Refrigeration and Air conditioning Engineering.

3rd year – refrigeration and Air conditioning Course

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COOLING LOAD ESTIMATION

Lecture -5

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1.7 COOLING LOAD ESTIMATION

1.7.1 External Heat Gain Solar Heat gain Glass

A large part of the solar heat energy that shines on a window or skylight is radiated through the glass and transmitted directly into the space. The amount of solar heat radiated through the glass depends primarily on the reflective characteristics of the glass and the angle at which the sun's rays strike the surface of the glass.

External Heat Gain

1- Solar Heat gain Glass

$$Q_{s/g} = SolHG . A_g . F$$

F	Factor 1.7 for steel sash		
A_g	Window area	m2	
$SolHG$	Solar Heat gain	W/m^2	T(12A)
$Q_{s/g}$	Heat gain from windows	W	

Table (12A) Solar Irradiance (EDN) and Solar Heat Gain Factors (SHGF) for 32° North Latitude

Time of Year	Exposure	6	7	8	9	10	11	Noon	1	2	3	4	5	6
JULY 23 & MAY 21	N	69	63	44	41	44	44	44	44	44	**41**	44	63	69
	NE	293	413	388	281	145	50	44	44	44	**41**	38	28	13
	E	315	489	517	457	312	139	44	44	44	**41**	38	28	13
	SE	132	259	315	315	262	167	69	44	44	**41**	38	28	13
	S	13	28	38	44	63	85	95	85	63	**44**	38	28	13
	SW	13	28	38	41	13	44	44	167	262	**315**	315	259	132
	W	13	28	38	41	44	44	44	139	312	**457**	517	489	315
	NW	13	28	38	41	44	44	44	50	145	**281**	388	413	293
	Horizontal	47	208	388	555	675	744	776	744	675	**555**	388	208	47
AUG 24 & APR 20	N	19	25	35	41	41	**44**	44	44	41	**41**	35	25	19
	NE	174	**341**	315	208	85	44	44	44	41	**41**	35	25	6
	E	208	464	**521**	467	322	145	44	44	41	**41**	35	25	6
	SE	0	309	**495**	407	353	259	123	47	57	**41**	35	25	6
	S	6	25	41	85	148	183	**199**	183	148	**85**	41	25	6
	SW	6	25	35	41	41	47	123	259	353	**407**	401	309	117
	W	6	25	35	41	41	44	44	145	322	**467**	**521**	464	208
	NW	6	16	35	41	41	44	44	44	85	**208**	315	**325**	174
	Horizontal	19	148	338	508	631	710	**741**	710	631	**508**	338	148	19

West= 467 North= 41 South= 85

East = 41 Horizontal = 508

2- Solar transmission window and door

Conduction is the process of transferring heat through a solid, such as a wall, roof, floor, ceiling, window, or skylight. Heat naturally flows by conduction from a higher temperature to a lower temperature. Generally, when estimating the maximum cooling load for a space, the temperature of the air outdoors is higher than the temperature of the air indoors.

Solar transmission window and door

$$Q_{t/g} = U \, A_{g/d} \, (T_o - T_i)$$

Outdoor, indoor		
Window or door area	m^2	
Glass heat transfer coefficient	$W/m^{2\,o}C$	T(20)
Solar transmission window and door	W	

TABLE 20-TRANSMISSION COEFFICIENT U-WINDOWS, SKYLIGHTS, DOORS & GLASS BLOCK WALLS W/m2 °C

	Vertical Glass							Horizontal Glass			
	Single	Double			Triple			Single		Double (6mm)	
Air Space Thickness (in.)	0	6	13	19-25	6	13	19-25	Summer	Winter	Summer	Winter
Without Storm Windows	6.42	3.46	3.12	3.01	2.33	2.04	1.93	4.88	7.95	2.84	3.98
With Storm Windows	3.07							2.44	3.64		

Door		
Nominal Thickness Of Wood (mm)	U Exposed Door	U With Storm Door
25	3.92	1.99
32	3.35	1.82
38	2.95	1.70
44	2.90	1.70
51	2.61	1.59
64	2.16	1.42
76	1.87	1.31
Glass (19 mm Herculite)	5.96	2.44

HOLLOW GLASS BLOCK WALLS	
Description	
Nominal Size 15X15X10	3.4
Nominal Size 20X20X10	3.2
Nominal Size 30X30X10	3.0
Thick with glass fibre screen dividing the cavity	2.7
Thick with glass fibre screen dividing the cavity	2.5

3- Solar and Transmission Gain- Walls

Most exterior surfaces of a building, however, are exposed to direct sunlight during some portion of the day. Solar heat energy is generated by the sun and radiated to earth. Radiant heat is similar to light, in that it travels in a straight line and can be reflected from a bright surface. Both light and radiant heat can pass through a transparent surface (such as glass), yet neither can pass directly through an opaque or non-transparent surface (such as a brick wall). When the sun’s rays strike an opaque surface, however, a certain amount of radiant heat energy is transferred to that surface, resulting in an increase in the surface temperature. The amount of heat transferred depends primarily on the color and smoothness of the surface, and the angle at which the sun’s rays strike the surface.

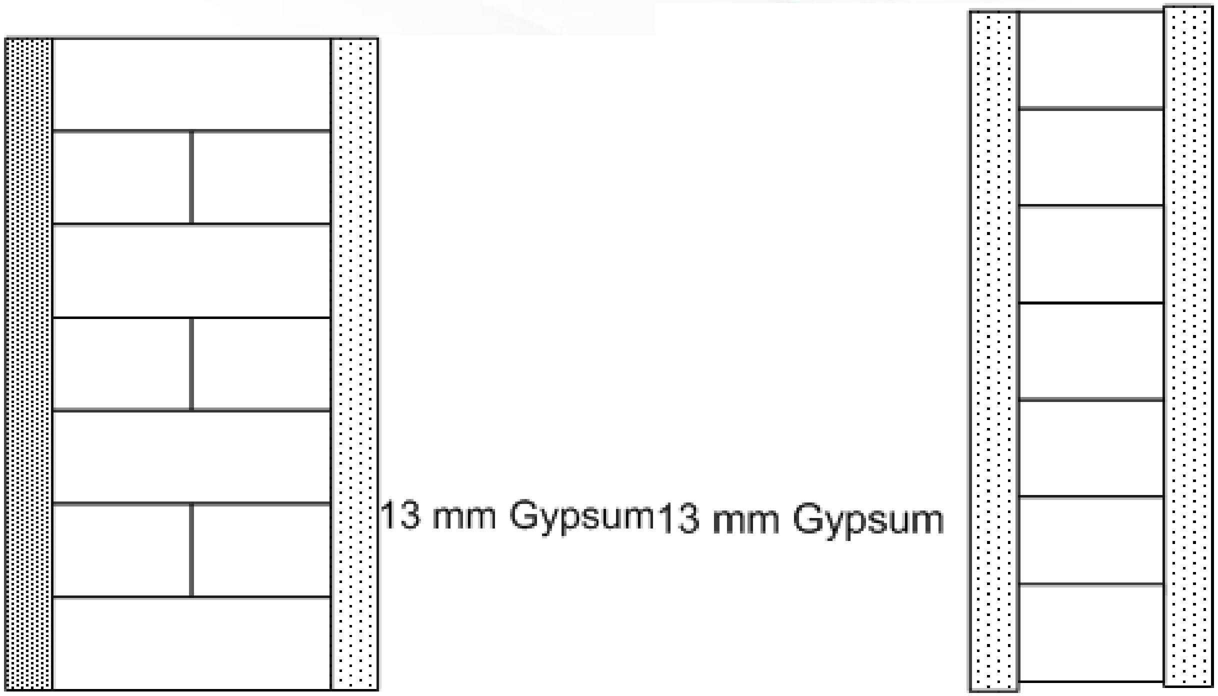
Solar and Transmission Gain- Walls

$Q_{s/W} = U \; A \; \Delta t_e$

Δt_e	Equivalent temp. diff.	
A	Wall area	m^2
U	Wall heat transfer coefficient	$W/m^{2o}C$
$Q_{s/W}$	Solar Transmission Gain- Walls	W

Table 19

Outer walls and partitions



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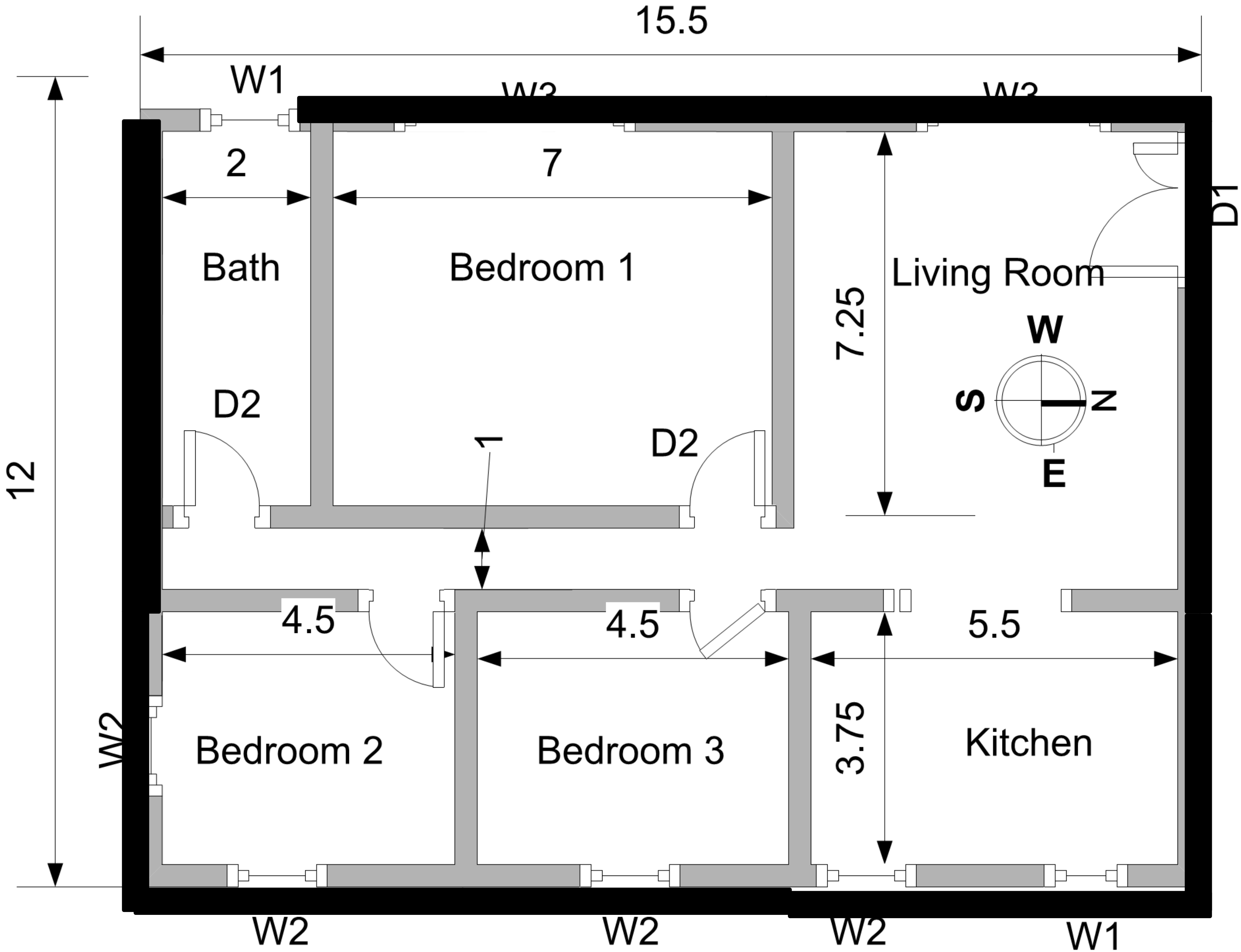
Outer walls


15.5
12
W1
W3
W3
D1
2
7
Bath
Bedroom 1
Living Room
7.25
W
S
N
E
D2
D2
1
4.5
4.5
5.5
W2
Bedroom 2
Bedroom 3
Kitchen
3.75
W2
W2
W2
W1

SUMMER

1.7.2 Internal Heat Gain Heat Transmission Partition

The partition between unconditioned spaces is treated as the unexposed roof. While the heat flow through the partitions between two conditioned rooms equals to zero, since there is no temperature difference between the partition sides.

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Internal Heat Gain Heat Transmission Partition

$$Q_{t/P} = U \; A_P \; (T_o - T_i - 9)$$

$(T_o - T_i - 9)$	Outdoor, indoor	
A_P	Partition area	m^2
U	Partition heat transfer coefficient	$W/m^{2\,o}C$
$Q_{t/P}$	Solar Transmission – Partition	W

Table 19

Solar and Transmission Gain **Roofs** and Floors

A- Exposed Roof

The exposed roof subjected to the outdoor conditions and solar radiation, so the equivalent temperature difference is used to calculate the heat flow to the building through the roof.

$$Q_{s/R} = U \quad A \quad \Delta t_e$$

Δt_e	Equivalent temp. diff.		
A	Roof area	m^2	
U	Roof heat transfer coefficient	$W/m^{2\,o}C$	Table 19
$Q_{s/R}$	Solar Transmission Gain- Roof	W	

B- Unexposed Roof and Unconditioned Space Above

For the unexposed roof to the outdoor conditions 9°C is extracted from the difference between the outdoor and indoor temperatures.

$$Q_{t/R} = U \; A_R \; (T_o - T_i - 9)$$

T_o, T_i	Outdoor, indoor		
A_R	Roof or floor area	m^2	
U	Roof heat transfer coefficient	$W/m^2\,^{\circ}C$	**Table 19**
$Q_{t/R}$	Solar Transmission - Roof	W	

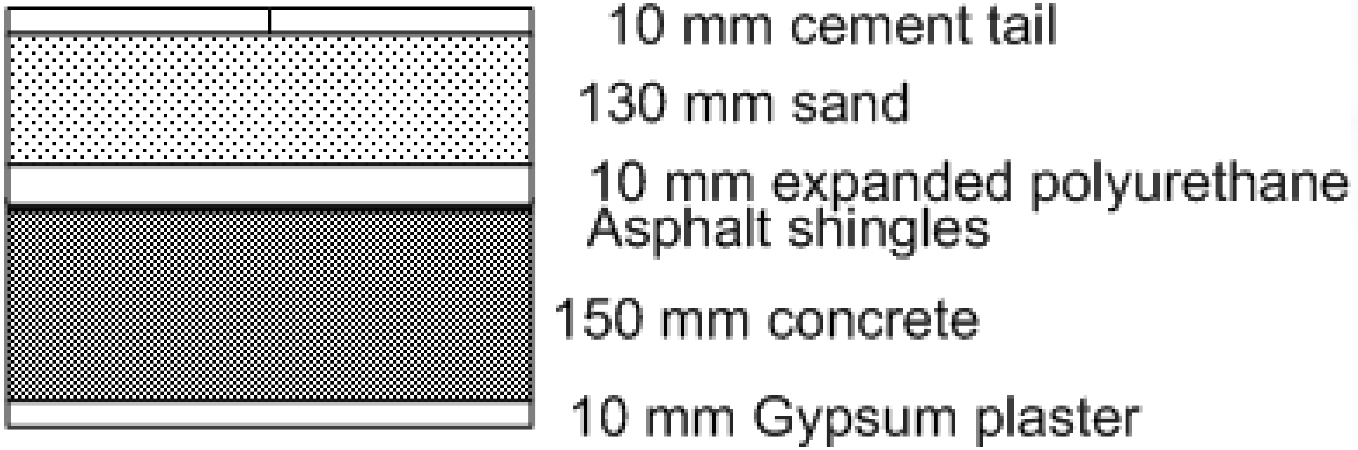
C- Roof or Floor Kitchen or boiler room Below

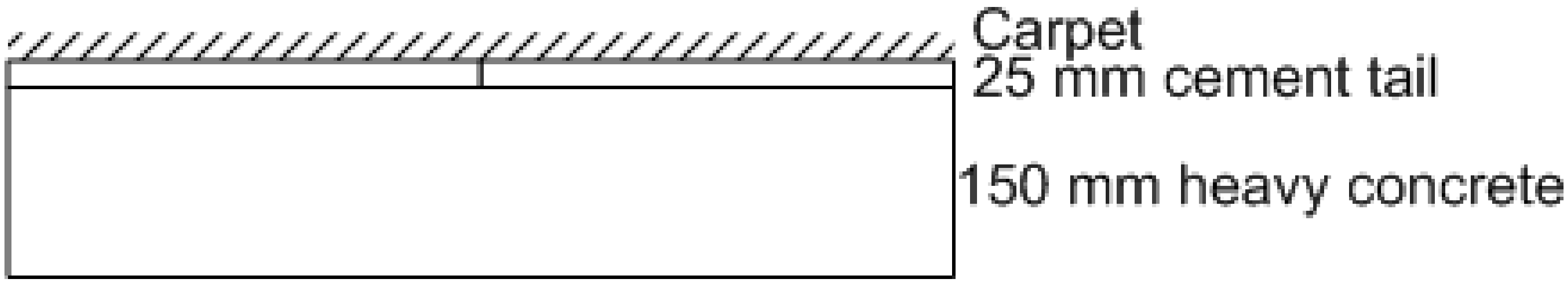
When the roof is shared with a boiler or kitchen floor or vies versa, 15°C is added to the indoor and outdoor temperature difference.

$$Q_{t/R} = U \; A_R \; (T_o - T_i + 15)$$

T_o, T_i	Outdoor, indoor		
A_R	Roof or floor area	m^2	
U	Roof heat transfer coefficient	$W/m^2\,^{\circ}C$	**Table 19**
$Q_{t/R}$	Solar Transmission - Roof	W	

Roof and floor





Heat Gain People

People generate more heat than is needed to maintain body temperature. This surplus heat is dissipated to the surrounding air in the form of sensible and latent heat. The amount of heat released by the body varies with age, physical size, gender, type of clothing, and level of physical activity. The human body generates both sensible and latent heat. The sensible heat is due to the temperature difference between body and room temperatures. While the latent heat is due the evaporation of sweat and steam accompanying human breath.

Heat Gain People

6a. Sensible Heat Gain

$$Q_s = No \cdot Sen.HG \cdot F$$

F=1 for men, 0,8 women, 0,75 children		
Sen H.G.	W/m^2	T(26)
Number of People	-	
Sensible Heat Gain	W	

6.b Latent Heat gain

$$Q_l = No \cdot Lat.HG \cdot F$$

F=1 for men, 0,8 women, 0,75 children		
Lat H.G.	W/m^2	T(26)
Number of People	-	
Sensible Heat Gain	W	

TABLE 26 -HEAT GAIN FROM PEOPLE

Degree of Activity		Total Heat, W		Sensible	Latent	% Sensible Heat that is	
		Adult	Adjusted,	Heat,	Heat,	Radiant	
		Male	M/F[a]	W	W	Low V	High V
Seated at theatre	Theatre, matinee	115	95	65	30		
Seated at theatre, night	Theatre, night	115	105	70	35	60	27
Seated, very light work	Offices, hotels, apartments	130	115	70	45		
Moderately active office work	Offices, hotels, apartments	140	130	75	55		
Standing, light work; walking	Department store; retail store	160	130	75	55	58	38
Walking, standing	Drug store, bank	160	145	75	70		
Sedentary work	Restaurant	145	160	80	80		
Light bench work	Factory	235	220	80	140		
Moderate dancing	Dance hall	265	250	90	160	49	35
Walking 4.8 km/h; light machine work	Factory	295	295	110	185		
Bowling	Bowling alley	440	425	170	255		
Heavy work	Factory	440	425	170	255	54	19
Heavy machine work; lifting	Factory	470	470	185	285		
Athletics	Gymnasium	585	525	210	315		

Heat Gain Lights

Heat generated by lights in the space is a significant contribution to the cooling load. For example, a 120-watt light fixture generates 120 W of heat—approximately the same amount of heat gain generated by an average office worker. Additionally, when estimating the heat gain from fluorescent lights, approximately 20% is added to the lighting heat gain to account for the additional heat generated by the ballast.

Heat Gain Lights

$$Q_{light} = \text{Light power in Watt} \quad F$$

F	F=1.25For Fluorescent	
Light power in Watt	To be assigned by electrical engineering, or it may be assumed $20 W/m^2$.Floor area	
Q_{light}	Heat Gain Lights	W

Heat Gain – Appliances

There are many types of appliances and equipment in restaurants, schools, office buildings, hospitals, and other types of buildings. This equipment may generate a significant amount of heat and should be accounted for when estimating the space cooling load.

Heat Gain – Appliances

8a Sensible Heat gain

$Q_s = No \cdot Sen.HG \cdot F$

F=0.5 Positive exhaust hood		
Sen H.G.	W	T(28-29)
Number of Appliances	-	
Sensible Heat Gain	W	

8b Latent Heat gain

$Q_l = No \cdot Lat.HG \cdot F$

F=0.5 Positive exhaust hood		
Lat H.G.	W	T(27-29)
Number of Appliances	-	
Sensible Heat Gain	W	

Heat gain from electric motors

$Q_s = No \cdot P$

Motor Power	W	T(27)
Number of Appliances	-	
Sensible Heat Gain	W	

Table 27 Heat Gain from Typical Electric Motors

Motor Name-plate or Rated Horse-	power (kW)	Motor Type	Nominal	Full Load Motor Efficiency,	Location of Motor and Driven Equipment with Respect to Conditioned Space or Airstream		
					A	B	C
					Motor in, Driven Equipment in,	Motor out, Driven Equipment in,	Motor in, Driven Equipment out,
			rpm	%	Watt	Watt	Watt
0.05	(0.04)	Shaded pole	1500	35	105	35	70
0.08	(0.06)	Shaded pole	1500	35	170	59	110
0.125	(0.09)	Shaded pole	1500	35	264	94	173
0.16	(0.12)	Shaded pole	1500	35	340	117	223
0.25	(0.19)	Split phase	1750	54	346	188	158
0.33	(0.25)	Split phase	1750	56	439	246	194
0.50	(0.37)	Split phase	1750	60	621	372	249
0.75	0.56	3-Phase	1750	72	776	557	217
1	0.75	3-Phase	1750	75	993	747	249
1.5	1.1	3-Phase	1750	77	1453	1119	334
2	1.5	3-Phase	1750	79	1887	1491	396
3	2.2	3-Phase	1750	81	2763	2238	525
5	3.7	3-Phase	1750	82	4541	3721	817
7.5	5.6	3-Phase	1750	84	6651	5596	1066
10	7.5	3-Phase	1750	85	8760	7178	1315
15	11.2	3-Phase	1750	86	13 009	11 192	1820
20	14.9	3-Phase	1750	87	17 140	14 913	2230
25	18.6	3-Phase	1750	88	21 184	18 635	2545
30	22.4	3-Phase	1750	89	25 110	22 370	2765
40	30	3-Phase	1750	89	33 401	29 885	3690
50	37	3-Phase	1750	89	41 900	37 210	4600
60	45	3-Phase	1750	89	50 395	44 829	5538
75	56	3-Phase	1750	90	62 115	55 962	6210
100	75	3-Phase	1750	90	82 918	74 719	8290
125	93	3-Phase	1750	90	103 430	93 172	10 342
150	110	3-Phase	1750	91	123 060	111 925	11 075
200	150	3-Phase	1750	91	163 785	149 135	14 738
250	190	3-Phase	1750	91	204 805	186 346	18 430

Table 28 Heat Gain Factors of Typical Electric Appliances

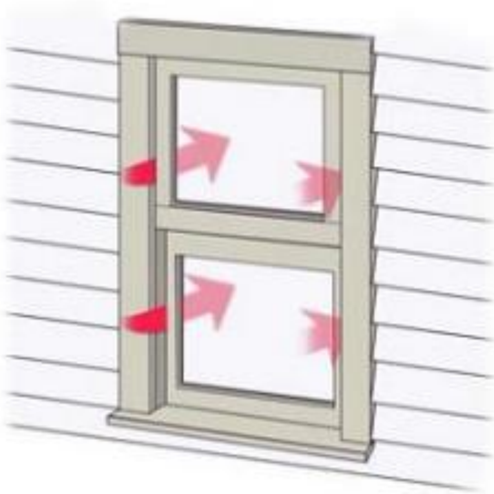
Appliance	Size	Input Rating		Heat Gain ,Watt ,Without Hood			With Hood
		Max	Standby	Sensible	Latent	Total	Sensible
		Watt	Watt	Watt	Watt	Watt	Watt
Electric ,No Hood Required							
Blender ,per liter capacity	1 to 4 lt.	480		310	160	470	150
Cabinet, ,large hot holding	460 to 490 lt.	2080		180	100	280	85
Coffee brewer	12 cups/2 burners	1660		1100	560	1600	530
Coffee brewer, large	28-38 lt.	660		440	220	660	210
Dishwasher ,hood type, per 100 dishes	950-2000 dishes/h	380		50	110	160	50
Display case, refrigerated, per m3	0.17to 1.9 m3/interior	1590		640	0	640	0
Food warmer ,per infrared bulb	1 to 6 bulbs	250		250	0	250	250
Food warmer ,per lt of well	20-70 lt	37.4		12.4	6.4	18.8	6
Freezer ,Large	2.07 m3	1340		540	0	540	0
Grill ,Large ,per m2 surface	0.4 to 1.1 m2	29000		1940	1080	3020	1080
Hot plate ,high speed double burner		4900		2290	1590	3880	1830
Ice maker ,large	100 kg/day	1090		2730	0	2730	0
Mixer ,large ,per lt	77 lt	29		29	0	29	0
Refrigerator ,large ,per m3	0.7 to 2.1 m3	78		31	0	31	0
Serving cart ,per lt of well	50to 90 lt	21.2		7.1	3.5	10.6	3.4

Table 29 Heat Gain Factors of Typical Gas Appliances

Appliance	Size	Input Rating		Heat Gain ,Watt ,Without Hood			With Hood
		Max	Standby	Sensible	Latent	Total	Sensible
		Watt	Watt	Watt	Watt	Watt	Watt
Gas ,No Hood Required							
Broiler ,per m2 surface	0.25 m^2	46600	190	16800	9030	25830	3840
Dishwasher ,hood type, per 100 dishes	950-2000 dishes/h	510	190	150	59	209	67
Grill ,Large ,per m2 surface	0.4 to 1.1 m^2	53600	1040	3600	1930	5530	1450
Oven ,pizza per m2 oven hearth	0.59 to 1.2 m^2	14900	190	1970	690	2660	270
Gas ,Exhaust Hood Required							
Char broiler ,per m2 cooking surface	0.14 to 0.43 m^2	51900	190				2490
Fryer (deep fat) per fat kg	5 to 32 kg	1470	190				100
Oven ,large convection ,per m3 oven	210 to 550 lt	89,7	0.19				2.6
Oven ,pizza per m^2 oven hearth	0.86 to 2.4 m2	22800	190				410

Infiltration

In a typical building, air leaks into or out of a space through doors, windows, and small cracks in the building envelope. Air leaking **into** a space is called **infiltration**. During the cooling season, when air leaks into a conditioned space from outdoors, it can contribute to both the sensible and latent heat gain in the space because the outdoor air is typically warmer and more humid than the indoor air. The amount of infiltration can be found by two methods as follows:



infiltration through windows

i- Depending on windows or doors area:

IOA = No V		
Volume flow rate /person per door		T(22 and 24)
Number of window and door	-	
Outdoor air	Lit/s	

ii- Depending on the crack length L_C

Depends on figure 6 , for single hung window or door, crack length can be calculated as follows:

$L_C = 2.(H+W)$

While for double hung window or door

$LC = 2.(H+W) + H$

$IOA = No\ L_c\ V$		
Volume flow rate/ m		T(24)
Number of window and doors		
Outdoor air	Lit/s	

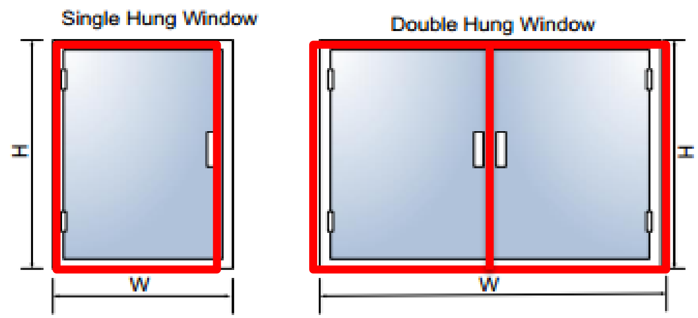


Figure 6 single and double hung windows

TABLE 22 INFILTRATION THROUGH DOORS

APPLICATION	Lit/s per person in room per door		
		90 cm Swinging Door	
	180 cm Revolving Door	No Vestibule	Vestibule
Bank	3.07	3.78	2.83
Barber Shop	1.89	2.36	1.79
Cigar Store	9.44	14.16	10.62
Department Store (Small)	3.07	3.78	2.83
Dress Shop	0.94	1.18	0.90
Drug Store	2.60	3.30	2.50
Hospital Room	0.00	1.65	1.23
Lunch Room	1.89	2.36	1.79
Restaurant	0.94	1.18	0.90
Shoe Store	1.27	1.65	1.23

TABLE 24 INFLITRATION THROUGH WINDOWS AND DOORS – CRACK METHOD SUMMER AND WINTER

TABLE 24a-DOUBLE HUNG WINDOWS-UN LOCKED ON WINDWARD SIDE

Type of Double Hung Window	Lit /s per meter of Crack length											
	Wind Velocity m/s											
	1.4		**2.8**		4.2		5.6		7		8.4	
	No W-Strip	W-Strip	**No W-Strip**	**W-Strip**	No W-Strip	W-Strip	No W-Strip	W-Strip	No W-Strip	W-Strip	No W-Strip	W-Strip
Wood Sash												
Average Window	0.2	0.1	**0.5**	**0.3**	1.0	0.6	1.5	0.9	2.1	1.3	2.7	1.6
Poorly Fitted Window	0.7	0.2	**1.8**	**0.5**	2.9	0.9	4.0	1.3	5.1	0.3	6.5	2.4
Poorly Fitted-with Storm Sash	0.4	0.1	**0.9**	**0.2**	1.4	0.5	2.0	0.7	2.5	0.9	3.3	1.2
Metal Sash	0.5	0.2	**1.2**	**0.5**	1.9	0.8	2.7	1.2	3.6	1.6	4.4	2.0

TABLE 24 c-DOORS ON WINDWARD SIDE

Type of Door	Crack width mm	Lit /s per meter of Crack length					
		Wind Velocity m/s					
		1.4	**2.8**	4.2	5.6	7	8.4
Glass Door							
Good Installation	1.6	4.98	**9.97**	14.95	20.25	24.92	29.59
Average Installation	0.8	7.48	**15.58**	21.81	31.15	37.38	45.17
Poor Installation	1.2	9.97	**20.25**	29.59	40.50	40.50	59.19
Ordinary Wood or Metal							
Well Fitted-W-Strip		0.70	**0.93**	1.40	2.02	2.65	3.27
Well Fitted-No W-Strip		1.40	**1.87**	2.80	4.05	5.14	6.54
Poorly Fitted-No W-Strip		1.40	**3.58**	5.76	8.10	10.28	13.08
Factory Door 1/8" crack		4.98	**9.97**	14.95	20.25	24.92	29.59

Ventilation:

Outdoor air is often used to dilute or remove contaminants from the indoor air. The intentional introduction of outdoor air into a space, through the use of the building's HVAC system, is called **ventilation**. This outdoor air must often be cooled and dehumidified before it can be delivered to the space, creating an additional load on the air-conditioning equipment. **You should never depend on infiltration to satisfy the ventilation requirement of a space.** On days when the outdoor air is not moving (due to wind), the amount of infiltration can drop to zero. Instead, it is common to introduce outdoor air through the HVAC system, not only to meet the ventilation needs, but also to maintain a positive pressure (relative to the outdoors) within the building. This positive pressure reduces, or may even eliminate, the infiltration of unconditioned air from outdoors. To pressurize the building, the amount of outdoor air brought in for ventilation must be greater than the amount of air exhausted through central and local exhaust fans. The ventilation can be calculated by two methods as follows:

SUMMER

i- Outdoor air ventilation depending on the number of people:

$V = N_o \cdot R_p$

Volume flow rate/ person (R_p)	Lit/s per Person	T(25)
Number of People (N_o)	-	
Outdoor air (V)	Lit/s	

ii- Outdoor air ventilation depending on the floor area

$V = A \cdot R_a$

Volume flow rate/area (R_a)	Lit/s per m^2	T(25)
Floor area (A)	m^2	
Outdoor air (V)	Lit/s	

iii- VOA= IOA +V

TABLE 25-VENTILATION STANDARDS

Space type	Rp (L/s-per)	Ra (L/s-m2)		Space type	Rp (L/s-per)	Ra (L/s-m2)
Art classroom	5	0.9		Legislative chambers	2.5	0.3
Auditorium seating area	2.5	0.3		Libraries	2.5	0.6
Bank vaults/safe deposit	2.5	0.3		Lobbies	2.5	0.3
Barber shop	7.5	0.3		Lobbies/perfection	3.8	0.3
Barracks sleeping areas	2.5	0.3		Main entry lobbies	2.5	0.3
Bars, cocktail lounges	3.8	0.9		Mall common areas	3.8	0.3
Beauty and nail salons	10	0.6		Media Centre	5	0.6
Bedroom/Living Room	2.5	0.3		Multi-purpose assembly	2.5	0.3
Booking/waiting	3.8	0.3		Multi-use Assembly	3.8	0.3
Bowling alley (seating)	5	0.6		Museums (Children's)	3.8	0.6
Cafeteria / fast food dining	3.8	0.9		Museums/Galleries	3.8	0.3
Cell	2.5	0.6		Music/theatre/dance	5	0.3
Classrooms (age 9 plus)	5	0.6		Office space	2.5	0.3
Classrooms (ages 5-8)	5	0.6		Pet shops (animal areas)	3.8	0.9
Coin operated laundries	3.8	0.3		Pharmacy (prep. area)	2.5	0.9
Computer (not printing)	2.5	0.3		Photo studios	2.5	0.6
Computer Lab.	5	0.6		Places of religious worship	2.5	0.3
Conference / meeting	2.5	0.3		Reception areas	2.5	0.3
Corridors	0	0.3		Restaurant dining rooms	3.8	0.9
Courtrooms	2.5	0.3		Sales (except as below)	3.8	0.6
Day care (through age 4)	5	0.9		Science laboratories	5	0.9
Dayroom	2.5	0.3		Shipping/Receiving	0	0.6
Disco/dance floors	10	0.3		Spectator areas	3.8	0.3
Gambling casinos	3.8	0.9		Sports arena (play area)	0	0.3
Game arcades	3.8	0.9		Stages, studios	5	0.3
Guard stations	2.5	0.3		Storage rooms	0	0.6
Gym, stadium (play area)	0	0.3		Supermarket	3.8	0.3
Health club/aerobics room	10	0.3		Swimming (pool & deck)	0	2.4
Health club/weight rooms	10	0.3		Telephone/data entry	2.5	0.3
Lecture Classroom	3.8	0.3		Transportation waiting	3.8	0.3
Lecture Hall (fixed seats)	3.8	0.3		Warehouses	0	0.3
Kitchen/ restaurant		4		Wood/metal shop	5	0.9
Kitchen/ residence		2		Toilet		2

Room Load

Room load is the summation of room sensible and latent heats

11a Outdoor Air Sensible heat OASH

$Q_s = 1.2\ VOA\ (T_o - T_i)$		
Outdoor, indoor	°C	
Ventilation rate	Lit/s	
Factor		
Outdoor Air Sensible heat	W	

11b Outdoor Air Latent Heat OALH

$Q_l = 3000.\ VOA\ (g_o - g_i)$		
Moisture content	kgw/kga	
Ventilation rate	Lit/s	
Factor		
Outdoor Air Sensible heat	W	

111c Outdoor air Total Heat OATH

$Q_T = 1.2\ VOA\ (h_o - h_i)$		
enthalpy	kJ/kg	
Ventilation rate	Lit/s	
Factor		
Outdoor Air Sensible heat	W	

22- TOTAL OUTDOOR SENSIBLE HEAT TOASH

$$Q_s = 1.2\ VOA_{od}\ (T_o - T_i)$$

$(T_o - T_i)$	Outdoor, indoor	°C	
VOA_{od}	Total outdoor air	Lit/s	
1.2	Factor		
Q_s	Total Outdoor Air Sensible heat	W	

23- TOTAL OUTDOOR AIR LATENT HEAT TOALH

$$Q_l = 3000\ VOA_{od}\ (g_o - g_i)$$

$(g_o - g_i)$	Moisture content	kgw/kga	
VOA_{od}	Total outdoor air	Lit/s	
3000	Factor		
Q_l	Total outdoor latent heat	W	

23- TOTAL OUTDOOR TOTAL HEAT TOATH

TOATH = TOASH +TOALH

Room load

11- **ROOM SENSIBLE HEAT** **RSH**

$$RSH = \sum equs.(1,2,3,4,5,6a,7,8a,9)$$

تجمع جميع المعادلات التي تخص كمية الحرارة المحسوسة التي تم حسابها

12- **ROOMLATENT HEAT** **RLH**

$$\boldsymbol{RLH} = \sum equs.(6b,8b)$$

تجمع جميع المعادلات التي تخص كمية الحرارة الكامنة

13- **ROOM TOTAL HEAT** **RTH**

RTH= RSH + RLH

14- **TOTAL SENSIBLE HEAT** **TSH**

TSH=RSH + (OASH (eques. 10 a and 11a))

15- **TOTAL LATENT HEAT** **TLH**

TLH=RLH + (OALH(eques. 10 b and 11b))

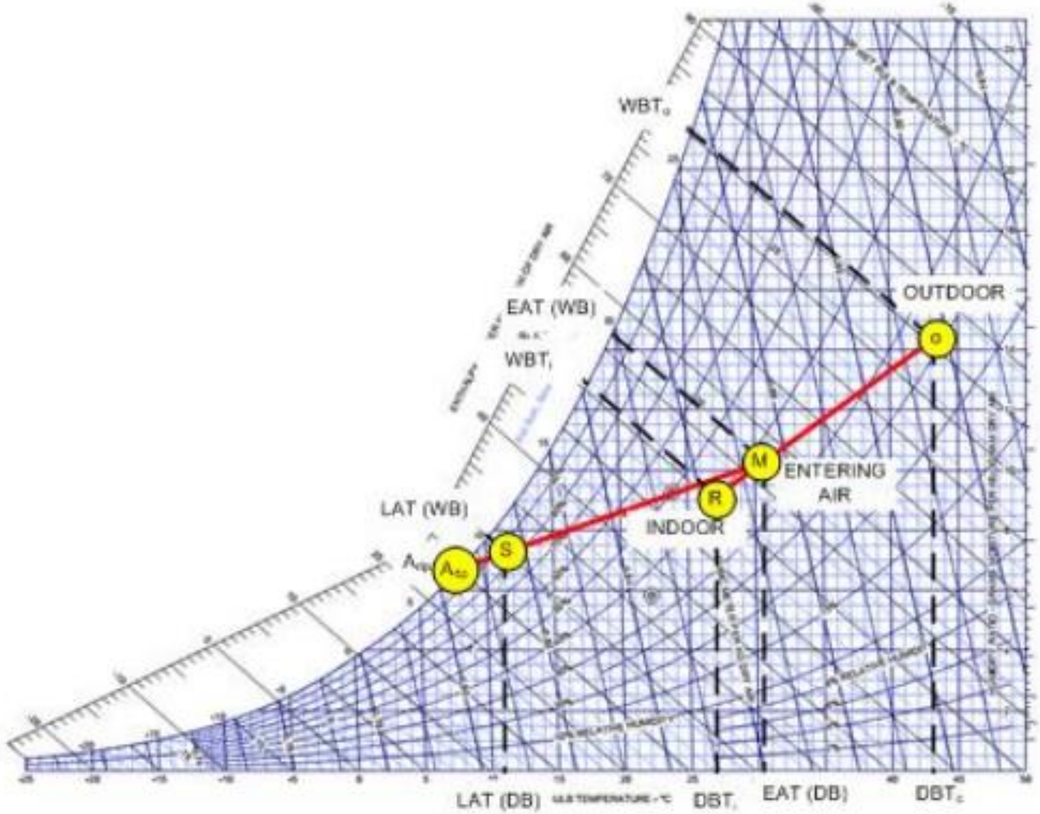
16- **GRANG TOTAL HEAT** **GTH**

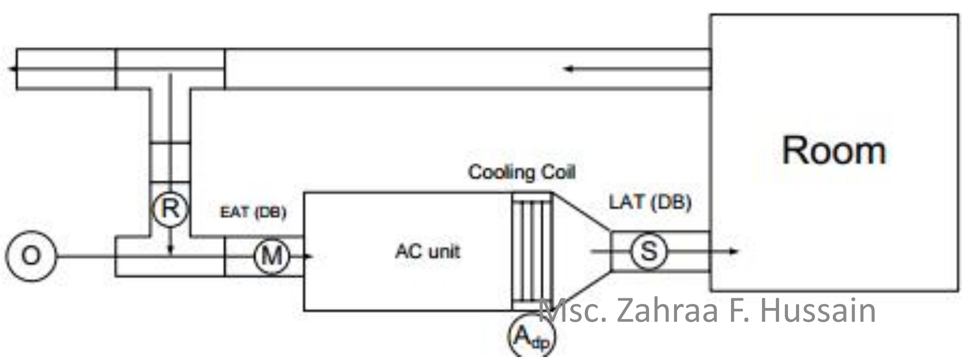
GTH = TSH + (TLH

Cooling Load	Building:	Room name:	Room No.
Indoor Design condition	°C DBT	°C WBT	RH %
Outdoor design condition	°C DBT	°C WBT	RH %
Month :	Peak time:	City:	Lat.

		Solar Gain windows								
	Eq	Q		SolHG.		A		F		
Glass	1	/ window	=		×		×		=	
		/ window	=		×		×		=	
		/ window	=		×		×		=	
		/ window	=		×		×		=	
		Transmission windows								
	2			W/m² °C		A		ΔT		
		window	=		×		×		=	
		Solar and Transmission Gain								
Walls, Floor and Roof	3			W/m² °C		A		ΔT_e		
		/Wall	=		×		×		=	
		/Wall	=		×		×		=	
		/Wall	=		×		×		=	
		/Wall	=		×		×		=	
	4	Roof	=		×		×		=	
		Floor	=		×		×		=	
	5	Partitions	=		×		×		=	
		Heat Gain								
People				Nos.		SenHG		F		
	6a	Sensible	=		×		×		=	
	6b	Latent	=		×		×		=	
App	8a	Sensible	=		×		×		=	
	8b	Latent	=		×		×		=	
Lig	7			m²		W		F		
		Light	=		×		×		=	
				Nos.		W		F		
	9	Elec. motor	=		×		×		=	
Vent & infilt.	10	IOA	=	Lc	×		×			
		IOA	=		×				=	Lit/s
	11	V	=	Nos.	x				=	Lit/s
		VOA	=	Lit/s	+			Lit/s	=	Lit/s
				F		VOA		Δ		
	11a	OASH	=	1.21	×		×		=	
	11b	OALH	=	3000	×		×		=	
	11c	OATH	=		+		=		=	
	12	RSH	=						=	
	13	RLH	=						=	
	14	RTH	=			+			=	
	15	TSH	=			+			=	
	16	TLH	=			+			=	
	17	GTH	=			+			=	

PSYCH ROMETERIC CHART





Thank you