



SET A

**UNIVERSITI KUALA LUMPUR
Malaysia France Institute**

**FINAL EXAMINATION
JANUARY 2014 SESSION**

SUBJECT CODE	: FCB 41003
SUBJECT TITLE	: AIR DISTRIBUTION AND SECONDARY FLUIDS
LEVEL	: BACHELOR
TIME/DURATION	: 9.00 am – 12.00 noon (3 HOURS)
DATE	: 29 MAY 2014

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper **CAREFULLY**.
 2. This question paper is printed on both sides of the paper.
 3. Please write your answers on the answer booklet provided.
 4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
 5. This question paper consists only **TWO** sections. Answer **ALL** questions.
 6. Answer all questions in English.
 7. All documents authorised. (**OPEN BOOK** examination).
 8. In the event of graphic resolution of a problem, return e graph and write down your ID on each return sheet.
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THERE ARE 6 PRINTED PAGES OF QUESTIONS.

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

In all problems, the density of the air is 1.2 kg/m^3 .

Question 1

We wish to select a fan with an air flow of $3000 \text{ m}^3/\text{hr}$ supplying a ductwork system. The system pressure drop is 340 Pa .

From manufacturers documents, we plans to use a fan whose non-dimensional characteristics (Rateau coefficients) are given in Table I (in the form of numerical values) and Figure 1 (in the form of graphs traced using the values of Table I).

The manufacturer of fans proposes two solutions to ensure the desired flow and the total head, at relatively comparable costs:

Fan 1 : dia 1.0 m turning at a speed of 750 rev/min

Fan 2 : dia 0.62 m turning at a speed of 1450 rev/min

- (a) From the provided Rateau coefficients, determine the best efficiency $\eta_{\max}$ and to deduce the values of coefficients μ_{opt} , δ_{opt} and τ_{opt} leading to this efficiency.
(3 marks)
- (b) From the values determined in question (a), evaluate the radius and the number of revolutions optima and to compare them with the radius and the speed proposed in fan 1 and fan 2. To indicate which is the best solution.
(2 marks)
- (c) For the solution chosen, to evaluate the efficiency and the power absorbed by the fan.
(2 marks)

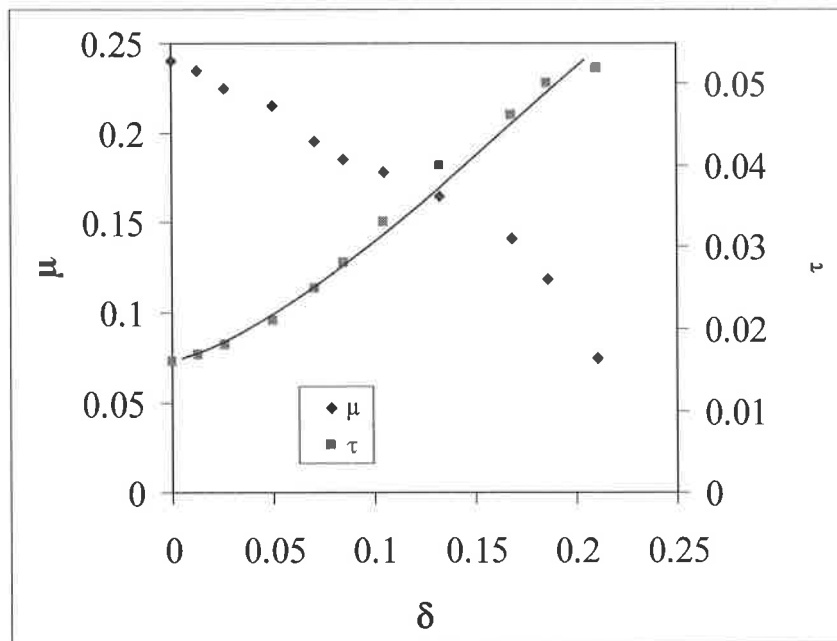


Figure 1 : Non-dimensional characteristics of the series of fans

δ	μ	τ
0	0,24	0,016
0,013	0,235	0,0169
0,026	0,225	0,018
0,0498	0,215	0,021
0,071	0,195	0,025
0,085	0,1857	0,028
0,105	0,178	0,033
0,1327	0,165	0,04
0,168	0,141	0,046
0,1854	0,119	0,05
0,21	0,075	0,052

Table I : Numerical values of figure 1

Question 2

We study a glycol system used as secondary fluid of a refrigerating unit. The circuit is represented in Figure 2.

Some data :

- for glycol water, $\rho = 1090 \text{ kg/m}^3$ and $\mu = 7 \cdot 10^{-3} \text{ Pa.s}$
- the elbows are with $R/D=1$ of the type 3-1 (ASHRAE nomenclature)
- angle of the elbows C1 and C2 = 45° and angle of the elbow C3 = 90°

- derivation D of the type 5-33 (ASHRAE) with an angle of 45°
- the exchangers E1 and E2 involve a pressure drop of 0,1 bar each
- pressure drop at the exit of each negligible branch
- Main: diameter 7 cm and flow $15 \text{ m}^3 / \text{h}$ - total pressure drop of 5000 Pa
- Branch A: diameter 5,5 cm - length 32 m (except exchanger) - flow $7,5 \text{ m}^3 / \text{h}$
- Branch b: diameter 5,5 cm - length 18 m (except exchanger) - flow $7,5 \text{ m}^3 / \text{h}$
- roughness: $80 \mu\text{m}$

(a) Calculate the pressure drop in each branch without taking account of the valve V. For the calculation of the pressure drop; we will use the correlation of Colebrook.

(3 marks)

(b) The valve V has as a function to balance the network. What pressure drop does it have to induce?

(2 marks)

(c) To determine the total head of the pump to install to ensure the operation of the installation after adjustment of the valve V.

(3 marks)

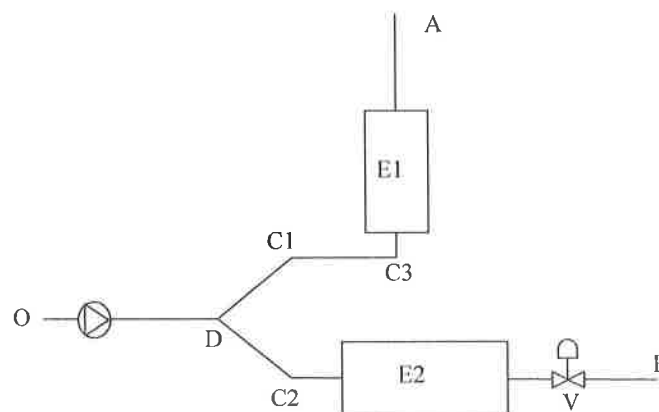
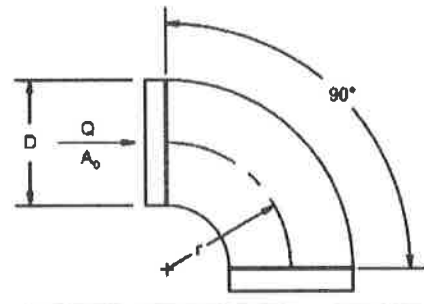


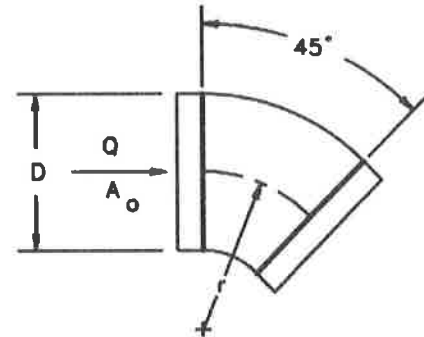
Figure 2: Glycol system – plan view - all the elements are in a horizontal plane.

CD3-1 Elbow, Die Stamped, 90 Degree, $r/D = 1.5$

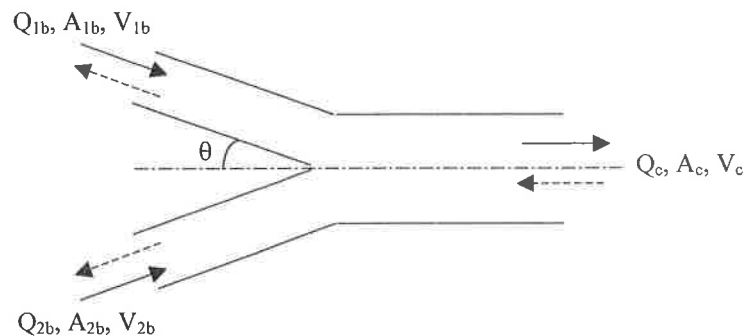
D, mm	75	100	125	150	180	200	230	250
C_o	0.30	0.21	0.16	0.14	0.12	0.11	0.11	0.11

CD3-3 Elbow, Die Stamped, 45 Degree, $r/D = 1.5$

D, mm	75	100	125	150	180	200	230	250
C_o	0.18	0.13	0.10	0.08	0.07	0.07	0.07	0.07



Derivation of the type 5-33



where, A is the section (m^2), Q the volume flow rate (m^3/s) and V speed (m/s).

Converging

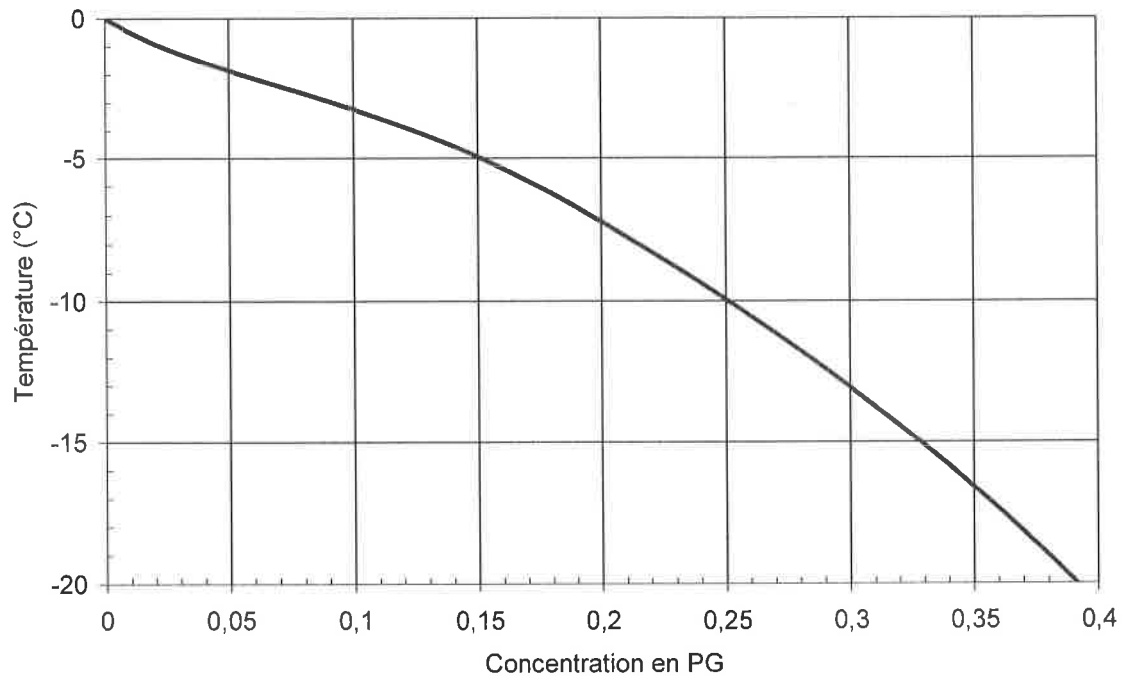
θ deg	ζ_{1b} or ζ_{2b}										
	Q_{1b}/Q_c or Q_{2b}/Q_c										
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
15	-2.6	-1.9	-1.3	-0.77	-0.30	0.10	0.41	0.67	0.85	0.97	1.0
30	-2.1	-1.5	-1.0	-0.53	-0.10	0.28	0.69	0.91	1.1	1.4	1.6
45	-1.3	-0.93	-0.55	-0.16	0.20	0.56	0.92	1.3	1.6	2.0	2.3

Diverging

ζ_{1b} or ζ_{2b}													
θ deg	V_{1b}/V_c or V_{2b}/V_c												
	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
15	0.81	0.65	0.51	0.38	0.28	0.20	0.11	0.06	0.14	0.30	0.51	0.76	1.0
30	0.84	0.69	0.56	0.44	0.34	0.26	0.19	0.15	0.15	0.30	0.51	0.76	1.0
45	0.87	0.74	0.63	0.54	0.45	0.38	0.29	0.24	0.23	0.30	0.51	0.76	1.0
60	0.90	0.82	0.79	0.66	0.59	0.53	0.43	0.36	0.33	0.39	0.51	0.76	1.0
90	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Question 3

The figure below represents the equilibrium curve solid/liquid of a mixture of water and mono propylene glycol.



One has a mixture with an initial concentration of 15% in PG

(a) What is the starting temperature of freezing for this mixture?

(1 mark)

One leads this mixture to a temperature of -10°C : a slurry of ice is obtained.

(b) What is the concentration in PG of the residual liquid (liquid phase).

(1 mark)

(c) What is the concentration in ice of this slurry?

(1 mark)

- (d) While taking into account only the latent heat of the ice (333 kJ kg^{-1}), what volume of this slurry is necessary to store 100 kWh necessary for the application as obtained at the time of problem 1? (Note: The density of the slurry is: 980 kg m^{-3}).

(2 mark)

END OF QUESTION