國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：工程數學

1. $y(t)$ is a continuous function of t.

(A) (12%)

$$\frac{dy}{dt} + ay = 1, \quad a = \begin{cases} 1 & \text{if } t \leq 3 \\ 0.1 & \text{if } t > 3 \end{cases}$$

If $y(0) = 0$, determine the value of $y(10)$.

(B) (13%)

$$\frac{dy}{dt} + ay = 0, \quad a = \begin{cases} 1 & \text{if } y \geq 2 \\ 0.1 & \text{if } y < 2 \end{cases}$$

If $y(0) = 10$, determine the value of $y(10)$.

2. Denote the eigenvalues of a 2×2 real symmetric matrix $\mathbf{A}$ by λ_1 and λ_2, and the corresponding eigenvectors by $\mathbf{v}_1$ and $\mathbf{v}_2$.

(Note: You may answer (B) and (C) before (A) if you like.)

(A) (10%) Show that both λ_1 and λ_2 are real.

(B) (10%) Let $\mathbf{B} = \alpha\mathbf{A} + \beta\mathbf{I}$, where α and β are real numbers, and

$$\mathbf{I} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

What are the eigenvalues and eigenvectors of $\mathbf{B}$? (Show your derivation.)

(C) (5%) Let $\mathbf{x} = [x_1 \ x_2]^T$. Determine the elements of $\mathbf{A}$ such that $\mathbf{x}^T\mathbf{A}\mathbf{x} = x_1^2 - 3x_1x_2 + 2x_2^2$.

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：工程數學

3. Solve the following partial differential equation.

$$\frac{\partial u}{\partial t}=9\frac{\partial^2 u}{\partial x^2} \quad (0\le x\le 5, t\ge 0) \qquad (25\%)$$

u(0, t)=0, u(5, t)=3

u(x, 0)=0

4. Evaluate $\int_c (y^2-6xy+6)dx+(2xy-3x^2)dy$ along the path c

(a) if path c: from (-1,0) to (3,0) along a straight line y=0 and then to (3,4) along a straight line x=3

(b) if path c:(-1,0) to (3,4) along a straight line y=x+1 (25%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：應用微積分

1. Let $f(x) = x^2 \sin(1/x)$ for $x \neq 0$, and let $f(0) = 0$. Suppose also that h is a function such that $h'(x) = f(x+1)$ and $h(0) = 3$

Please find (i) $(h \circ f)'(0)$ (8%)

(ii) $(f \circ h)'(0)$ (8%)

(iii) If $g(x) = h(x+h(x))$, find $g'(0)$ (9%)

Note: ' means the derivative, and $(f \circ h)$ means $f(h(x))$.

2. Please sketch the graphs of function h(x)

where $h(x) = (x^2-2x+2)/(x-1)$

Note that you *must* show

(1) the critical points of h(x) at which the sign of slope changes (8%)

(2) the value of h(x) at each critical point (4%)

(3) the sign of h'(x) in the regions between critical points (6%)

(4) the behavior of h(x) as x becomes large or large negative or approaches the singular points. (7%)

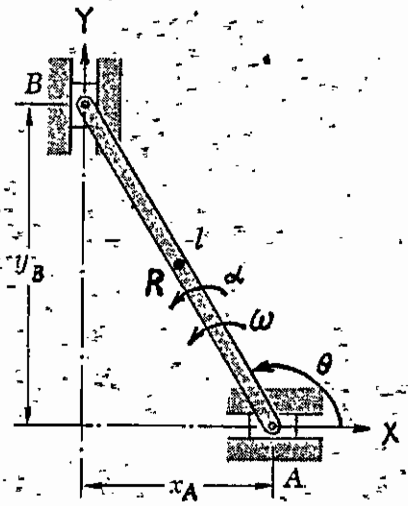
3. Find the <u>closed</u> cylinder of volume $V = \pi r^2 h = 16\pi$ that has the least surface area. (i.e. determine the radius r and the length h) (25%)

4. The curve is given by $x = \cos^3 t$, $y = \sin^3 t$. Its non-parametric form is $x^{\frac{2}{3}} + y^{\frac{2}{3}} = 1$. Find its length from $t = 0$ to $t = \frac{\pi}{2}$. (25%)

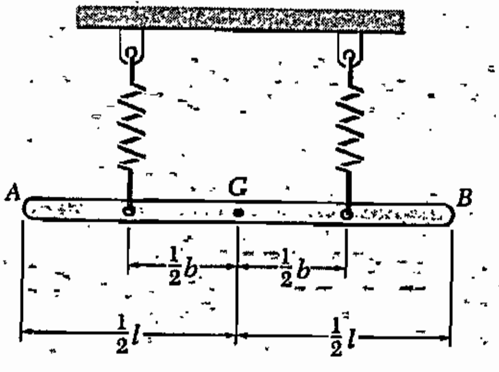
國立雲林科技大學 系所：機械系
八十九學年度研究所碩士班入學考試試題 科目：動力學

本試題計 4 題，每題 25 分，共 100 分

1. The uniform rod of length l is guided by two blocks A and B which slide without friction in the slots shown below. The angle θ 、angular velocity ω and angular acceleration α of uniform rod are given.
   (a) Determine the degree of freedom of the mechanism. (5%)
   (b) Determine the velocity and acceleration of block A. (10%)
   (c) Determine the velocity and acceleration at point R which is located at the middle of uniform rod. (10%)



2. A slender rod of mass m and length l is held by two springs, each of constant k.
   (a) Determine the frequency of the resulting vibration if the rod is given a small vertical displacement and released. (10%)
   (b) Determine the frequency of the resulting vibration if the rod is rotated through a small angle about a horizontal axis through G and released. (10%)
   (c) Determine the ratio b/l for which the frequencies found in parts (a) and (b) are equal. (5%)



國立雲林科技大學
八十九學年度研究所碩士班入學考試試題
系所：機械系
科目：動力學

3. As shown in Figure 3, the linkage consists of two 8-lb rods AB and CD and a 10-lb rod AD. When $\theta = 0°$, rod AB is rotating with an angular velocity $\omega_{AB} = 2$ rad/s. If at this instant rod CD is subjected to a couple moment $M = 15$ lb·ft and rod AD is subjected to a horizontal force $P = 20$ lb and a vertical force $Q = 25$ lb, determine ω_{AB} at the instant $\theta = 90°$. [25%]

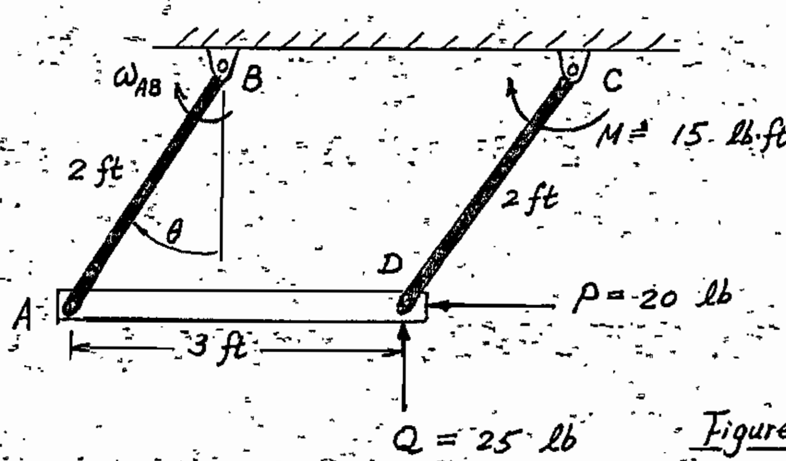


Figure 3

4. The 10-kg wheel with a moment of inertia $I_G = 0.156$ kg·m^2 is released from position B with an initial speed v_o. There is no slipping between surface and wheel. As shown in Figure 4, after the wheel arrives at the horizontal plane, it has a contact with point A. Assuming that the wheel does not slip or rebound, determine the minimum v_o it must have to just roll over the obstruction at A. (Hint: you may use the concepts of the conservation of angular momentum and energy) [25%]

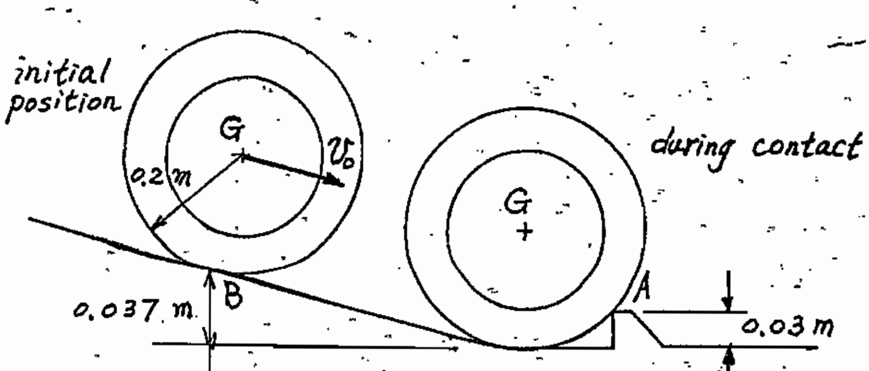


Figure 4

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：機械製造

1.(a)板片材料的塑性變形比(plastic strain ratio) r 值與應變硬化指數 (strain hardening exponent) n 值是很重要的成形性指標；試說明 r 值和 n 值的定義，測量 r 值和 n 值的實驗方法，r 值和 n 值與成形性的關係。
(15%)
(b)何謂回火脆化？說明其原因。
(10%)

2.(a)試說明精密鑄造(investment casting)的作業流程及其產品可能的缺陷。
(10%)
(b)試說明金屬粉末射出成型技術的作業流程及其優缺點及其應用。
(15%)

3.微小衝孔(Micro Hole Punching)會有那些問題？如何解決？(25%)

4.試繪圖說明超音波加工機的組成？加工原理？加工特性？優點缺點？應用範圍？(25%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題
系所：機械系
科目：熱力學

1. [25%] 有一個絕熱的硬体容器体積 $V=0.1m^3$，此容器內有空氣压力 $P_1=400kPa$ 和溫度 $T_1=37°C$，此時將容器上的一個 Valve 打開使容器內的 air 流出，直到此容器內空氣質量流出一半時（即 $m_2=0.5m_1$）再把 Valve 關住。a) 試求此容器在終態時的溫度和压力（T_2, P_2）。流出空氣的焓可假設是初態和終態焓的平均值（$h_e=\frac{1}{2}(h_1+h_2)$），且可視此空氣是 ideal gas；$R=0.287\frac{kPa\cdot m^3}{kg\cdot K}$，b) 容器內的空氣由於流出而減少的能量，$C_p=1.005\ kJ/kg\cdot K$，$C_v=0.718\ kJ/kg\cdot K$，$h_1=310.2\ kJ/kg$，$u_1=221.3\ kJ/kg$。

2. [25%] 有一個銅塊質量 $m=1.5kg$，比熱 $C=0.39\ kJ/kg\cdot K$，初溫 $T_1=700K$。此銅塊置於 300K 的空氣下冷卻至 $T_2=300K$。a) 試求此銅塊的 entropy 變化量 b) 銅塊和周邊空氣的總 entropy 的變化量？

$$Tds=du+Pdv$$

3. Consider a two-stage turbine operating at steady state with reheat at constant pressure between the stages. Show that the maximum work is developed when the pressure ratio is the same across each stage. Use a cold air standard analysis, assuming the inlet state and the exit pressure are specified, each expansion process is isentropic, and the temperature at the inlet to each turbine stage is the same. Kinetic and potential energy effects can be ignored. **25%**

4. Consider a Brayton refrigeration cycle with a regenerative heat exchanger. Air enters the compressor at 540 ^{o}R, 20 lbf/in^2 and is compressed isentropically to 80 lbf/in^2. Compressed air enters the regenerative heat exchanger at 600 ^{o}R and is cooled to 540 ^{o}R before entering the turbine. The expansion through the turbine is isentropic. If the refrigeration capacity is 15 tons, calculate
   (a) the mass flow rate of air, in lb/min. **13%**
   (b) the coefficient of performance. **12%**

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：熱力學

TABLE A-22E Ideal Gas Properties of Air

T(°R), h and u(Btu/lb), $s°$(Btu/lb · °R)

T	h	p_r	u	v_r	$s°$	T	h	p_r	u	v_r	$s°$
360	85.97	0.3363	61.29	396.6	0.50369	940	226.11	9.834	161.68	35.41	0.73509
380	90.75	0.4061	64.70	346.6	0.51663	960	231.06	10.61	165.26	33.52	0.74030
400	95.53	0.4858	68.11	305.0	0.52890	980	236.02	11.43	168.83	31.76	0.74540
420	100.32	0.5760	71.52	270.1	0.54058	1000	240.98	12.30	172.43	30.12	0.75042
440	105.11	0.6776	74.93	240.6	0.55172	1040	250.95	14.18	179.66	27.17	0.76019
460	109.90	0.7913	78.36	215.33	0.56235	1080	260.97	16.28	186.93	24.58	0.76964
480	114.69	0.9182	81.77	193.65	0.57255	1120	271.03	18.60	194.25	22.30	0.77880
500	119.48	1.0590	85.20	174.90	0.58233	1160	281.14	21.18	201.63	20.29	0.78767
520	124.27	1.2147	88.62	158.58	0.59172	1200	291.30	24.01	209.05	18.51	0.79628
537	128.34	1.3593	91.53	146.34	0.59945	1240	301.52	27.13	216.53	16.93	0.80466
540	129.06	1.3860	92.04	144.32	0.60078	1280	311.79	30.55	224.05	15.52	0.81280
560	133.86	1.5742	95.47	131.78	0.60950	1320	322.11	34.31	231.63	14.25	0.82075
580	138.66	1.7800	98.90	120.70	0.61793	1360	332.48	38.41	239.25	13.12	0.82848
600	143.47	2.005	102.34	110.88	0.62607	1400	342.90	42.88	246.93	12.10	0.83604
620	148.28	2.249	105.78	102.12	0.63395	1440	353.37	47.75	254.66	11.17	0.84341
640	153.09	2.514	109.21	94.30	0.64159	1480	363.89	53.04	262.44	10.34	0.85062
660	157.92	2.801	112.67	87.27	0.64902	1520	374.47	58.78	270.26	9.578	0.85767
680	162.73	3.111	116.12	80.96	0.65621	1560	385.08	65.00	278.13	8.890	0.86456
700	167.56	3.446	119.58	75.25	0.66321	1600	395.74	71.73	286.06	8.263	0.87130
720	172.39	3.806	123.04	70.07	0.67002	1650	409.13	80.89	296.03	7.556	0.87954
740	177.23	4.193	126.51	65.38	0.67665	1700	422.59	90.95	306.06	6.924	0.88758
760	182.08	4.607	129.99	61.10	0.68312	1750	436.12	101.98	316.16	6.357	0.89542
780	186.94	5.051	133.47	57.20	0.68942	1800	449.71	114.0	326.32	5.847	0.90308
800	191.81	5.526	136.97	53.63	0.69558	1850	463.37	127.2	336.55	5.388	0.91056
820	196.69	6.033	140.47	50.35	0.70160	1900	477.09	141.5	346.85	4.974	0.91788
840	201.56	6.573	143.98	47.34	0.70747	1950	490.88	157.1	357.20	4.598	0.92504
860	206.46	7.149	147.50	44.57	0.71323	2000	504.71	174.0	367.61	4.258	0.93205
880	211.35	7.761	151.02	42.01	0.71886	2050	518.61	192.3	378.08	3.949	0.93891
900	216.26	8.411	154.57	39.64	0.72438	2100	532.55	212.1	388.60	3.667	0.94564
920	221.18	9.102	158.12	37.44	0.72979	2150	546.54	233.5	399.17	3.410	0.95222

T(°R), h and u(Btu/lb), $s°$(Btu/lb · °R)

T	h	p_r	u	v_r	$s°$	T	h	p_r	u	v_r	$s°$
2200	560.59	256.6	409.78	3.176	0.95868	3700	998.11	2330	744.48	.5882	1.10991
2250	574.69	281.4	420.46	2.961	0.96501	3750	1013.1	2471	756.04	.5621	1.11393
2300	588.82	308.1	431.16	2.765	0.97123	3800	1028.1	2618	767.60	.5376	1.11791
2350	603.00	336.8	441.91	2.585	0.97732	3850	1043.1	2773	779.19	.5143	1.12183
2400	617.22	367.6	452.70	2.419	0.98331	3900	1058.1	2934	790.80	.4923	1.12571
2450	631.48	400.5	463.54	2.266	0.98919	3950	1073.2	3103	802.43	.4715	1.12955
2500	645.78	435.7	474.40	2.125	0.99497	4000	1088.3	3280	814.06	.4518	1.13334
2550	660.12	473.3	485.31	1.996	1.00064	4050	1103.4	3464	825.72	.4331	1.13709
2600	674.49	513.5	496.26	1.876	1.00623	4100	1118.5	3656	837.40	.4154	1.14079
2650	688.90	556.3	507.25	1.765	1.01172	4150	1133.6	3858	849.09	.3985	1.14446
2700	703.35	601.9	518.26	1.662	1.01712	4200	1148.7	4067	860.81	.3826	1.14809
2750	717.83	650.4	529.31	1.566	1.02244	4300	1179.0	4513	884.28	.3529	1.15522
2800	732.33	702.0	540.40	1.478	1.02767	4400	1209.4	4997	907.81	.3262	1.16221
2850	746.88	756.7	551.52	1.395	1.03282	4500	1239.9	5521	931.39	.3019	1.16905
2900	761.45	814.8	562.66	1.318	1.03788	4600	1270.4	6089	955.04	.2799	1.17575
2950	776.05	876.4	573.84	1.247	1.04288	4700	1300.9	6701	978.73	.2598	1.18232
3000	790.68	941.4	585.04	1.180	1.04779	4800	1331.5	7362	1002.5	.2415	1.18876
3050	805.34	1011	596.28	1.118	1.05264	4900	1362.2	8073	1026.3	.2248	1.19508
3100	820.03	1083	607.53	1.060	1.05741	5000	1392.9	8837	1050.1	.2096	1.20129
3150	834.75	1161	618.82	1.006	1.06212	5100	1423.6	9658	1074.0	.1956	1.20738
3200	849.48	1242	630.12	.9546	1.06676	5200	1454.4	10539	1098.0	.1828	1.21336
3250	864.24	1328	641.46	.9069	1.07134	5300	1485.3	11481	1122.0	.1710	1.21923
3300	879.02	1418	652.81	.8621	1.07585						
3350	893.83	1513	664.20	.8202	1.08031						
3400	908.66	1613	675.60	.7807	1.08470						
3450	923.52	1719	687.04	.7436	1.08904						
3500	938.40	1829	698.48	.7087	1.09332						
3550	953.30	1946	709.95	.6759	1.09755						
3600	968.21	2068	721.44	.6449	1.10172						
3650	983.15	2196	732.95	.6157	1.10584						

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：專業實務

(1) 抽水馬桶水箱之水位高低控制是屬於一種閉迴路(closed-loop)控制系統，請說明其工作原理並繪其方塊圖(block diagram). (10%)

(2) 目前一般產業機械(例如：液壓壓床之功率單元)所使用的電動馬達是屬於何種電機機械？爲何使用它？又若您發現該馬達轉向錯誤時，您應如何處理？ (10%)

(3) 冷氣機在除濕運轉時室溫會下降；而一般除濕機運轉時室溫卻會上升，爲什麼？ (10%)

(4) (a) 在電腦控制系統中經常使用的 AD/DA 界面卡，請說明 A/D 及 D/A 之個別功能爲何？

(b) 爲何在微處理機內部所使用的機器語言爲二進位制？ (10%)

(5) CNC 工具機是一項標準的機電整合(Mechatronics) 產品，因其結合了電控及機械輸出二項合而爲一，請列舉其他三種屬於機電整合的產品，並請說明您的理由. (10%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：專業實務

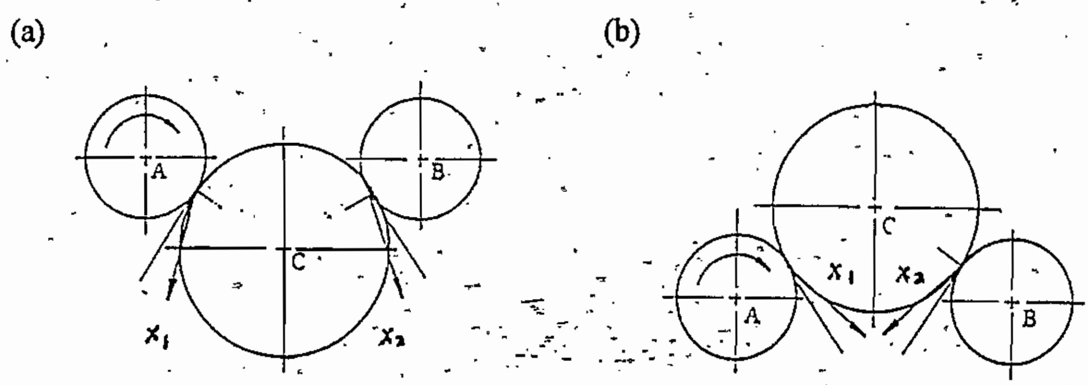
6. 常用之熱機中，應採用黏度指數較高或較低的潤滑油？ 請簡要說明其原因。(10%)

7. 兩同質量車輪輪胎摩擦係數大小不同，同時由一米高之斜面而下至摩擦係數甚小光滑地面，請問那一個跑得較遠？ 請簡要說明其原因。(10%)

8. 有四種製造程序 Milling、Lapping、Grinding、Forging，請比較此四種製造程序所能達致的精度與粗糙度。(10%)

9. 機械元件若以使用目的之不同來分類，大約有那些種類？ 各種類之機械元件請舉例之。(10%)

10. 下列 A、B、C 三齒輪傳動軸之排列方式(a)、(b)兩種中，當主動軸 A 旋轉後可得 A、B 軸之分力 X_1、X_2，則相對 C 軸所承受之力，那一種排列方式對其軸承較有利？ 請簡要說明其原因。(10%)



國立雲林科技大學 系所：機械系

八十九學年度研究所碩士班入學考試試題 科目：自動控制

1. (1) What tell us in Table 1? Please explain it as clear as possible. What are the physical meanings of "step input", "ramp input" and "parabola input"? (10%)

(2) A small boat is circling a large ship that is using a tracking radar. The speed of the small boat is 20 knots, and it is circling the large ship at a distance of 1 nautical mile, as shown in Figure 2(a). A simplified model of the tracking system is shown in Figure 2(b). Find the value of K so that the small boat is kept in the center of the radar beam with no more than 0.1-degree error. (1 knot = 1 nautical mile per hour) (15%)

Table 1 Summary of Relationships between Input, System Type, Static Error Coefficients, and Steady-State Errors

		Type 0		Type 1		Type 2	
Input	Steady-state error formula	Static error constant	Error	Static error constant	Error	Static error constant	Error
Step, $u(t)$	$\frac{1}{1+K_p}$	$K_p =$ Constant	$\frac{1}{1+K_p}$	$K_p = \infty$	0	$K_p = \infty$	0
Ramp, $tu(t)$	$\frac{1}{K_v}$	$K_v = 0$	∞	$K_v =$ Constant	$\frac{1}{K_v}$	$K_v = \infty$	0
Parabola, $\frac{1}{2}t^2u(t)$	$\frac{1}{K_a}$	$K_a = 0$	∞	$K_a = 0$	∞	$K_a =$ Constant	$\frac{1}{K_a}$

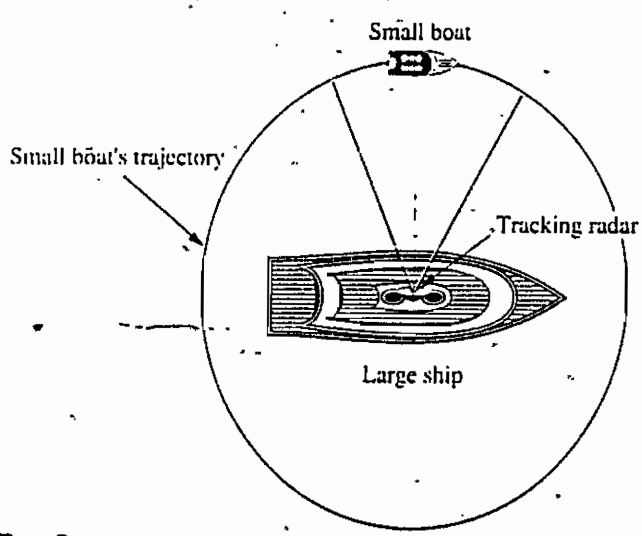
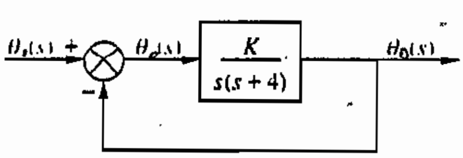


Fig. 2

(a)



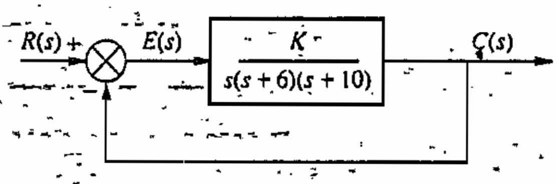
(b)

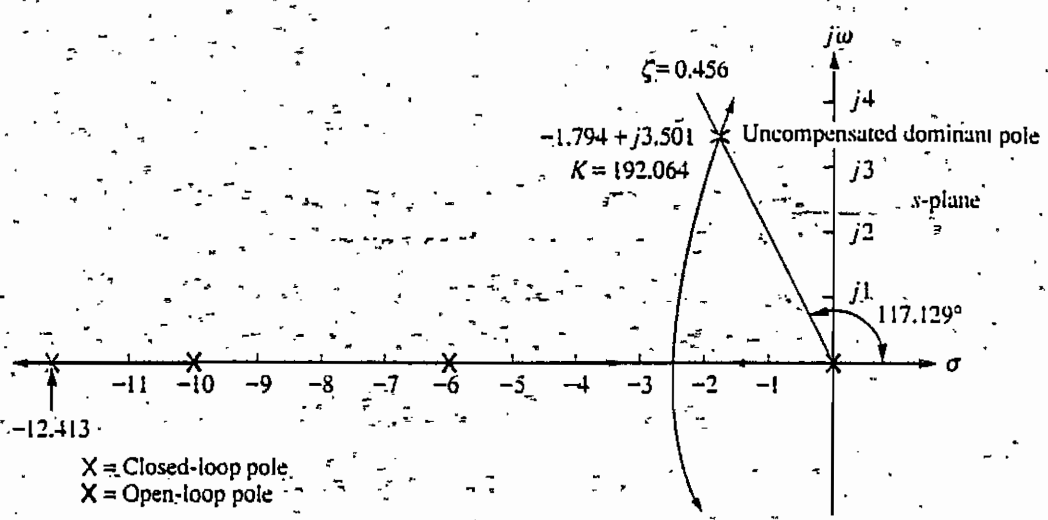
國立雲林科技大學
八十九學年度研究所碩士班入學考試試題
系所：機械系
科目：自動控制

2. (1) For a cascade compensation system, describe as clear as possible the purposes of PI, PD, and PID compensations. Describe also the purposes of Lag compensation, Lead compensation and Lag-Lead compensation. What is the difference between PID compensation and Lag-Lead compensation? (10%)

(2) Design a Lag-Lead compensator for the system of Figure 3 so that the system will operate with 20% overshoot, and a twofold reduction (i.e. 1/2) in settling time. Further, the compensated system will exhibit a tenfold improvement (i.e. 1/10) in steady-state error for a ramp input. First of all, please describe step by step the way you will solve the problem. Then you show the detailed calculations. (15%)

Figure 3 Uncompensated System





Root Locus for Uncompensated

	Uncompensated
Plant	$\dfrac{K}{s(s+6)(s+10)}$
Dom. poles	$-1.794 \pm j3.501$
K	192.064
ζ	0.456
ω_n	3.934
%OS	20
T_s	2.230
T_p	0.897
K_v	3.201
$e(\infty)$	0.312
Third pole	−12.413
Zero	None
Comments	Second-order approx. OK

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：自動控制

3. (1) When K = 10, please find the roots of the characteristic equation for the system shown in figure A. (10%)

(2) Then, determine the response $c(t)$ for the case in which K = 10, $r(t) = 0$, $c(0) = \dot{c}(0) = 0$ and $\ddot{c}(0) = 10$. (15%)

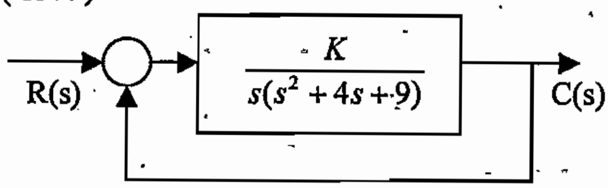


figure A

4. The oven shown in figure B is supplied with heat from an electric source. The rate of heat supplied Q_s is proportional to the voltage, $Q_s = k_1 E_s$. The rate at which heat is lost Q is proportional to the difference in the oven temperature T and the ambient temperature T_a, thus $Q = k_2(T - T_a)$.

The rate of change of temperature of the oven is $\dot{T} = k_3(Q_s - Q)$.

(1) Please construct the overall block diagram for this oven. (10%)

(2) Determine the differential equation which relates the oven temperature T to the voltage E_s and the ambient temperature T_a. (10%)

(3) What is the time constant of this oven? (5%)

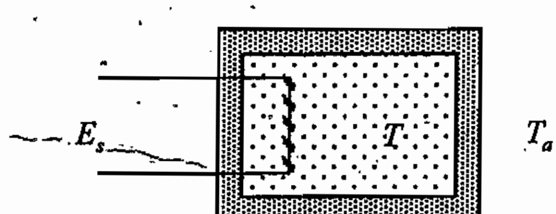
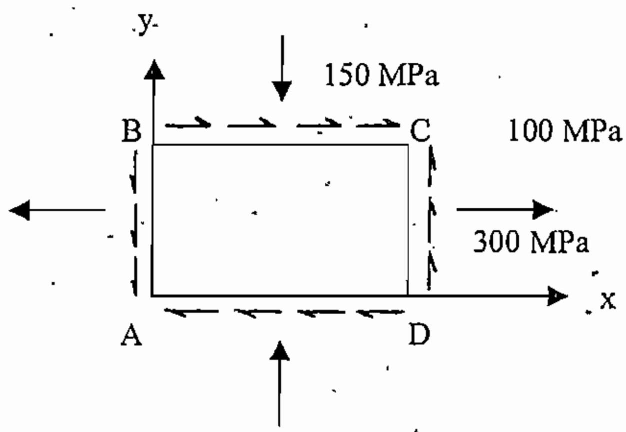


figure B

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

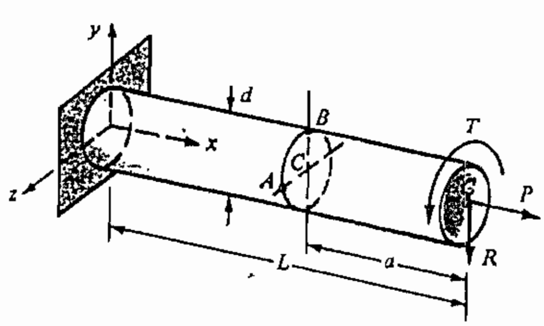
系所：機械系
科目：材料力學

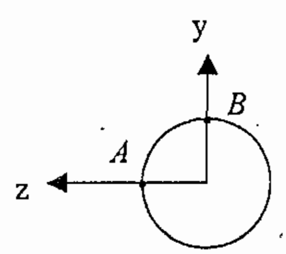
1. A 60 × 80-mm rectangular steel (with Young's modulus E = 210 GPa, Poisson's ration $\nu = 1/3$) plate is subjected to the uniform stresses as shown.
   (a) 畫出此一應力狀態之 Mohr's circle 並標出各個重要的數據資料，包括圓心和半徑，principal stresses(σ_1, σ_2)及其對應之方向角度，與在此 x-y 面上之 maximum shear stress 及其對應之方向角度。 (6%)
   (b) 求 normal strain ε_x, ε_y, 及 engineering shear strain γ_{xy}, 並畫出在此 x-y 面上 Mohr's circle for strain，並標出 principal strains (ε_1, ε_2)。 (6%)
   (c) 試由(a)的答案中，直接求 principal strains 及其對應之方向角度。 (5%)
   (d) 求對角線 AC 與 BD 之伸長量(或縮短量)。 (8%)



AD = 80 mm, AB = 60 mm

2. A cantilever aluminum bar (of diameter *d*) is loaded as shown by a force *P* (Newton), a torque *T* (N-m), and a transverse force *R* (Newton).
   (a) Determine the state of stress (in terms of *P*, *T*, *R*, *a*, *d*) at *A* and *B* respectively. (10%)
   (b) Given allowable stresses of 90 MPa in tension and 50 MPa in shear on a section 320 mm from the free end, determine the largest value of *R*. Let $T = 0.2R$, $P = 20R$, and $d = 80$ mm. (15%)





3.In Fig.3 the three bars are of the same material and have equal cross sections and lengths, find the force in each bar. [25%]

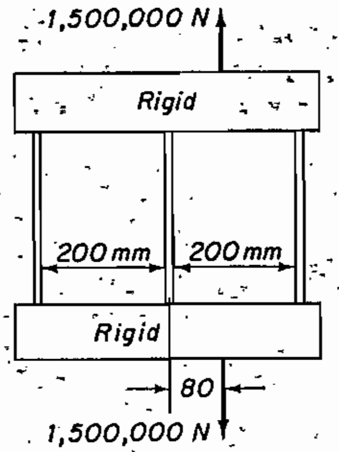


Figure 3

4.A simply supported cast-iron beam is $900mm$ long and carries a $1,350N$ load at the center. Note that the two cross sections in Fig.4 have areas equal to each other. Find the stress and deflection at the center for each beam. $E = 103,400Mpa$. $y_{max} = \dfrac{PL^3}{48EI}$, L: length. [25%]

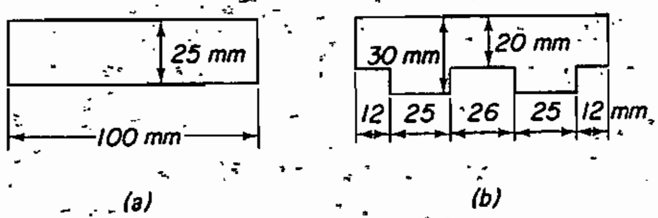


Figure 4

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：機械系
科目：流體力學

1. (25%) An open rectangular tank 1 m wide and 2 m long contains gasoline to a depth of 1m. If the height of the tank sides 1.5 m; what is the maximum horizontal acceleration (along the long axis of the atnk) that can develop before the gasoline would begin to spill?

2. (25%) Air at 27 °C and 1 atm flows over a flat plate at a speed of 2 m/s. It assumed that the plate is heated over its entire length to a temperature of 60 °C. Calculate the heat transferred in the first 20 cm of the plate. The air properties are ν=17.36 x 10^{-6} m^2/s, k=0.02749 W/mK, Pr=0.7 and c_p= 1.006 kJ/kgK.
(For the plate heated over its entire length, the Nu_x equal to 0.332 $Pr^{1/3}$ $Re_x^{1/2}$)

3. (25%)A short length pipe is connected close to the bottom of a reservoir of water level height h. A nozzle of exit area A_j is connected to the pipe, the pipe cross-sectional area being three times that of the nozzle exit. The velocity coefficient of the nozzle is c_v(where V_{actual}=c_v*V_{ideal}). The head loss in the pipe (including any entrance loss) is given by $h_f=k(V^2/2g)$, where k is a given loss coefficient and V is the velocity in the pipe. Obtain an algebraic expression for the final jet velocity V_j coming out of the nozzle.(20%) What is the effect on the volume flow rate if a diffuser is attached to the nozzle? Simply state your answer with a brief explanation. (5%)

4. (25%)Fluid of uniform velocity U_o and constant pressure flows over a flat plate. Due to the action of viscosity, the fluid adjacent to the plate is slowed down and at the end of the plate the velocity component parallel to the plate is distributed as $u=U_of(y/y_o)$, where y_o is the distance from the plate for which $u=U_o$. The pressure may be assumed constant. Show that the drag force on the plate per unit width is $D=\int_0^{y_0}\rho(U_0-u)udy$. (Note: The streamlines are not all straight)