UNIVERSITE LIBANAISE

FACULTE DE GENIE **Département Mécanique**

BRANCHE II – Roumieh **Semestre IX**

EPREUVE DE PLOMBERIE

Date : 25 Novembre 2013

Durée : Deux heures

Notes : Documents permis

Exercise 1: (15 points)

What will be the water temperature of a hot water cylinder 300 liters capacity, heated at 60°C, after 3 consecutive showers, knowing that for each shower we need 75 liters at 43°C, and the cold water temperature is 20°C?

Exercise 2: (10 points)

Calculate the boiler capacity for a villa including 4 floors, with heating loads as follow:

1st floor = 20Kw, 2nd floor = 21550Kcal/h, 3rd floor = 85000Btu/hr, and 4th floor = 15000J/s

The domestic hot water cylinder volume is 500 Liters and should be heated in 45 minutes.

The cold water temperature is 15°C, and the storage hot water temperature is 60°C.

Ex 1.

BE $\Rightarrow V = 300L$. $t_p = 60°$

Shower 1 $= 75L$ à $43°C = t_0$.

$$43 = \frac{V_1 t_1 + V_2 t_2}{V_1 + V_2} = \frac{60V_1 + 20V_2}{75} \Rightarrow \begin{cases} 60V_1 + 20V_2 = 3225 \\ V_1 + V_2 = 75 \end{cases} \begin{cases} V_1 = 43,125 \\ V_2 = 31,875 \end{cases}$$

$$t_{m_1} = \frac{(300 - 43,125) \times 60 + 43,125 \times 20}{300} = 54,25°C.$$

Shower 2. $\begin{cases} 54,25 V_1 + 20 V_2 = 3225 \\ V_1 + V_2 = 75 \end{cases} \begin{cases} V_1 = 50,3649L \\ V_2 = 24,635L \end{cases}$

$$\Rightarrow t_{m_2} = \frac{(300 - 50,365) \times 54,25 + 50,365 \times 20}{300} = 48,5°C.$$

Shower 3. $\begin{cases} 48,5 V_1 + 20V_2 = 3225 \\ V_1 + V_2 = 75 \end{cases} \begin{cases} V_1 = 60,53L. \\ V_2 = 14,371 L. \end{cases}$

$t_{m_3} = 42,74965°C$.

after 3 consecutive showers the water T° in the cylendar will be 42,71

Exercice 2.

1st floor $\Rightarrow 20KW$

2nd floor $\Rightarrow 21550 Kcal/h = 21550 \times 1,16 \times 10^{-3} = 25KW$.

3rd floor $\Rightarrow 85000$ BTU/h $= 85000 \times 0,29\,30911 \times 10^{-3} = 24,911 KW$

4th floor $\Rightarrow 15KW$.

$Q = mC\Delta T = 500 \times 1 \times (60 - 15) = 22500$ Kcal.

$P = \frac{Q}{t} = \frac{22500}{0,75(h)} = 30000 Kcal/h = 34,8 Kw$.

then for the 4th floor

Boiler capacity $= 34,89 \times 4 = 139,32 Kw = 144 Kw$.

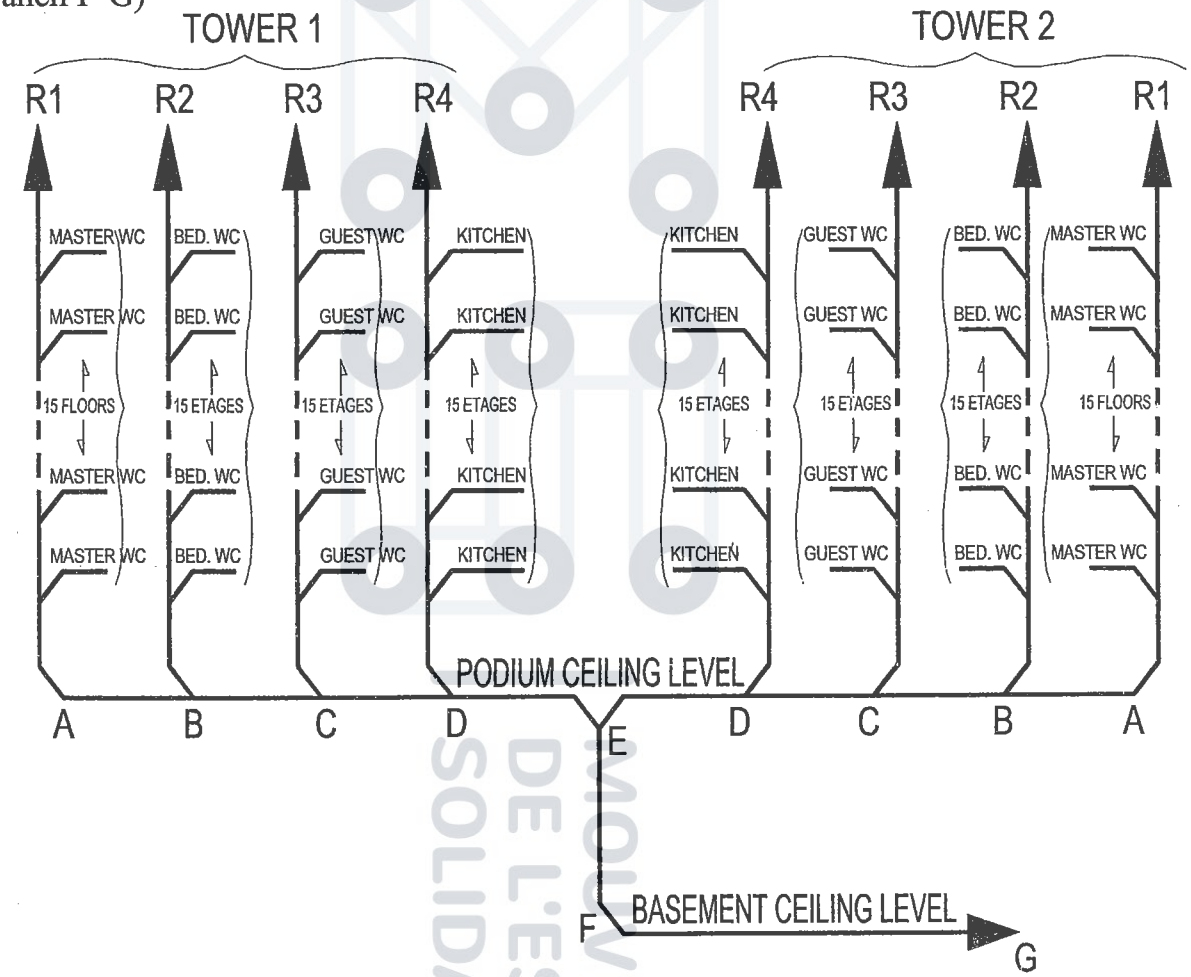
Exercise 3: (30 points)

We have 2 typical residential buildings, each including 15 floors, located at one podium floor.

Each floor includes 1 apartment with the following wet areas:

a) Master WC = 2 lavatories, 1 Water closet, 1 bidet, and 1 shower — Riser R1
b) Bedrooms WC = 1 lavatories, 1 Water closet, 1 bidet, and 1 shower — Riser R2
c) Guest WC = 1 lavatories, and 1 Water closet — Riser R3
d) Kitchen = 1 sink, and 1 laundry tray — Riser R4

Each wet area of all typical floors is connected to one common riser and collected at podium ceiling level (branch A-E), and after connecting both towers to riser E-F the drainage pipes go down to basement ceiling level (riser E-F), and finally connected to the municipality sewage network (branch F-G)



a) Calculate the dimensions of risers R1, R2, R3 & R4
b) Calculate the sizes of branches [A-B], [B-C], [C-D], [D-E], [E-F], & [F-G], by considering a slope of 2% for all horizontal pipes

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Ex 3.

2b-15-floors.

a) Master WC = 2 lav 2 x 2.
1 water closet 4
1 bidet 3
1 shower 2
+ 1
14 FU tableau 11.4.2 p.11-7

pour 15 etage 14 x 15 = 210 FU tableau

=> 4" diameter ✓

Riser 1 : 4" -> vertical. 210 > 72.

b) Bedrooms WC = 1 lav 2.
1 WC 4
1 bidet 3
1 shower 2
+ 1
12 FU pour 1 etage.

pour le 15 etage => 12 x 15 = 180 FU
180 > 72 ✓

=> DR_2 = 4" vertical.

c) Guest wc : 1 lav 2.
1 wc 4.
+1
7 FU.

pour 15 etage 7 x 15 = 105 FU. 105 > 72. ✓

DR_3 = 4" vertical.

d) Kitchen. 1 sink. 3
1 laundry tray 2
+ 1
6 FU

pour 15 etage = 6 x 15
= 90 FU
90 > 72
DR_4 = 4"

b) [A-B] → 210 FU slope 2%. ⇒ 4"
horizontal 216 > 210.

[B-C] → 210 FU + 180 FU = 390 FU slope 2% → 5"
Horizontal 390 < 480

[C-D] → 390 FU + 105 FU = 495 FU. slope 2% → 6"
480 < 495 < 840

[D-E] → 495 FU + 90 FU = 585 FU slope 2% → 6"
480 < 585 < 840.

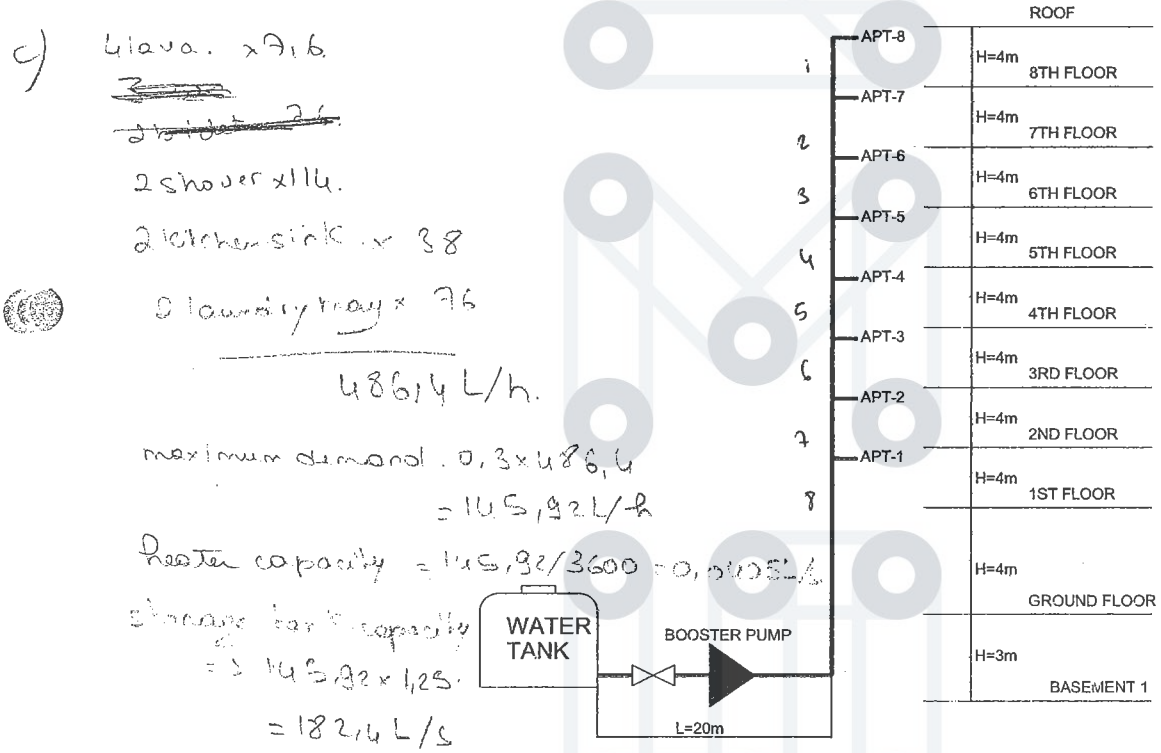
[E-F] vertical pipe → 585 FU × 2 = 1170 U. → 6"
vertical 1100 < 1170 < 1900.

[F-G] → 1170 FU 2% slope. → 8"
800 < 1170 < 1920

Exercise 4: (45 points)

By considering a residential building of 8 floors, where each floor is one apartment including:

a) Master WC = 2 lavatories, 1 Water closet, 1 bidet, and 1 shower
b) Bedrooms WC = 1 lavatories, 1 Water closet, 1 bidet, and 1 shower
c) Guest WC = 1 lavatories, and 1 Water closet
d) Kitchen = 2 sink, and 2 laundry tray
e) Hose bib at main balcony (D_b=0.1L/s)



Each floor level is 4m height; the ground floor is a reception area, the water tank and the booster set are located in basement floor. (For pipes lengths and floors heights refer to schematic riser)

a) Calculate the pipe sizes for the cold water riser following the French code
b) Calculate the domestic hot water storage tank capacity of typical floors based on ASHRAE standards
c) Calculate the static head of the booster pump to provide a residual pressure of 1.5bars at apartment main isolating valve (consider j=0.01m/m), and define the values of P_d & P_e
d) Indicate the residual pressure at each floor level, and show where the pressure reducing valve is required to avoid exceeding a residual pressure of 50PSI

Good Luck

4ème bram.

$D_b = 8,58 + 2,86 = 11,44$ litres.

$N = 60 \Rightarrow C_s = \frac{0,8}{\sqrt{59}} = 0,10415$.

$D_p = 1,1915$ litre.

5ème branchement.

$D_b = 11,44 + 2,86 = 14,3$ ℓ.

$N = 75 \Rightarrow C_s = \frac{0,8}{\sqrt{74}} = 0,093$.

$D_p = 1,331$ litre.

6ème br.

$D_b = 14,3 + 2,86 = 17,16$ ℓ. $N = 90 \Rightarrow C_s = \frac{0,8}{\sqrt{89}} = 0,085$

$D_p = 1,455$ ℓ.

7ème br.

$D_b = 17,16 + 2,86 = 20,02$ ℓ. $N = 105 \Rightarrow C_s = 0,0784$

$D_p = 1,57$ ℓ.

8ème $D_b = 20,02 + 2,86$. $N = 120 \Rightarrow C_s = 0,073 \Rightarrow D_p = 1,6779$.

Soit la perte de charge et 0,1.

$\Rightarrow$ Apt 8. $D_p = 0,612$ ℓ. $\delta = 0,1$

$D = 27,3 \Rightarrow 1''1/4$ $V = 1,1 < 1,5$ OK.

branch 1 $D_p = 0,612$ $\delta = 0,1$.

$D = 1''1/4$

Apt 7. Apt 6 —— Apt 1 $\Rightarrow D = 1''1/4$

bram 2. $D_p = 0,85$. $\Rightarrow 1''1/4$ $V < 1,5$ OK.

bram 3. $D_p = 1,0384 \Rightarrow 1''1/2$ $V < 1,5$ OK

br 4 $1''1/2$ $V < 1,5$ OK br 5. $1''1/2$ $V < 1,5$ OK

c) $P_r = 1,5$ bar.

$j = 0,01$ m/m.

$J = j \times L_{eq} = 0,01 \times (4 \times 9 + 3) \times 1,15 = 0,45$.

$H_s = 4 \times 9 + 3 = 39$ m.

$P_r = 1,5$ bars $= 15$ m.

$P = \rho (J + P_r + H_s)$

$= - 54,4573$ m/c car perte

the pump have a static head of 54,4573 m.

$\Rightarrow 5,445$ bars $\simeq 5,5$ bars

the $P_e = 5,5$ bars P_{min} of service = cut in.

$P_d = 5,5 + 1 = 6,5$ bars = cut off

d) $P_r = P + J + H_s$

$P_r = P - J - H_s$.

$\underline{F_1} = H_s = 11$ m.

$J = 0,01 \times (11) \times 1,15 = 0,118$.

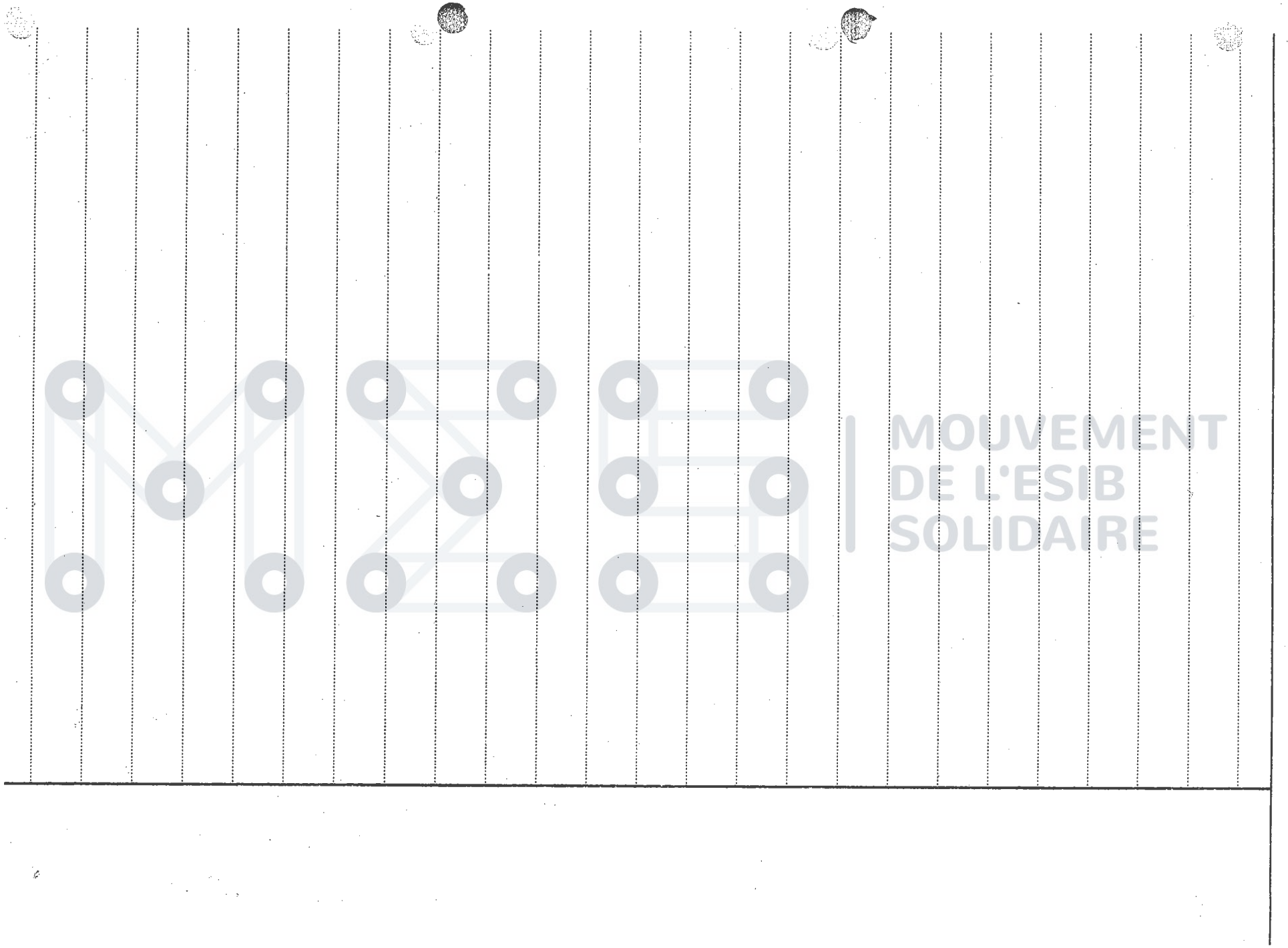
43,382 m.

$P_{r_1} = 62,9$ PSI > 50 PSI

$\underline{F_2}$ $H_s = 15$ m.

$J = 0,01 \times 15 \times 1,15 =$ -

$P_{r_2} = 39,25$ m $= 56,985$ PSI > 50 PSI PRV.



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Date : 22 Janvier 2014

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Exercise 1: (10pts)

Define the following:

a) Débit de base b) Fixture unit c)Stack vent d)Pressure relief vent

Exercise 2: (25pts)

Consider the building dimensions as shown in figure-1.

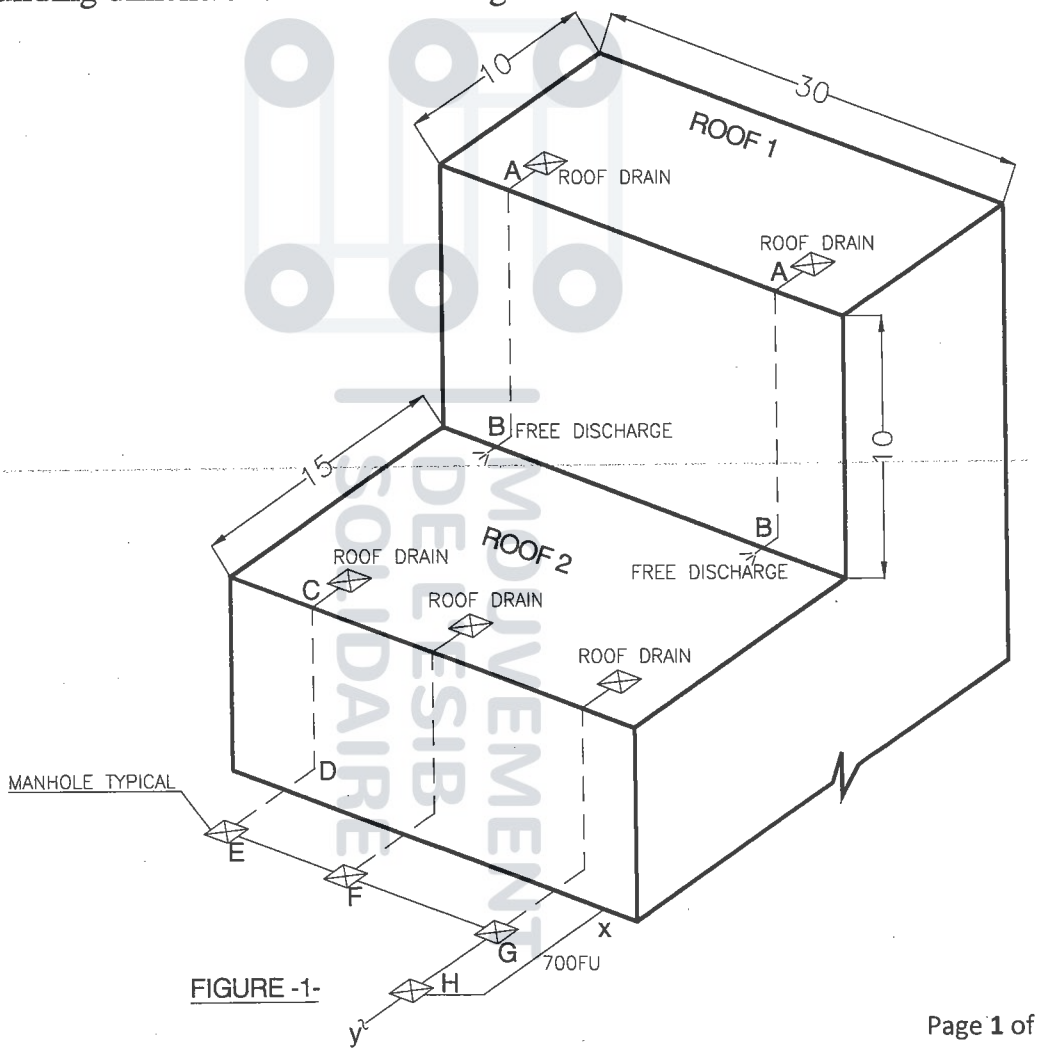


FIGURE -1-

The roof 1 is discharging the storm water to roof 2, and storm water is collected from roof 2 to discharge the storm water to municipality storm network at point H.

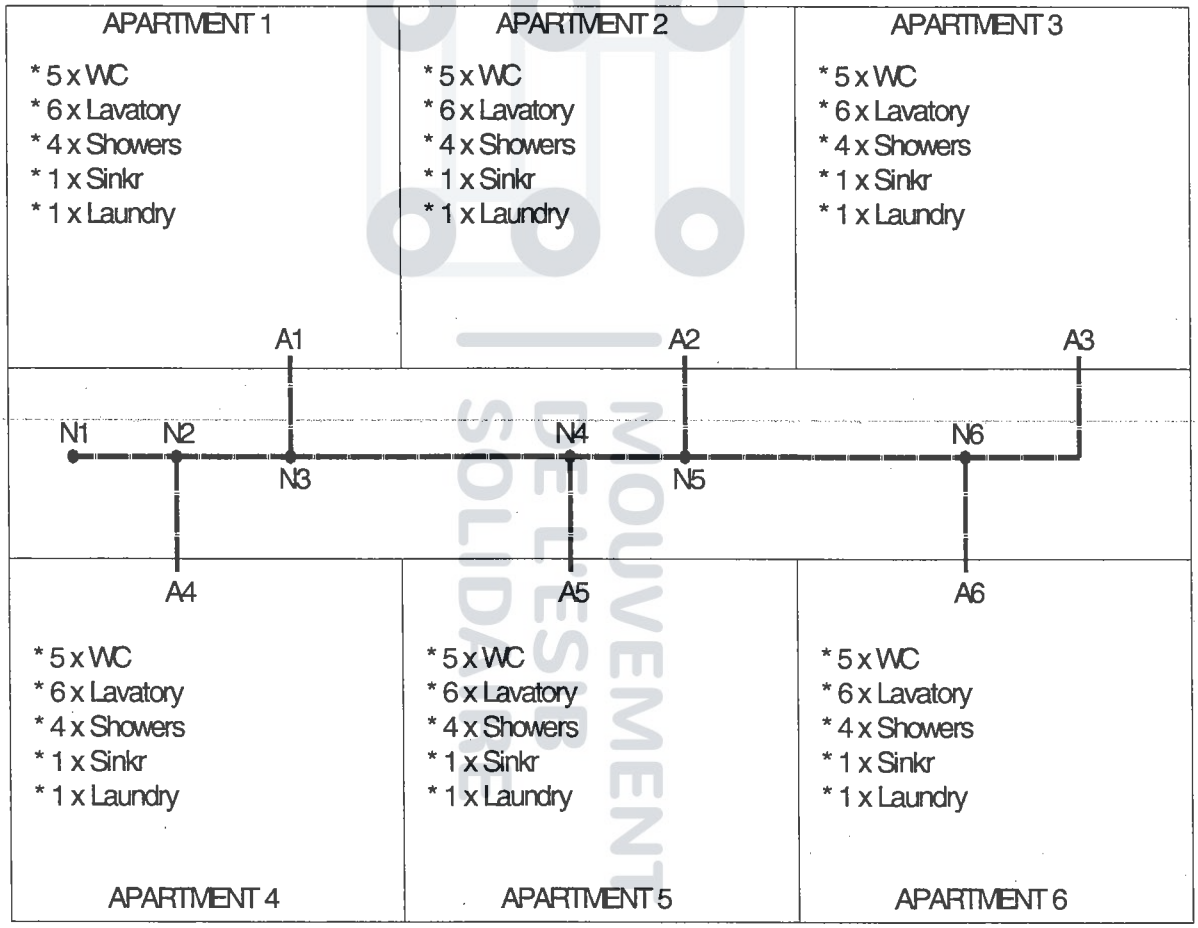
a) Calculate the dimensions of the branches [A-B], [C-D], [D-E], [E-F], [F-G], [G-H], by considering the slope of horizontal pipes 2%, and the rainfall rate is 5 inches per hour

b) The sewage from the building is collected to one main [X-H], with total fixture units = 700, determine the dimension of the main sewer branch [X-H] by considering a slope of 2%

c) Calculate the size of the combined storm and sewer line [H-Y] by considering the slope of pipe is 2%.

Exercise 3: (65pts)

a) Calculate the dimensions for all water distribution branches shown in below figure by using the fixture method, the maximum velocity shall be 2m/s, and the maximum friction loss shall be 4psi/100ft

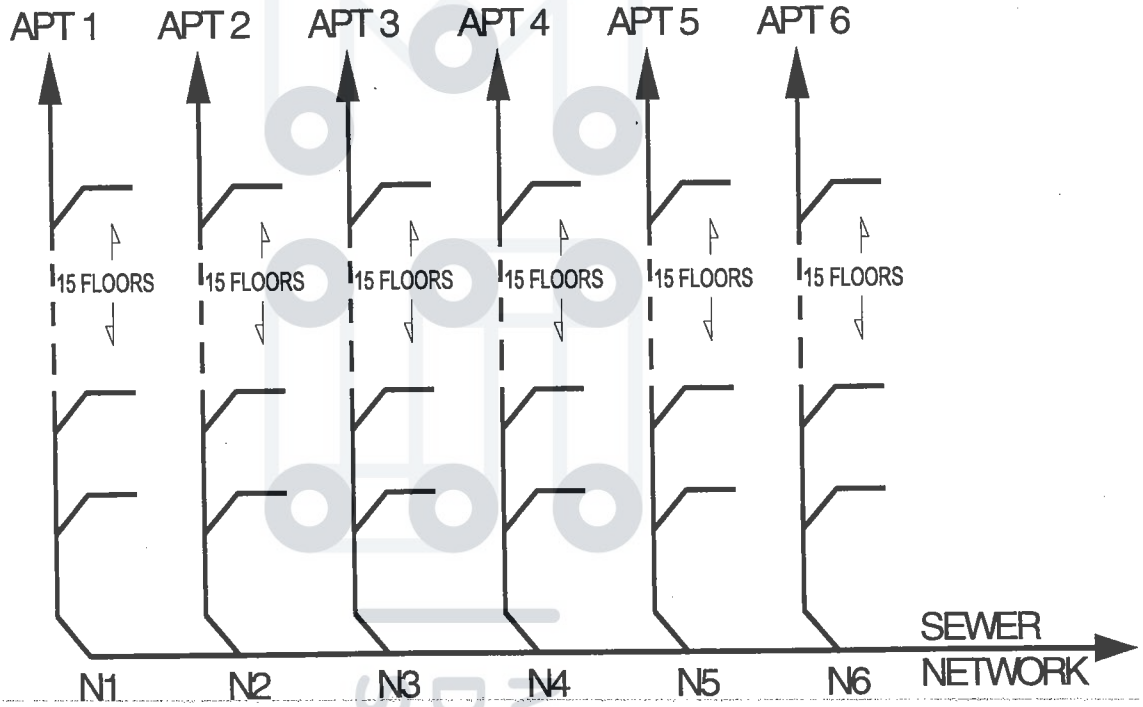


b) The domestic hot water serving the building is centralized in 1 storage tank; define the required storage capacity by using the ASHRAE method.

c) The cold water is distributed by booster pump located in basement floor at 10m below the apartment's level. Calculate the required flow and head of the booster pump to provide a minimum residual pressure of 1.5bars at any point of the system

d) Describe the sequence of operation of the booster set if operating as duplex, and indicate the values of P_{e1}, P_{e2}, P_{d1} and P_{d2} for proper operation of the set.

e) Each superposed apartments are drained to a separate soil stack as shown in the below picture; calculate the size of the typical stack if the building includes 15 floors.



f) Calculate the dimensions of all branched from N1 to N6, considering a slope of 2%

g) Calculate the dimension of the vent stack and indicate the location of the relief vent if required.

Bonne Chance