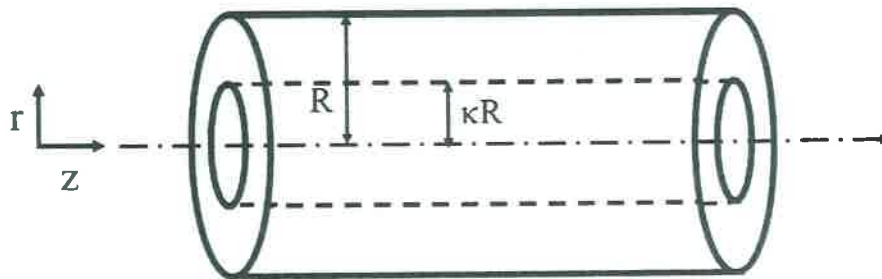


國立臺灣科技大學 111 學年度碩士班招生試題

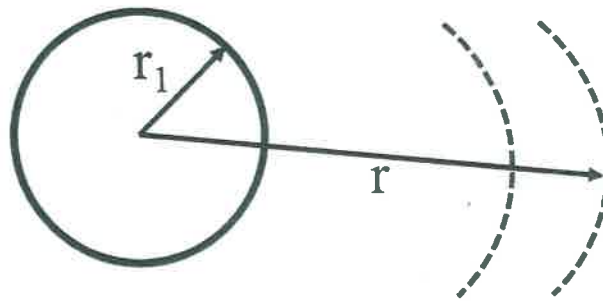
系所組別：化學工程系碩士班
 科目：工程數學與輸送現象

(總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分)

1. (10 %) Solve the initial value problem: $(e^y - x^2) y' + \cos(2x) = 2xy$; $y(0) = 2$.
 2. (10 %) Solve the initial value problem: $y'' + 4y = f(t)$; $y(0) = 0$, $y'(0) = 0$,
 $f(t) = 0$ for $t < 1$ and $f(t) = t$ for $t \geq 1$.
 3. (10 %) Evaluate $\oint_C \frac{-2y}{x^2 + y^2} dx + \frac{2x}{x^2 + y^2} dy$ for all simple closed paths in the plane
 not passing through the origin.
 4. (8 %) Compute the Fourier transform of $f(x) = H(x) e^{-4x}$.
 $H(x)$ is the Heaviside function: $H(x) = 1$ for $x \geq 0$ and $H(x) = 0$ for $x < 0$.
 5. (12 %) Solve the differential equation $y_{tt} = 4 y_{xx}$ for $0 < x < L$, $t > 0$ with
 BCs: $y(0, t) = y(L, t) = 0$ and ICs: $y(x, 0) = f(x)$, $y_t(x, 0) = 0$
 6. (5 %) (a) Consider a one-dimensional steady-state laminar flow inside a cylindrical
 annulus (the grey region in the following figure). Please use the shell
 momentum balance to establish the governing equation.
- (10 %) (b) Find the velocity profile. [Hint: $\nabla = \frac{\partial}{\partial r} \bar{\delta}_r + \frac{1}{r} \frac{\partial}{\partial r} \bar{\delta}_\theta + \frac{\partial}{\partial z} \bar{\delta}_z$ in cylindrical
 coordinates and the pressure drop can be regarded as constant]



7. (15 %) There is a fragrance ball with a diameter of 2.0 mm. This fragrance ball is
 suspended in a large volume of still air at 1 atm and 318 K. If the surface of
 fragrance ball is 318 K and its vapor pressure is 0.555 mmHg. Here, the air can be
 regarded as stagnant gas and the diffusion coefficient (D_{AB}) of fragrance ball is
 $6.92 \times 10^{-6} \text{ m}^2/\text{s}$. Please estimate the rate of evaporation of the fragrance ball from
 The surface. [gas constant = $8314 \text{ m}^3 \cdot \text{Pa}/\text{kgmol} \cdot \text{K}$]



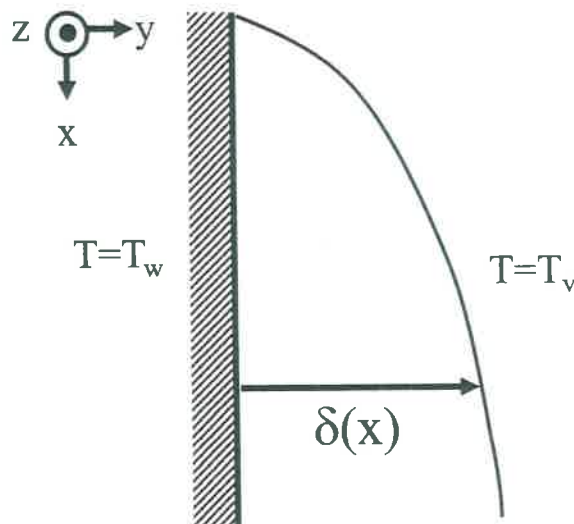
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8. (10 %) (a) A vertical wall is exposed to the steam (density is ρ_v and the latent heat is h_v) and a condensate water film (density is ρ_f , viscosity is μ_f and thermal conductivity is k_f) is flowing down in laminar flow. The film thickness is zero at the top of the wall and increases in thickness as it flows downward because of condensation. Assuming the width of the wall is regarded as a unit and temperature is T_w . In addition, the temperature distribution in the water film is linear, please establish the relation between the condensation film thickness (δ) and the wall length (x).
- (10 %) (b) Consider a wall with a length of 50 cm and a temperature of 86.11°C . The steam is saturated at 68.9 kPa. Please determine the thickness of water film at the bottom of the wall. [$g=9.806\text{ m/s}^2$]



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Supporting materials:

Table 1 Thermal conductivity of liquid water

Temperature			Thermal Conductivity	
°C	°F	K	btu/h·ft·°F	W/m·K
0	32	273.15	0.329	0.569
37.8	100	311.0	0.363	0.628
93.3	200	366.5	0.393	0.680
148.9	300	422.1	0.395	0.684
215.6	420	588.8	0.376	0.651
326.7	620	599.9	0.275	0.476

Table 2 Heat capacity of liquid water at 1 atm

Temperature		Heat Capacity, c_p		Temperature		Heat Capacity, c_p	
°C	K	cal/g·°C	kJ/kg·K	°C	K	cal/g·°C	kJ/kg·K
0	273.15	1.0080	4.220	50	323.15	0.9992	4.183
10	283.15	1.0019	4.195	60	333.15	1.0001	4.187
20	293.15	0.9995	4.185	70	343.15	1.0013	4.192
25	298.15	0.9989	4.182	80	353.15	1.0029	4.199
30	303.15	0.9987	4.181	90	363.15	1.0050	4.208
40	313.15	0.9987	4.181	100	373.15	1.0076	4.219



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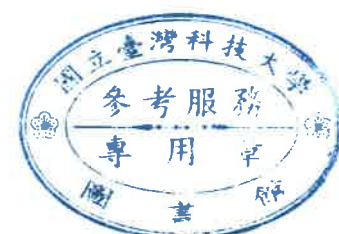
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Table 3 Viscosity of liquid water

Temperature		Viscosity [(Pa·s)10 ³ , (kg/m·s) 10 ³ , or cp]	Temperature		Viscosity, [(Pa·s)10 ³ , (kg/m·s) 10 ³ , or cp]
K	°C		K	°C	
273.15	0	1.7921	323.15	50	0.5494
275.15	2	1.6728	325.15	52	0.5315
277.15	4	1.5674	327.15	54	0.5146
279.15	6	1.4728	329.15	56	0.4985
281.15	8	1.3860	331.15	58	0.4832
283.15	10	1.3077	333.15	60	0.4688
285.15	12	1.2363	335.15	62	0.4550
287.15	14	1.1709	337.15	64	0.4418
289.15	16	1.1111	339.15	66	0.4293
291.15	18	1.0559	341.15	68	0.4174
293.15	20	1.0050	343.15	70	0.4061
293.35	20.2	1.0000	345.15	72	0.3952
295.15	22	0.9579	347.15	74	0.3849
297.15	24	0.9142	349.15	76	0.3750
298.15	25	0.8937	351.15	78	0.3655
299.15	26	0.8737	353.15	80	0.3565
301.15	28	0.8360	355.15	82	0.3478
303.15	30	0.8007	357.15	84	0.3395
305.15	32	0.7679	359.15	86	0.3315
307.15	34	0.7371	361.15	88	0.3239
309.15	36	0.7085	363.15	90	0.3165
311.15	38	0.6814	365.15	92	0.3095
313.15	40	0.6560	367.15	94	0.3027
315.15	42	0.6321	369.15	96	0.2962
317.15	44	0.6097	371.15	98	0.2899
319.15	46	0.5883	373.15	100	0.2838
321.15	48	0.5683			



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Table 4 Steam table

T (°C)	P (kPa)	Specific volume (m ³ /kg)		Enthalpy (kJ/kg)		Entropy (kJ/kg·K)	
		Liquid	Sat'd vapor	Liquid	Sat'd vapor	Liquid	Sat'd vapor
0.01	0.6113	0.0010002	206.136	0.00	2501.4	0.0000	9.1562
3	0.7577	0.0010001	168.132	12.57	2506.9	0.0457	9.0773
6	0.9349	0.0010001	137.734	25.20	2512.4	0.0912	9.0003
9	1.1477	0.0010003	113.386	37.80	2517.9	0.1362	8.9253
12	1.4022	0.0010005	93.784	50.41	2523.4	0.1806	8.8524
15	1.7051	0.0010009	77.926	62.99	2528.9	0.2245	8.7814
18	2.0640	0.0010014	65.038	75.58	2534.4	0.2679	8.7123
21	2.487	0.0010020	54.514	88.14	2539.9	0.3109	8.6450
24	2.985	0.0010027	45.883	100.70	2545.4	0.3534	8.5794
25	3.169	0.0010029	43.360	104.89	2547.2	0.3674	8.5580
27	3.567	0.0010035	38.774	113.25	2550.8	0.3954	8.5156
30	4.246	0.0010043	32.894	125.79	2556.3	0.4369	8.4533
33	5.034	0.0010053	28.011	138.33	2561.7	0.4781	8.3927
36	5.947	0.0010063	23.940	150.86	2567.1	0.5188	8.3336
40	7.384	0.0010078	19.523	167.57	2574.3	0.5725	8.2570
45	9.593	0.0010099	15.258	188.45	2583.2	0.6387	8.1648
50	12.349	0.0010121	12.032	209.33	2592.1	0.7038	8.0763
55	15.758	0.0010146	9.568	230.23	2600.9	0.7679	7.9913
60	19.940	0.0010172	7.671	251.13	2609.6	0.8312	7.9096
65	25.03	0.0010199	6.197	272.06	2618.3	0.8935	7.8310
70	31.19	0.0010228	5.042	292.98	2626.8	0.9549	7.7553
75	38.58	0.0010259	4.131	313.93	2635.3	1.0155	7.6824
80	47.39	0.0010291	3.407	334.91	2643.7	1.0753	7.6122
85	57.83	0.0010325	2.828	355.90	2651.9	1.1343	7.5445
90	70.14	0.0010360	2.361	376.92	2660.1	1.1925	7.4791
95	84.55	0.0010397	1.9819	397.96	2668.1	1.2500	7.4159
100	101.35	0.0010435	1.6729	419.04	2676.1	1.3069	7.3549

