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Date of Submission: 25-March-2025

ASSIGNMENT-1
Building Services(CIL7690)

Problem Statement 1:
Calculate the heating/cooling degree days for the year 2024 for your hometown.

- **Heating Degree Day:** Heating degree days are the measure of the how much (in degree) and for long (in days) the outside air temperature was below the certain temperature.

- That temperature is known as **Heating Base temperature** and it is defined as the temperature of the building is the outside air temperature **below** which the building needs **heating.**

- **Cooling Degree Day:** Cooling degree days are the measure of the how much (in degree) and for long (in days) the outside air temperature was above the certain temperature.

- That temperature is known as **Cooling Base temperature** and it is defined as the temperature of the building is the outside air temperature **above** which the building needs **cooling.**

Hometown: Dehradun,Uttarakhand
Assumptions:
1.) Heating Base Temperature= 16 degree celsius
2.) Cooling Base Temperature= 24 degree celsius

Month	Total Heating degree days	Total Cooling degree days
January	190	0
February	22.5	0
March	4	32.5
April	0	158.5
May	0	347.5
June	0	379.5
July	0	311.5
August	0	254.5
September	0	230.5
October	0	166
November	0	25
December	58	0
Total for year	274.5	1905

Problem Statement 2:

Assume the 5 * 3 * 4 m3 office is located in your hometown where 5 people work. The office contains five 75 W bulbs and four 100 W bulbs operating continuously. A single window of size 1.5m * 1.5m is located on the south-facing side of the wall. From the temperature data collected for the previous question calculate the maximum cooling/heating load for each of the 12 months.
Assume appropriate values for the missing data that is required.

Assumptions:

1. The office room is in the intermediate level,thus only four walls are exposed to sun.
2. Transmittance value for the window is 4.48 W/m^2 degC and for the wall 1.35W/m2 deg C.
3. Number of air changes per hour is 3.
4. Absorbance of the wall is 0.5
5. Solar gain factor for window is 0.75
6. The incident radiation is 550 W/m^2
7. Surface conductance for the wall is 10 W/m^2

The equation for the heat exchange of the building :

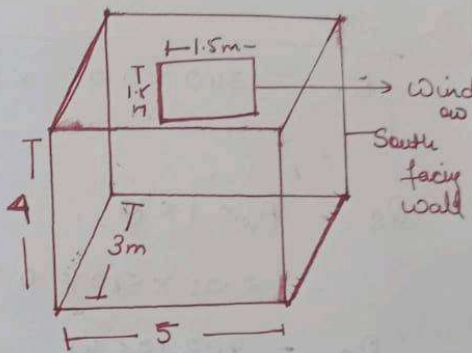
$$Qi + Qv + Qm\,(+\,/\,-)\,Qc(+\,/\,-)Qv - Qe = 0$$

Here Qe will not be considered.

Calculations

Wall → 4×5 (South facing)

Other wall → 2 (3×4) & 1 (4×5)



Area of south facing wall = $20 m^2$.

Area of window (Awi) $= 1.5 \times 1.5$

$= 2.25 m^2$

Area of south wall (eff.) (Aws) $= 20 - 2.25$

$= 17.75 m^2$

$Q_{c'} =$ Sol air temp. $(T_s) = T_o + \frac{I \times a}{f_o}$

$= T_o + \frac{(550 \times 0.5)}{10}$

$$\boxed{T_s = T_o + 27.5} \quad \text{— (I)}$$

$\Delta T_s = (T_o + 27.5) -$ Internal temp.

where I = Intensity = 550 W/m²

absorbance (a) = 0.5, f_o = Surface conductance = 10 W/m² deg C

$Q_{c_s} = A_{wi} \times 4.48 \times \Delta T + A_{ws} \times 1.35 \times \Delta T_s$

$= 10.08 \Delta T + 23.9625 \Delta T_s$

Total $Q_c = Q_{cs} + (1.35 \times \Delta T_s \times (5 \times 4 + 2(2 \times 4)))$

$$\boxed{Q_c = 10.08 \Delta T + \cancel{59.4}\ 33.3625\ T_s.} \quad \text{— (II)}$$

Ventilation rate $= \frac{n \times \text{volume of room}}{3600}.$

$$= \frac{3 \times 4 \times 3 \times 5}{3600}$$

$$= 0.05$$

$$\boxed{Q_v = 1300 \times 0.05 \times \Delta T} \quad \text{--- (11)}$$

$Q_S = A_{wi} \times I \times \theta$

$= 2.25 \times 550 \times 0.75$ {θ - solar gain factor}

$Q_S = 928.125\ W$

$Q_i = 5 \times 175 + 75 \times 5 + 4 \times 100$

{ 175 - average heat realised by one person while working.

$$\boxed{Q_i = 1680\ W}$$

In case of Heating load,

$Q_m = Q_c + Q_v - (Q_i + Q_S)$

(if negative no heating req.)

In case of Cooling load,

$Q_m = -[(Q_c + Q_v) + (Q_i + Q_S)]$

Month	Max Heating Required(KW)	Max Cooling Required (KW)
January	0	0
February	0	0
March	0	7.1
April	0	7.6
May	0	8.6
June	0	8.8
July	0	8.2
August	0	7.8
September	0	7.9
October	0	7.6
November	0	7
December	0	0

In case of the maximum heating load calculations ,the internal heat gain and solar heat gain are always greater than the total heat loss due conductance and ventilation. Therefore , there is no heating required for the entire year.

Note: Since the calculations are on the basis of average temperature the results show this but to get the exact requirement we need to do it for minimum temperature for the heating requirements.