Bangladesh University of Engineering and Technology

Course No: ME 415
Course Title: Refrigeration & Building Mechanical Systems.

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Assignment on Cooling Load Calculation.

Submitted by,

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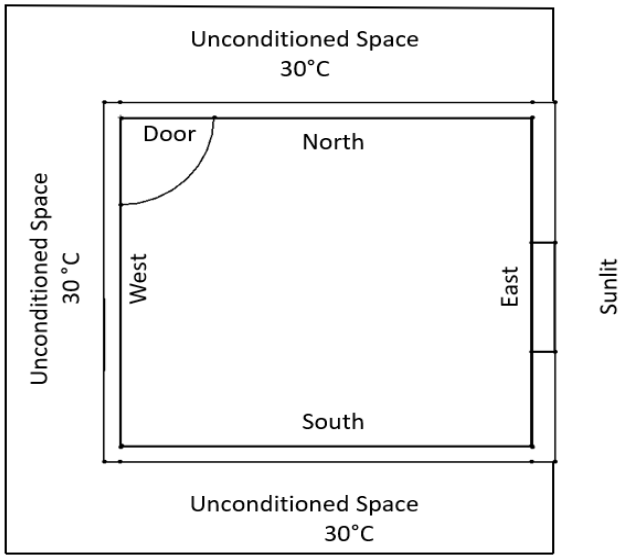

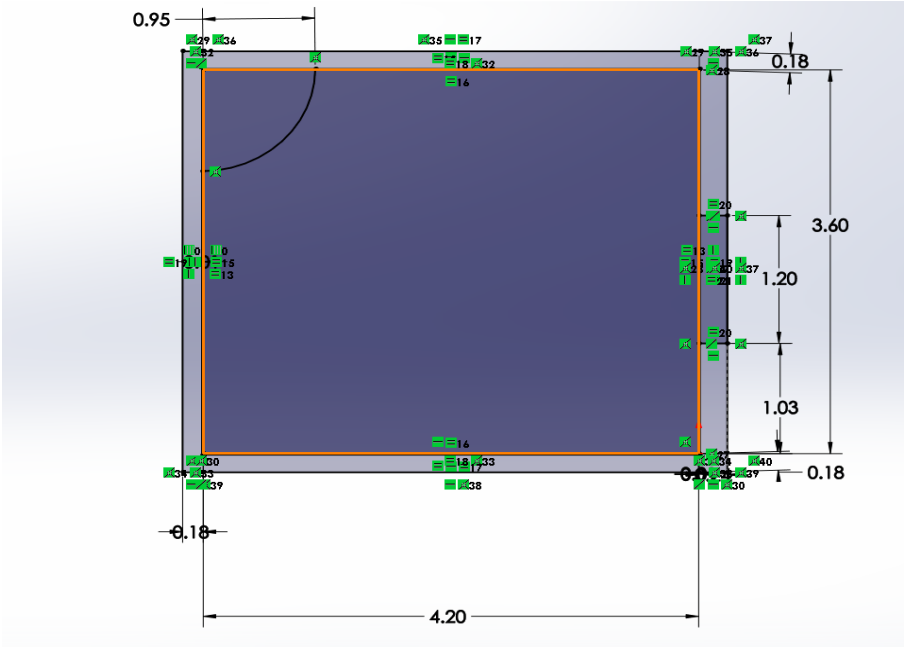

Room Specification:
Roof: Type-4, 50 mm insulation without suspended ceiling.
West, North & South wall: 125 mm brick with 25 mm plaster both sides.
East-Sunlit, dark color, Type B 203.2 H.W. concrete wall with 25.4mm insulation.

Window- Area-2.4 m^2 ; U = 2.86 W/m^2k ; 15 mm thickness ,light construction.
No heat transfer through floor.
Air exchange rate 1.0/h.
Light & occupants from 9.00 a.m. to 10.00 p.m.
Three occupants seated , one computer(250 W)
Door in North wall 2.1m*0.95m, 30 mm thick hard wood.
One Light 20 W.
Date: 23 July, 4.00 p.m.

Calculations:
Roof: Type-4 , 50 mm insulation.

Table 12(a)--Layers :	A0	E2	E3	B6	C12	E0
Table 16---R(m2K/W) :	0.059	0.099	0.05	1.173	0.029	0.121

R_{th} =R1+R2+R3+R4+R5+R6=1.531

$U=\frac{1}{R_{th}}$ = 0.653 Wm2 /K

East Wall: Sunlit, dark color , Type B 203.2 H.W. concrete wall with 25.4mm insulation.

Table 14--Layers :	A0	A1	C10	B5	E1	E0
Table 16---R(m2K/W) :	0.059	0.037	0.1174	0.587	0.026	0.121

R_{th} =R1+R2+R3+R4+R5 =0.9474

$U=\frac{1}{R_{th}}$ = 1.06 Wm2 /K

Door: North wall 2.1m*0.95m, 30 mm thick hard wood.

From Table-17, hard wood: oak, k=0.17 W/m.K

$R=R_d=L/k$ =0.03/0.17 =0.176

$R_{th} = R_o + R_d + R_i$ = 0.059 + 0.176 + 0.121 = 0.356

U = $\frac{1}{R_{th}}$ = 2.81 Wm2 /K

North, South and West walls: 125 mm brick with 25 mm plaster both sides.

From table-16, 100 mm Common brick k = 0.727 W/m.K

R_2 = L/k = 0.125/0.727 = 0.172

E1: 20 mm plaster or gypsum with k=0.7277 W/m.K

$R=R_1=R_3 = \frac{L}{k} = \frac{0.025}{0.7277} = 0.0344$

$R_{th} = R_o+R_1+R_2+R_3+R_i$ = 0.059+0.0344+0.172+0.0344+0.121 = 0.421

U = $\frac{1}{R_{th}}$ = 2.38 Wm2 /K

Floor: 30 mm clay tiles with no insulation

Layer:	A0	C12	C1	E0
Resistance(R):	0.059	0.029	0.053	0.121

C1 ; R = L/k = 0.03/0.571 = 0.053

From table 16, !00 mm clay tile k=0.571

R_{th} =R1+R2+R3+R4 = 0.059 + 0.029 + 0.053 + 0.121 = 0.262

U = $\frac{1}{R_{th}}$ = 3.82 Wm2 /K

Cooling Load Temperature Difference:

Corrected CLTD for roof:

$CLTD_C = [(CLTD+LM).k + (25.5-T_i) + (T_{o,av} - 29.4)]f$

For Roof, Table 12(b), CLTD = 37 ; Table 13, LM =0 (for July at 24º Latitude)

k=1, DR =11º , Ti = 25.5 ℃

$T_{o,max}$ = 33 ℃

$T_{o,av} = T_{o,max} - \frac{DR}{2} = 33 - \frac{11}{2} = 27.5$ ℃

$CLTD_C$ = [(37+0).1 + (25.5-25.5) + (27.5 -29.4)].1 =35.1

Corrected CLTD for east walls: CLTD =16 (Table 15)

LM =0 ,k=1 , Ti =25.5 ℃, $T_{o,av}$ = 27.5 ℃

$CLTD_C$ = [(16+0).1 + (25.5-25.5) + (27.5 -29.4)].1 =14.1

Corrected CLTD for glass, $CLTD_g$ = 8 (Table 20)

Heat Conduction through Partition Walls: **Q = U*A*TD**

SL NO	**Item**	**Description**	**Area,A(m2)**	**U(W/m^2.K)**	**TD**	**Q(W) U*A*TD**
1	Partition walls	North	4.2×3.2 - 2.1×0.95 = 11.45	2.38	4.5	122.6
2	Partition walls	West	3.6×3.2- 2.1×0.95 = 9.53	2.38	4.5	102.1
3	Partition walls	South	4.2×3.2 = 13.44	2.38	4.5	143.94
4	Door	North	2.1×0.95 = 1.995	2.81	4.5	25.23
5	Floor	Bottom	4.2×3.6 = 15.12	3.82	4.5	259.92
Total						**653.82 W**

TD=$T_{o,max}$ - T_i = 30 -25.5 = 4.5 ℃

SL NO	Item	Description	Area,A(m2)	U(W/m².K)	$CLTD_C$	Q(W) U*A*CLTD
1	Roof	Top	4.2×3.6 = 15.12	0.653	35.1	346.55
2	Sunlit Walls	East	3.6×3.2-2.4 = 9.12	1.06	14.1	136.31
3	Sunlit Glass	East, Window	2.4	2.86	8	54.912
Total						**537.8 W**

Heat gain through glasses

Q = A. SC. $SHGF_{max}$. CLF

Area A =2.4 m^2 ; SC = 0.88(Table-21) ; $SHGF_{max}$ = 672 Table 18(a)

CLF = 0.25 (Table 19) east & light construction

Q = A. SC. $SHGF_{max}$. CLF

= 2.4×0.88×672×0.25

= 354.82 W

In our case 4.2×3.6×3.2 m room with 1.0 ACH

V = 48.4 m^3 ; V = 48.4 m^3/hr = 0,01344 m^3/sec.

Latent heat gain, $Q_L = \rho h_{fg} V(wo - wi)$

wo = 0.0207 kg moisture/dry air , at dbt = 33 ℃, wbt =27 ℃

wi = 0.0102 kg moisture/dry air , at 25.50 ℃ dbt and 50% RH

Latent heat gain, $Q_L = \rho h_{fg} V(wo - wi)$

$= 3010000V(wo\text{-}wi)$

$= 3010000 \times 0.01344 \times (0.0207\text{-}0.0102)$

= 424.8 W

Sensible heat gain, $Q_S = \rho C_p v(To - Ti)$

= 1200×0.01344×(33-25.5)

=121 W

Table 28, Qs =75 W, Q_L =55 W

Total Qs = 4×75 = 300 W

Q_L = 4×55 = 220 W

Heat Gain Due to equipments, Q = P×CLF

= 250×1

= 250 W

Cooling Load Due to lights , Qs = PL×BF×D×CLF = 20 ×1.2×1×0.85 = 20.4 W

PL = 20 W

BF = 1.2 (Fluorescent Light)

D =1

CLF = 0.85 (assume)

SL No	Item with Description	Qs(W)	Q_L(W)	Q = Qs + QL (W)
1	Heat Conduction through partition walls.	653.82		653.82
2	Heat Conduction through sunlit walls, glasses and roof.	537.8		537.8
3	Solar heat gain through glasses.	354.82		354.82
4	Cooling load for air exchange.	121	424.8	545.8
5	Heat Gain due to occupants.	300	220	520
6	Heat gain due to equipments.	250		250
7	Heat gain due to lights.	20.4		20.4
Total				**2882.64 W**

Total Cooling Load = 2882.64 W

$$= \frac{2882.64}{1000 \times 3.51}$$

= 0.82 TR

= 1 TR