98             | 215.19                  | 17.28                    | 217.16             | 234.44                  | 0.07188                  | 0.87995            | 0.95183                 |
| 120              | -22.32                         | 0.0007324                    | 0.16212                 | 22.40                     | 195.11             | 217.51                  | 22.49                    | 214.48             | 236.97                  | 0.09275                  | 0.85503            | 0.94779                 |
| 140              | -18.77                         | 0.0007383                    | 0.14014                 | 26.98                     | 192.57             | 219.54                  | 27.08                    | 212.08             | 239.16                  | 0.11087                  | 0.83368            | 0.94456                 |
| 160              | -15.60                         | 0.0007437                    | 0.12348                 | 31.09                     | 190.27             | 221.35                  | 31.21                    | 209.90             | 241.11                  | 0.12693                  | 0.81496            | 0.94190                 |
| 180              | -12.73                         | 0.0007487                    | 0.11041                 | 34.83                     | 188.16             | 222.99                  | 34.97                    | 207.90             | 242.86                  | 0.14139                  | 0.79826            | 0.93965                 |
| 200              | -10.09                         | 0.0007533                    | 0.099867                | 38.28                     | 186.21             | 224.48                  | 38.43                    | 206.03             | 244.46                  | 0.15457                  | 0.78316            | 0.93773                 |
| 700              | 26.69                          | 0.0008331                    | 0.029361                | 88.24                     | 156.24             | 244.48                  | 88.82                    | 176.21             | 265.03                  | 0.33230                  | 0.58763            | 0.91994                 |
| 750              | 29.06                          | 0.0008395                    | 0.027371                | 91.69                     | 154.08             | 245.67                  | 92.22                    | 173.98             | 266.20                  | 0.34345                  | 0.57567            | 0.91912                 |
| 800              | 31.31                          | 0.0008458                    | 0.025621                | 94.79                     | 152.00             | 246.79                  | 95.47                    | 171.82             | 267.29                  | 0.35404                  | 0.56431            | 0.91835                 |
| 850              | 33.45                          | 0.0008520                    | 0.024069                | 97.87                     | 149.98             | 247.85                  | 98.60                    | 169.71             | 268.31                  | 0.36413                  | 0.55349            | 0.91762                 |
| 900              | 35.51                          | 0.0008580                    | 0.022683                | 100.83                    | 148.01             | 248.85                  | 101.61                   | 167.66             | 269.26                  | 0.37377                  | 0.54315            | 0.91692                 |
| 950              | 37.48                          | 0.0008641                    | 0.021438                | 103.69                    | 146.10             | 249.79                  | 104.51                   | 165.64             | 270.15                  | 0.38301                  | 0.53323            | 0.91624                 |
| 1000             | 39.37                          | 0.0008700                    | 0.020313                | 106.45                    | 144.23             | 250.68                  | 107.32                   | 163.67             | 270.99                  | 0.39189                  | 0.52368            | 0.91558                 |
| 1200             | 46.29                          | 0.0008934                    | 0.016715                | 116.70                    | 137.11             | 253.81                  | 117.77                   | 156.10             | 273.87                  | 0.42441                  | 0.48863            | 0.91303                 |
| 1400             | 52.40                          | 0.0009166                    | 0.014107                | 125.94                    | 130.43             | 256.37                  | 127.22                   | 148.90             | 276.12                  | 0.45315                  | 0.45734            | 0.91050                 |

TABLE A-13

Superheated refrigerant-134a

| T<br>°C                                           | v<br>$m^3/kg$ | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K | v<br>$m^3/kg$                                     | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K | v<br>$m^3/kg$                                     | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg·K |
|---------------------------------------------------|---------------|------------|------------|--------------|---------------------------------------------------|------------|------------|--------------|---------------------------------------------------|------------|------------|--------------|
| P = 0.06 MPa ( $T_{sat} = -36.95^\circ\text{C}$ ) |               |            |            |              | P = 0.10 MPa ( $T_{sat} = -26.37^\circ\text{C}$ ) |            |            |              | P = 0.14 MPa ( $T_{sat} = -18.77^\circ\text{C}$ ) |            |            |              |
| Sat.                                              | 0.31121       | 209.12     | 227.79     | 0.9544       | 0.19254                                           | 215.19     | 234.44     | 0.9518       | 0.14014                                           | 219.54     | 239.16     | 0.9446       |
| -20                                               | 0.33608       | 220.60     | 240.76     | 1.0174       | 0.19841                                           | 219.66     | 239.50     | 0.9721       |                                                   |            |            |              |
| -10                                               | 0.35048       | 227.55     | 248.58     | 1.0477       | 0.20743                                           | 226.75     | 247.49     | 1.0030       | 0.14605                                           | 225.91     | 246.36     | 0.9724       |
| 0                                                 | 0.36476       | 234.66     | 256.54     | 1.0774       | 0.21630                                           | 233.95     | 255.58     | 1.0332       | 0.15263                                           | 233.23     | 254.60     | 1.0031       |
| 10                                                | 0.37893       | 241.92     | 264.66     | 1.1066       | 0.22506                                           | 241.30     | 263.81     | 1.0628       | 0.15908                                           | 240.66     | 262.93     | 1.0331       |
| 20                                                | 0.39302       | 249.35     | 272.94     | 1.1353       | 0.23373                                           | 248.79     | 272.17     | 1.0918       | 0.16544                                           | 248.22     | 271.38     | 1.0624       |
| 30                                                | 0.40705       | 256.95     | 281.37     | 1.1636       | 0.24233                                           | 256.44     | 280.68     | 1.1203       | 0.17172                                           | 255.93     | 279.97     | 1.0912       |
| 40                                                | 0.42102       | 264.71     | 289.97     | 1.1915       | 0.25088                                           | 264.25     | 289.34     | 1.1484       | 0.17794                                           | 263.79     | 288.70     | 1.1195       |
| 50                                                | 0.43495       | 272.64     | 298.74     | 1.2191       | 0.25937                                           | 272.22     | 298.16     | 1.1762       | 0.18412                                           | 271.79     | 297.57     | 1.1474       |
| 60                                                | 0.44883       | 280.73     | 307.66     | 1.2463       | 0.26783                                           | 280.35     | 307.13     | 1.2035       | 0.19025                                           | 279.96     | 306.59     | 1.1749       |
| 70                                                | 0.46269       | 288.99     | 316.75     | 1.2732       | 0.27626                                           | 288.64     | 316.26     | 1.2305       | 0.19635                                           | 288.28     | 315.77     | 1.2020       |
| 80                                                | 0.47651       | 297.41     | 326.00     | 1.2997       | 0.28465                                           | 297.08     | 325.55     | 1.2572       | 0.20242                                           | 296.75     | 325.09     | 1.2288       |
| 90                                                | 0.49032       | 306.00     | 335.42     | 1.3260       | 0.29303                                           | 305.69     | 334.99     | 1.2836       | 0.20847                                           | 305.38     | 334.57     | 1.2553       |
| 100                                               | 0.50410       | 314.74     | 344.99     | 1.3520       | 0.30138                                           | 314.46     | 344.60     | 1.3096       | 0.21449                                           | 314.17     | 344.20     | 1.2814       |
| P = 0.18 MPa ( $T_{sat} = -12.73^\circ\text{C}$ ) |               |            |            |              | P = 0.20 MPa ( $T_{sat} = -10.09^\circ\text{C}$ ) |            |            |              | P = 0.24 MPa ( $T_{sat} = -5.38^\circ\text{C}$ )  |            |            |              |
| Sat.                                              | 0.11041       | 222.99     | 242.86     | 0.9397       | 0.09987                                           | 224.48     | 244.46     | 0.9377       | 0.08390                                           | 227.14     | 247.28     | 0.9346       |
| -10                                               | 0.11189       | 225.02     | 245.16     | 0.9484       | 0.09991                                           | 224.55     | 244.54     | 0.9380       |                                                   |            |            |              |
| 0                                                 | 0.11722       | 232.48     | 253.58     | 0.9798       | 0.10481                                           | 232.09     | 253.05     | 0.9698       | 0.08617                                           | 231.29     | 251.97     | 0.9519       |
| 10                                                | 0.12240       | 240.00     | 262.04     | 1.0102       | 0.10956                                           | 239.67     | 261.58     | 1.0004       | 0.09026                                           | 238.98     | 260.65     | 0.9831       |
| 20                                                | 0.12748       | 247.64     | 270.59     | 1.0399       | 0.11418                                           | 247.35     | 270.18     | 1.0303       | 0.09423                                           | 246.74     | 269.36     | 1.0134       |
| 30                                                | 0.13248       | 255.41     | 279.25     | 1.0690       | 0.11874                                           | 255.14     | 278.89     | 1.0595       | 0.09812                                           | 254.61     | 278.16     | 1.0429       |
| 40                                                | 0.13741       | 263.31     | 288.05     | 1.0975       | 0.12322                                           | 263.08     | 287.72     | 1.0882       | 0.10193                                           | 262.59     | 287.06     | 1.0718       |
| 50                                                | 0.14230       | 271.36     | 296.98     | 1.1256       | 0.12766                                           | 271.15     | 296.68     | 1.1163       | 0.10570                                           | 270.71     | 296.08     | 1.1001       |
| 60                                                | 0.14715       | 279.56     | 306.05     | 1.1532       | 0.13206                                           | 279.37     | 305.78     | 1.1441       | 0.10942                                           | 278.97     | 305.23     | 1.1280       |
| 70                                                | 0.15196       | 287.91     | 315.27     | 1.1805       | 0.13641                                           | 287.73     | 315.01     | 1.1714       | 0.11310                                           | 287.36     | 314.51     | 1.1554       |
| 80                                                | 0.15673       | 296.42     | 324.63     | 1.2074       | 0.14074                                           | 296.25     | 324.40     | 1.1983       | 0.11675                                           | 295.91     | 323.93     | 1.1825       |
| 90                                                | 0.16149       | 305.07     | 334.14     | 1.2339       | 0.14504                                           | 304.92     | 333.93     | 1.2249       | 0.12038                                           | 304.60     | 333.49     | 1.2092       |
| 100                                               | 0.16622       | 313.88     | 343.80     | 1.2602       | 0.14933                                           | 313.74     | 343.60     | 1.2512       | 0.12398                                           | 313.44     | 343.20     | 1.2356       |

قسم السيارات  
١/٥

القسم : هندسة تقنية السيارات  
المرحلة : الاولى  
المادة : الرياضيات  
وقت الامتحان : ساعتان  
التاريخ : 2016/2 /



وزارة التعليم العالي والبحث العلمي  
هيئة التعليم التقني  
جامعة الفرات الاوسط التقنية  
الكلية التقنية الهندسية - النجف

امتحان الفصل الأول للعام ٢٠١٥ - ٢٠١٦

Note : Answer all the questions

Q1/ Differentiate each of the following with respect to  $x$  and find  $\frac{dy}{dx}$ .

a)  $\sin y + x^2 + 4y = \cos x$

b)  $3xy^2 + \cos y^2 = 2x^3 + 5$

c)  $5x^2 - x^3 \sin y + 5xy + 10$

d)  $x - \cos x^2 + \frac{y^2}{x} + 3x^5 = 4x^3 -$

e)  $\tan 5y - y \sin x + 3xy^2 = 9$

(25 MARK)

\*\*\*\*\*

Q2/ 1) Prove that the differentiation of the function  $f(x) = \frac{\cos x}{1 + \sin x}$  is  $f(x)' = -\frac{1}{(1 + \sin x)}$

2) Prove that the differentiation of the function  $f(x) = \sin x$  is  $f(x)' = \cos x$  (25 MARK)

\*\*\*\*\*

Q3/ 1) Find the inverse of  $f(x) = 4x$ . Then verify that both  $f(f^{-1}(x))$  and  $f^{-1}(f(x))$  are equal to the identity function.

2) Find the first, second and third derivatives for  $y = \sqrt{5x^2 - 2x + 1}$  (25 MARK)

\*\*\*\*\*

Q4/ Find the slope of the parabola  $y = x^2$  at the point  $P(2,4)$ . Write an equation for the tangent to the parabola at this point. (25 MARK)

Good luck

رئيس القسم

مدرس المادة



**Note: Answer all the questions**

**Q1/ Give the full terms of the following abbreviations: (20M)**

- |           |           |
|-----------|-----------|
| 1) CPU    | 2) PPM    |
| 2) OCR    | 4) CD-ROM |
| 5) Pixels | 6) DVD    |
| 7) LCD    | 8) DOS    |
| 9) MP     | 10) FAT   |

**Q2/ Write the following commands (30M) (Choose six only)**

1. Remove Directory Ali
2. Delete all file except Techcollege
3. Change Directory AlNajaf
4. Make Directory Ahmed
5. Copy all file in drive (c) to drive (d)
6. Delete all the file
7. Move the file Ali from directory Ahmed to directory Amjed

**Q3/ What the difference between: (20M)**

1. The hardware and software
2. RAM and ROM
3. Windows and Ms-Dos
4. Hard disc and CD
5. Minicomputer and Mainframe computers.



**Q4/ Answer the following: (30M)**

- 1) What is the major limitation of RAM?
- 2) What is the Allocation Unit?
- 3) How the leaser image printed to the paper by laser printer?
- 4) What is the bios?
- \*5) What is the Modem? And what are its functions?
- 6) What are kind of storage in computers?

With my best wishes



Lecture  
Basil Noori Merzah



Head of department  
Dr. Haider Hassan





Answer four questions only

Q1) Determine the force acting along the axis of each of the three struts needed to support the 500-kg block. (25 degree)

Q2) A vertical force  $p=20\text{KN}$  is applied to the ends of the 2-ft cord AB and spring AC. If the spring has an unstretched length of 2 ft, determine the angle  $\theta$  for equilibrium. Take  $k = 15 \text{ KN/m}$ . (25 degree).

Q3) Blocks A and B have a mass of 100kg and 150kg, respectively. If the coefficient of static friction between A and B and C is  $\mu_s=0.25$ , and between the ropes and the pegs D and E  $\mu_s=0.5$ , determine the smallest force F needed to cause motion of block B if  $P=30\text{N}$ . (25 degree).

Q4) Replace the force system in Figure 4 by a resultant force and couple moment at point O. (25 degree)

Q5) The uniform thin pole has a weight of 30 lb and a length of 26 ft. If it is placed against the smooth wall and on the rough floor in the position  $d=10\text{ft}$ , will it remain in this position when it is released? The coefficient of static friction is  $\mu_s = 0.3$ . (25 degree)

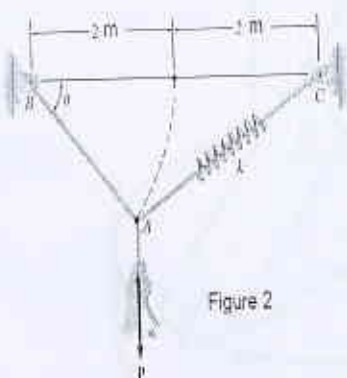
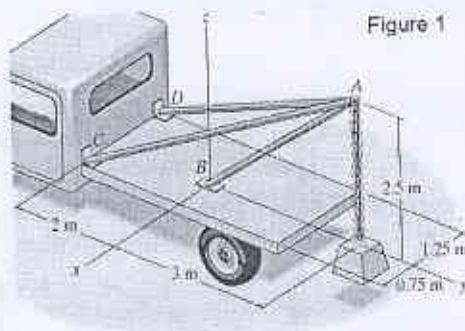
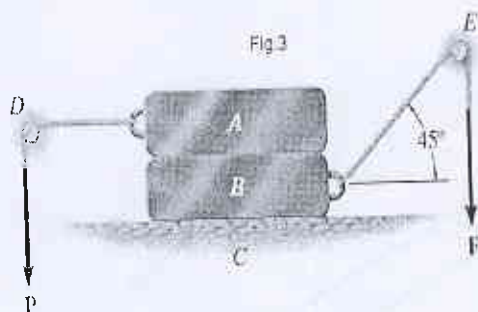


Figure 4

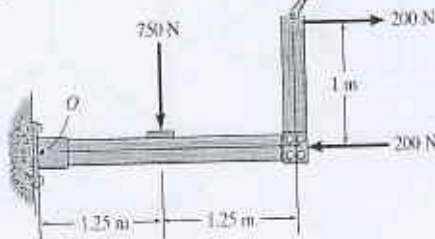


Figure 5

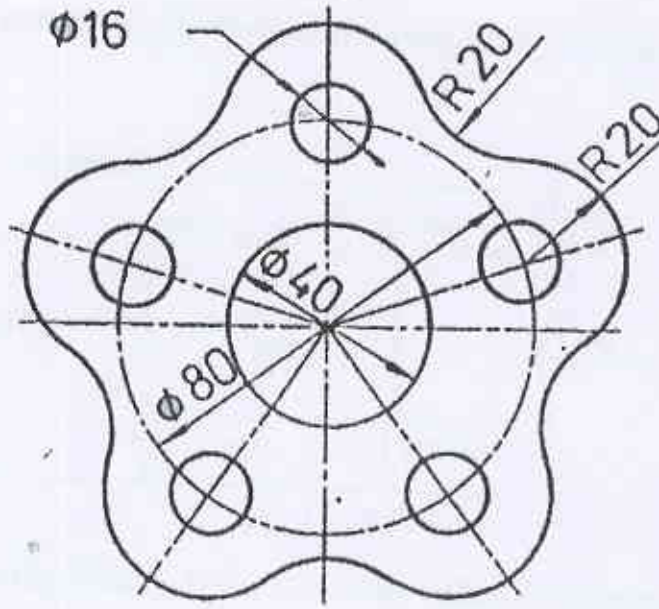


Handwritten signature



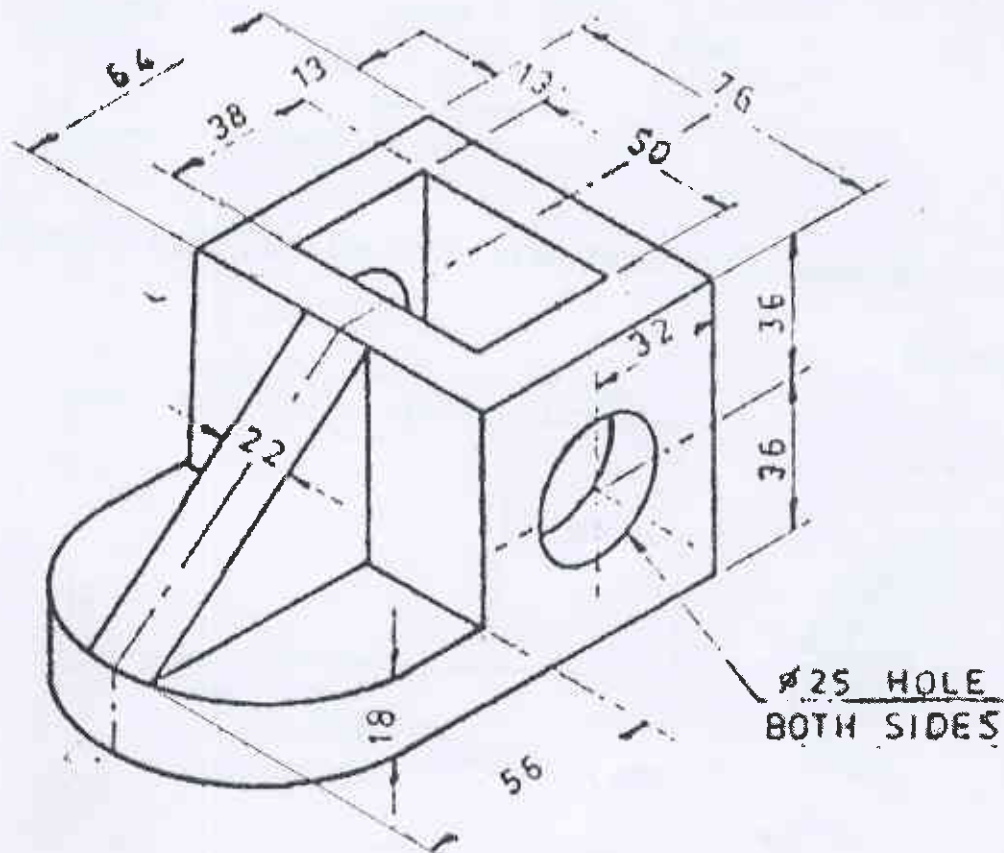
50 درجة

س1: ارسم الشكل ادناه



50 درجة

س2: ارسم المساقط الثلاث للشكل ادناه



القسم : هندسة تقنيات السيارات  
المرحلة : الاولى  
المادة : دوائر كهربائية  
زمن الامتحان : ساعتان  
التاريخ : 2016 / 3 / 1



جمهورية العراق  
وزارة التعليم العالي والبحث العلمي  
هيئة التعليم التقني  
جامعة الفرات الأوسط التقنية  
الكلية التقنية الهندسية / نجف

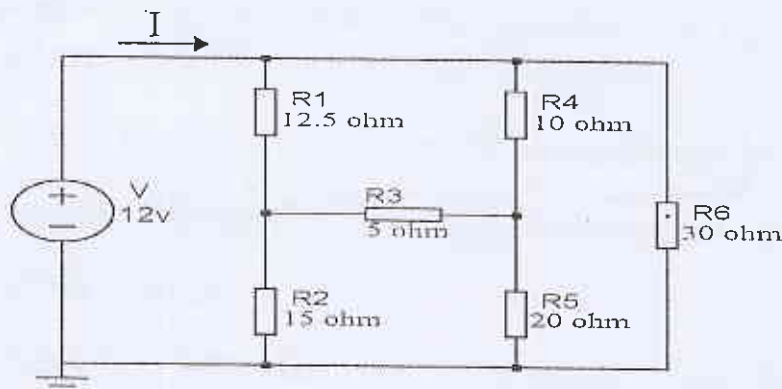
امتحان الفصل الأول - العام الدراسي 2015/2016

Note: Answer all questions

Q1/Obtain the equivalent resistance for the circuit shown in fig.(1) and use it to find the current I.

(25 marks)

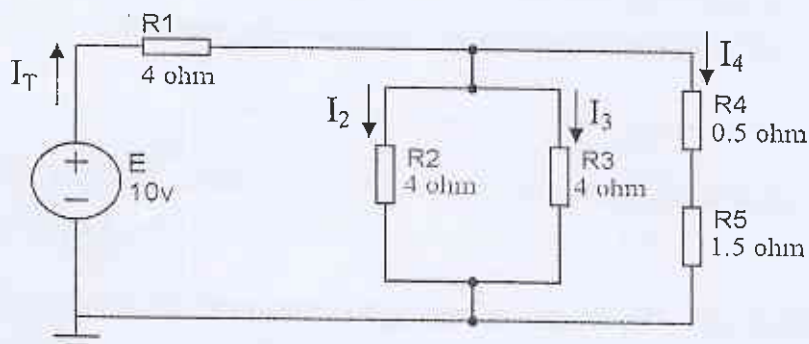
Fig.1



Q2/For circuit shown in fig.(2), find  $I_T$ ,  $I_2$ ,  $I_3$ ,  $I_4$  and the voltage for every resistors.

(25 marks)

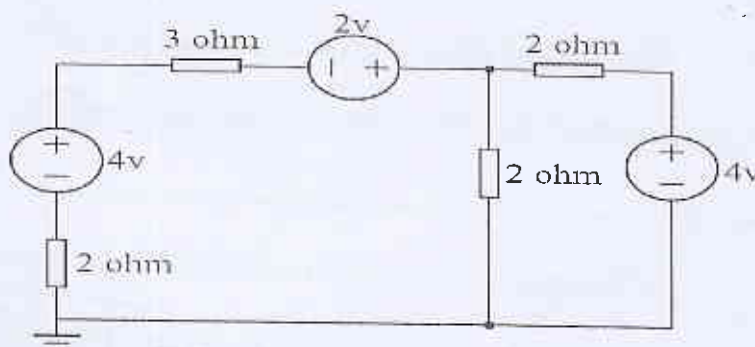
Fig.2



Q3/For the circuit shown in fig.(3), find the current in the 3ohm resistor using loop current method.

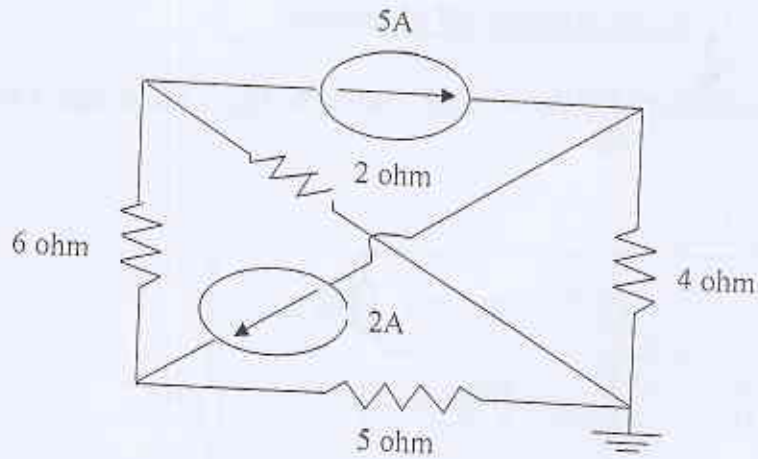
(25\*marks)

Fig.3



Q4/ For the network shown in fig.(4), write the nodal equations and solve for the nodal voltages. (25 marks)

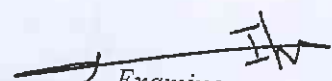
Fig.4



GOOD LUCK

  
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Examiner  
I. ALSHIMAYSAWI

Technical College of Najaf

Subject: Automotive Materials

Automotive Department

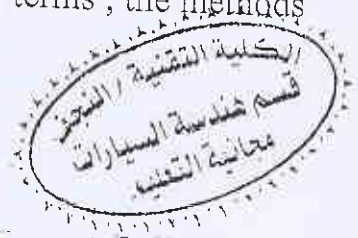
Class: 1<sup>st</sup> Stage

aminer: Oraskhudayer

First Attempt (2015-2016) Time :hrs.

- .....
- Q1/(A) Pure Copper is weak. How has it been found possible to increase the strength of the melt and still retain a relatively high conductivity? (6 D)
- (B) Discuss the reasons why copper-base alloys have tended to be replaced by other materials during the past twenty years ago or so? (5 D)
- (C) Describe the effects of alloying on the following properties with respect to copper :
- (a) electrical conductivity , (b) machinability , (c) formability , (d) corrosion – resistance
- (e) mechanical strength? (10 D)
- (D) Discuss the factors which influence the choice of nickel –based alloys for high temperature engineering ? (5 D)
- (E) Discuss the influence of the following elements on the structure and properties of cast iron : (a) silicon , (b) manganese , (c) sulphur , (d) phosphorus ? (4 D)
- .....

- Q2/(A) Explain fully what is meant by the term **growth** as applied to cast irons. Discuss methods which are used to overcome this phenomena? (15 D)
- (B) Cast iron is a cheap , easily produced engineering material , but ordinary grey cast iron has relatively poor mechanical properties , Discuss in general terms , the methods employed to overcome these limitations? (15 D)
- .....



- Q3/ (A) How you can form the sand core for the cylinder? (10 D)
- (B) Describe the balance between material property and heat management? (10 D)
- .....

- Q4/ (A) How you can distinguish between inlet and exhaust valve? (10 D)
- (B) Show the aims from multi valves configuration? (10 D)
- .....

*[Handwritten signature and notes]*

