國立雲林科技大學
八十七學年度研究所博士班入學考試試題

所別：工程技術研究所
科目：工程數學

1. Please solve the following equations:

(a) $x^2y'' - 2xy' + 2y = 0$ (8%)

(b) $y'' - 4y' + 4y = 0, \quad y(0) = 2, y'(0) = 1,$ (8%)

(c) $xe^y y' + (2x + e^y) = 0$ (8%)

(d) $y''' - 2y'' - y' + 2y = 2x^2 - 6x + 4, \quad y(0) = 5, y'(0) = -5, y''(0) = 1,$ (6%)

(e) $y' - 7y = -2y^2$ (6%)

2. Solve the following equation by Laplace transform method.

$$y'' - 2y' + y = e^t, \quad y(0) = 1, y'(0) = 0 \qquad (14\%)$$

3. If A has eigenvalues 0 and 1, corresponding to the eigenvectors,

$$\begin{bmatrix} 1 \\ 2 \end{bmatrix} \text{ and } \begin{bmatrix} 2 \\ -1 \end{bmatrix}$$

respectively,

(a) What is the matrix A ? (7%)

(b) What will be the eigenvalues and eigenvectors of A^2 ? (8%)

4. Let W be a subspace of a vector space V. Consider the following three subsets of W : (20%)

$$\begin{aligned} S_1 &= \{\mathbf{u}_1, \mathbf{u}_2, \ldots, \mathbf{u}_7\} \\ S_2 &= \{\mathbf{v}_1, \mathbf{v}_2, \ldots, \mathbf{v}_{10}\} \\ S_3 &= \{\mathbf{v}_1, \mathbf{v}_2, \ldots, \mathbf{v}_{10}, \mathbf{v}_{11}, \mathbf{v}_{12}\} \end{aligned}$$

It is understood that each of S_1, S_2, and S_3 is a set of distinct vectors of V. Note that S_2 is a subset of S_3 but there are no other known relationships among the vectors in S_1, S_2, and S_3. Here is a list of possible responses (*answers*) to the questions below ($(i) - (v)$):

(A) ... *is linearly independent.*

(B) ... *is linearly dependent.*

(C) ... *is not a basis for W.*

(D) ... *spans W.*

(E) ... *does not span W.*

(F) *The hypothesis provides no information about the set mentioned in the conclusion.*

Fill in the blanks (on your answer sheet) with a list of **all** those possible responses (*answers*) that can be justifiably concluded.

(i) If S_1 spans W, then S_2 _____.

(ii) If S_2 spans W, then S_3 _____.

(iii) If S_3 is a basis for W, then S_1 _____.

(iv) If S_3 is linearly independent, then S_2 _____.

(v) If S_2 is linearly independent, then S_3 _____.

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科目：工程數學

5. Let

$$A = \begin{bmatrix} 1 & 2 & -3 \\ 2 & -1 & 4 \\ 4 & 3 & -2 \end{bmatrix}$$

Find a basis for

(a) the column space of A. (5%)
(b) the row space of A. (5%)
(c) the null space of A. (5%)

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所別：工程技術研究所
科目：電路學

注意：全部四題，總計一百分。

1 (25%)The switch in the circuit shown in Figure 1 has been in position 1 for a very long time. At $t = 0$ it was placed in position 2 for 8 ms and then replaced into position 1. Find

(a) $dv_C / dt(0^+)$, the initial rate of change of v_C.

(b) v_C at $t = 8$ ms.

(c) The last time at which v_C is 10V.

(d) The last time at which $i = 20$mA.

(e) The time at which $i = -2$mA.

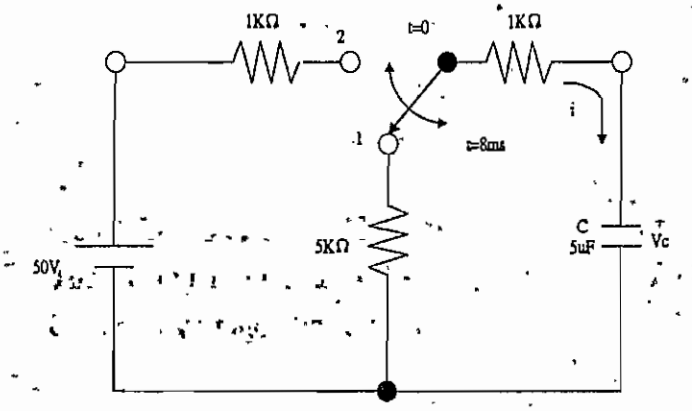

Figure 1

2.(25%)For the circuit shown in Figure 2, find

(a) I.

(b) V_D.

(c) The phase angle between the Y_A and the Y_B waveforms.

(d) The equivalent simple series circuit at this frequency.

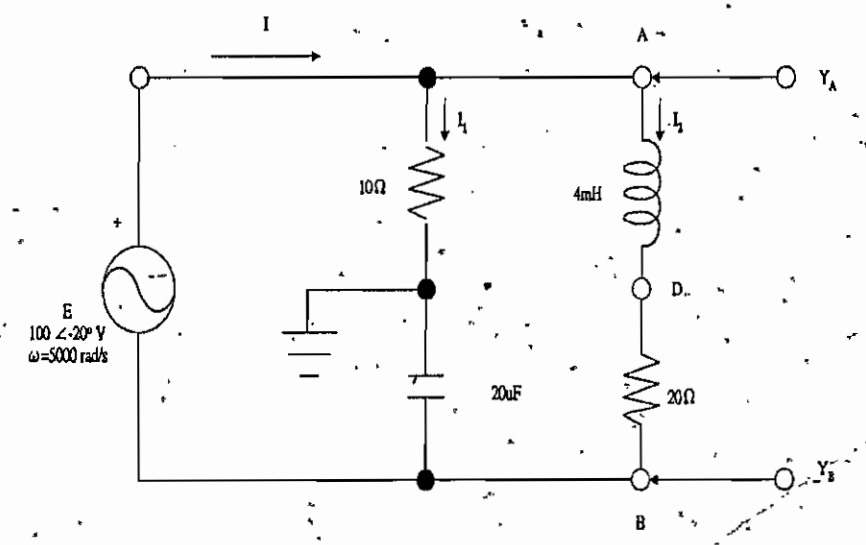

Figure 2

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八十七學年度研究所博士班入學考試試題　　科目：電路學

3. (25%) The network shown in Figure 3 is excited as follows.

$$i_1(t) = \cos(t) \qquad i_2(t) = 2\cos(t + \pi/2)$$

Find the sinusoidal steady-state response for $v_1(t)$ and $v_2(t)$.

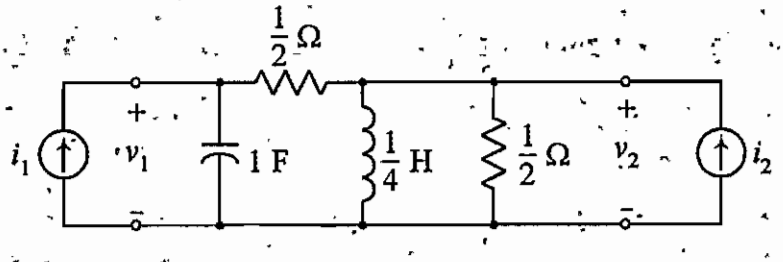

Figure 3

4. (25%) In the circuit of Figure 4, the initial voltage across the capacitor $v(0) = 0$. The switch is closed at $t = 0$. Assume the diode is ideal. Find and sketch the capacitor voltage as a function of time.

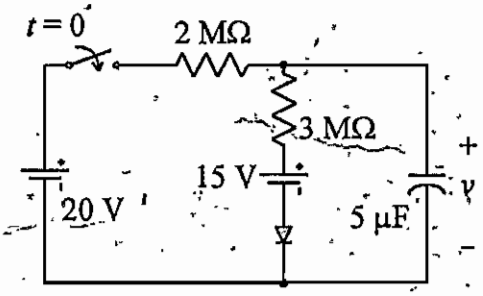

Figure 4

國立雲林科技大學
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所別：工程技術研究所
科目：自動控制

1. Briefly explain (or definition) the following terminologies (20%)
   (a) linear causal systems. (5%)
   (b) Routh–Hurwitz criterion. (5%)
   (c) Nyquist criterion. (5%)
   (d) overshoot percentage. (5%)

2. Find the fundamental matrix and state transition matrix of the following equation.

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-1 & e^{-t}\\ 0 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$ (10%)

3. Why does the root locus of $1+ kG(s)H(s) = 0$, begin ($k = 0$) at the poles of $G(s)H(s)$ and the end ($k = \infty$) at the zeros of $G(s)H(s)$. (10%)

4. Briefly explain how to find the static error constant from the Bode magnitude plot. (10%)

5. Determine whether the following state equation is stable or not. (15%)

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-1 & 0\\ e^{2t} & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

6. The forward transfer function of a unity feedback system is given by

$$G(s) = \frac{50(s+\alpha)}{s(s+10)(s+30)}$$

Design the value of α so that the closed–loop poles will have a damping ratio of 0.5. For this value of α, obtain the response to a unit step. (20%)

7. Given the plant, $G(s) = \frac{y(s)}{u(s)} = \frac{10}{(s+1)(s+2)}$, design the state feedback for the plant represented in cascade form to yield a 15% overshoot with a settling time of 0.5 second. (15%)

國立雲林科技大學
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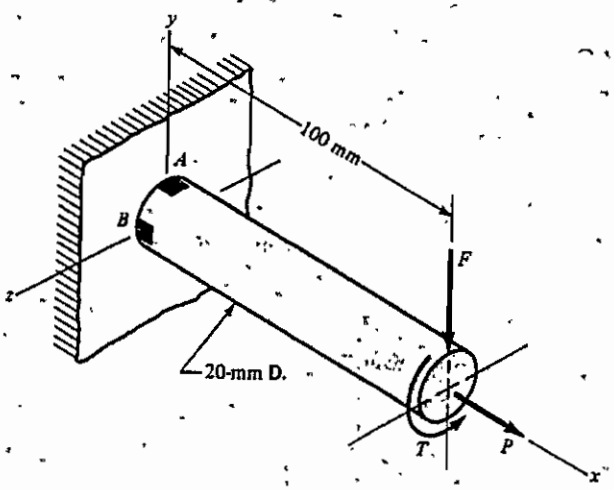
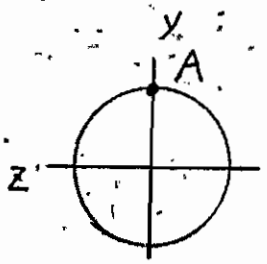
所別：工程技術研究所
科目：機械設計

1. The 20 mm diameter bar shown below is made of AISI 1006 cold drawn street with yielding stress 330 Mpa. The bar is loaded by the forces F=0.55 KN, p=8.0 KN, and T=30 Nm.
   (a) Determine the state of stress at point A. [15%]
   (b) Determine the factor of safety against yielding at point A by the maximum shear stress theory. [10%]





2. A component undergoes a cyclic stress with a maximum value of 110 ksi and a minimum value of 10 ksi. The component is made from a steel with an ultimate strength, S_u, of 150 ksi, an endurance limit, S_e, of 60 ksi, and a fully reversed stress at 1000 cycles, S_{1000}, of 110 ksi. Using the modified Goodman relationship, determine the life of the component. [25%]

國立雲林科技大學
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所別：工程技術研究所
科目：機械設計

3. Find the friction power loss for a Petroff bearing 100 mm in diameter and 150 mm long. Radial clearance c is 0.05 mm. Speed is 900 rpm. SAE oil 10 is used at 175°F. [25%]

$\mu = 0.000\ 001\ 03$ lb sec/in.^{2}

$1 \frac{\text{lb sec}}{\text{in.}^2} = \frac{1}{145} \frac{\text{Nsec}}{\text{mm}^2}$

$\frac{F_1}{\mu U}\left(\frac{c}{r}\right) = 2\pi$ (Petroff's bearing Equation)

4. Two module 3 gears are to be mounted on a center distance of 384 mm. The speed ratio is 7:9. Find the number of teeth in each gear. [25%]

$m_o = d/N$

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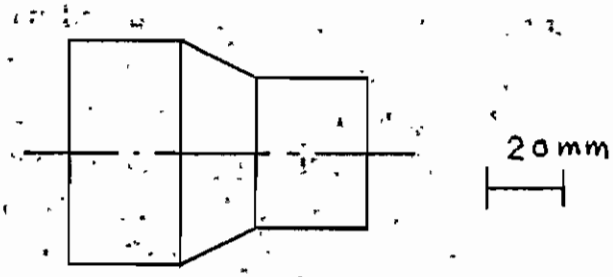
所別：工程技術研究所
科目：機械製造

1. 欲製造如圖所示之金屬工件若干個，試由製造成本、工件成品之機械性質(強度等)、尺寸精度、表面光度等方面，說明與比較以(1)車削；(2)鍛造；(3)焊接；(4)鑄造；(5)粉末冶金等五種製法之優缺點。(50%)



2. 試說明以何種製造程序可製作一長 200μm, 內徑 30 μm 外徑 50 μm 之銅管，並比較各方法之優缺點。又如果管內壁之粗糙度希望在 R_{amax} 0.1μm 以下，當如何處理? (25%)

3. 試說明雷射於機械製造工程之應用現況及未來發展。(25%)

國立雲林科技大學
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所別：工程技術研究所
科目：材料科學概論

請依題序將答案寫在答案卷

20% 1.Plot and describe the point and line defects of the crystal.

20% 2.How to protect a metal to prevent it from the corrosion, please describe the optimum methods.

20% 3.Explain the following strengthening mechanisms
(a) precipitation hardening 4%
(b) strengthening by grain size reduction 4%
(c) solid-solution strengthening 4%
(d) strain hardening 4%
(e) texture hardening 4%

20% 4.Explain the following terms
(a) Glass transition temperature 4%
(b) Fick's second law 4%
(c) Transition band 4%
(d) Zener formula 4%
(e) Amorphous metal 4%

20% 5.(a)Explain the purpose and principle of zone melting. 10%
(b)Continuous cooling transformation (C-C-T) diagram is important for a heat treatment engineer. Explain how to make a C-C-T diagram of a new steel alloy in detail. 10%

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八十七學年度研究所博士班入學考試試題 科目：熱力學

1. (20 points)

Nitrogen gas is being withdrawn from a 0.15 m^3 cylinder at the rate of 10 mol/min. The cylinder initially contains the gas at a pressure of 100 bar and 170 K. The cylinder is well insulated and there is a negligible heat transfer between the cylinder walls and the gas. What will be the temperature and pressure of the gas in the cylinder after 50 minutes? Assume that nitrogen is an ideal gas. Gas constant, R, is 8.314×10^{-5} bar m^3/mol K. C_p (J/mol K) = $27.2 + 4.2 \times 10^{-3}$ T.

2. (30 points)

Find ΔU, ΔH, Q, W, and ΔS for the following processes, all performed on 1 g mol of an ideal gas with $C_v = 5/2$ R.

a. A constant-pressure heating from 25℃ to 100℃

b. An adiabatic reversible expansion from 200℃, 5 atm to 1 atm

c. An isothermal reversible expansion from 200℃, 5 atm to 1 atm

d. A constant-volume heating from 25℃, 1 atm to 100℃

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八十七學年度研究所博士班入學考試試題　　科目：熱力學

3. (30 points)

In large steam power plants, the feedwater is frequently heated in closed feedwater heaters, which are basically heat exchangers, by steam extracted from the turbine at some stage. Steam enters the feedwater heater at 1MPa and 200℃ and leaves as saturated liquid at the same pressure. Feedwater enters the heater at 2.5 MPa and 50℃ and leaves 10℃ below the exit temperature of the steam. Neglecting any heat losses from the outer surfaces of the heater, determine (a) the ratio of the mass flow rates of the extracted steam and the feedwater and (b) the reversible work for this process per unit mass of the feedwater. Assume the surroundings to be at 25℃, and the properties of compressed liquid can be approximated using saturated liquid's data under the same temperature. (15 points each)

4. (20 points)

(1) Fig. 1 is the schematic of a combined cycle plant. Under the operating condition shown in the figure, its overall efficiency is only 34.2% which means that 65.8% of the energy of the fuel is wasted. Please propose some feasible ideas about how to improve its overall efficiency. (10 points)

(2) Is it possible to maintain a pressure of 10 kPa in a condenser which is being cooled by river water entering at 20℃ ? Why ? (10 points)

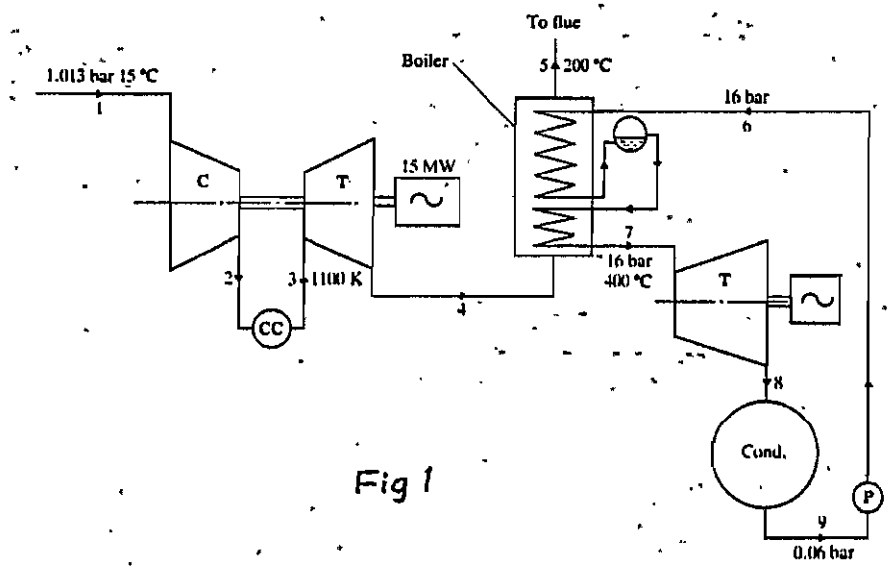

Fig 1

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八十七學年度研究所博士班入學考試試題

所別：工程技術研究所
科目：熱力學

Temp. °C T	Sat. press. kPa P_{sat}	Specific volume m³/kg: Sat. liquid v_f	Specific volume m³/kg: Sat. vapor v_g	Internal energy kJ/kg: Sat. liquid u_f	Internal energy kJ/kg: Evap. u_{fg}	Internal energy kJ/kg: Sat. vapor u_g	Enthalpy kJ/kg: Sat. liquid h_f	Enthalpy kJ/kg: Evap. h_{fg}	Enthalpy kJ/kg: Sat. vapor h_g	Entropy kJ/(kg·K): Sat. liquid s_f	Entropy kJ/(kg·K): Evap. s_{fg}	Entropy kJ/(kg·K): Sat. vapor s_g
0.01	0.6113	0.001 000	206.14	0.0	2375.3	2375.3	0.01	2501.3	2501.4	0.000	9.1562	9.1562
5	0.8721	0.001 000	147.12	20.97	2361.3	2382.3	20.98	2489.6	2510.6	0.0761	8.9496	9.0257
10	1.2276	0.001 000	106.38	42.00	2347.2	2389.2	42.01	2477.7	2519.8	0.1510	8.7498	8.9008
15	1.7051	0.001 001	77.93	62.99	2333.1	2396.1	62.99	2465.9	2528.9	0.2245	8.5569	8.7814
20	2.339	0.001 002	57.79	83.95	2319.0	2402.9	83.96	2454.1	2538.1	0.2966	8.3706	8.6672
25	3.169	0.001 003	43.36	104.88	2304.9	2409.8	104.89	2442.3	2547.2	0.3674	8.1905	8.5580
30	4.246	0.001 004	32.89	125.78	2290.8	2416.6	125.79	2430.5	2556.3	0.4369	8.0164	8.4533
35	5.628	0.001 006	25.22	146.67	2276.7	2423.4	146.68	2418.6	2565.3	0.5053	7.8478	8.3531
40	7.384	0.001 008	19.52	167.56	2262.6	2430.1	167.57	2406.7	2574.3	0.5725	7.6845	8.2570
45	9.593	0.001 010	15.26	188.44	2248.4	2436.8	188.45	2394.8	2583.2	0.6387	7.5261	8.1648
50	12.349	0.001 012	12.03	209.32	2234.2	2443.5	209.33	2382.7	2592.1	0.7038	7.3725	8.0763
55	15.758	0.001 015	9.568	230.21	2219.9	2450.1	230.23	2370.7	2600.9	0.7679	7.2234	7.9913
60	19.940	0.001 017	7.671	251.11	2205.5	2456.6	251.13	2358.5	2609.6	0.8312	7.0784	7.9096
	Sat. press. MPa											
100	0.101 35	0.001 044	1.6729	418.94	2087.6	2506.5	419.04	2257.0	2676.1	1.3069	6.0480	7.3549
105	0.120 82	0.001 048	1.4194	440.02	2072.3	2512.4	440.15	2243.7	2683.8	1.3630	5.9328	7.2958
110	0.143 27	0.001 052	1.2102	461.14	2057.0	2518.1	461.30	2230.2	2691.5	1.4185	5.8202	7.2387
115	0.169 06	0.001 056	1.0366	482.30	2041.4	2523.7	482.48	2216.5	2699.0	1.4734	5.7100	7.1833
120	0.198 53	0.001 060	0.8919	503.50	2025.8	2529.3	503.71	2202.6	2706.3	1.5276	5.6020	7.1296
125	0.2321	0.001 065	0.7706	524.74	2009.9	2534.6	524.99	2188.5	2713.5	1.5813	5.4962	7.0775
130	0.2701	0.001 070	0.6685	546.02	1993.9	2539.9	546.31	2174.2	2720.5	1.6344	5.3925	7.0269
135	0.3130	0.001 075	0.5822	567.35	1977.7	2545.0	567.69	2159.6	2727.3	1.6870	5.2907	6.9777
140	0.3613	0.001 080	0.5089	588.74	1961.3	2550.0	589.13	2144.7	2733.9	1.7391	5.1908	6.9299
145	0.4154	0.001 085	0.4463	610.18	1944.7	2554.9	610.63	2129.6	2740.3	1.7907	5.0926	6.8833
150	0.4758	0.001 091	0.3928	631.68	1927.9	2559.5	632.20	2114.3	2746.5	1.8418	4.9960	6.8379
155	0.5431	0.001 096	0.3468	653.24	1910.8	2564.1	653.84	2098.6	2752.4	1.8925	4.9010	6.7935
160	0.6178	0.001 102	0.3071	674.87	1893.5	2568.4	675.55	2082.6	2758.1	1.9427	4.8075	6.7502
165	0.7005	0.001 108	0.2727	696.56	1876.0	2572.5	697.34	2066.2	2763.5	1.9925	4.7153	6.7078
170	0.7917	0.001 114	0.2428	718.33	1858.1	2576.5	719.21	2049.5	2768.7	2.0419	4.6244	6.6663

Press. MPa P	Sat. temp. °C T_{sat}	Specific volume m³/kg: Sat. liquid v_f	Specific volume m³/kg: Sat. vapor v_g	Internal energy kJ/kg: Sat. liquid u_f	Internal energy kJ/kg: Evap. u_{fg}	Internal energy kJ/kg: Sat. vapor u_g	Enthalpy kJ/kg: Sat. liquid h_f	Enthalpy kJ/kg: Evap. h_{fg}	Enthalpy kJ/kg: Sat. vapor h_g	Entropy kJ/(kg·K): Sat. liquid s_f	Entropy kJ/(kg·K): Evap. s_{fg}	Entropy kJ/(kg·K): Sat. vapor s_g
0.80	170.43	0.001 115	0.2404	720.22	1856.6	2576.8	721.11	2048.0	2769.1	2.0462	4.6166	6.6628
0.85	172.96	0.001 118	0.2270	731.27	1847.4	2578.7	732.22	2039.4	2771.6	2.0710	4.5711	6.6421
0.90	175.38	0.001 121	0.2150	741.83	1838.6	2580.5	742.83	2031.1	2773.9	2.0946	4.5280	6.6226
0.95	177.69	0.001 124	0.2042	751.95	1830.2	2582.1	753.02	2023.1	2776.1	2.1172	4.4869	6.6041
1.00	179.91	0.001 127	0.194 44	761.68	1822.0	2583.6	762.81	2015.3	2778.1	2.1387	4.4478	6.5865
1.10	184.09	0.001 133	0.177 53	780.09	1806.3	2586.4	781.34	2000.4	2781.7	2.1792	4.3744	6.5536
1.20	187.99	0.001 139	0.163 33	797.29	1791.5	2588.8	798.65	1986.2	2784.8	2.2166	4.3067	6.5233

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/(kg·K)
	P = 1.00 MPa (179.91°C)			
Sat.	0.194 44	2583.6	2778.1	6.5865
200	0.2060	2621.9	2827.9	6.6940
250	0.2327	2709.9	2942.6	6.9247
300	0.2579	2793.2	3051.2	7.1229
350	0.2825	2875.2	3157.7	7.3011
400	0.3066	2957.3	3263.9	7.4651
500	0.3541	3124.4	3478.5	7.7622

國立雲林科技大學
八十七學年度研究所博士班入學考試試題

所別：工程技術研究所
科目：物理及化學

下列各題，每題10分

1. The complete combustion of 1 mole ethyl alcohol(ℓ) produces heat of 326.7 kcal. The heat of formation of CO_2 and water are 97.0 kcal and 68.4 kcal, respectively. Calculate the heat of formation of ethyl alcohol(ℓ).

2. Define in detail (A)Pauli exclusion principle and (B)Ionization energy.

3. The production of NO by reaction of N_2 and O_2 in an automobile engine is an important source of nitrogen oxide pollution. At 1000℃ the reaction $N_{2(g)}+O_{2(g)} \rightleftarrows 2NO_{(g)}$ has $kp = 4.8 \times 10^{-7}$. Suppose that the partial pressure of N_2 and O_2 in the cylinder of an engine after gasoline vapor has been ignited are $p_{N_2} = 33.6$ atm and $p_{O_2} = 4.0$ atm. Assume the temperature is 1000℃. Calculate the partial pressure of NO in the mixture if the system has reached equilibrium.

4. What gives stability to hydrophobic colloids (particulates will not settle easily) in water? How to destabilize these colloids?

5. How many grams of HCl gas would have to be dissolved in 500ml of 1.0M $NaCH_3COO$ to give a solution having a pH = 4.74?
$Ka = 1.8 \times 10^{-5}$

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6. A weather balloon is loosely inflated with helium at a pressure of 1.0atm(=760torr) and a temperature of 20℃. The gas volume is $2.2m^3$. At an elevation of 20,000 ft, the atmospheric pressure is down to 380 torr and the helium has expanded, being under no restraint from confining bag. At this elevation the gas temperature is -48℃. What is the gas volume now?

7. Two charged, parallel, flat conducting surfaces are spaced d = 1.00cm apart and produce a potential difference $\Delta V=625V$ between them. An electron is projected from one surface directly toward the second. What is the initial speed of the electron if it comes to rest just at the second surface?

8. A solenoid having an inductance of $6.30\,\mu H$ is connected in series with a $1.20\ k\Omega$ resistor. (a) If a 14.0V battery is switched across the pair, how long will it take for the current through the resistor to reach 80.0% of its final value? (b) What is the current through the resistor at time $t = 1.0\,\tau_L$?

9. The mean lifetime of stationary muons is measured to be $2.2\,\mu s$. The mean lifetime of high-speed muons in a burst of cosmic rays observed from Earth is measured to be $16\,\mu s$. Find the speed of these cosmic-ray muons relative to Earth.

10. Calcuate the energy released in the fission reaction

$$^{235}U + n \rightarrow {}^{141}Cs + {}^{93}Rb + 2n.$$

Needed atomic and particle masses are

^{235}U	235.04392 u	^{93}Rb	92.92157 u
^{141}Cs	140.91963 u	n	1.00867 u

(Hint: u=932MeV)

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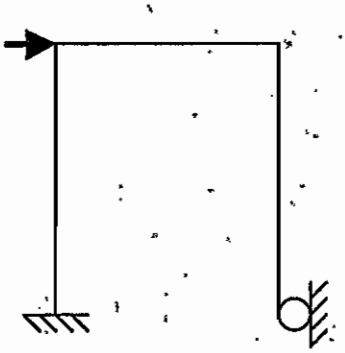
一、何謂莫氏圓(Mohr's circle)？其用途爲何？證明之！〔13 分〕

二、房屋結構可分爲基礎、柱、梁及樓板，如果硬要討論各別的重要性的話，請排列其重要性順序並說明之。〔12 分〕

三、挑高的房子爲何有安全顧慮？〔13 分〕

四、以直覺繪出下圖所示結構之變形，請先繪原圖於答案卷上，再於該圖上繪出變形之圖形，以便與原圖對照。[12 分]



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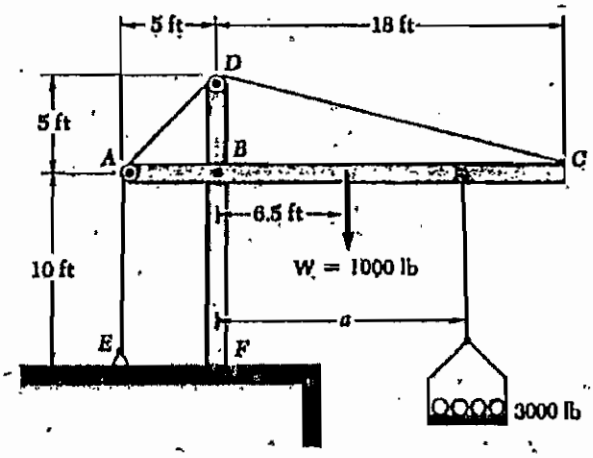
五、如圖所示之吊架之水平桿件 ABC 重 1000 磅， 且由一個鉸接 B 和一根纜繩 $EADC$ 所支撐。由於纜繩跨過在 A 及 D 點之滑輪，纜繩所有部份之張力可假設爲大小均相同。當以此吊架舉起一個 3000 磅重的重物（與垂直桿件 DF 之距離 $a = 12$ ft）時，求（1）纜繩中之張力〔10 分〕，（2）在 B 點的反力之水平與垂直分量〔15 分〕。



六、一根 T 型斷面之懸臂梁，受一個大小爲 10 kN 之傾斜力作用於自由端之上緣（如下圖），計算位於梁腹之 A 及 B 點處之主應力 σ_1 和 σ_2，以及最大之 in-plane 剪應力 τ_{max} 。〔25 分〕