Energy Efficient Buildings
Sequence, Energy Balance and Weather Homework

1) Consider the following building loads where + is heat into the building and – is heat out of the building.

Q_{people} = 5,000 Btu/hr	$Q_{windows}$ = -4,000 Btu/hr
Q_{solar} = 15,000 Btu/hr	$Q_{ceiling}$ = -1,000 Btu/hr
Q_{elec} = 10,000 Btu/hr	$Q_{infiltration}$ = -4,000 Btu/hr
Q_{walls} = -3,000 Btu/hr	Q_{ground} = -1,000 Btu/hr

   a) Does the building require heating or cooling?
   $Q_{net} = (Q_{people} + Q_{solar} + Q_{elec} + Q_{wall} + Q_{windows} + Q_{ceiling} + Q_{infiltration} + Q_{ground}) = 5{,}000 + 15{,}000 + 10{,}000 + 3{,}000 – 4{,}000 – 1{,}000 – 4{,}000 – 1{,}000 = 23{,}000$ Btu/hr
   So, the building require cooling.
   b) If heating, how much natural gas does the furnace require (Btu/h) if it is 80% efficient? If cooling, how much electricity (kWh/h) does the air conditioner require if the COP is 2.8?
   $W_{elec} = Q_{net} / COP = (23{,}000$ Btu/hr / 2.8) / 3,412 Btu/kWh = 2.407 kW

2) Consider the following building loads where + is heat into the building and – is heat out of the building.

Q_{people} = 5,000 Btu/h	$Q_{windows}$ = -6,000 Btu/hr
Q_{solar} = 1,000 Btu/h	$Q_{ceiling}$ = -5,000 Btu/hr
Q_{elec} = 1,000 Btu/h	$Q_{infiltration}$ = -6,000 Btu/hr
Q_{walls} = -8,000 Btu/h	Q_{ground} = -2,000 Btu/hr

   a) Does the building require heating or cooling?
   $Q_{net} = (Q_{people} + Q_{solar} + Q_{elec} + Q_{wall} + Q_{windows} + Q_{ceiling} + Q_{infiltration} + Q_{ground}) = 5{,}000 + 1{,}000 + 1{,}000 - 8{,}000 – 6{,}000 – 5{,}000 – 6{,}000 – 2{,}000 = -20{,}000$ Btu/hr
   So, the building requirs heating.
   b) If heating, how much natural gas does the furnace require (Btu/h) if it is 80% efficient? If cooling, how much electricity (kWh/h) does the air conditioner require if the COP is 2.8?
   $W_{elec} = Q_{net} / COP = (20{,}000$ Btu/hr / 0.8) = 25,000 Btu/hr

3) Find a) the single average temperature (F) in Minneapolis, Minnesota (Minneapolis St. Paul Intl AP) over the entire period from October through March using TMY3 data and b) the single average temperature (F) over the entire period from October, 2000 through March, 2001 using actual average daily temperatures.

a)

	A	B	C	D	E	F	G	H	I	J
1	Mo	Yr	Ta(F)	Sol-H(Btu/ft2dy)	Sol-E(Btu/ft2dy)	Sol-S(Btu/ft2dy)	Sol-W(Btu/ft2dy)	Sol-N(Btu/ft2dy)	w(lbw/lba)	Tg(F)
2	1	1995	11.49	547	305	990	327	109	0.0013	39.15
3	2	1995	23.29	821	418	1114	443	172	0.0018	35.98
4	3	1995	35.68	1170	568	1064	566	232	0.003	36.57
5	4	1995	45.56	1510	730	895	759	247	0.0045	39.26
6	5	1995	61.72	1871	851	831	834	375	0.0072	44.12
7	6	1995	68.65	2034	888	753	936	419	0.0087	48.59
8	7	1995	74.8	1908	858	764	852	401	0.0123	52.66
9	8	1995	69.14	1638	803	870	785	355	0.011	55.11
10	9	1995	60.49	1276	630	996	594	245	0.0079	54.95
11	10	1995	46.77	892	474	1045	469	188	0.0047	52.27
12	11	1995	32.54	505	301	830	264	109	0.0029	48.27
13	12	1995	19.45	383	202	633	215	103	0.0017	43.36
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b)

I can not find this data from TMY3

4) Find the maximum hourly solar radiation on a horizontal surface (Btu/hr-ft2) in a) Dayton, OH (Dayton Intl AP) and b) Phoenix, AZ (Phoenix Sky Harbor Intl AP) using TMY3 files.

Dayton, OH (Dayton Intl AP)	1266 W/m^2 = 401.32 Btu/(h*ft2)
Phoenix, AZ (Phoenix Sky Harbor Intl AP)	1300 W/m^2 = 412.10 Btu/(h*ft2)

	A	B	C	D	E
	724290	DAYTON INTERNATIONAL AIRPORT	OH	-5	
	Date (MM/DD/YYYY)	Time (HH:MM)	ETR (W/m^2)	ETRN (W/r	GHI (\
	06/13/1990	13:00	1266	1324	
	06/14/1990	13:00	1266	1324	
	06/15/1990	13:00	1266	1324	
	06/16/1990	13:00	1266	1324	
	06/17/1990	13:00	1266	1323	
	06/08/1990	13:00	1265	1326	
	06/09/1990	13:00	1265	1325	

	A	B	C	D	E	F	G
1	722780	PHOENIX S	AZ	-7	33.45	-111.983	337
2	Date (MM/	Time (HH:M	ETR (W/m^2)	ETRN (W/r	GHI (W/m	GHI source	GHI uncert	DN
3	06/03/198	13:00	1300	1328	1002	1	9	
4	06/04/198	13:00	1300	1327	1046	1	9	
5	06/05/198	13:00	1300	1327	1034	1	9	
6	06/06/198	13:00	1300	1326	1032	1	9	
7	06/07/198	13:00	1300	1326	1049	1	9	
8	06/08/198	13:00	1300	1326	1066	1	9	
9	06/09/198	13:00	1300	1325	1056	1	9	
10	06/10/198	13:00	1300	1325	1081	1	9	
11	06/11/198	13:00	1300	1325	1072	1	9	
12	06/12/198	13:00	1300	1325	1064	1	9	
13	06/13/198	13:00	1300	1324	1064	1	9	
14	06/14/198	13:00	1300	1324	1051	1	9	
15	06/15/198	13:00	1300	1324	1046	1	9	
16	06/16/198	13:00	1300	1324	1067	1	9	
17	06/17/198	13:00	1300	1323	1035	1	9	
18	06/18/198	13:00	1300	1323	1062	1	9	
19	06/19/198	13:00	1300	1323	1059	1	9	
20	06/20/198	13:00	1300	1323	1075	1	9	
21	05/30/197	13:00	1299	1329	1038	1	9	

5) Find a) the maximum hourly temperature in Dayton, OH (F) from the TMY3 file and b) the 1% Annual Cooling Design dry-bulb temperature (F) from ASHRAE.

a) The maximum hourly temperature in Dayton is 32.8 C.

A	B	AF	AG	
724290	DAYTON INTERNATIONAL AIRPORT			
Date (MM/DD/YYYY)	Time (HH:MM)	Dry-bulb (C)	Dry-bulb s	Dry-b
07/24/1987	14:00	32.8	A	
07/24/1987	15:00	32.8	A	
07/25/1987	15:00	32.8	A	
06/30/1990	16:00	32.8	A	
07/25/1987	16:00	32.8	A	
07/22/1987	13:00	32.2	A	
06/30/1990	14:00	32.2	A	
07/24/1987	13:00	32.2	A	
07/23/1987	14:00	32.2	A	
07/25/1987	14:00	32.2	A	
06/30/1990	15:00	32.2	A	
07/20/1987	15:00	32.2	A	

b) DB: 88 F; MCWB: 73 F

6) Find how many hours per typical year the temperature in Chinandega, Nicaragua is between 75 F and 79 F according to bin data from WeaTran.

I can not search this TMY3 data.