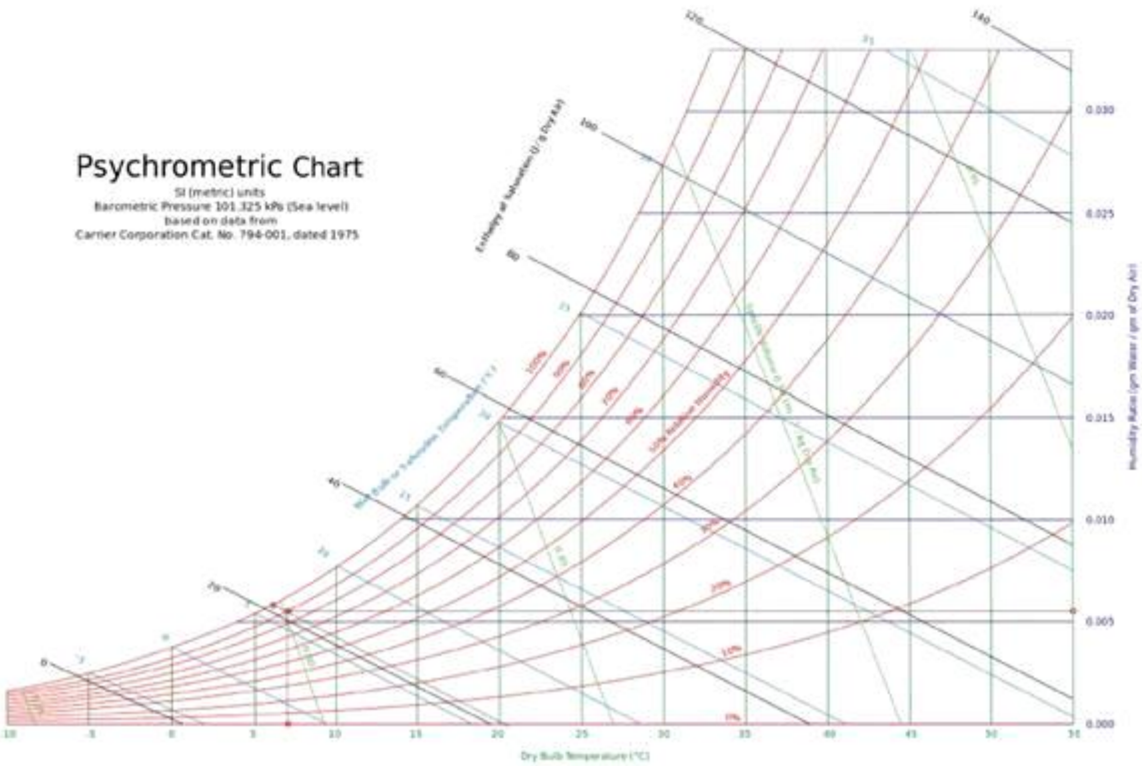
Submission 9

Use a weather forcast web site, 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 water vapour in the air in the classroom A (Aula A) of Piacenza campus in the moment that you solving this exercise

Il tempo oggi in Piacenza *Lunedì, 02 Dicembre 2019*							
	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	PartlyCloud	PartlyCloud	LightCloud	LightCloud	PartlyCloud	Cloud	PartlyCloud
Temperatura effettiva	10°C	10°C	9°C	6°C	7°C	7°C	8°C
Temperatura percepita	10°C	10°C	8°C	5°C	7°C	6°C	7°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	79 %	77 %	89 %	90 %	90 %	92 %	91 %
Pressione atmosferica	1016 hPa	1015 hPa	1016 hPa	1017 hPa	1019 hPa	1019 hPa	1020 hPa

Now the time is 21:00 and from the data given on the website we have:

- Humidity 92% Φ (relative humidity)=92%
- Pressione atmosferica 1019 hPa P=101,9 kPa
- Temperatura effettiva 7°C T=280,15 K



With the psychrometric Chart we can see:

The humidity ratio, i.e., the absolute humidity ω=0.0055

The web bulb temperature $T_{wb} = 6°C$

P_v =0.893 kPa

$\boldsymbol{\omega} = \frac{0.622P_v}{P_a} = \frac{0.622P_v}{P-P_v} = 0.0055 \quad 0.622P_v = 0.0055\,(P - P_v) \;\; 0.622P_v = 0.0055P - 0.0055P_v$

$0.6275P_v = 0.0055P \quad \boldsymbol{P} = \frac{0.6275P_v}{0.0055} = 114.09P_v = 101.88\,kPa$

For any ideal gas $m = \frac{PV}{R_{spt}T}$, for water vapor Rspt=0.4615

The pressure of water vapor Pv=0.893 kPa , V is the volume of aula A:

$$\boldsymbol{m_v} = \frac{0.893V}{0.4615 * 230} = 8.41 * 10^{-3}V$$

mg is the maximum water vapor:

$$\boldsymbol{m_{g}}{=}\frac{m_v}{0.9} = 9.34 * 10^{-3}V$$

Task 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)

Internal Gains

Calculate the sensible $q_{ig,s} = 136 + 2.2A_{cf} + 12N_{oc} = 136 + 2.2 * 200 + 22 * 2 = 620\,W$

$q_{ig,l} = 20 + 0.22A_{cf} + 12N_{oc} = 20 + 0.22 * 200 + 12 * 2 = 88\,W$

Infiltration

For a house with a good construction quality, unit leakage area $A_{ul} = 1.4cm^{\,2}/m^2$

And the exposed surface $A_{es} = A_{wall} + A_{roof} = 200 + 144 = 344\,m^2$

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

$T_{cooling} = 24°C$, this is the cooling temperature in Brindisi

$T_{heating} = 20°C$, this is the heating temperature in Brindisi

$\Delta T_{cooling} = 31.1°C - 24°C = 7.1°C = 7.1\,K$

$T_{heating} = 20°C - (-4.1°C) = 24.1°C = 24.1\ K$

DR=7.1°C= 7.1 K

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

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

Calculate infiltration airflow rate:

$Q_{i,heating} = A_L * IDF_{heating} = 481.6 * 0.073 = 35.157 \frac{L}{s}$

$Q_{i,cooling} = A_L * IDF_{cooling} = 481.6 * 0.033 = 15.893 \frac{L}{s}$

The minimum required whole building ventilation rate is

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

$Q_{i-v,heating} = Q_{i,heating} + Q_v = 35.157 + 17 = 52.157\ \frac{L}{s}$

$Q_{i-v,cooling} = Q_{i,cooling} + Q_v = 15.893 + 17 = 32.893\ \frac{L}{s}$

Given that $C_{sensible} = 1.23$ $C_{latent} = 3010$ $\Delta\omega_{cooling} = 0.0039$

$Q_{{inf-ventilation}_{cooling}}{}_{sensible} = C_{sensible} Q_{i-v,cooling} \Delta T_{cooling} = 1.23 * 32.893 * 7.1$

$Q_{{inf-ventilation}_{cooling}}{}_{latent} = C_{latent} Q_{i-v,cooling} \Delta\omega_{cooling} = 3010 * 32.893 * 0.0039$

$Q_{{inf-ventilation}_{healting}}{}_{sensible} = C_{sensible} Q_{i-v,cooling} \Delta T_{heating} = 1.23 * 52.157 * 24.1$