國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：工程數學

1. Solve the following differential equations:

(a) $y'' - y = e^x(x^2 - 1)$ (7%)

(b) $x^3\frac{d^3y}{dx^3} + 4x^2\frac{d^2y}{dx^2} - 5x\frac{dy}{dx} - 15y = 0$ (8%)

(c) $\begin{cases} \frac{dy_1}{dt} + y_1 = \frac{dy_2}{dt} + y_2 \\ \frac{d^2y_1}{dt^2} + \frac{d^2y_2}{dt^2} = e^t \end{cases}$ and $y_1(0) = 0,\ \frac{dy_1(0)}{dt} = 1,\ y_2(0) = 1,\ \frac{dy_2(0)}{dt} = 0$

Hint: Use Laplace transform (10%)

2. (a)Solve the following matrix equation for matrix $\underline{X}$

$\underline{X}^2 - 4\underline{X} + 4\underline{I} = \begin{bmatrix} 4 & 3 \\ 5 & 6 \end{bmatrix}$ (15%)

(b) Evaluate $\int_0^{2\pi} \frac{d\theta}{3 - 2\cos\theta + \sin\theta}$ (10%)

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：工程數學

3.

(a) Evaluate the line integral of (10%)

$$\vec{F} = 3x^2\vec{i} - z^2\vec{j} - 2yz\vec{k}$$

from (-5,2,2) to (1,-1,3).

(b) Evaluate (15%)

$$\oint_C [z^2 + \mathrm{Im}(z)]dz$$

where C: the square with vertices 0, -2i, 2-2i, 2
z : complex variable

4. Solve the boundary-value problem. (25%)

$$\frac{\partial u}{\partial t} = \frac{\partial}{\partial x}[(1-x^2)\frac{\partial u}{\partial x}] \qquad (-1<x<1,\ t>0)$$

With initial condition $u(x, 0)=f(x)$ $(-1<x<1)$

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：應用微積分

1. Two posts, one 12 feet high, the other 28 feet high, stand 30 feet apart. They are to be stayed by two wires, attached to a single stake, running from ground level to the top of each post. Where should the stake be placed to use the least wire? (20%)

2. A space module weighs 15 tons on the surface of the earth. (a) How much work is done in propelling the module to a height of 800 miles above the earth? (Do not consider the effect of air resistance or the weight of the propellant, and the radius of the earth is approximately 4000 miles). (b) How much work is required to propel the module an unlimited distance away from the earth's surface? (20%)

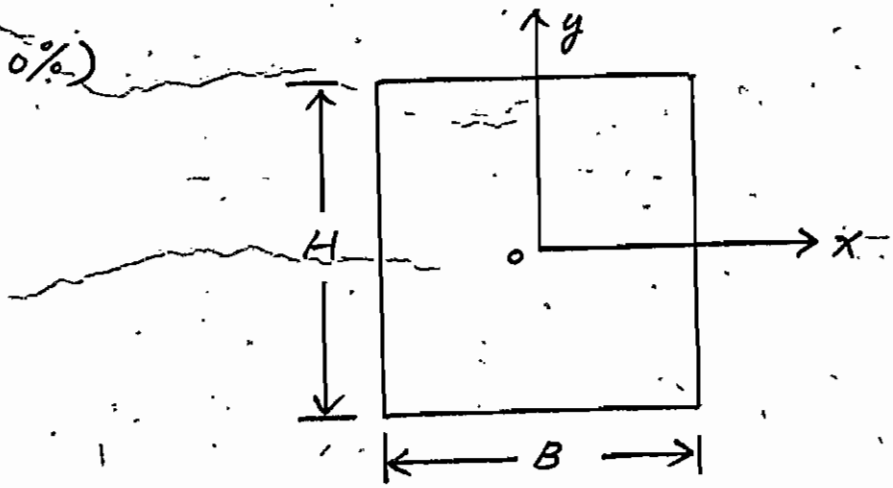
國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：應用微積分

3. 已知二正數的和為 20，今欲使其乘積儘可能為一極大值，則該二正數之值各為多少？（20%）

4. 已知一加工路徑如曲線 $3y^2 = x^3$ 之弧，求由原點至 $x=4$ 處之弧長。（20%）

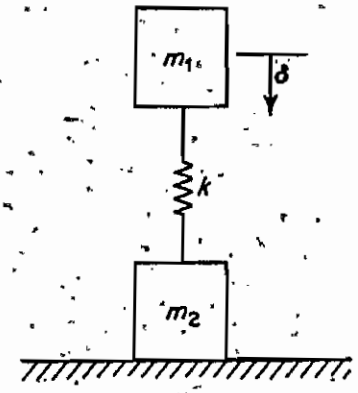
求底為 B，高為 H 之矩形對於經過中心 O 且平行於底之直線的面積轉動慣量（moment of inertia）。亦即求 I_{xx} 的值。（20%）



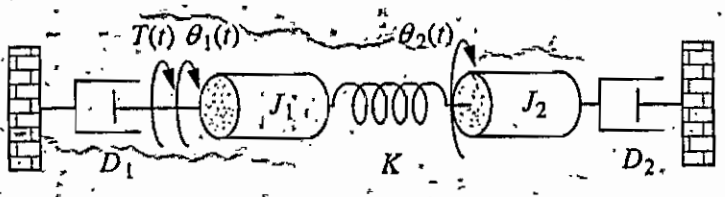
國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：動力學

1. What is the minimum spring compression δ necessary to cause m2 to leave the floor after m1 is suddenly released with zero velocity? Measure δ from the unstressed length of the spring and assume that all motion is in the vertical direction. [25%]



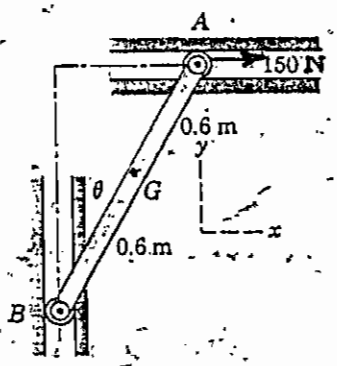
2. Find the transfer function, $\theta_2(s)/T(s)$, for the rotational system shown in the figure. [25%]



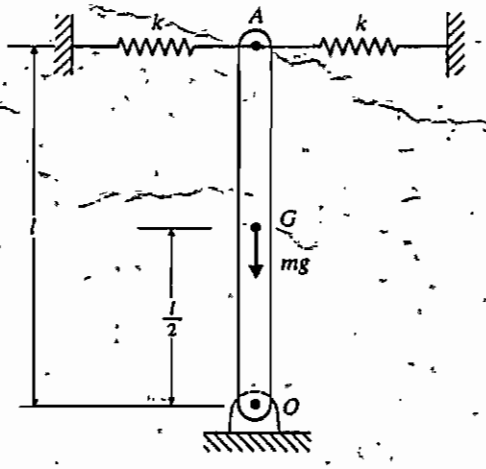
國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：動力學

3. The slender 30-kg bar AB moves in the vertical plane with its ends constrained to follow the smooth horizontal and vertical guides. If the 150-N force is applied at A with the bar initially at rest in the position for which $\theta = 30°$, calculate the resulting angular acceleration of the bar and the forces on the small end rollers at A and B. [25%]



4. Consider a uniform bar that is pivoted at one end and connected symmetrically by two springs at the other end. Assume that the mass of the bar is m and that the spring are unstretched when the bar is verical. If the system is under the assumption of small oscillation,
   (a) derive the equation of motion. [10%]
   (b) find the period of the system. [7%]
   (c) find the condition such that the period of the system is infinite. [8%]



國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：機械製造

1. (1) 試說明鋼之正常化處理(normalizing)與球狀化處理 (spheroidizing)之目的與做法。 (10 %)

   (2) Describe the following processes: (15 %)

   (a) thread rolling (b) hot extrusion (c) stud welding

   (d) shell molding (e) blow molding

2. (1) What are the principal defects in forging? How are they occurred? (5 %)

   (2) How will a lubricant influence the manufacturing processes? Use milling and drawing as examples to answer this question. (8 %)

   (3) 想要在 5mm 厚的鋁板上加工出一個直徑 1mm的貫穿孔，你會用何種傳統加工法與非傳統加工法來完成？試比較其做法與優缺點。(12 %)

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：機械製造

3.(1)試述如何使用雷射加工來作材料的表面處理。(１５%)
(2)試述超音波加工材料的原理及適合加工的材料必需要具備的條件。(１０%)

4.(1)試述如何使用放電加工來作材料的表面處理。(１５%)
(2)試述電解加工的加工液的功能及電解研磨的加工原理。(１０%)

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：熱力學

1. One half kilogram of air as an ideal gas executes a Carnot power cycle having a thermal efficiency of 50%. The heat transfer to the air during the isothermal expansion is 40 KJ. At the beginning of isothermal expansion, the pressure is 7 bars and the volume is 0.12 m^3, Determine
   (a) the maximum and minimum temperatures for the cycle, in K, **(6%)**
   (b) the volume at the end of the isothermal expansion, in m^3, **(6%)**
   (c) the work and heat transfer for each of the four processes, in KJ, **(6%)**
   (d) sketch the cycle on p-v coordinates. **(7%)**

2. In a gas turbine operating at steady-state, air enters the compressor at 0.95 bar and 22 ℃ and exits at 5.7 bars. The air then passes through a heat exchanger before entering the turbine at 1100 K, 5.7 bars. Air exits the turbine at 0.95 bars. The compressor and turbine operate adiabatically and kinetic and potential energy effects can be ignored. Determine the net work developed by the plant, in KJ per Kg of air flow, if
   (a) the compressor and turbine operate without internal irreversibilities, **(10%)**
   (b) the compressor and turbine isentropic efficiencies are 82% and 85%, respectively. **(15%)**

國立雲林技術學院　所別：機械工程技術研究所
八十六學年度研究所碩士班入學考試試題　科目：熱力學

3.(a) 有一個密閉的系統在何種條件下，狀態的改變可視為 isentropic process。(5%)

(b) 渦輪机在操作時，冷卻它的外表是否可增加工作效率，而加熱流入 pump 的流体是否可增加 pump 的效率，並說明之。(5%)

(c) 一個 ideal otto cycle，若它的压縮比是定值，則選用高 (Specific heat ratio) k 或是低 k 值的氣体，可得較高的工作效率，並說明之。(5%)

(d) 有一個空調机可使室溫都維持在 25°C，夏天時室外溫度 35°C，冬天時室外溫 10°C 請問此空調机在冬天和夏天之最佳操作效率 (Reversible process)

$COP_{heat\ pump,\ reversible}$ = ?　冬天 COP = ?　夏天；冷氣，Reversible (5%)

(e) 过熱蒸氣存置於一個汽缸內，它的初態是 $P_1 = 1.00\ MPa$，$T_1 = 600°C$，$v_1 = 0.4011\ m^3/kg$，此 steam 先被等压冷卻至飽和氣態 $P_1 = P_2$，$v_{2g} = 0.1944\ m^3/kg$，再從此飽和氣体以等容冷卻至 $T_3 = 150°C$，$v_3 = v_{2g}$，試求此氣体從初態 T_1 至終態 T_3 冷卻过程之压縮功。(5%)

國立雲林技術學院 所別：機械工程技術研究所
八十六學年度研究所碩士班入學考試試題 科目：熱力學

4. 有一個 ideal vapor-compression 冷凍循環，使用冷媒 F-12，此循環的 refrigeration rate $\dot{Q}_L = 5\,kW$，此冷媒流入压縮机的狀態是飽和氣体 $P_1 = 140\,kPa$，$h_{1g} = 177.87\,KJ/kg$，$S_{1g} = 0.7102\,\frac{KJ}{kg\cdot K}$. 經过压縮後(isentropic process)压力升至 $P_2 = 800\,kPa$，$S_2 = S_{1g}$，$h_2 = 208.65\,KJ/kg$，此过熱冷媒氣体流入冷凝器將熱量排至外界，而從冷凝器流出的是飽和冷媒液体 $P_3 = P_2$，$h_{3f} = 67.3\,KJ/kg$，此飽和冷媒液体再流过膨脹閥(throttling value)降压至 $P_4 = P_1 = 140\,kPa$ $h_{fp=140kPa} = 16.09\,KJ/kg$，$h_{fg_{p=140kPa}} = 161.78\,\frac{KJ}{kg}$

試求

a) 經过膨脹閥後冷媒的乾度 x_4 (quality) [7%]

b) the coefficient of performance of this refrigerator, $COP_R = ?$ [6%]

c) the power input to the compressor, $\dot{W}_{in}$ [6%]

d) the mass flow rate of refrigerant F-12. [6%]

(25%)

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：熱力學

附表

TABLE A-16 Ideal Gas Properties of Air

T (K), h and u (kJ/kg), s° (kJ/kg · K)

T	h	p_r	u	v_r	s°	T	h	p_r	u	v_r	s°
200	199.97	0.3363	142.56	1707.	1.29559	450	451.80	5.775	322.62	223.6	2.11161
210	209.97	0.3987	149.69	1512.	1.34444	460	462.02	6.245	329.97	211.4	2.13407
220	219.97	0.4690	156.82	1346.	1.39105	470	472.24	6.742	337.32	200.1	2.15604
230	230.02	0.5477	164.00	1205.	1.43557	480	482.49	7.268	344.70	189.5	2.17760
240	240.02	0.6355	171.13	1084.	1.47824	490	492.74	7.824	352.08	179.7	2.19876
250	250.05	0.7329	178.28	979.	1.51917	500	503.02	8.411	359.49	170.6	2.21952
260	260.09	0.8405	185.45	887.8	1.55848	510	513.32	9.031	366.92	162.1	2.23993
270	270.11	0.9590	192.60	808.0	1.59634	520	523.63	9.684	374.36	154.1	2.25997
280	280.13	1.0889	199.75	738.0	1.63279	530	533.98	10.37	381.84	146.7	2.27967
285	285.14	1.1584	203.33	706.1	1.65055	540	544.35	11.10	389.34	139.7	2.29906
290	290.16	1.2311	206.91	676.1	1.66802	550	554.74	11.86	396.86	133.1	2.31809
295	295.17	1.3068	210.49	647.9	1.68515	560	565.17	12.66	404.42	127.0	2.33685
300	300.19	1.3860	214.07	621.2	1.70203	570	575.59	13.50	411.97	121.2	2.35531
305	305.22	1.4686	217.67	596.0	1.71865	580	586.04	14.38	419.55	115.7	2.37348
310	310.24	1.5546	221.25	572.3	1.73498	590	596.52	15.31	427.15	110.6	2.39140
315	315.27	1.6442	224.85	549.8	1.75106	600	607.02	16.28	434.78	105.8	2.40902
320	320.29	1.7375	228.42	528.6	1.76690	610	617.53	17.30	442.42	101.2	2.42644
325	325.31	1.8345	232.02	508.4	1.78249	620	628.07	18.36	450.09	96.92	2.44356
330	330.34	1.9352	235.61	489.4	1.79783	630	638.63	19.84	457.78	92.84	2.46048
340	340.42	2.149	242.82	454.1	1.82790	640	649.22	20.64	465.50	88.99	2.47716
350	350.49	2.379	250.02	422.2	1.85708	650	659.84	21.86	473.25	85.34	2.49364
360	360.58	2.626	257.24	393.4	1.88543	660	670.47	23.13	481.01	81.89	2.50985
370	370.67	2.892	264.46	367.2	1.91313	670	681.14	24.46	488.81	78.61	2.52589
380	380.77	3.176	271.69	343.4	1.94001	680	691.82	25.85	496.62	75.50	2.54175
390	390.88	3.481	278.93	321.5	1.96633	690	702.52	27.29	504.45	72.56	2.55731
400	400.98	3.806	286.16	301.6	1.99194	700	713.27	28.80	512.33	69.76	2.57277
410	411.12	4.153	293.43	283.3	2.01699	710	724.04	30.38	520.23	67.07	2.58810
420	421.26	4.522	300.69	266.6	2.04142	720	734.82	32.02	528.14	64.53	2.60319
430	431.43	4.915	307.99	251.1	2.06533	730	745.62	33.72	536.07	62.13	2.61803
440	441.61	5.332	315.30	236.8	2.08870	740	756.44	35.50	544.02	59.82	2.63280

T (K), h and u (kJ/kg), s° (kJ/kg · K)

T	h	p_r	u	v_r	s°	T	h	p_r	u	v_r	s°
750	767.29	37.35	551.99	57.63	2.64737	1300	1395.97	330.9	1022.82	11.275	3.27345
760	778.18	39.27	560.01	55.54	2.66176	1320	1419.76	352.5	1040.88	10.747	3.29160
770	789.11	41.31	568.07	53.39	2.67595	1340	1443.60	375.3	1058.94	10.247	3.30959
780	800.03	43.35	576.12	51.64	2.69013	1360	1467.49	399.1	1077.10	9.780	3.32724
790	810.99	45.55	584.21	49.86	2.70400	1380	1491.44	424.2	1095.26	9.337	3.34474
800	821.95	47.75	592.30	48.08	2.71787	1400	1515.42	450.5	1113.52	8.919	3.36200
820	843.98	52.59	608.59	44.84	2.74504	1420	1539.44	478.0	1131.77	8.526	3.37901
840	866.08	57.60	624.95	41.85	2.77170	1440	1563.51	506.9	1150.13	8.153	3.39586
860	888.27	63.09	641.40	39.12	2.79783	1460	1587.63	537.1	1168.49	7.801	3.41247
880	910.56	68.98	657.95	36.61	2.82344	1480	1611.79	568.8	1186.95	7.468	3.42892
900	932.93	75.29	674.58	34.31	2.84856	1500	1635.97	601.9	1205.41	7.152	3.44516
920	955.38	82.05	691.28	32.18	2.87324	1520	1660.23	636.5	1223.87	6.854	3.46120
940	977.92	89.28	708.08	30.22	2.89748	1540	1684.51	672.8	1242.43	6.569	3.47712
960	1000.55	97.00	725.02	28.40	2.92128	1560	1708.82	710.5	1260.99	6.301	3.49276
980	1023.25	105.2	741.98	26.73	2.94468	1580	1733.17	750.0	1279.65	6.046	3.50829
1000	1046.04	114.0	758.94	25.17	2.96770	1600	1757.57	791.2	1298.30	5.804	3.52364
1020	1068.89	123.4	776.10	23.72	2.99034	1620	1782.00	834.1	1316.96	5.574	3.53879
1040	1091.85	133.3	793.36	22.39	3.01260	1640	1806.46	878.9	1335.72	5.355	3.55381
1060	1114.86	143.9	810.62	21.14	3.03449	1660	1830.96	925.6	1354.48	5.147	3.56867
1080	1137.89	155.2	827.88	19.98	3.05608	1680	1855.50	974.2	1373.24	4.949	3.58335
1100	1161.07	167.1	845.33	18.896	3.07732	1700	1880.1	1025	1392.7	4.761	3.5979
1120	1184.28	179.7	862.79	17.886	3.09825	1750	1941.6	1161	1439.8	4.328	3.6336
1140	1207.57	193.1	880.35	16.946	3.11883	1800	2003.3	1310	1487.2	3.944	3.6684
1160	1230.92	207.2	897.91	16.064	3.13916	1850	2065.3	1475	1534.9	3.601	3.7023
1180	1254.34	222.2	915.57	15.241	3.15916	1900	2127.4	1655	1582.6	3.295	3.7354
1200	1277.79	238.0	933.33	14.470	3.17888	1950	2189.7	1852	1630.6	3.022	3.7677
1220	1301.31	254.7	951.09	13.747	3.19834	2000	2252.1	2068	1678.7	2.776	3.7994
1240	1324.93	272.3	968.95	13.069	3.21751	2050	2314.6	2303	1726.8	2.555	3.8303
1260	1348.55	290.8	986.90	12.435	3.23638	2100	2377.4	2559	1775.3	2.356	3.8605
1280	1372.24	310.4	1004.76	11.835	3.25510	2150	2440.3	2837	1823.8	2.175	3.8901
						2200	2503.2	3138	1872.4	2.012	3.9191
						2250	2566.4	3464	1921.3	1.864	3.9474

Source: Adapted from K. Wark, *Thermodynamics, 4th ed.*, McGraw-Hill, New York, 1983, as based on J. H. Keenan and J. Kaye, "Gas Tables," Wiley, New York, 1945.

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：專業實務

I.第一部分

1.弓是古代很重要的武器，請問
a.優良的弓有那些主要特性？
b.從力學的基礎分析弓的原理？
c.弓的材料必須具備那些機械性質？
d.那些材料可滿足弓的性質要求？ (10 %)

2.自行車的發展從早期的單輪車到最近的變速自行車，請從機構和材料兩方面，說明其改進項目和增加的功能。(10 %)

3.汽車的外板需利用鋼片的深衝成型技術，說明那些因素會影響到鋼片的深衝成型破裂。(10 %)

4.當溫度 2802°F 的鐵水注入 4 in. 寬的扁鋼胚砂模中，計算完全凝固所需要的時間？假設砂模的厚度遠大於扁鋼胚厚度，砂模的初始溫度爲 82°F，
鐵的數據：凝固溫度 = 2802°F，凝固熱 = 117 Btu/ lb_m，
固態密度 = 490 lb_m/ft^3，液態密度 = 460 lb_m/ft^3，
液態比熱 = 0.18 Btu/ lb_m °F
砂模的數據：比熱 = 0.28 Btu/ lb_m °F，熱傳導率 = 0.50 Btu/ft-hr °F，
密度 = 100 lb_m/ft^3 (10 %)

5.鐵基非晶質合金的磁伸縮量約爲 10^{-6}，請概念性的設計一裝置來量測鐵基非晶質合金在磁場作用下的磁伸縮量，並說明其量測原理。(10 %)

II.第二部分

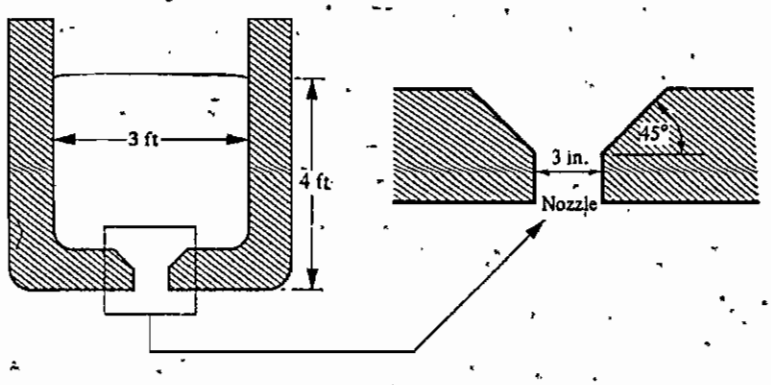
1.說明半導體構裝(IC Package) 的製造流程和各製程可能發生的問題。(10 %)

2.請用形狀記憶合金設計一個空調的制動器，並繪圖說明其作動原理。(10 %)

3.繪出鐵-碳平衡圖。(10 %)

4.比較傳統設計和破壞力學設計的差異。(10 %)

5.如下圖的盛桶裝有 704 °C的 Al-7% Si 金屬液，其內直徑爲 3 ft，金屬液高爲 4 ft，底部澆口直徑爲 3 in.，計算金屬液從 4ft 高到流光所需的時間？
假設 η =2.57 cP = 6.59 lb_m/ft hr，
ρ =150 lb_m/ft^3 (10 %)



國立雲林技術學院 所別：機械工程技術研究所
八十六學年度研究所碩士班入學考試試題 科目：自動控制

1. Consider the system

$$\frac{Y(s)}{U(s)} = \frac{2}{s^2 + 0.2s + b}$$

where u is the input variable, y is the output variable, and b is a constant but uncertain value between 7 and 13, i.e., $7 < b < 13$.

(A) If $b = 10$, find a constant input r, i.e., $u(t) = r$, such that the output variable tends to a constant value 3, i.e., $y(\infty) = 3$. What is the damping ratio of the system? [13%]

(B) Suppose the nominal value of b is 10 and the target value for y is 3. Design a control algorithm by which the damping ratio of the closed-loop system is 0.7 (for the nominal system); and a 10 percent variation of b results in a steady-state error less than 1 percent of the target value. ($|y(\infty) - 3| < 0.03$ if b is 9 instead of 10, for example.) [12%]

2. (A) Consider the system

$$\begin{aligned} \dot{x}_1 &= x_2 \\ \dot{x}_2 &= -x_1 + 2x_2 + 2 + u \\ u &= -k_1 x_1 - k_2 x_2 + r \end{aligned}$$

where k_1, k_2, and r are constants to be determined. Find all values of k_1, k_2, and r for which the origin, $(x_1, x_2) = (0, 0)$, is an asymptotically stable point. [13%]

(B) Consider the system

$$\begin{aligned} \dot{x}_1 &= x_2 \sin x_1 - (x_1 + 2)^3 \\ \dot{x}_2 &= -x_1 \cos x_2 + 3(x_2 - 1) + u \\ u &= -k_1 x_1 - k_2 x_2 + r \end{aligned}$$

Find all values of k_1, k_2, and r for which the origin is an asymptotically stable point. [12%]

國立雲林技術學院　　所別：機械工程技術研究所
八十六學年度研究所碩士班入學考試試題　　科目：自動控制

3. Given a transfer function as below :

$$G(s) = \frac{2000}{s(s+10)(s+30)}$$

(1) Design a Lead compensator with unit feedback configuration by Root-Locus, and show all possible Root-Locus patterns. (15%)

(2) Determine and show the " best " result of those patterns. (10%)

4. A nonlinear system is modeled as below

$$\ddot{y} + 2\dot{y} + y^3 + \frac{4}{y} = 4;$$

(1) Linearize the above equation at the operating point with $y_o = 1$, $\dot{y}_o = 0$. (Hint : Set $\hat{y} = y - y_o$, $\dot{\hat{y}} = \dot{y} - \dot{y}_o$) (15%)

(2) Find the steady state solution of the linearized equation. (10%)

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：材料力學

1. The bottom member in Fig. 1 is of uniform cross section and can be assumed to be rigid. Find the value of the distance x if the lower member is to be horizontal. (25%)

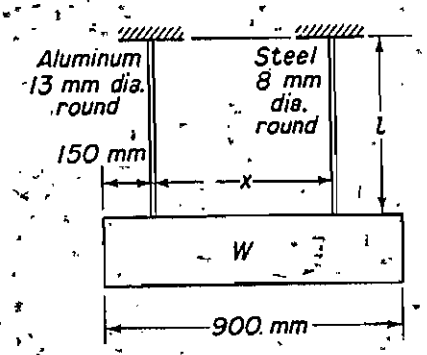


Fig. 1

$E_s = 3E_a$

2. A 380 × 380-mm steel plate of material with $\sigma_{yp} = 400$ MPa has normal stresses only acting on all edges. Stress σ_x is tension and σ_y is compression. The length in the y-direction is reduced by 0.2 mm. F_s is equal to 2 by the maximum shear theory. Find the values of the stresses. (25%)

$E = 206900$ MPa

國立雲林技術學院　　所別：機械工程技術研究所
八十六學年度研究所碩士班入學考試試題　　科目：材料力學

3. 如圖三所示一複合桿長 L。A 材料之外徑爲 a，剪力模數(shear modulus) $G_A = 2G_o$，可承受之最大剪應力(shear stress)爲 τ_o；而 B 材料之外徑爲 b，內徑爲 a，剪力模數 $G_B = G_o$，可承受之最大剪應力爲 $2\tau_o$。

(1) 今施加一大小爲 T 之扭矩 (torque) 於端面上，則扭曲角 ϕ 爲多少？[7%]

(2) 此時 A、B 材料內之最大剪應力 τ_{max} 各爲多少？[6%]

(3) 可允許之最大 T 值（即 T_{allow}）爲多少？[6%]　(25%)

(4) 如半徑 a 可變，b 固定不變，則當 a 爲多少時可獲得最高之 T_{allow} 值？[6%]

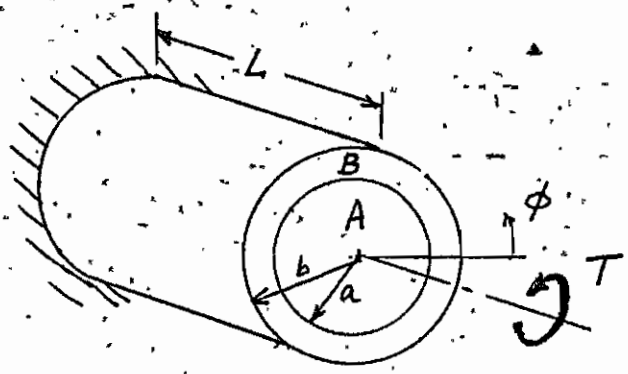


圖 三

4. 如圖四所示爲截面是邊長 t 之方形鋼條所構成，受外力 P 作用致使 A、D 兩點之距離減小。如欲使 A、D 兩點之距離恢復爲 a，則應於 B、C 兩點施加之力矩 M 爲多少？設楊氏係數爲 E。(25%)

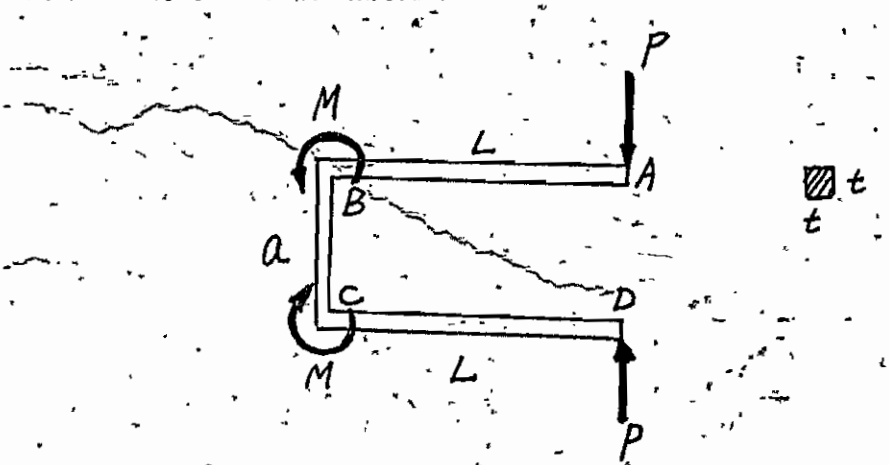


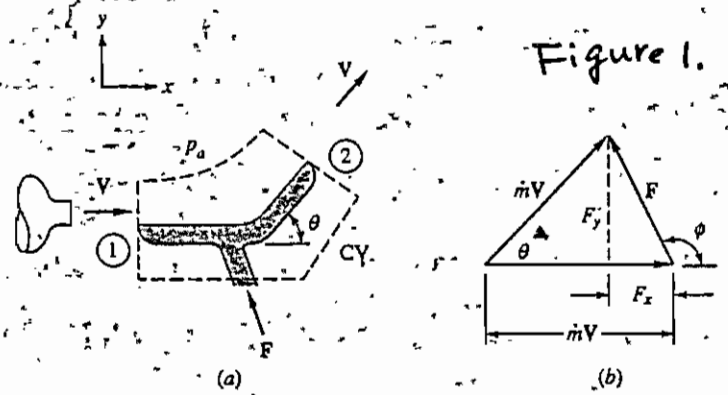
圖 四

國立雲林技術學院
八十六學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：流體力學

1. As shown in Figure 1, a fixed vane turns a water jet of area A through an angle θ without changing its velocity magnitude. The flow is steady, pressure is P_a everywhere, and friction on the vane is negligible. (a) Find the components F_x and F_y of the applied vane force (12%). (b) Find expressions for the force magnitude F and the angle ϕ between F and the horizontal (13%).

Figure 1.



2. The drag on a sphere moving in a fluid is known to be a function of the sphere diameter, the velocity, and the fluid viscosity and density. Laboratory tests on a 4-in diameter sphere were performed in a water tunnel and some model data are plotted in Figure 2. For these tests the viscosity of the water was 2.3×10^{-5} lbs/ft^2 and the water density was 1.94 slugs/ft^3. Estimate the drag on an 8-ft diameter balloon moving in air at a velocity of 3 ft/s. Assume the air to have a viscosity of 3.7×10^{-7} lbs/ft^2 and a density of 2.38×10^{-3} slugs/ft^3. (25%).

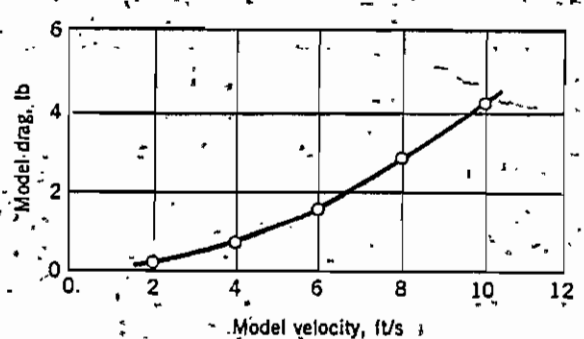
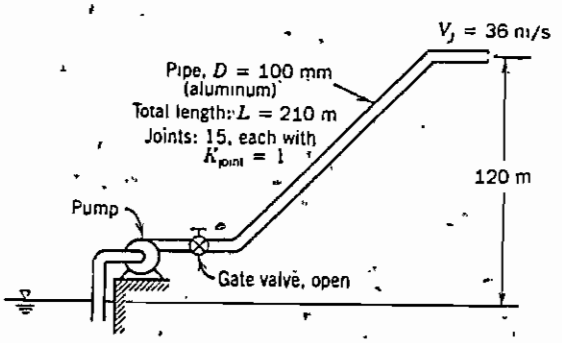


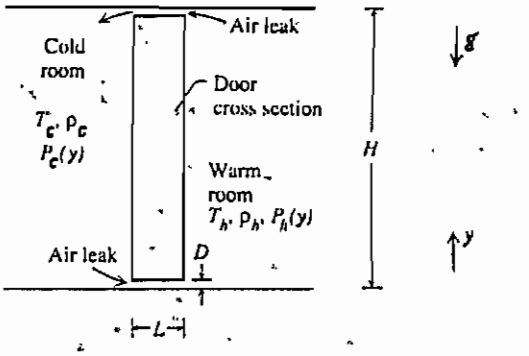
FIGURE 2.

國立雲林技術學院　所別：機械工程技術研究所
八十六學年度研究所碩士班入學考試試題　科目：流體力學

3. Cooling water is pumped from a reservoir to rock drills on a construction job using the pipe system shown. The flow rate must be 135 m^3/h and water must leave the spray nozzle at 36m/s. Calculate the minimum supply pressure needed at the pump outlet. (15%) Estimate the required power input if the pump efficiency is 70 percent.(10%) (f=0.0136, minor head loss can be expressed as $f\frac{L_e}{D}\frac{\bar{V}^2}{2g}$ or $K\frac{\bar{V}^2}{2g}$, for gate valve(open), $\frac{L_e}{D}=8$; also,the height difference between water level and pump outlet can be neglected)



4. The air flow through the gaps formed at the top and bottom of a closed door is driven by the local air pressure difference between the two sides of the door. The door separates two isothermal rooms at different temperatures, T_c and T_h. In each room the pressure distribution is purely hydrostatic, $P_c(y)$ and $P_h(y)$, and the height-averaged pressure is the same on both sides of the door.



1) Assume that the air flow through each gap is laminar and fully developed. In terms of the geometric parameters indicated in the figure, show that the air flowrate through one gap is.

$$\dot{m}=(\bar{\rho}_c-\bar{\rho}_h)\frac{gD^3WH}{24\nu L}$$

where W is the door width in the direction perpendicular to the plane of the figure.(12%)

2) What is the net convection heat transfer rate(q) from the warm room to the cold room, through the two gaps.(10%) And Comment on how the quantities($\dot{m}, q$) react to an increase in the gap thickness D.(3%)