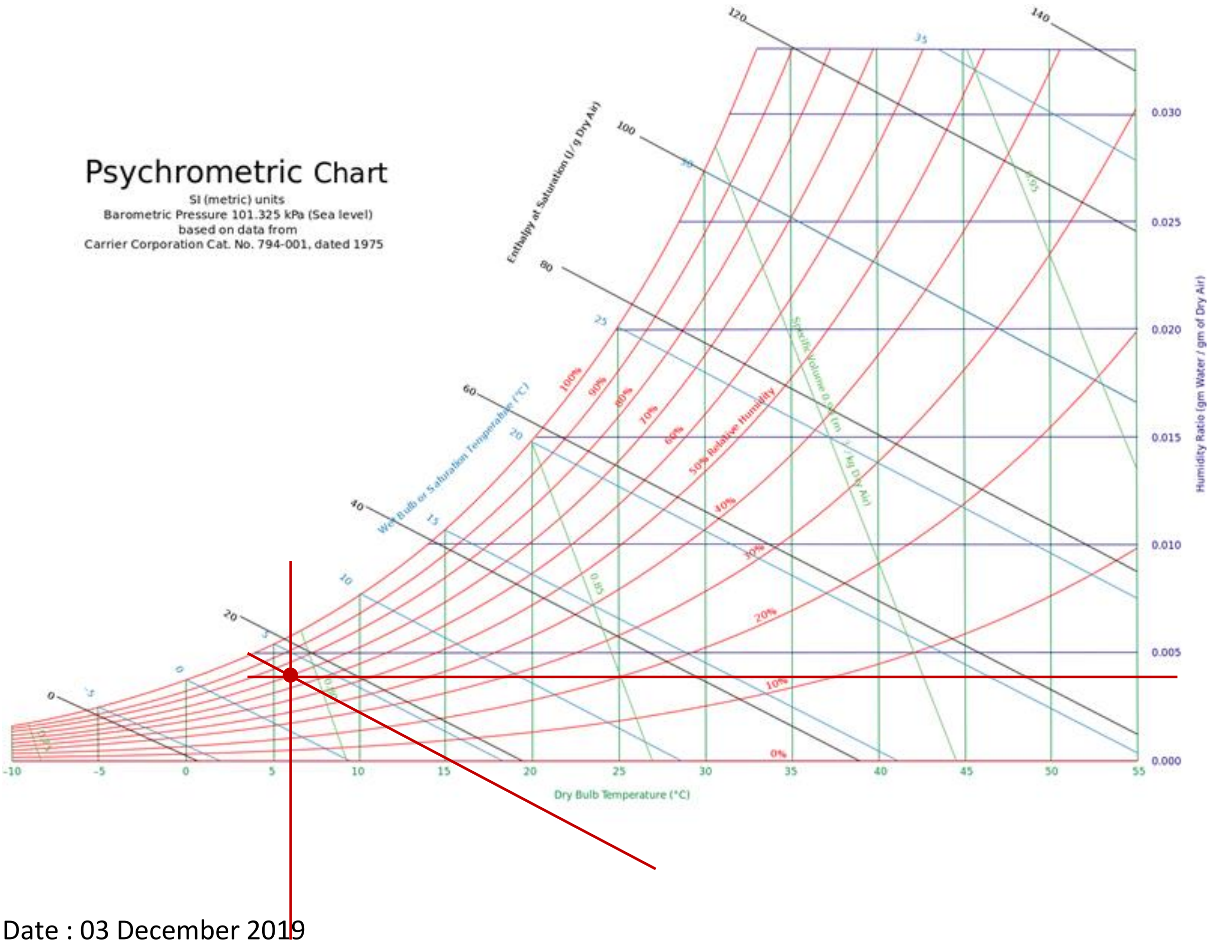
WEEK NINE- ASSIGNMENT

QUESTION 1

Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absolute humidity, the wet-bulb temperature and the mass of water vapour in the air in ClassRoom A (Aula A) of Piacenza campus in the moment that you are solving this exercise (provide the inputs that you utilized)

Weather Forecast Website example

Soln:



Date : 03 December 2019

Piacenza Weather Data:

$T_{out} = 6°c$

Relative Humidity = 90%

Atmospheric pressure = 1017kpa

From the Graph:

Specific Humidity = 0.005 $\left(\frac{gm\ of\ water}{gm\ of\ dry\ air}\right)$

Wet bulb temperature = 5°c

Specific enthalpy of humid air = 19$\left(\frac{KJ}{Kg\ of\ dry\ air}\right)$

$$P_v = \frac{p.\omega}{0.622 \quad + \omega} = 0.84\ kg$$

$$V_{room\ A} = \ 20\ x\ 6\ x\ 6 = 720\ m^2$$

$$m_v = \frac{p_v.v}{R_v.T} = \frac{0.84\ x\ 720}{0.4615x\ (273{+}6)} = 4.7\ kg$$

QUESTION 2

Utilize the same methodology we went through in the class and determine the sensible and latent load corresponding to internal gains, the ventilation, and the infiltration in a house with a good construction quality and with the same geometry as that of the example which is located in Brindisi, Italy.

BRINDISI, Italy WMO#: **163200**

Lat: **40.65N** Long: **17.95E** Elev: **10** StdP: **101.2** Time Zone: **1.00 (EUW)** Period: **86-10** WBAN: **99999**

Annual Heating and Humidification Design Conditions

	Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		
				99.6%			99%			0.4%		1%				
		99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	
(1)	2	2.9	4.1	-5.1	2.5	7.2	-3.0	3.0	7.4	13.4	10.2	12.4	10.6	3.4	250	(1)

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

	Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB		
			0.4%		1%		2%		0.4%		1%		2%				
			DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(2)	8	7.1	32.8	23.6	31.1	24.3	29.9	24.3	27.2	29.7	26.3	29.0	25.6	28.3	4.2	180	(2)

	Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Hours 8 to 4 & 12.8/20.6	
	0.4%			1%			2%			0.4%		1%		2%			
	DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(3)	26.3	21.8	29.2	25.4	20.7	28.5	24.7	19.7	27.9	86.0	30.1	82.2	29.1	78.5	28.3	1236	(3)

Extreme Annual Design Conditions

	Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB								
					Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years		
	1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(4)	11.3	9.9	8.7	31.4	0.4	37.3	1.4	3.0	-0.6	39.4	-1.4	41.1	-2.2	42.8	-3.2	44.9	(4)

Soln:

Number of occupants = 2

Number of bed rooms = 1

Height of the building = 2.5m

Area of the floor = 200 m^2

Internal gains :

$\dot{Q}_{\text{igsensible}} = 136 + 2.2A_{cf} + 22Noc$

= 136 + 2.2 (200) + 22(2)

= 620 W

$\dot{Q}_{\text{iglatent}} = 20 + 0.22A_{cf} + 12Noc$

= 20 + 0.22 (200) + 12(2)

= 88 W

INFILTRATION

A house with good construction quality, $A_{ul} = 1.4\frac{cm^2}{m^2}$

Table 3 Unit Leakage Areas

Construction	Description	A_{ul}, cm^2/m^2
Tight	Construction supervised by air-sealing specialist	0.7
Good	Carefully sealed construction by knowledgeable builder	1.4
Average	Typical current production housing	2.8
Leaky	Typical pre-1970 houses	5.6
Very leaky	Old houses in original condition	10.4

$A_{es} = A_{wall} + A_{roof} = 200 + 144 = 344\ m^2$

$A_L = A_{es}\ x\ A_{ul} = 344\ x\ 1.4 = 481.6\ cm^2$

$T_{cooling}$ = 24°c

$T_{heating}$ = 20°c

$\Delta T_{cooling}$ = 31.1°c - 24°c = 7.1 °c

$\Delta T_{heating}$ = 20°c – (-4.1)°c = 24.1 °c

DR = 7.1°c

Given $IDF_{heating} = 0.073\frac{L}{s\ x\ cm^2}$

$IDF_{cooling} = 0.033\frac{L}{s\ x\ cm^2}$

INFILTRATION AIRFLOW RATE

$Q_{i.heating} = A_L\, x\, IDF_{heating} = 481.6 \text{ x } 0.073 = 35.15\frac{L}{s}$

$Q_{i.cooling} = A_L\, x\, IDF_{cooling} = 481.6 \text{ x } 0.033 = 15.89\frac{L}{s}$

VENTILATION

$Q_v = 0.05A_{cf} + 3.5(N_{br} + 1) = 0.05 \text{ x } 200 + 3.5(1 + 1) = 17\frac{L}{s}$

$Q_{i-v.heating} = Q_{i.heating} + Q_{v}$ = 35.15 +17 = 52.15 $\frac{L}{s}$

$Q_{i-v.cooling} = Q_{i.cooling} + Q_{v}$ = 15.89 +17 = 32.89 $\frac{L}{s}$

Given that

$C_{sensible} = 1.23$,

$C_{latent} = 3010$,

$\Delta\omega_{cooling} = 0.0039$

$q_{inf-ventilation\ cooling\ sensible} = C_{sensible}\, Q_{i-v.cooling}\, \Delta T_{cooling} = 1.23\ x\ 32.89\ x\ 7.1 = 287.25W$

$q_{inf-ventilation\ cooling\ latent} = C_{latent}\, Q_{i-v.cooling}\, \Delta\omega_{cooling} = 3010\ x\ 32.89\ x\ 0.0039$
$= 386.13\ W$

$q_{inf-ventilation\ heating\ latent} = C_{sensible}\, Q_{i-v.heating}\, \Delta T_{heating} = 1.23\ x\ 52.15\ x\ 24.1 = 1546W$