SULIT

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER I
SESI 2013/2014

NAMA KURSUS	:	REKABENTUK SISTEM PENYAMAN UDARA
KOD KURSUS	:	DDF 2083
PROGRAM	:	3 DDT
TARIKH PEPERIKSAAN	:	DISEMBER 2013 / JANUARI 2014
JANGKA MASA	:	2 ½ JAM
ARAHAN	:	JAWAB **EMPAT (4)** SOALAN SAHAJA DARIPADA ENAM (6) SOALAN

KERTAS SOALAN INI MENGANDUNGI DUA PULUH (20) MUKA SURAT

SULIT

SOALAN DI DALAM BAHASA MELAYU

S1 (a) Penyaman udara adalah bertujuan untuk mencapai keadaan atmosfera yang terkawal dengan ruangan tertutup pada waktu tertentu sepanjang tahun, dengan menggunakan udara sebagai medium kitaran dan kawalan alam sekitar.

(i) Nyatakan bahagian komponen-komponen utama pada sistem penyejukan dan jelaskan bagaimanakah fungsi sistem dengan setiap komponen tersebut.

(15 markah)

(ii) Apakah kesan penggunaan air dengan sistem penyejukan dan fungsinya kepada sistem?

(5 markah)

(iii) Apakah kepentingan sistem penyamanan udara yang baik untuk manusia dan industri?

(5 markah)

S2 (a) Udara atmosfera pada bebuli basah bersuhu 15^0C dan 25% kelembapan bandingan bergerak melalui sebuah relau dan kemudian melalui *humidifier*. Keadaan tersebut menyebabkan suhu akhir bebuli kering pada 30^0C dan kelembapan bandingannya 50%. Tentukan:

(i) kelembapan tambahan kepada udara.
(ii) haba tambahan kepada udara.
(iii) faktor haba pendam daripada proses.

(9 markah)

(b) Salah satu sebab untuk penyamanan udara ialah untuk memastikan tahap kemurnian dan kebersihan udara di dalam ruangan tertutup. Apakah jenis dan sumber-sumber gas umum yang berbahaya dan pencemaran yang boleh mempengaruhi kemurnian dan kebersihan udara di ruangan tertutup?

(3 markah)

(c) Bagaimana sistem penyamanan udara boleh membantu untuk mencapai keselesaan manusia dan terma dalam ruangan tertutup?

(13 markah)

S3 (a) Sebuah bangunan terletak pada latitud utara 40°. Ia mempunyai 120 kaki x 80 kaki bumbung jenis 4 inci konkrit berat dengan 2 inci penebat di sebelah dalam dan siling tergantung. Dinding sebelah timur mempunyai luas bersih 9703 kaki persegi dibina dari konkrit berat 8 inci dengan 2 inci penebat. Ia mempunyai 3 tingkap cermin tunggal dengan bingkai aluminum dan ¼ inci kaca jernih dengan bidai dalam berwarna cerah. Luas setiap tingkap ialah 128 kaki persegi. Bangunan tersebut mempunyai 10 biji lampu pendarfluor 40 W yang dipasang dan boleh memuatkan seramai 50 orang dalam satu-satu masa untuk kerja-kerja ringan sambil duduk.
Proses merekabentuk adalah pada pukul 12 tengah hari pada 1 April.
Nota: Julat Harian = 20°F;
Bebuli kering rekabentuk luar = 94°F;
Suhu dalaman = 75°F

(i) Anggarkan beban haba penyejukan untuk dinding.

(3 markah)

(ii) Cari penyejukan ketika pengaliran pertambahan haba melalui tingkap.

(5 markah)

(iii) Cari beban penyejukan radiasi sinaran matahari.

(5 markah)

(iv) Berapakah keperluan beban penyejukan untuk sistem lampu?

(2 markah)

(v) Berapakah penambahan haba daripada 55 orang yang bekerja ringan sambil duduk di dalam bangunan tersebut?

(5 markah)

(vi) Apakah cadangan anda untuk mengurangkan haba di dalam bangunan tersebut dengan membandingkan cadangan kira-kira tersebut dengan spesifikasi di atas?

(5 markah)

S4 (a) Sebagai seorang jurutera rekabentuk, apakah kriteria-kriteria pemilihan yang perlu dipertimbangkan sebelum merekabentuk sistem penyejukan udara.

(6 markah)

(b) Apakah faktor yang harus dipertimbangkan dalam suatu sistem pengedaran udara?

(6 markah)

(c) Huraikan kepentingan sistem pengedaran udara dalam sistem penyejukan udara.

(8 markah)

(d) Jelaskan keperluan sistem saluran dalam sistem penyejukan udara.

(5 markah)

S5 (a) Sebuah bilik mempunyai siling berukuran 5 m x 5 m dengan bahan akustik yang mempunyai pekali penyerapan 0.45. Keluasan keseluruhan dinding adalah 60 m^2 dengan pekali penyerapan 0.33. Sementara itu, ukuran lantai adalah bersamaan dengan ukuran siling dengan pekali penyerapan 0.13. Punca bunyi daripada penyaman udara yang berkedudukan di tengah bilik menghasilkan paras kuasa bunyi (PWL) 0.01 mW. Tentukan paras tekanan bunyi (SPL) pada kedudukan 2 m dari punca.

(13 markah)

(b) Huraikan secara ringkas maksud perkara di bawah menurut bidang kejuruteraan:

(i) paras kuasa bunyi (PWL).
(ii) paras tekanan bunyi (SPL).
(iii) bunyi.
(iv) kebisingan.

(4 markah)

(c) Kira paras tekanan bunyi dalam dB(A) untuk kebisingan yang dihasilkan oleh sistem penyaman udara daripada analisa berikut:

Pusat Frekuensi (Hz)	31.5	63	125	250	500	1000	2000	4000
SPL (dB)	60	60	65	70	65	65	45	40

(8 markah)

Q6 (a) Apakah bahagian-bahagian komponen utama prinsip sistem HVAC?

(5 markah)

(b) Apakah yang dimaksudkan keselesaan terma?

(5 markah)

(c) Apakah faktor unsur-unsur mempengaruhi untuk keselesaan terma?

(5 markah)

(d) Udara luar pada 0^0C bebuli kering (db) dan ketepuan 100% dipanaskan dengan bateri air panas pada tekanan rendah 30^0C bebuli kering (db). Lakarkan kitar *psychrometric* pada carta dan tentukan syarat-syarat berikut daripada carta bagi mengesahkan nilai jadual data seperti berikut:

(i) peratusan ketepuan.
(ii) isipadu tentu.
(iii) titik embun.
(iv) entalpi tentu.
(v) kandungan lembapan.

(10 markah)

-SOALAN TAMAT-

SOALAN DI DALAM BAHASA INGGERIS

Q1 (a) Air conditioning is a mean to achieve a controlled atmospheric condition of an enclosed space at specific time of the year, using air as the medium of circulation and environmental control.

(i) State the main component parts of air conditioning system and explain how the system functioning and interrelated with every component.

(15 marks)

(ii) What is the effect of using water with a refrigeration system and its function to the system?

(5 marks)

(iii) What is the importance of good air conditioning system to the human and industrial?

(5 marks)

Q2 (a) Atmospheric air at a dry bulb temperature of 15°C and 25% R.H. passes through a furnace and then through a humidifier, in such a way that the final dry bulb temperature is 30°C and 50% R.H. Determine:

(i) the moisture added to the air.
(ii) the heat added to the air.
(iii) the sensible heat factor (SHF) of the process.

(9 marks)

(b) One of the reasons for air conditioning is to ensure a level of purity and cleanliness of the air inside the closed space. What is the type and sources of common harmful gases and contaminants which effected purity and cleanliness of the air in closed space?

(3 marks)

(c) How the air conditioning system can help to achieve human and thermal comfort in a closed space?

(13 marks)

Q3 (a) A building located at 40°N latitude. It has 120 ft x 80 ft with 2 in insulation inside 4 in heavyweight concrete type of roof and a suspended ceiling. The east-facing wall has net area of 9703 ft^2 constructed by 8 in concrete heavyweight with 2 in insulation. It has 3 single glass windows with aluminums frame and ¼ in clear glaze with light colored interior venetian blinds. The area of each window is 128ft^2. The building has 10 of 40W fluorescent lighting fixtures and can accommodate about 50 people every single time for light bench work.
Design process at 12 p.m. solar time on 1 April.
Notes: Daily Range = 20°F ;
Outdoor design dry bulb = 94°F ;
Inside Temperature = 75°F

(i) Estimate the wall cooling load.

(3 marks)

(ii) Find the cooling due to conduction heat gain through the windows.

(5 marks)

(iii) Find the solar radiation cooling load.

(5 marks)

(iv) What is the cooling load requirement for lighting system?

(2 marks)

(v) What is the heat gain from 55 people for light bench work in the building?

(5 marks)

(vi) What is your suggestion to reduce heat in this building by compared the calculation of your suggestion with the above specification?

(5 marks)

Q4 (a) As a designer engineer, what are the types of selection criteria should be considered before designed the air conditioning systems.

(6 marks)

(b) What are the factors to be considered in an air-distribution system?

(6 marks)

(c) Describe the importance of an air distribution system in an air-conditioning system.

(8 marks)

(d) Explain the necessity of duct system in an air conditioning system.

(5 marks)

Q5 (a) A room has a ceiling size 5 m x 5 m with acoustic material that has an absorption coefficient of 0.45; the walls have a total area of $60m^2$ with absorption coefficient 0.33 and floor size is same as ceiling size with absorption coefficient 0.13. A sound source from air condition located in the center of the room emits a sound power level of 0.01 mW. What is the SPL at location 2 m from the source?

(13 marks)

(b) Describe briefly the meaning of the following in engineering field:

(i) sound power level (PWL).
(ii) sound pressure level (SPL).
(iii) sound.
(iv) noise.

(4 marks)

(c) Calculate the sound pressure level in dB(A) of noise generated by air-condition system from the following analysis:

Centre frequency (Hz)	31.5	63	125	250	500	1000	2000	4000
SPL (dB)	60	60	65	70	65	65	45	40

(8 marks)

Q6 (a) What are the main component parts of the principle of an HVAC system?

(5 marks)

(b) What is the thermal comfort?

(5 marks)

(c) What is the elements factor of affecting to the thermal comfort?

(5 marks)

(d) Outdoor air at 0°C dry bulb (d.b.) and 100% saturation is heated with a low-pressure hot-water battery to 30°C dry bulb (d.b.). Sketch the psychrometric cycle on a chart and find the following conditions from a chart and verify them from the data tables:

(i) percentage saturation.
(ii) specific volume.
(iii) dew point.
(iv) specific enthalpy.
(v) moisture content.

(10 marks)

- END OF QUESTION -

TABLE 1 : Cooling Load Temperature Differences (CLTD) for calculating cooling load from flat roofs

Roof No	Description of Construction	Weight lb/ft^2	U-value BTU h*ft^2*°F	Solar Time 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Hour of Max CLTD	Min CLTD	Max CLTD	Diff CLTD
				with Suspended Ceiling																											
1	Steel sheet with 1 in (or 2 in) insulation	9 (10)	0.134 (0.092)	2	0	-2	-3	-4	-4	-1	9	23	37	50	62	71	77	78	74	67	56	42	28	18	12	8	5	15	-4	78	82
2	1 in wood with 1 in insulation	10	0.115	20	15	11	8	5	3	2	3	7	13	21	30	40	48	55	60	62	61	58	51	44	37	30	25	17	2	62	60
3	4 in lightweight concrete	20	0.134	19	14	10	7	4	2	0	0	4	10	19	29	39	48	56	62	65	64	61	54	46	38	30	24	17	0	65	65
4	2 in heavyweight concrete with 1 in insulation	30	0.131	28	25	23	20	17	15	13	13	14	16	20	25	30	35	39	43	46	47	46	44	41	38	35	32	18	13	47	34
5	1 in wood with 2 in insulation	10	0.083	25	20	16	13	10	7	5	5	7	12	18	25	33	41	48	53	57	57	56	52	46	40	34	29	18	5	57	52
6	6 in lightweight concrete	26	0.109	32	28	23	19	16	13	10	8	7	8	11	16	22	29	36	42	48	52	54	54	54	47	42	37	20	7	54	47
7	2.5 in wood with 1 in insulation	15	0.096	34	31	29	26	23	21	18	16	15	15	16	18	21	25	30	34	38	41	43	44	44	42	40	37	21	15	44	29
8	8 in lightweight concrete	33	0.093	39	36	3	3	29	26	23	20	18	15	14	14	15	17	20	25	29	34	38	42	45	46	44	42	21	14	46	32
9	4 in heavyweight concrete with 1 in (or 2 in) insulation	53 (54)	0.128 (0.090)	30	29	27	26	24	22	21	20	20	21	22	24	27	29	32	34	36	38	38	38	37	36	34	33	19	20	38	18
10	2.5 in wood with 2 in insulation	15	0.072	35	33	30	28	26	24	22	20	18	18	18	20	22	25	28	32	35	38	40	41	41	40	39	37	21	18	41	23
11	Roof terrace system	77	0.082	30	29	28	27	26	25	24	23	22	22	22	23	23	25	26	28	29	31	32	33	33	33	33	32	22	22	33	11
12	6 in heavyweight concrete with 1 in (or 2 in) insulation	77 (77)	0.125 (0.088)	29	28	27	26	25	24	23	22	21	21	22	23	25	26	28	30	32	33	34	34	34	33	32	31	20	21	34	13
13	4 in wood with 1 in (or 2 in) insulation	19 (20)	0.082 (0.064)	35	34	33	32	31	29	27	26	24	23	22	21	22	22	24	25	27	30	32	34	35	36	37	36	23	21	37	16

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TABLE 2 : Cooling Load Temperature Differences (CLTD) for calculating cooling load from sunlit walls,F

	Solat Time, h																							Hour of max	min	max	diff
	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	CLTD	CLTD	CLTD	CLTD
North Latitude Wall Facing	Group A Walls																											
N	14	14	14	13	13	13	12	12	11	11	10	10	10	10	10	10	11	11	12	12	13	13	14	14	2	10	14	4
NE	19	19	19	18	17	17	16	15	15	15	15	15	16	16	17	18	18	18	19	19	20	20	20	20	22	15	20	5
E	24	24	23	23	22	21	20	19	19	18	19	19	20	21	22	23	24	24	25	25	25	25	25	25	22	18	25	7
SE	24	23	23	22	21	20	20	19	18	18	18	18	18	19	20	21	22	23	23	24	24	24	24	24	22	18	24	6
S	20	20	19	19	18	18	17	16	16	15	14	14	14	14	14	15	16	17	18	19	19	20	20	20	23	14	20	6
SW	25	25	25	24	24	23	22	21	20	19	19	18	17	17	17	17	18	19	20	22	23	24	25	25	24	17	25	8
W	27	27	26	26	25	24	24	23	22	21	20	19	19	18	18	18	18	19	20	22	23	25	26	26	1	18	27	9
NW	21	21	21	20	20	19	19	18	17	16	16	15	15	14	14	14	15	15	16	17	18	19	20	21	1	14	21	7
	Group B Walls																											
N	15	14	14	13	12	11	11	10	9	9	9	8	9	9	9	10	11	12	13	14	14	15	15	15	24	8	15	7
NE	19	18	17	16	15	14	13	12	12	13	14	15	16	17	18	19	19	20	20	21	21	21	20	20	21	12	21	9
E	23	22	21	20	18	17	16	15	15	15	17	19	21	22	24	25	26	26	27	27	26	26	25	24	20	15	27	12
SE	23	22	21	20	18	17	16	15	14	14	15	16	18	20	21	23	24	25	26	26	26	26	25	24	21	14	26	12
S	21	20	19	18	17	15	14	13	12	11	11	11	11	12	14	15	17	19	20	21	22	22	22	21	23	11	22	11
SW	27	26	25	24	22	21	19	18	16	15	14	14	13	13	14	15	17	20	22	25	27	28	28	28	24	13	28	15
W	29	28	27	26	24	23	21	19	18	17	16	15	14	14	14	15	17	19	22	25	27	29	29	30	24	14	30	16
NW	23	22	21	20	19	18	17	15	14	13	12	12	12	11	12	12	13	15	17	19	21	22	23	23	24	11	23	9
	Group C Walls																											
N	15	14	13	12	11	10	9	8	8	7	7	8	8	9	10	12	13	14	15	16	17	17	17	16	22	7	17	10
NE	19	17	16	14	13	11	10	10	11	13	15	17	19	20	21	22	22	23	23	23	23	22	21	20	20	10	23	13
E	22	21	19	17	15	14	12	12	14	16	19	22	25	27	29	29	30	30	30	29	28	27	26	24	18	12	30	18
SE	22	21	19	17	15	14	12	12	12	13	16	19	22	24	26	28	29	29	29	29	28	27	26	24	19	12	29	17
S	21	19	18	16	15	13	12	10	9	9	9	10	11	14	17	20	22	24	25	26	25	25	24	22	20	9	26	17
SW	29	27	25	22	20	18	16	15	13	12	11	11	11	13	15	18	22	26	29	32	33	33	32	31	22	11	33	22
W	31	29	27	25	22	20	18	16	14	13	12	12	12	13	14	16	20	24	29	32	35	35	35	33	22	12	35	23
NW	25	23	21	20	18	16	14	13	11	10	10	10	10	11	12	13	15	18	22	25	27	27	27	26	22	10	27	17
	Group D Walls																											
N	15	13	12	10	9	7	6	6	6	6	6	7	8	10	12	13	15	17	18	19	19	19	18	16	21	6	19	13
NE	17	15	13	11	10	8	7	8	10	14	17	20	22	23	23	24	24	25	25	24	23	22	20	18	19	7	25	18
E	19	17	15	13	11	9	8	9	12	17	22	27	30	32	33	33	32	32	31	30	28	26	24	22	16	8	33	25
SE	20	17	15	13	11	10	8	8	10	13	17	22	26	29	31	32	32	32	31	30	28	26	24	22	17	8	32	24
S	19	17	15	13	11	9	8	7	6	6	7	9	12	16	20	24	27	29	29	29	27	26	24	22	19	6	29	23
SW	28	25	22	19	16	14	12	10	9	8	8	8	10	12	16	21	27	32	36	38	38	37	34	31	21	8	38	30
W	31	27	24	21	18	15	13	11	10	9	9	9	10	11	14	18	24	30	36	40	41	40	38	34	21	9	41	32
NW	25	22	19	17	14	12	10	9	8	7	7	8	9	10	12	14	18	22	27	31	32	32	30	27	22	7	32	25
	Group E Walls																											
N	12	10	8	7	5	4	3	4	5	6	7	9	11	13	15	17	19	20	21	23	20	18	16	14	20	3	22	19
NE	13	11	9	7	6	4	5	9	15	20	24	25	25	26	26	26	26	26	25	24	22	19	17	15	16	4	26	22
E	14	12	10	8	6	5	6	11	18	26	33	36	38	37	36	34	33	32	30	28	25	22	20	17	13	5	38	33
SE	15	12	10	8	7	5	5	8	12	19	25	31	35	37	37	36	34	33	31	28	26	23	20	17	15	5	37	32
S	15	12	10	8	7	5	4	3	4	5	9	13	19	24	29	32	34	33	31	29	26	23	20	17	17	3	34	31
SW	22	18	15	12	10	8	6	5	5	6	7	9	12	18	24	32	38	43	45	44	40	35	30	26	19	5	45	40
W	25	21	17	14	11	9	7	6	6	6	7	9	11	14	20	27	36	43	49	49	45	40	34	29	20	6	49	43
NW	20	17	14	11	9	7	6	5	5	5	6	8	10	13	16	20	26	32	37	38	36	32	28	24	20	5	38	33
	Group F Walls																											
N	8	6	5	3	2	1	2	4	6	7	9	11	14	17	19	21	22	23	24	23	20	16	13	11	19	1	23	23
NE	9	7	5	3	2	1	5	14	23	28	30	29	28	27	27	27	27	26	24	22	19	16	13	11	11	1	30	29
E	10	7	6	4	3	2	6	17	28	38	44	45	43	39	36	34	32	30	27	24	21	17	15	12	12	2	45	43
SE	10	7	6	4	3	2	4	10	19	28	36	41	43	42	39	36	34	31	28	25	21	18	15	12	13	2	43	41
S	10	8	6	4	3	2	1	1	3	7	13	20	27	34	38	39	38	35	31	26	22	18	15	12	16	1	39	38
SW	15	11	9	6	5	3	2	2	4	5	8	11	17	26	35	44	50	53	52	45	37	28	23	18	18	2	53	48
W	17	13	10	7	5	4	3	3	4	6	8	11	14	20	28	39	49	57	60	54	43	34	27	21	19	3	60	57
NW	14	10	8	6	4	3	2	2	3	5	8	10	13	15	21	27	35	42	46	43	35	28	22	18	19	2	46	44
	Group G Walls																											
N	3	2	1	0	-1	2	7	8	9	12	15	18	21	23	24	24	25	26	22	15	11	9	7	5	18	-1	26	27
NE	3	2	1	0	-1	9	27	36	39	35	30	26	26	27	27	26	25	22	18	14	11	9	7	5	9	-1	39	40
E	3	2	1	0	-1	11	31	47	54	55	50	40	33	31	30	29	27	24	19	15	12	10	8	6	10	-1	55	56
SE	3	2	1	0	-1	5	18	32	42	49	51	48	42	36	32	30	27	24	19	15	12	10	8	6	11	-1	51	52
S	3	2	1	0	-1	0	1	5	12	22	31	39	45	46	43	37	31	25	20	15	12	10	8	5	14	-1	46	47
SW	5	4	3	1	0	0	2	5	8	12	16	26	38	50	59	63	61	52	37	24	17	13	10	8	16	0	63	63
W	6	5	3	2	1	1	2	5	8	11	15	19	27	41	56	67	72	67	48	29	20	15	11	8	17	1	72	71
NW	5	3	2	1	0	0	2	5	8	11	15	18	21	27	37	47	55	55	41	25	17	13	10	7	18	0	55	55

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TABLE 3 : Wall construction group description

Group No	Description of Construction	Weight (lb/ft^2)	U-Value ($BTU/h*ft^2*°F$)
4 in Face brick + (brick)			
C	Air space + 4 in face brick	83	0.358
D	4 in common brick	90	0.415
C	1 in insulation or air space + 4 in common brick	90	0.174-0.301
B	2 in insulation + 4 in common brick	88	0.111
B	8 in common brick	130	0.302
A	Insulation or air space + 8 in common brick	130	0.154-0.243
4 in Face brick + (heavyweight concrete)			
C	Air space + 2 in concrete	94	0.35
B	2 in insulation + 4 in concrete	97	0.116
A	Air space or insulation + 8 in or more concrete	143 - 190	0.110-0.243
4 in Face brick + (light or heavyweight concrete block)			
E	4 in block	62	0.319
D	Air space or insulation + 4 in block	62	0.153-0.246
D	8 in block	70	0.274
C	Air space or 1 in insulation + 6 in or 8 in block	73 - 89	0.221-0.275
B	2 in insulation + 8 in block	89	0.096-0.107
4 in Face brick + (clay tile)			
D	4 in tile	71	0.381
D	Air space + 4 in tile	71	0.281
C	Insulation + 4 in tile	71	0.169
C	8 in tile	96	0.275
B	Air space or 1 in insulation + 8 in tile	96	0.142-0.221
A	2 in insulation + 8 in tile	97	0.097
Heavyweight concrete wall + (finish)			
E	4 in concrete	63	0.585
D	4 in concrete + 1 in or 2 in insulation	63	0.119-0.200
C	2 in insulation + 4 in concrete	63	0.119
C	8 in concrete	109	0.49
B	8 in concrete + 1 in or 2 in insulation	110	0.115-0.187
A	2 in insulation + 8 in concrete	110	0.115
B	12 in concrete	156	0.421
A	12 in concrete + insulation	156	0.113
Light and heavywweight concrete block + (finish)			
F	4 in block + air space/insulation	29	0.161-0.263
E	2 in insulation + 4 in block	29 - 37	0.105-0.114
E	8 in block	47 - 51	0.294-0.402
D	8 in block + air space/insulation	41 - 57	0.149-0.173
Clay tile + (finish)			
F	4 in tile	39	0.419
F	4 in tile + air space	39	0.303
E	4 in tile + 1 in insulation	39	0.175
D	2 in insulation + 4 in tile	40	0.11
D	8 in tile	63	0.296
C	8 in tile + air space/1 in insulation	63	0.151-0.231
B	2 in insulation + 8 in tile	63	0.099
Metal curtain wall			
G	With/without air space + 1 to 3 in insulation	5 - 6	0.091-0.230
Frame wall			
G	1 in to 3 in insulation	16	0.081 - 0.178

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TABLE 4 : CLTD Correction for latitude and month applied to walls and roofs, North Latitudes, F

Lat	Month	N	NNE NNW	NE NW	ENE WNW	E W	ESE WSW	SE SW	SSE SSW	S	HOR
0	Dec	-3	-5	-5	-5	-2	0	3	6	9	-1
	Jan/Nov	-3	-5	-4	-4	-1	0	2	4	7	-1
	Feb/Oct	-3	-2	-2	-2	-1	-1	0	-1	0	0
	Mar/Sept	-3	0	1	-1	-1	-3	-3	-5	-8	0
	Apr/Aug	5	4	3	0	-2	-5	-6	-8	-8	-2
	May/Jul	10	7	5	0	-3	-7	-8	-9	-8	-4
	Jun	12	9	5	0	-3	-7	-9	-10	-8	-5
8	Dec	-4	-6	-6	-6	-3	0	4	8	12	-5
	Jan/Nov	-3	-5	-6	-5	-2	0	3	6	10	-4
	Feb/Oct	-3	-4	-3	-3	-1	-1	1	2	4	-1
	Mar/Sept	-3	-2	-1	-1	-1	-2	-2	-3	-4	0
	Apr/Aug	2	2	2	0	-1	-4	-5	-7	-7	-1
	May/Jul	7	5	4	0	-2	-5	-7	-9	-7	-2
	Jun	9	6	4	0	-2	-6	-8	-9	-7	-2
16	Dec	-4	-6	-8	-8	-4	-1	4	9	13	-9
	Jan/Nov	-4	-6	-7	-7	-4	-1	4	8	12	-7
	Feb/Oct	-3	-5	-5	-4	-2	0	2	5	7	-4
	Mar/Sept	-3	-3	-2	-2	-1	-1	0	0	0	-1
	Apr/Aug	-1	0	-1	-1	-1	-3	-3	-5	-6	0
	May/Jul	4	3	3	0	-1	-4	-5	-7	-7	0
	Jun	6	4	4	1	-1	-4	-6	-8	0	-7
24	Dec	-5	-7	-9	-10	-7	-3	3	9	13	-13
	Jan/Nov	-4	-6	-8	-9	-6	-3	9	3	13	-11
	Feb/Oct	-4	-5	-6	-6	-3	-1	3	7	10	-7
	Mar/Sept	-3	-4	-3	-3	-1	-1	1	2	4	-3
	Apr/Aug	-2	-1	0	-1	-1	-2	-1	-2	-3	0
	May/Jul	1	2	2	0	0	-3	-3	-5	-6	1
	Jun	3	3	3	1	0	-3	-4	-6	-6	1
32	Dec	-5	-7	-10	-11	-8	-5	2	9	12	-17
	Jan/Nov	-5	-7	-9	-11	-8	-15	-4	2	9	12
	Feb/Oct	-4	-6	-7	-8	-4	-2	4	8	11	-10
	Mar/Sept	-3	-4	-4	-4	-2	-1	3	5	7	-5
	Apr/Aug	-2	-2	-1	-2	0	-1	0	1	1	-1
	May/Jul	1	1	1	0	0	-1	-1	-3	-3	1
	Jun	1	2	2	1	0	-2	-2	-4	-4	2
40	Dec	-6	-8	-10	-13	-10	-7	0	7	10	-21
	Jan/Nov	-5	-7	-10	-12	-9	-6	1	8	11	-19
	Feb/Oct	-5	-7	-8	-9	-6	-3	3	8	12	-14
	Mar/Sept	-4	-5	-5	-6	-3	-1	4	7	10	-8
	Apr/Aug	-2	-3	-2	-2	0	0	2	3	4	-3
	May/Jul	0	0	0	0	0	0	0	0	1	1
	Jun	1	1	1	0	1	0	0	-1	-1	2
48	Dec	-6	-8	-11	-14	-13	-10	-3	2	6	-25
	Jan/Nov	-6	-8	-11	-13	-11	-8	-1	5	8	-24
	Feb/Oct	-5	-7	-10	-11	-8	-5	1	8	11	-18
	Mar/Sept	-4	-6	-6	-7	-4	-1	4	8	11	-11
	Apr/Aug	-3	-3	-3	-3	-1	0	4	6	7	-5
	May/Jul	0	-1	0	0	1	1	3	3	4	0
	Jun	1	1	2	1	2	1	2	2	3	2

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TABLE 5 : Cooling Load Temperature Differences (CLTD) for conduction through glass

Solar Time, h	CLTD °F	Solar Time, h	CLTD °F
0100	1	1300	12
0200	0	1400	13
0300	-1	1500	14
0400	-2	1600	14
0500	-2	1700	13
0600	-2	1800	12
0700	-2	1900	10
0800	0	2000	8
0900	2	2100	6
1000	4	2200	4
1100	7	2300	3
1200	9	2400	2

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TABLE 6 : Overall heat transfer coefficient U for glass (BTU/h*ft^2*°F) (for glass installed vertically)

Type of Glazing	Type of Frame (Sash)			
	Aluminum (with thermal		Wood or Vinyl	
	Winter	Summer	Winter	Summer
Single glass	1.1	1.01	0.98	0.9
Double glass				
3/8 in. air space	0.6	0.56	0.51	0.47
3/8 in. air space E-film	0.48	1.45	0.39	0.37
Triple Glass				
3/8 in. air space	0.46	0.43	0.38	0.36
3/8 in. argon space	0.34	0.33	0.25	0.24

Note: E-film is a reflective coating (E=0.15)
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TABLE 7 : Maximum Solar Heat Gain Factor (SHGF) BTU/h*ft^2 for sunlit glass, North Latitude

	40°N. Lat									
	N (shade)	**NNE/ NNW**	**NE/ NW**	**ENE/ WNW**	**E/ W**	**ESE/ WSW**	**SE/ SW**	**SSE/ SSW**	**S**	**HOR**
Jan	20	20	20	74	154	205	241	252	254	133
Feb	24	24	50	129	186	234	246	244	241	180
Mar	29	29	93	169	218	238	236	216	206	223
Apr	34	71	140	190	224	223	203	170	154	252
May	37	102	165	202	220	208	175	133	113	265
Jun	48	113	172	205	216	199	161	116	95	267
July	38	102	163	198	216	203	170	129	109	262
Aug	35	71	135	185	216	214	196	165	149	247
Sep	30	30	87	160	203	227	226	209	200	215
Oct	25	25	49	123	180	225	238	236	234	177
Nov	20	20	20	73	151	201	237	248	250	132
Dec	18	18	18	60	135	188	232	249	253	113

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TABLE 8 : Shading coefficients for glass without or with interior shading device

Type of Glazing	Nominal Thickness, in (each light)	Without shading	With Interior Shading				
			Venetian blinds		Roller shades		
					Opaque		Translucent
			medium	light	dark	light	light
Single Glass							
clear	¼	0.94	0.74	0.67	0.81	0.39	0.44
heat absorbing	¼	0.69	0.57	0.53	0.45	0.3	0.36
Double Glass							
clear	¼	0.81	0.62	0.58	0.71	0.35	0.4
heat absorbing	¼	0.55	0.39	0.36	0.4	0.22	0.3

Note: Venetian blinds are assumed set at a 45° position
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TABLE 9 : Cooling Load Factors (CLF) for glass with interior shading, North Latitudes (All room constructions)

Fenestration facing	Solar Time, h																							
	0100	**0200**	**0300**	**0400**	**0500**	**0600**	**0700**	**0800**	**0900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**	**2300**	**2400**
N	0.08	0.07	0.06	0.06	0.07	0.73	0.66	0.65	0.73	0.8	0.86	0.89	0.89	0.86	0.82	0.75	0.78	0.91	0.24	0.18	0.15	0.13	0.11	0.1
NNE	0.03	0.03	0.02	0.02	0.03	0.64	0.77	0.62	0.42	0.37	0.37	0.37	0.36	0.35	0.32	0.28	0.23	0.17	0.08	0.07	0.06	0.05	0.04	0.04
NE	0.03	0.02	0.02	0.02	0.02	0.56	0.76	0.74	0.58	0.37	0.29	0.27	0.26	0.24	0.22	0.2	0.16	0.12	0.06	0.05	0.04	0.04	0.03	0.03
ENE	0.03	0.02	0.02	0.02	0.02	0.52	0.76	0.8	0.71	0.52	0.31	0.26	0.24	0.22	0.2	0.18	0.15	0.11	0.06	0.05	0.04	0.04	0.03	0.03
E	0.03	0.02	0.02	0.02	0.02	0.47	0.72	0.8	0.76	0.62	0.41	0.27	0.24	0.22	0.2	0.17	0.14	0.11	0.06	0.05	0.05	0.04	0.03	0.03
ESE	0.03	0.03	0.02	0.02	0.02	0.41	0.67	0.79	0.8	0.72	0.54	0.34	0.27	0.24	0.21	0.19	0.15	0.12	0.07	0.06	0.05	0.04	0.04	0.03
SE	0.03	0.03	0.02	0.02	0.02	0.03	0.57	0.74	0.81	0.79	0.68	0.49	0.33	0.28	0.25	0.22	0.18	0.13	0.08	0.07	0.06	0.05	0.04	0.04
SSE	0.04	0.03	0.03	0.03	0.02	0.12	0.31	0.54	0.72	0.81	0.81	0.71	0.54	0.38	0.32	0.27	0.22	0.16	0.09	0.08	0.07	0.06	0.05	0.04
S	0.04	0.04	0.03	0.03	0.03	0.09	0.16	0.23	0.38	0.58	0.75	0.83	0.8	0.68	0.5	0.35	0.27	0.19	0.11	0.09	0.08	0.07	0.06	0.05
SSW	0.05	0.04	0.04	0.03	0.03	0.09	0.14	0.18	0.22	0.27	0.43	0.63	0.78	0.84	0.8	0.66	0.46	0.25	0.13	0.11	0.09	0.08	0.07	0.06
SW	0.05	0.05	0.04	0.04	0.03	0.07	0.11	0.14	0.16	0.19	0.22	0.38	0.59	0.75	0.83	0.81	0.69	0.45	0.16	0.12	0.1	0.09	0.07	0.06
WSW	0.05	0.05	0.04	0.04	0.03	0.07	0.1	0.12	0.14	0.16	0.17	0.23	0.44	0.64	0.78	0.84	0.78	0.55	0.16	0.12	0.1	0.09	0.07	0.06
W	0.05	0.05	0.04	0.04	0.03	0.06	0.09	0.11	0.13	0.15	0.16	0.17	0.31	0.53	0.72	0.82	0.81	0.61	0.16	0.12	0.1	0.08	0.07	0.06
WNW	0.05	0.05	0.04	0.03	0.03	0.07	0.1	0.12	0.14	0.16	0.17	0.18	0.22	0.43	0.65	0.8	0.84	0.66	0.16	0.12	0.1	0.08	0.07	0.06
NW	0.05	0.04	0.04	0.03	0.03	0.07	0.11	0.14	0.17	0.19	0.2	0.21	0.22	0.3	0.52	0.73	0.82	0.69	0.16	0.12	0.1	0.08	0.07	0.06
NNW	0.05	0.05	0.04	0.03	0.03	0.11	0.17	0.22	0.26	0.3	0.32	0.33	0.34	0.34	0.39	0.61	0.82	0.76	0.17	0.12	0.1	0.08	0.07	0.06
HOR	0.06	0.05	0.04	0.04	0.03	0.12	0.27	0.44	0.59	0.72	0.81	0.85	0.85	0.81	0.71	0.58	0.42	0.25	0.14	0.12	0.1	0.08	0.07	0.06

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TABLE 10 : Rates of heat gain from occupants

Degree of Activity	Typical Applications	Total Heat Adults, Male, Btu/h	Total heat Adjusted, [d]Btu/h	Sensible Heat, Btu/h	Latent Heat, Btu/h
Seated at theater	Theater – Matinee	390	330	225	105
Seated at theater	Theater-Evening	390	350	245	105
Seated, very light work	Offices, hotels, apartments	450	400	245	155
Moderately active office work	Offices, hotels, apartments	475	450	250	200
Standing, light work; walking	Department store, retail store	550	450	250	200
Walking; standing	Drug store, bank	550	500	250	250
Sedentary work	Restaurant	490	550	275	275
Light bench work	Factory	800	750	275	475
Moderate dancing	Dance hall	900	850	305	545
Walking 3 mph : light machine work	Factory	1000	1000	375	625
Bowling	Bowling alley	1500	1450	580	870
Heavy work	Factory	1500	1450	580	870
Heavy machine work; lifting	Factory	1600	1600	635	965
Athletics	Gymnasium	2000	1800	710	1090

[A] Tabulated values are based on 75°F room dry-bulb temperature. For 80°F room dry-bulb, the total heat remains the same, but the sensible heat values should be decreased by approximately 20%, and the latent heat values increased accordingly.

[c] All values are rounded to nearest 5 Btu/h.

[d] *Adjusted heat gain* is based on normal percentage of men, women and children for the application listed, with the postulate that the gain from an adult female is 85% of that for an adult male, and that the gain from a child is 75% of that for an adult male.

[e] Adjusted total heat gain for *Sedentary work*. *Restaurant* includes 60 Btu/h for food per individual (30 Btu/h sensible and 30 Btu/h latent.)

[f] For Bowling, figure one person per alley actually bowling, and all others at sitting (400 Btu/h) or standing and walking slowly (550 Btu/h)

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