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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
SEPTEMBER 2014 SESSION

SUBJECT CODE	:	**FCB41003**
SUBJECT TITLE	:	**AIR DISTRIBUTION AND SECONDARY FLUIDS**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**9.00 AM – 12.00 PM (3 HOURS)**
DATE	:	**2 JANUARY 2015**

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 ONE section. Answer ALL questions.**
6. **Answer all questions in English.**
7. **All documents authorised . (OPEN BOOK EXAMINATION)**

THERE ARE 8 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

Ventilation Duct

One studies the ventilation duct as represented on Figure 1 (the various assemblies: bend, entry, leaving, junction, etc are also numbered on the figure).

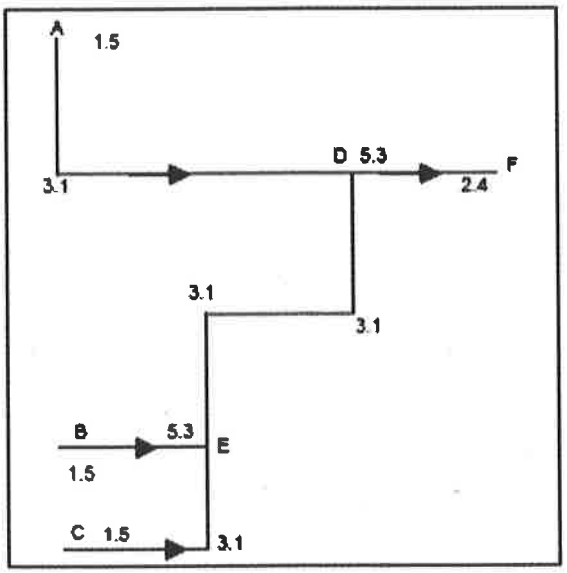


Figure 1. Ventilation Duct

The properties of the air are $\rho = 1.2$ kg/m^3 and $\mu = 1.7 \times 10^{-5}$ Pa.s. The data of the ducts are shown in Table 1 below:

Table 1 Data on the ductwork in Figure 1

Duct	flow (m^3 / h)	diameter (mm)	length (m)	λ (-)
AD	2800	350	20	0,01497
BE	1700	250	5	0,01559
EC	2500	350	15	0,01539
ED	4200	350	60	0,01352
DF		350	10	

The elbow is of type 3-1 (ASHRAE) with an angle of 90° and a r/D ratio of 0.75. The entries are of type 1-5 (ASHRAE) with a ratio L/D equal to 0.10 and an angle of 45° so $\zeta = 0.21$. The exit is of type 2-4 (ASHRAE) with a ratio A_1 / A_0 equal to 4.0 and an angle of 30° so $\zeta = 0.7$. The junctions in E and D are of type 5-3 (ASHRAE). (Do not interpolate to find C). Answer these questions:

(a) Calculate the coefficient λ for duct DF. The roughness of the duct is 0.09 mm. Use Blasius equation.

(4 marks)

(b) Fill in Table 2.

Table 2

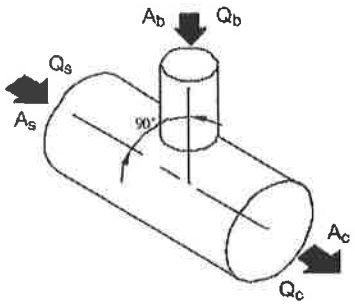
Duct	λ	Linear pressure drop (Pa)	Fitting pressure drop (Pa)	Total Pressure drop (Pa)
AD	0.01497			
BE	0.01559			
EC	0.01539			
ED	0.01352			
DF				

(8 marks)

(c) If the network is not balanced, one decides to use a register of the type 6-1 (ASHRAE) of ratio $D/D_0 = 1$. After having indicated on which branch you install this register, calculate the angle of adjustment of the damper.

(4 marks)

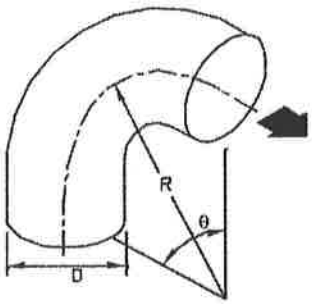
B. CONVERGING TEE, 90°, ROUND Type 5.3



Branch, Coefficient C (*See* Note 8)							
O_b/Q_c	A_b/A_c						
	0.1	0.2	0.3	0.4	0.6	0.8	1.0
0.1	0.40	-0.37	-0.51	-0.46	-0.50	-0.51	-0.52
0.2	3.8	0.72	0.17	-0.02	-0.14	-0.18	-0.24
0.3	9.2	2.3	1.0	0.44	0.21	0.11	-0.08
0.4	16	4.3	2.1	0.94	0.54	0.40	0.32
0.5	26	6.8	3.2	1.1	0.66	0.49	0.42
0.6	37	9.7	4.7	1.6	0.92	0.69	0.57
0.7	43	13	6.3	2.1	1.2	0.88	0.72
0.8	65	17	7.9	2.7	1.5	1.1	0.86
0.9	82	21	9.7	3.4	1.8	1.2	0.99
1.0	101	26	12	4.0	2.1	1.4	1.1

Main, Coefficient C (*See* Note 8)										
O_b/Q_c	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
C	0.16	0.27	0.38	0.46	0.53	0.57	0.59	0.60	0.59	0.55

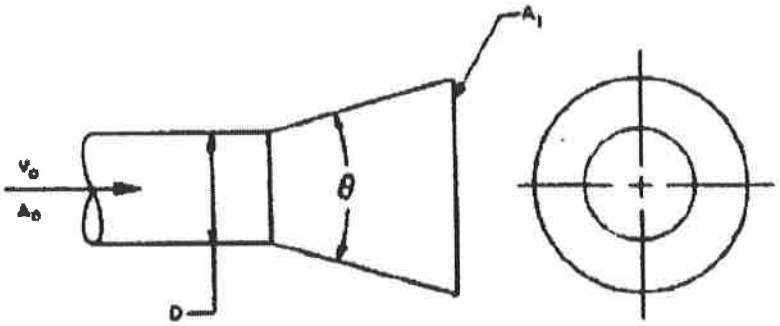
A. ELBOW, SMOOTH RADIUS (DIE STAMPED), ROUND Type 3.1



Coefficients for 90° Elbows (*See* Note 1)						
R/D	0.5	0.75	1.0	1.5	2.0	2.5
C	0.71	0.33	0.22	0.15	0.13	0.12

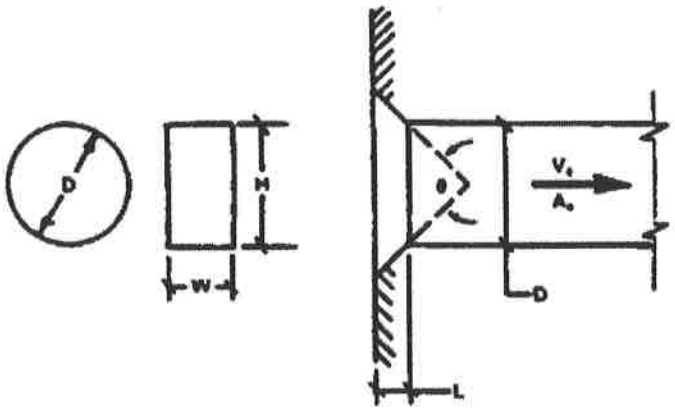
Note 1: For angles other than 90° multiply by the following factors:											
θ	0°	20°	30°	45°	60°	75°	90°	110°	130°	150°	180°
K	0	0.31	0.45	0.60	0.78	0.90	1.00	1.13	1.20	1.28	1.40

2-6 Exit, Round, Diverging (Idelchik 1986, Diagram 11-3)



	ζ						
	θ, degrees						
A_1/A_0	8	10	14	20	30	45	≥ 60
2	0.36	0.33	0.37	0.31	0.90	1.0	1.0
4	0.24	0.21	0.28	0.40	0.70	0.99	1.0
6	0.20	0.19	0.26	0.37	0.67	0.99	1.0
10	0.18	0.16	0.24	0.36	0.68	0.99	1.0
16	0.16	0.16	0.20	0.36	0.66	0.99	1.0

1-8 Conical Converging Bellmouth with End Wall, Round and Rectangular (Idelchik 1986, Diagram 3-7)



Rectangular: $D = 2HW/(H + W)$

	ζ									
	θ, degrees									
L/D	0	10	20	30	45	60	90	120	150	180
0.025	0.50	0.47	0.45	0.43	0.41	0.40	0.42	0.44	0.46	0.50
0.05	0.50	0.45	0.41	0.36	0.32	0.30	0.34	0.39	0.44	0.50
0.075	0.50	0.42	0.35	0.30	0.25	0.23	0.28	0.35	0.43	0.50
0.10	0.50	0.39	0.32	0.25	0.21	0.18	0.25	0.33	0.41	0.50
0.15	0.50	0.37	0.27	0.20	0.16	0.13	0.23	0.31	0.40	0.50
0.60	0.50	0.27	0.18	0.13	0.11	0.12	0.20	0.30	0.40	0.50

Question 2

To supply a secondary network of fluid at –45° C (HYCOOL 50, ρ = 1383 kg/m^3, μ = 4940x10^{-5} Pa.s), the following pump was selected: diameter of the impeller: 10 cm, number of revolutions 2900 RPM.

For water one will take the following characteristics: ρ = 1000 kg/m^3, μ = 8,4x10^{-4} Pa.s

The pump manufacturer has given the pump characteristics as in Table 3 (The data are tested based on running with water). Answer these questions:

Table 3 Pump data

flow (m^3 / h)	Pressure (m WG)	Power (W)
0	67.3	977
1.2	65.5	1045
2.4	61.9	1114
3.6	58.3	1205
4.8	54.2	1273
6	49.4	1341
7.2	44	1364
8.4	37.5	1386
9.6	31.0	1386
10.8	23.2	1364

(a) Convert the pump data to Rateau coefficients and fill in Table 3.

(6 marks)

(b) To determine the number of revolutions to regulate to ensure the schedule of conditions (specification) of the secondary loop with a flow of 6 m^3 / h for a pressure loss of 49 m WG. You can make use of the graph provided in Figure 2. **In this case, return Figure 3 with your answer sheet.**

(6 marks)

Table 3 Rateau Coefficients

δ (-)	μ (-)	η (-)

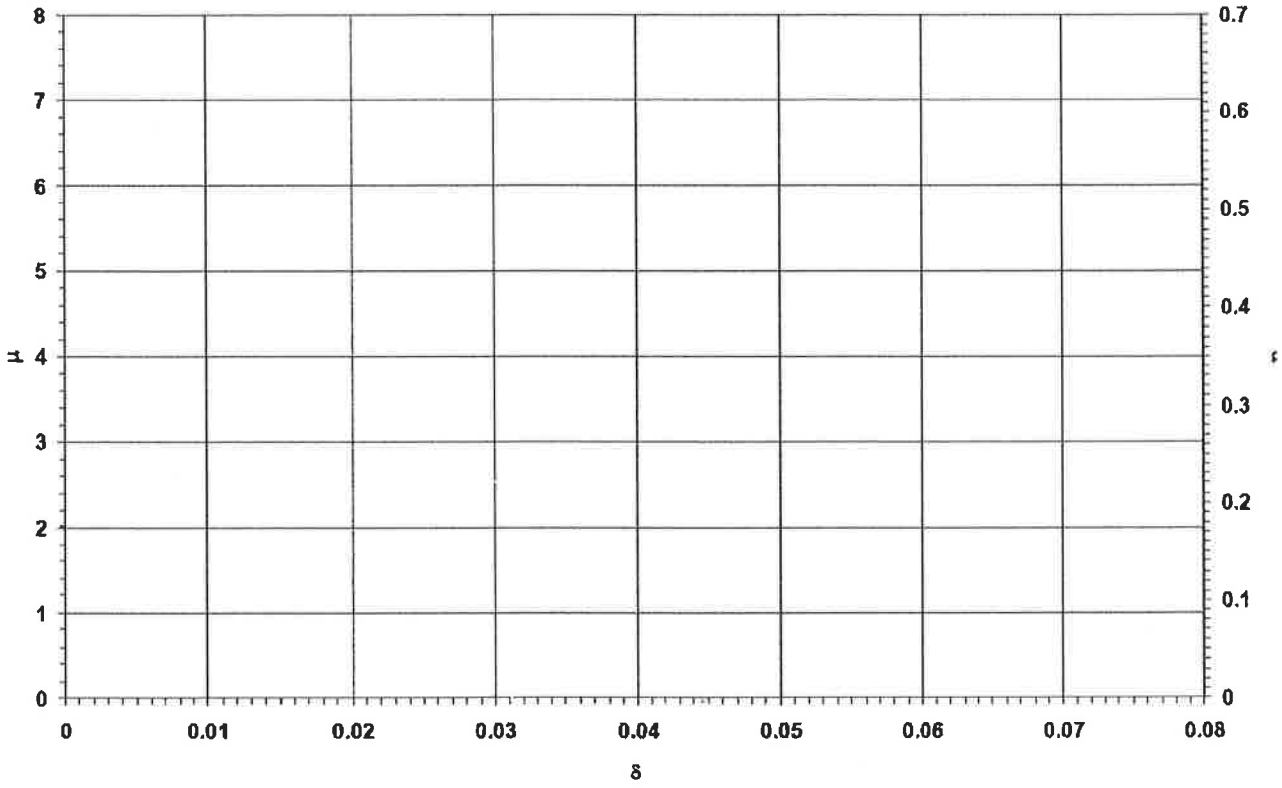


Figure 2 Non-dimensional characteristics of the pump (to be returned with your copy)

Question 3

An exchanger consists of a tube of 30 m long and 10 cm in interior diameter. A secondary fluid based on ethylene glycol circulates in the tube at a velocity of 1.55 m/s. The average temperature of the exchange is of -5° C. One wish "to protect" the secondary fluid for a temperature from -15° C. Answer these questions:

(a) What is the minimum concentration EG one need to adopt?

(2 marks)

(b) Is the flow laminar or turbulent?

(1 marks)

(c) To calculate the internal coefficient of heat transfer under these conditions.

(2 marks)

(d) One adopts a "protection" at -30° C. To answer the same question as in (a), (b) and (c).

(5 marks)

(e) What can you conclude from it?

(2 marks)

END OF QUESTION