week9

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 and the mass of water vapor 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)

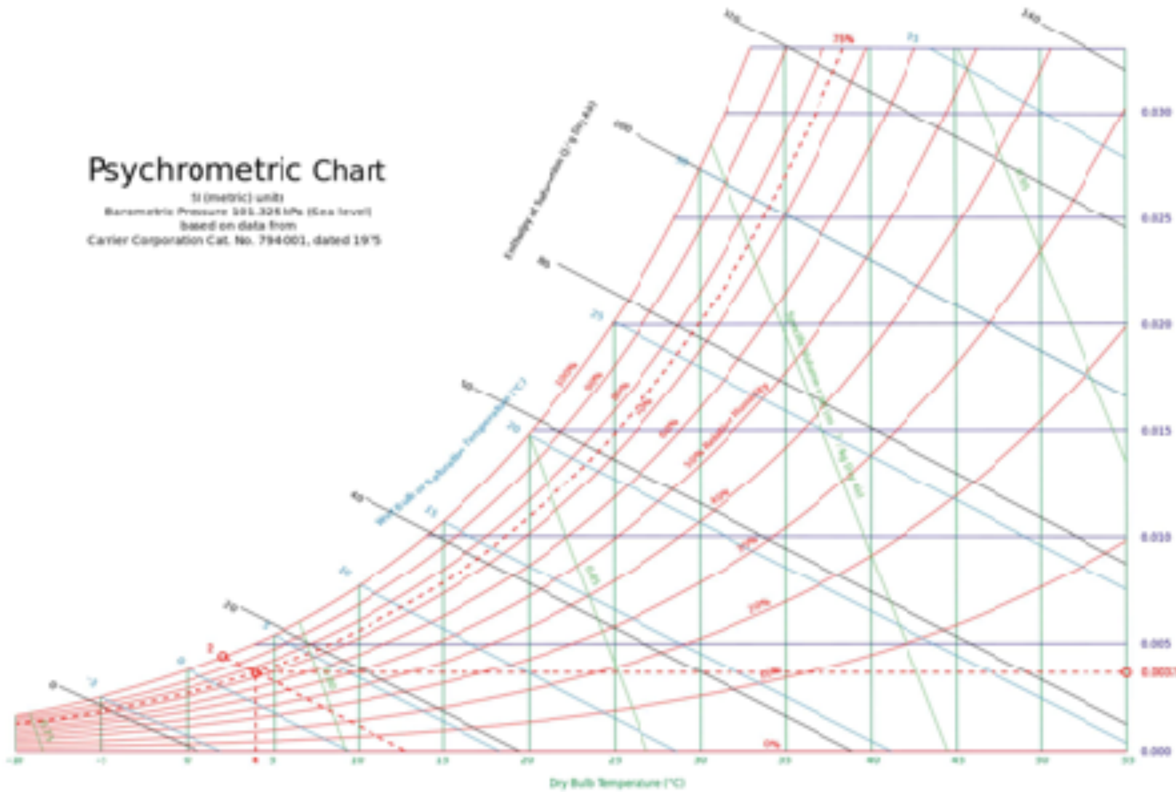
Umidità: Relative humidity, Pressione atmosferica: Air total pressure (1 hPa: 0.1 kPa), Temperatura effettiva: temperature to be utilized.

Il tempo oggi in Piacenza
Martedì, 03 Dicembre 2019

	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	LightCloud	LightCloud	PartlyCloud	LightCloud	Sun	Sun	Sun
Temperatura effettiva	9°C	10°C	8°C	6°C	4°C	2°C	2°C
Temperatura percepita	7°C	10°C	6°C	4°C	2°C	0°C	0°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	67 %	65 %	69 %	70 %	75 %	83 %	87 %
Pressione atmosferica	1025 hPa	1025 hPa	1025 hPa	1026 hPa	1027 hPa	1027 hPa	1028 hPa

As the weather forecast shows above, we can have these data:

$\phi = 75\%$, $T = 4°C = 277K$, $P = 102.7\ kPa$



From the Psychrometric Chart, when $T = 4°C$ and $\phi = 75\%$, the ω=0

From formula :

ω = 0.622* Pv/(P-Pv)

Pv= 0.62 KPa

We consider the size of Aula A is 20m*10m*3m, V= 20 $*$ 10 $*$ 3 = 600m,

from the class we have Rv=0.4615

Mv=Pv*V/(T*Rv)=2.91 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)

A building with a height of 2.5 m and an GOOD construction quality, is located in Brindisi, considering two occupants and one bed room calculate, and a conditioned floor area of 200 m², and wall area is 144m², calculate the internal gains, infiltration, and ventilation loads.

Internal gain

Qig sensible= 136+ 2.2*Acf+ 22* Noc= 620 W

Qig latent= 20+ 2.2*Acf+ 12* Noc= 88 W

Infiltration

Table 3 Unit Leakage Areas

Construction	Description	A_{ul}, cm²/m²
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

$$A_L = A_{es}A_{ul}$$

where

A_{es} = building exposed surface area, m²

A_{ul} = unit leakage area, cm²/m² (from Table 3)

From Table 3, we can know:

Good quality → A= 1.4 cm/m

Exposed surface = Wall area +roof area

A_{ES}=200+144=344 m

A_L= A_{ES}* A_{UL}= 344×1.4 = 481.6 cm

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	0.095	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

Table 5 Typical IDF Values, L/(s cm²)

$$Q_i = A_L \, \mathrm{IDF}$$

where

A_L = building effective leakage area (including flue) at reference pressure difference = 4 Pa, assuming discharge coefficient C_D = 1, cm²

IDF = infiltration driving force, L/(s·cm²)

From Table 5, we can know when T heating design =4.1°C, T cooling design =31.1°C

→

IDFheating = 0.065 L/(s·cm)

IDFcooling = 0.032 L/(s·cm)

→

$Q = A \times IDF$ = 481.6 $*$ 0.065 = 31.30 L/s infiltration heating

$Q = A \times IDF$ = 481.6 $*$ 0.032 = 15.41 L/s infiltration cooling

ventilation

Indoor Conditions.
Based on ASHRAE Standard 55 typical practices are the following:

For cooling: 24°C db and a maximum of 50 to 65% rh.
For heating: 20°C db and 30% rh

$\triangle T_{heating}$= 15.9 °C

$\triangle T_{cooling}$= 7.7 °C

DR = 7.1 °C

$$Q_v = 0.05A_{cf} + 3.5(N_{br} + 1)$$

where

Q_v = required ventilation flow rate, L/s
A_{cf} = building conditioned floor area, m^2
N_{br} = number of bedrooms (not less than 1)

Qv= 17L/s

Qv-heating= 48.3 L/s

Qv-cooling= 32.41 L/s

We have already known：C = 1.23 , C = 3010

Qv-cooling sensible= 306.96W

Qv-cooling latent= 380.46W

Qv-heating sensible= 944.60W