Task 1 Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absoloute 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]

Umidità: Relative humidity, Pressione atmosferica: Air total pressure (1 hPa: 0.1 kPa), Temperatura effettiva: temperature to be utilized.

Weather data: Piacenza 3 December, 2019

Now the time is around 18 , so the effective temperature in Piacenza is 6°C and in Kelvin the temperature is 279. The relative humidity is 80 % (Ø) and the atmospheric pressure is 30 hg=101,59 kPa.

- *Humidity ratio*

We need to use the steam table to find the value of P_V, that is the saturation pressure of water at 6°C and its value is equal to 0,935 kPa.

$$\emptyset = \frac{m_v}{m_g} = \frac{P_v}{P_G}$$

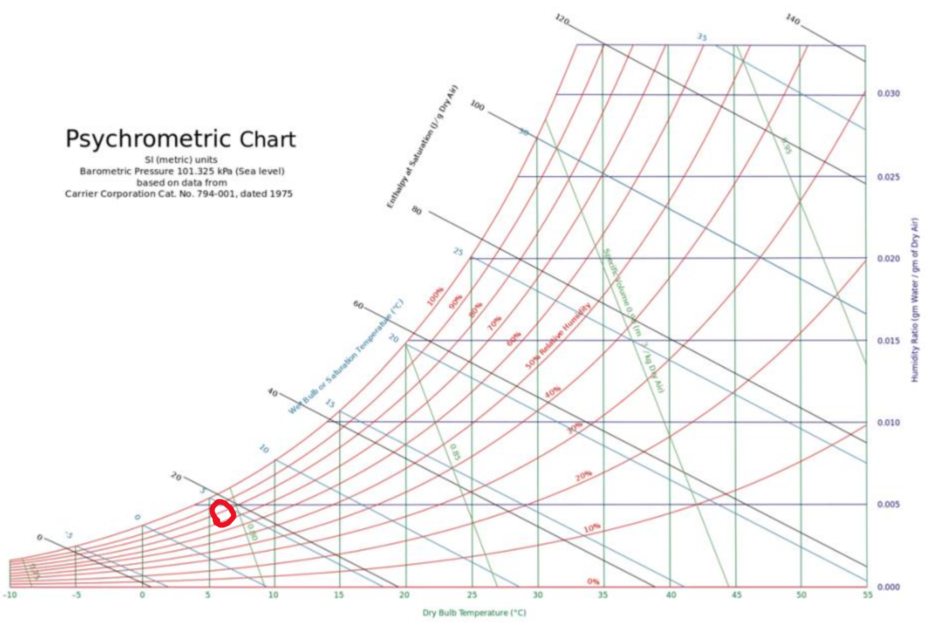
$$P_V = \emptyset * P_G = 0,8 * 0,935 = 0,748\ kPa$$

$$P_a = P - P_V = 101,59 - 0,748 = 100,842\ kPa$$

$$\omega = 0,622 * \frac{P_V}{P - P_V} = \frac{0,622 * 0,748}{100,842} = 0,00461\ Kg_{\%vapour}/Kg_{dryair}$$

- *Wetbulb temperature*

Using of the psycometric chart we were able to find the missed data that we need like the wet-bulb temperature that in our case is equal to 4°C. In the charts we have to intersect the value of the relative humidity with the value of the dry bulb temperature and the humidity ratio, so the wet bulb temperature correspond to the blue line.



- *The mass of water vapour in the air in classroom (5m;5m;3m)*

Assuming the air as an ideal gas

$$m = \frac{P_V}{R_{SP} * T}$$

$$m_a = (P_A * V_a)/(R_a * T) = 100{,}842 * (5 * 5 * 3)\ /\ 0{,}287 * 279 = 94{,}4531\ Kg$$

$$m_V = (P_V * V_a)/(R_V * T) = 0{,}748 * (5 * 5 * 3)/0{,}416 * 279 = 0{,}0396\ Kg$$

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)

- *Sensible load*

A_{cf} = 200 m^2
N_{cf} = 2

$$Q_{igs} = 136 + 2{,}2 * A_{cf} + 22 * N_{cf} = 136 + 2{,}2 * 200 + 22 * 2 = 620\ W$$
$$Q_{igl} = 20 + 0{,}22 * A_{cf} + 12 * N_{cf} = 20 + 0{,}22 * 200 + 12 * 2 = 88W$$

- *Infiltration*

$$Q_i = A_L * IDF$$

$A_{unit} = 1{,}4\ cm^2/m^2$ (good construction quality)
$A_{es} = 200 + 144 = 344$ (surface floor+ surface walls)
$A_L = A_{es} * A_{unit} = 344 * 1{,}4 = 481{,}6\ cm^2$

The value of IDF depends on the temperature of the season

$IDF_{heating}$ = 0,073 L/Scm^3
$IDF_{cooling}$ = 0,0375 L/Scm^3

Table 5 Typical IDF Values, L/(s·cm^2)

H, m	Heating Design Temperature, °C					Cooling Design Temperature, °C			
	−40	−30	−20	−10	0	10	30	35	40
2.5	0.10	0.095	0.086	0.077	0.069	0.060	0.031	0.035	0.040
3	0.11	0.10	0.093	0.083	0.072	0.061	0.032	0.038	0.043
4	0.14	0.12	0.11	0.093	0.079	0.065	0.034	0.042	0.049
5	0.16	0.14	0.12	0.10	0.086	0.069	0.036	0.046	0.055
6	0.18	0.16	0.14	0.11	0.093	0.072	0.039	0.050	0.061
7	0.20	0.17	0.15	0.12	0.10	0.075	0.041	0.051	0.068
8	0.22	0.19	0.16	0.14	0.11	0.079	0.043	0.058	0.074

$$V_{infiltrationheating} = A_L * IDF_{heating} = 481{,}6 * 0{,}073 = 35{,}156\ L/S$$
$$V_{infiltrationcooling} = A_L * IDF_{cooling} = 481{,}6 * 0{,}0375 = 18{,}06\ L/S$$

- *Ventilation*

A_{cf} = 200
N_{br} = 1

$$V_{ventilation} = 0{,}05 * A_{cf} + 3{,}5 * (N_{br} + 1) = 0{,}05 * 200 + 3{,}5 * (1 + 1) = 17\ L/S$$

$$V_{infiltration,ventilation,heating} = V_{ifh} + V_v = 35{,}156 + 17 = 52{,}156\ L/S$$
$$V_{infiltration,ventilation,cooling} = V_{ifc} + V_v = 18{,}06 + 17 = 35{,}06\ L/S$$

$C_{sensible}$ = 1,23
C_{latent}= 3010
$\Delta\omega_{cooling} = 0{,}0132 - 0{,}0093 = 0{,}0039$
$\Delta\omega_{heating} = 0{,}0190 - 0{,}0140 = 0{,}005$

$$Q_{infventilation,coolingsensible} = C_{sensible} * V_{inf,cooling} * \Delta T_{cooling} = 1{,}23 * 35{,}06 * 7{,}9 = 340{,}67W$$
$$Q_{infventilation,coolinglatent} = C_{latent} * V_{inf,cooling} * \Delta\omega_{cooling} = 3010 * 35{,}06 * 0{,}0039 = 411{,}57\ W$$

$$Q_{infventilation,heatingsensible} = C_{sensible} * V_{inf,heating} * \Delta T_{heating} = 1{,}23 * 52{,}156 * 24{,}8 = 1590{,}97W$$
$$Q_{infventilation,heatinglatent} = C_{latent} * V_{inf,heating} * \Delta\omega_{heating} = 3010 * 52{,}156 * 0{,}005 = 784{,}95W$$