UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2005/2006

November 2005

REG 562 –Teknologi Perkhidmatan Bangunan
(Building Services Technology)

Duration: 3 hours
(Masa: 3 jam)

Sila pastikan bahawa kertas peperiksaan ini mengandungi **ENAM BELAS** muka surat yang tercetak sebelum anda memulakan peperiksaan ini.

*Please check that this examination paper consists of **SIXTEEN** pages of printed material before you begin the examination.*

Pelajar dibenarkan menjawab semua soalan dalam Bahasa Inggeris ATAU Bahasa Malaysia ATAU kombinasi kedua-duanya.

Students are allowed to answer all questions in English OR in Bahasa Malaysia OR in both languages.

Jawab **EMPAT** soalan sahaja. Pilih **DUA (2)** soalan dari **Bahagian A** dan **DUA (2)** soalan dari **Bahagian B**
*Answer **FOUR** questions only. **TWO** questions should be answered from **Part A**, and **TWO** questions from **Part B.***

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BAHAGIAN A

1. (a) Mengapakah seorang pakar atau jurutera perkhidmatan bangunan diperlukan dalam industri pembinaan?

Explain why a building services professional is needed within building industry?

(5 markah/*marks*)

(b) Bidang teknologi perkhidmatan bangunan mempunyai pelbagai kegunaan dalam meningkatkan prestasi sesebuah bangunan. Huraikan kepentingan setiap sistem dalam bangunan, fungsi, hubungan antara dua sistem dan kawalan rekabentuk sistem tersebut.

Building Services technology is having a high potential to increase the total building performance. Elaborate the importance of each system within the building, it's functions, and also focused on two system that are inter-related which includes it's design control system.

(20 markah/*marks)*

2. (a) Mengapakah sistem keselamatan kebakaran atau "fire safety" dikatakan begitu penting sekali didalam industri binaan?

Explain why the fire safety system is very important in building industry?

(5 markah/*marks)*

(b) Keselamatan kebakaran seringkali dikaitkan dengan pihak bomba dan penyelamat. Namun demikian, pihak pereka dan professional mahu pun penghuni bangunan perlu memahami 14 komponen-komponen kebakaran dan hayat tumbesaran kebakaran "Fire Growth Graph" bagi tujuan pengurusan keselamatan. Nyatakan dan huraikan kenyataan ini.

Fire safety is often related to the Fire Brigade reponsibility. However, the understanding of the 14 components of fire safety in buildings and the Fire Growth Graph should also be known by the professionals and designers in order to manage the entire safety of a building. List down and elaborate the facts above.

(20 markah/*marks)*

3. (a) Nyatakan perbezaan *Traction Lift* dan *Hydraulic Lift.*

List the differences between Traction Lift and Hydraulic Lift.

(5 markah/*marks*)

(b) Huraikan secara ringkas apakah 3 keperluan penting dalam merekabentuk sistem lif dan nyatakan kriteria yang digunakan untuk membuat penganalisaan prestasi lif.

Elaborate the 3 main requirements of lift design and list the criteria used for analysing the lift performance

(10 markah/*marks)*

(c) Apakah yang dimaksudkan dengan Masa Perjalanan (T) bagi sesebuah perkhidmatan lif? Kirakan masa perjalanan (T) untuk lif sebuah bangunan pejabat jika spesifikasinya adalah seperti berikut:-

Jumlah kereta lif sekumpulan	=	4
Kapasiti kereta lif	=	21 orang
Kontrak kelajuan lif	=	2.0 m/s
Ketinggian bangunan	=	3.5 m
Bilangan tingkat	=	16 tingkat (termasuk aras tingkat bawah)
Jumlah keluasan pejabat	=	5400 sq.m
Lebar pintu lif	=	1100 mm
Jenis penggerak lif	=	Gearless variable voltage
Jenis pintu lif	=	Bukaan tengah

$$Sp = S - S\left[\frac{(S-1)}{S}\right]^{n}$$

Di mana: Sp = kemungkinan bilangan hentian per trip
S = Bilangan aras yang diberi perkhidmatan selain tingkat bawah. *(Number of floors served above ground floor)*
n = bilangan penumpang yang memasuki lif di aras tingkat bawah (kebiasaannya diambil sebanyak 80% dari beban kotrak)

$$T = \frac{2\,(d\,Sp + D + d)}{V}$$

Iaitu;- T = Jumlah masa perjalanan
d = Jarak memecut
Sp = Kemungkinan bilangan hentian per trip
D = Jarak keseluruhan di antara aras bawah dengan aras teratas.
V = Kelajuan lif (m/s)

Jarak memecut bergantung kepada penggerak (drive) lif tertentu dan rekabentuk kelajuan yang diberikan:-

Kelajuan Lif (speed)	**Jenis**	**Jarak memecut (d)**
0.5 m/s	Geared Rheostatic	0.3 m
1.0 m/s	Geared Rheostatic	1.5 m
1.5 m/s	Geared Rheostatic	2.6 m
1.5 m/s	Variable Voltage GR	1.3 m
2.0 m/s	Gearless Variable Voltage	2.2 m
2.5 m/s	Gearless Variable Voltage	3.1 m
3.0 m/s	Gearless Variable Voltage	4.0 m

Anggap bangunan itu dipunyai oleh satu penyewa dan keluasan lantai setiap tingkat adalah sama serta setiap orang memerlukan keluasan *"occupancy density"* = 9.5 sq.m.

(10 markah)

What is meaning of Tranportation Time (T) for a lift?
Calculate the (T) for the lift system of a office building with the relevant specification:-

Total lift car in a lobby	=	*4*
Lift car capacity	=	*21 persons*
Lift contract speed	=	*2.0 m/s*
Building height per floor	=	*3.5 m*
Nos. of storey	=	*16 floor (including ground floor)*
Total office floor area	=	*5400 sq.m*
Lift door	=	*1100 mm*
Lift drive type	=	*Gearless variable voltage*
Lift openning	=	*Centre.*

$$Sp = S\text{-}S\left[\frac{(S-1)}{S}\right]^{n}$$

Where: *Sp = probability of stop per trip*
S = Number of floors served above ground floor
n = Number of passenger entering the lift at ground floor (80% from the design contract)

$$T = \frac{2\,(d\,Sp + D + d)}{V}$$

That is:- *T = Total travelling time*
d = Acceleration distance
Sp = Probability of stop per trip
D = Total distance between ground floor to the highest floor level
V = Lift speed (m/s)

The acceleration distance depending on the lift drive types and also the design speed given:-

Lift contract speed	***Life drive types***	***Acceleration distance (d)***
0.5 m/s	*Geared Rheostatic*	*0.3 m*
1.0 m/s	*Geared Rheostatic*	*1.5 m*
1.5 m/s	*Geared Rheostatic*	*2.6 m*
1.5 m/s	*Variable Voltage GR*	*1.3 m*
2.0 m/s	*Gearless Variable Voltage*	*2.2 m*
2.5 m/s	*Gearless Variable Voltage*	*3.1 m*
3.0 m/s	*Gearless Variable Voltage*	*4.0 m*

Assuming that the building is a single tenant with a standard floor area level and each person required occupancy density = 9.5 sq.m.

(10 markah/marks)

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4. (a) Berikan sumber-sumber cahaya yang berkaitan dengan sains pencahayaan dan apakah objektif rekabentuk pencahayaan? Terangkan secara terperinci setiap objektif tersebut dengan penerangan yang jelas. Nyatakan juga keperluan kawalan sistem pencahayaan.

List the source of lights which are related to the science of lighting and also the objectives of lighting design. Explain in detail each of the objectives with clear examples. Also write the usage of lighting control system that is needed and available.

(15 markah/*marks)*

(b) Jika satu sumber cahaya mempunyai "*intensity*" yang seragam iaitu 60 cd dari semua arah. Apakah jumlah (total) "*luminous flux*" yang dipancarkan? Sekiranya fluks itu disumbang oleh lampu tungsten halogen (30 lm/W), berapakah kuasa elektrik yang akan diserap oleh lampu itu?
Memandangkan ia adalah sumber satu titik (*one point source*) dan difokuskan kepada solid angle $\omega = 0.5$ sr, jika 80% fluks itu kekal dalam proses ini, apakah purata "*intensity*" di dalam "*solid angle*" itu?

$$I = \frac{F}{\omega}$$

di mana I = intensity
F = flux atau fluks
ω = solid angle $= \frac{A}{r^2}$ atau $\frac{2\pi r^2}{r^2} = 2\pi$

If the single source of light with the constant intensity of 60 cd is coming from all direction, what is the total "luminous flux" that will be emitted? And if the flux given by the tungsten halogen lamp (30 lm/W), how many electricity watt will the lamp absorb?
It is coming from a single point source and being focused into solid angle angle $\omega = 0.5$ sr, if 80% flux is being maintained in this process, what is the overall " intensity" within that "solid angle"?

$$I = \frac{F}{\omega}$$

Where I = intensity
F = flux atau fluks
ω = solid angle $= \frac{A}{r^2}$ or $\frac{2\pi r^2}{r^2} = 2\pi$

(10 markah / *marks)*

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(c) Kirakan pemasangan bilangan "*luminaire*" yang sesuai bagi sebuah bilik untuk mencapai purata pencahayaan "*illuminance*" dengan spesifikasi yang diberikan.

Dimensi ruang bilik: Panjang = 20m
Lebar = 10m
Ketinggian lantai ke siling = 3m
Ketinggi meja kerja = 0.8m

Pembalikan efektif ruang lantai = R[F] = 0.20
Pembalikan efektif dari dinding = R[W] = 0.50
Pembalikan efektif ruang syiling = R[C] = 0.70

Diberi juga jenis pemasangan lampu iaitu lampu 2 tiub 1.5m panjang yang dipasang terus ke siling. Ia memerlukan pencahayaan "i*lluminance*" sebanyak 500 lux di atas ruang meja kerja. Anggapkan nilai F = 5400 dan Faktor hilang cahaya = 80%.

$$E(s) = \frac{F \times n \times N \times LLF \times UF(s)}{\text{Keluasan ruang (s)}}$$

OR

Calculate using the lumen method to obtain the number of luminaires necessary for the following room in order to achieve a given average illuminance.

Room dimensions : *Length* = *20m*
Width = *10m*
Height (floor to ceiling) = *3m*
Height of working plane = *0.8m*

Effective reflectance of floor cavity = *R[F]* = *0.20*
Effective reflectance of walls = *R[W]* = *0.50*
Effective reflectance of ceiling cavity = *R[C]* = *0.70*

Also given luminaire types as twin popular pack 1.5m long luminaire mounted directly to the ceiling. And illuminance required on he working plane is 500 lux.
Assuming F = 5400 and light loss factor = 80%.

$$E(s) = \frac{F \times n \times N \times LLF \times UF(s)}{\text{Area of surface (s)}}$$

(10 markah/*marks*)

BAHAGIAN B

5. (a) Berikan definisi terma-terma ini yang biasa digunakan dalam kajian keselesaan terma.

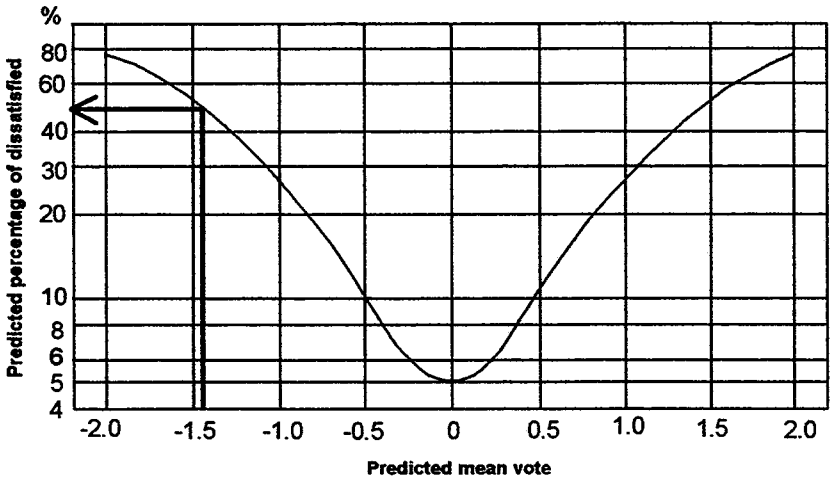
i. PMV
ii. PPD
iii. Pilihan tahap keselesaan
iv. Ketidakpuasan
v. Kebolehterimaan terma

Define these common terms in thermal comfort study:

i. PMV
ii PPD
iii. Comfort vote
iv Dissatisfied
v. Thermal acceptability

(b) Berdasarkan definisi yang diberikan dalam 4(a) di atas huraikan keadaan yang ditunjukkan dalam gambarajah ini.

Based on the definitions in 4(a) discuss the situation that is shown in the figure.



(25 markah/*marks*)

6. (a) Bincangkan lima (5) kriteria yang dipertimbangkan dalam pemilihan sistem pendingin hawa.

Discuss five (5) criteria that are always considered in air-conditioning system selection.

(b) Satu sistem pendingin hawa digunakan untuk menyejukkan udara bekal pada suhu 27 °Cbk dan 20 °Cbb kepada 20 °Cbk dan 14 °Cbb, bagi satu ruang berisipadu 1500 m^3 yang memerlukan 5 pertukaran udara sejam.

An air-conditioning system is used to cool supply air at 27 °Cdb and 20 °Cdb to 20 °Cdb and 14 °Cdb, in an area of 1500 m^3 volume, requiring 5 air changes per hour.

i. Berdasarkan kepada carta psikrometrik, plotkan proses-proses yang terlibat.

Based on the psychrometric chart, plot the process involved

ii. Tentukan keupayaan pendingin

Determine the chiller rating

(25 markah/*marks*)

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INTERIOR LIGHTING DESIGN

Worksheet for determination of UF(F) or U(F)

Floor cavity reflectance = 20%		ROOM INDEX (RI)								
		0.75	1.00	1.25	1.50	2.00	2.50	3.00	4.00	5.00
Reflect-ances %	D(F) or DF(F)									
	D(W) or DF(W)									
C W F	D(C) or DF(C)									
70 50 20	TF(F,F)	1.055	1.067	1.078	1.086	1.099	1.109	1.116	1.125	1.132
	TF(W,F)	0.237	0.275	0.303	0.325	0.355	0.377	0.392	0.411	0.426
	TF(C,F)	0.349	0.423	0.477	0.519	0.578	0.617	0.645	0.684	0.707
	U(F) or UF(F)									
70 30 20	TF(F,F)	1.035	1.047	1.057	1.066	1.081	1.092	1.100	1.113	1.121
	TF(W,F)	0.119	0.141	0.159	0.172	0.193	0.207	0.218	0.232	0.243
	TF(C,F)	0.288	0.362	0.419	0.463	0.528	0.573	0.605	0.650	0.678
	U(F) or UF(F)									
70 10 20	TF(F,F)	1.020	1.031	1.041	1.051	1.066	1.078	1.087	1.101	1.111
	TF(W,F)	0.034	0.041	0.047	0.052	0.059	0.064	0.068	0.073	0.077
	TF(C,F)	0.245	0.317	0.373	0.419	0.487	0.535	0.570	0.621	0.652
	U(F) or UF(F)									
50 50 20	TF(F,F)	1.045	1.053	1.060	1.065	1.073	1.079	1.083	1.089	1.093
	TF(W,F)	0.217	0.248	0.270	0.287	0.311	0.328	0.339	0.354	0.365
	TF(C,F)	0.241	0.291	0.328	0.357	0.396	0.423	0.442	0.468	0.483
	U(F) or UF(F)									
50 30 20	TF(F,F)	1.028	1.036	1.043	1.049	1.059	1.066	1.071	1.079	1.084
	TF(W,F)	0.110	0.129	0.143	0.155	0.171	0.182	0.191	0.201	0.210
	TF(C,F)	0.202	0.253	0.292	0.322	0.366	0.396	0.418	0.448	0.467
	U(F) or UF(F)									
50 10 20	TF(F,F)	1.015	1.023	1.030	1.036	1.047	1.055	1.061	1.071	1.077
	TF(W,F)	0.032	0.038	0.043	0.047	0.052	0.057	0.060	0.064	0.067
	TF(C,F)	0.173	0.224	0.263	0.294	0.341	0.373	0.397	0.431	0.451
	U(F) or UF(F)									
30 50 20	TF(F,F)	1.036	1.040	1.043	1.045	1.049	1.051	1.053	1.055	1.057
	TF(W,F)	0.199	0.223	0.240	0.253	0.271	0.283	0.291	0.301	0.310
	TF(C,F)	0.140	0.169	0.190	0.206	0.229	0.244	0.255	0.269	0.278
	U(F) or UF(F)									
30 30 20	TF(F,F)	1.022	1.026	1.030	1.033	1.038	1.042	1.044	1.048	1.051
	TF(W,F)	0.102	0.118	0.129	0.138	0.150	0.158	0.165	0.172	0.179
	TF(C,F)	0.119	0.148	0.171	0.188	0.213	0.230	0.243	0.260	0.270
	U(F) or UF(F)									
30 10 20	TF(F,F)	1.011	1.015	1.019	1.023	1.029	1.033	1.037	1.042	1.045
	TF(W,F)	0.030	0.035	0.039	0.042	0.046	0.050	0.052	0.055	0.057
	TF(C,F)	0.103	0.133	0.156	0.174	0.200	0.219	0.232	0.251	0.262
	U(F) or UF(F)									

UF(F) = [DF(F).TF(F,F)] + [DF(W).TF(W,F)] + [DF(C).TF(C,F)]

U(F) = [D(F).TF(F,F)] + [D(W).TF(W,F)]

INTERIOR LIGHTING DESIGN

Light Output Ratio — Up 0.45 — Down 0.41 — Total 0.86
Max. Spacing to Height Ratio — SHR MAX 1.68 — SHR MAX TR 2.03

Utilisation Factors UF[F]

Reflectances C	W	F	Room Index 0.75	1.00	1.25	1.50	2.00	2.50	3.00
0.70	0.50	0.20	0.39	0.46	0.51	0.55	0.60	0.64	0.67
	0.30		0.33	0.40	0.45	0.49	0.55	0.59	0.62
	0.10		0.29	0.35	0.41	0.45	0.51	0.55	0.59
0.50	0.50	0.20	0.34	0.39	0.43	0.46	0.51	0.54	0.56
	0.30		0.29	0.34	0.39	0.42	0.47	0.50	0.53
	0.10		0.26	0.31	0.35	0.39	0.44	0.47	0.50
0.30	0.50	0.20	0.29	0.33	0.36	0.38	0.42	0.44	0.46
	0.30		0.25	0.29	0.33	0.35	0.39	0.42	0.44
	0.10		0.22	0.26	0.30	0.33	0.37	0.40	0.42
0.00	0.00	0.00	0.17	0.19	0.22	0.24	0.26	0.28	0.30
BZ Class			5	5	5	5	5	5	
DF[F]			0.17	0.19	0.22	0.24	0.26	0.28	0.30
DF[W]			0.24	0.22	0.19	0.17	0.15	0.13	0.11
DF[C]			0.45	0.45	0.45	0.45	0.45	0.45	0.45
DF[V]Cylindrical			0.03	0.04	0.05	0.06	0.07	0.08	0.09
DF[S]Scalar			0.05	0.06	0.07	0.08	0.09	0.10	0.11

Flux Fraction Ratio 1.10 — CIE Flux Code 7

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Assessing the Quality of Lift Service

Lampiran A

Quality of Service

Classification	Transportation Time
excellent	less than 45s
good	45s to 55s
fair	55s to 65s
satisfactory	above 65s

Calculation of Transportation Time

Transportation Time = INTERVAL(2+N)/4

Round Trip Time

To calculate the Round Trip Time it is necessary to determine the following :

- Probable number of stops per trip
- Travelling time allowing for acceleration and deceleration
- Door opening time
- Passenger entering and leaving time

$$S_P = S - S\left[\frac{(S-1)}{S}\right]^n$$

Where S_P = probable number of stops
S = number of floors served above ground floor
n = number of passengers entering lift on ground floor (normally taken as 80% of the lift contract load)

Where the population on each floor are different :

$$S_P = S - \left[\left[\frac{(P_t - P_1)}{P_t}\right]^n + \left[\frac{(P_t - P_2)}{P_t}\right]^n + \cdots \left[\frac{(P_t - P_n)}{P_t}\right]^n\right]$$

Where S_P = probable number of stops
S = number of floors served above ground
P_t = total population on all floors above ground
P_1 = population on floor 1
P_2 = population on floor 2
P_n = population on the nth floor
n = number of passengers entering lift at ground floor (normally taken as 80% of the lift car contract load)

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$$t = 2(dS_p + D + d)/V$$

Where
- t = total travelling time
- V = lift speed (m/s)
- d = acceleration distance
- S_p = probable number of stops
- D = Overall distance between ground and top floors

The acceleration distance depends on the particular lift drive and design speed and the following are normally used values :

Lift Speed	Type	Acceleration Distance(d)
0.5 m/s	Geared Rheostatic	0.3 m
1.0 m/s	Geared Rheostatic	1.5 m
1.5 m/s	Geared Rheostatic	2.6 m
1.5 m/s	Variable Voltage GR	1.3 m
2.0 m/s	Gearless Variable Voltage	2.2 m
2.5 m/s	Gearless Variable Voltage	3.1m
3.0 m/s	Gearless Variable Voltage	4.0 m

Door Width (mm)	Side Opening		Centre Opening	
	Opening	Closing	Opening	Closing
800	2.5	2.6	1.4	1.8
900	2.7	3.0	1.6	2.0
1100	2.9	3.7	1.9	2.6

Actual number of passengers entering	8	10	12	14	16	18	20
Passenger entering time (s)	8	10	11	13	14	16	20

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Transportation Capacity

The transportation capacity is defined as the total number of persons the lift installation can handle in a peak 5 minute period. The requirement depends on the type of building and the tenancy arrangement. The peak generally occurs during the morning when people are arriving to start work and the Transportation Capacity is normally specified as 17% of the total number of persons to be handled in a 5 minute period in the case of a single tenancy building and 12% in the case of a multi let building. The transportation capacity can be calculated as follows and has units of persons per 5 minutes :

Lift Capacity (kg)	900	1150	1400	1600	1800
Exit time per stop (s)	1.2	1.5	1.6	1.8	2.0

Door Width	800	900	1100	1200
Efficiency	0.92	0.92	0.95	1.00

$$\text{Transportation Capacity (5mins)} = (N \times n\ (5 \times 60)) / RTT$$

Where N = the number of lifts in the bank
n = number of passengers entering lift on ground floor (normally taken as 80% of the lift contract load)
RTT = round trip time

The Required Capacity is calculated from the following :

$$\text{Required Capacity (5 mins)} = \frac{\text{No of floors above ground floor} \times \text{floor area of each floor} \times Ps}{A_p}$$

Where Ps = Five-minute peak traffic as a percent of the building population above the ground floor
A_p = the occupancy density in sq.m per person

The value taken for Ps varies with the type of building and suggested values are given in the folowing table :

Five Minute Peak Traffic Ps	
Apartment building	6%
College residence	12%
Department Store	20%
Hospital	12%
Hotel	10%
Office(single tenant)	17%
Office(multi tenant)	12%

Standard Lift Car Sizes

Load kg	Persons
630	8
800	10
1000	13
1250	16
1600	21