Prince of Songkla University
Faculty of Engineering

Final Examination **Semester 1/2554**

11 October 2011 **Time 9:00-12:00**

215-663 Energy Management in Buildings **Room:** R201

Directions

- A4 paper is allowed and can be written **only one side of the A4 paper**.
- All types of calculator and dictionary are permitted.
- Attempt all 5 questions.
- The exam paper has 12 pages.

Juntakan Taweekun
Instructor

Problem	Marks
1	20
2	20
3	20
4	20
5	20
Total	100

Name _____

ID _____

Name ..... ID .....

Question 1 (20 marks)

The reflectance values of the surfaces of a room of length 6 m, width 6 m and height 3.5 m are ceiling 80%, wall 50% and floor 20%. The work plan is at 0.75 m from the floor and the fixtures are on the ceiling. Use LLF of 0.70. Task area and general area of this room is 15 m^2 and 20 m^2, remaining area is non-critical area. The value of Luminaire Coefficient of Utilization (CU) can be obtained from the following table.

Room Cavity Ratio	0	1	2	3	4	5	6	7	8	9	10
Luminaire Coefficient of Utilization	.55	.55	.50	.45	.40	.36	.32	.26	.26	.26	.26

The efficacy of lamp is 55 lm/W. If the uniform illuminance of visual task of 500 lux is required, calculate

(1.1) Total electric power required (in unit of Watt)

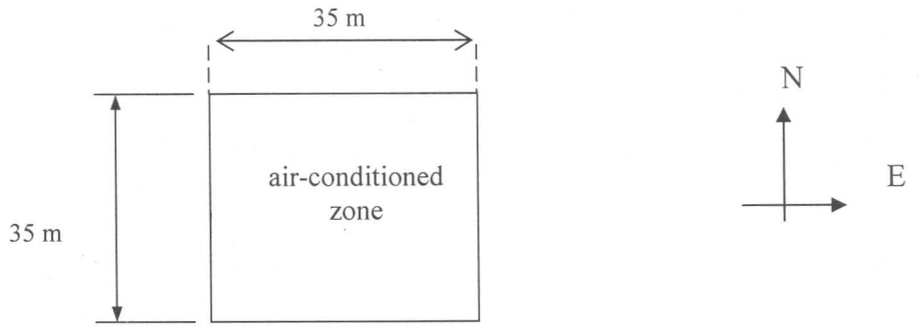
(1.2) Power intensity for this room (W/m^2)

(1.3) Compare result from (1.2) with the maximum allowable power for illumination in building interior which recommended by ASHRAE for office

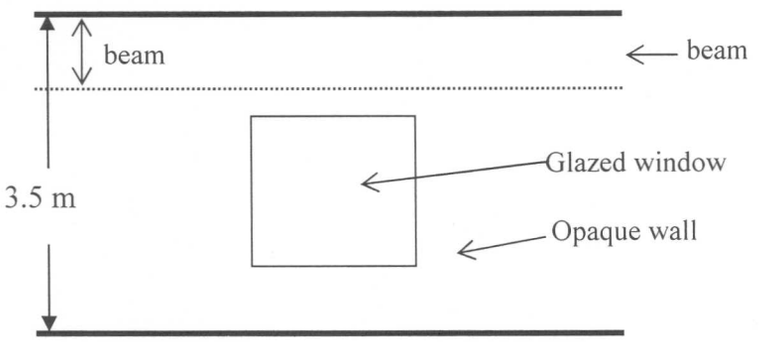
Name ..... ID .....

Question 2 (20 marks)

The arrangement of a typical floor in a square office building is as shown.



A) Building plan



B) Details on the wall of a storey, WWR 0.25

The wall of the building comprises a beam, an opaque section, and a glazed window as shown. The height of each floor is 3.5 m and the ratio of window area to overall wall area (WWR) is 0.25. The facades of the building face cardinal directions. Material details of the beam, glazing and opaque wall are given in the following table.

Section	Details
Beam	Concrete slab, thickness 40 cm, width 60 cm, Low-color exterior (α_b=0.3) k 0.8 $Wm^{-1}K^{-1}$, density 1,800 kgm^{-3}
Glazing	Single, reflective gray 6 mm, SC 0.6, U_f 5.96 $Wm^{-2}K^{-1}$
Opaque wall	Plaster-brick-plaster, 1-8-1 cm Low-color exterior (α_w=0.3) Plaster: k 0.9 $Wm^{-1}K^{-1}$, density 1,700 kgm^{-3} Brick: k 0.7 $Wm^{-1}K^{-1}$, density 1,400 kgm^{-3}

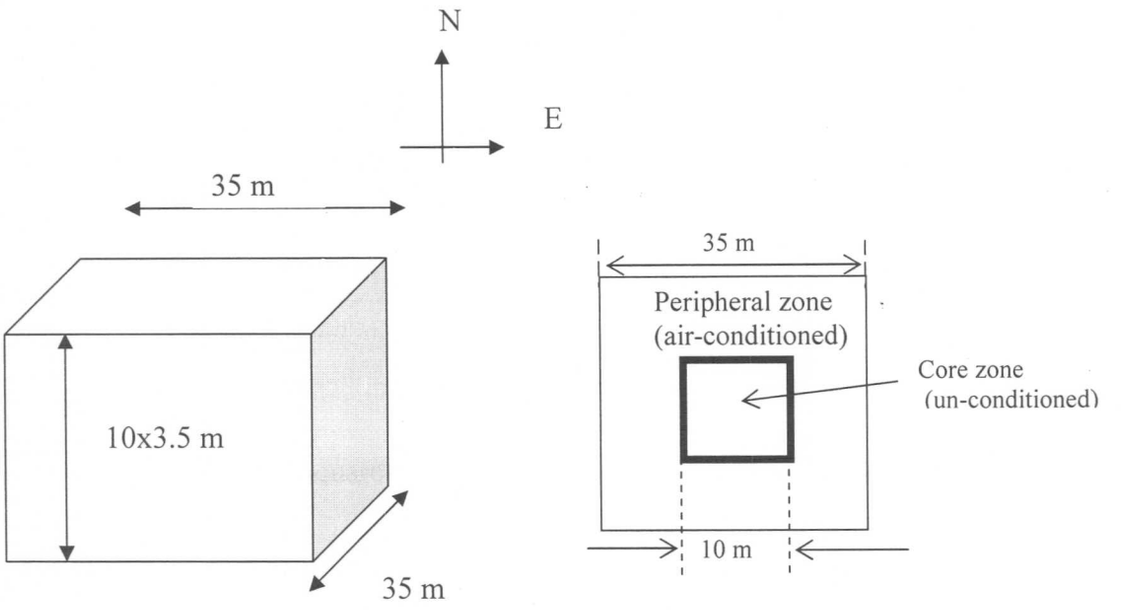
Here, the columns are neglected. The value of h_o is 22 $Wm^{-2}K^{-1}$ and h_i is 8 $Wm^{-2}K^{-1}$.

2.1) Calculate U value of each wall component
2.2) Calculate the wall OTTV of this building

Name ..... ID .....

Question 3 (20 marks)

A office building has a square shape as shown. The building comprises 8 floors.



The following information are applicable.

- OTTV = 35 Wm^{-2}
- RTTV = 10 Wm^{-2}.
- Uniform lighting is used
  - Office space 22 Wm^{-2}
  - Circulation area 9 Wm^{-2}
- Office equipment 8 Wm^{-2}
- Number of people: 1 person/10 m^2 of office space
- Ventilation in office space 1 l/(s.m^2), 25 W/(l/s)
- Total average power taken by lifts are 40 kW during office hours.
- System COP of air-conditioning system is 2.5.
- Security lighting during night time totals 40 kW
- Day time operating hours 2,500 per annum
- Night time operating hours 4,200 per annum

Compute the followings

i) Average cooling load due to external factor (kW)
ii) Average cooling load of the building (kW)
iii) Average electrical power for day time (kW)
iv) Average electrical power for night time (kW)
v) Annual energy consumption ($kWhm^{-2}Yr^{-1}$)

Name ..... ID .....

Question 4 (20 marks)

At the design condition, an air-conditioner is rated at 100 kW_{th}. It is expected to supply air at 14°C, RH 85%, with a supply flow rate of 5 kg/s. When the air-conditioner is used in a space, the latent load is 5 kW and the sensible load is 50 kW.

i) Calculate the condition of the air in the room

ii) Calculate the ventilation load when the ventilation air flow is at 0.5 kg/s and the outside condition is given as T_o 35°C, RH_o 70%

Name ..... ID .....

Question 5 (20 points)

An air stream flowing at 1 kg/s, with dry-bulb temperature of 30 °C and RH of 60 %, is cooled down to 20 °C and RH 90%.

a) What is the cooling load to the air-conditioner and what are the values of sensible and latent loads?
b) How much water is condensed per hour?

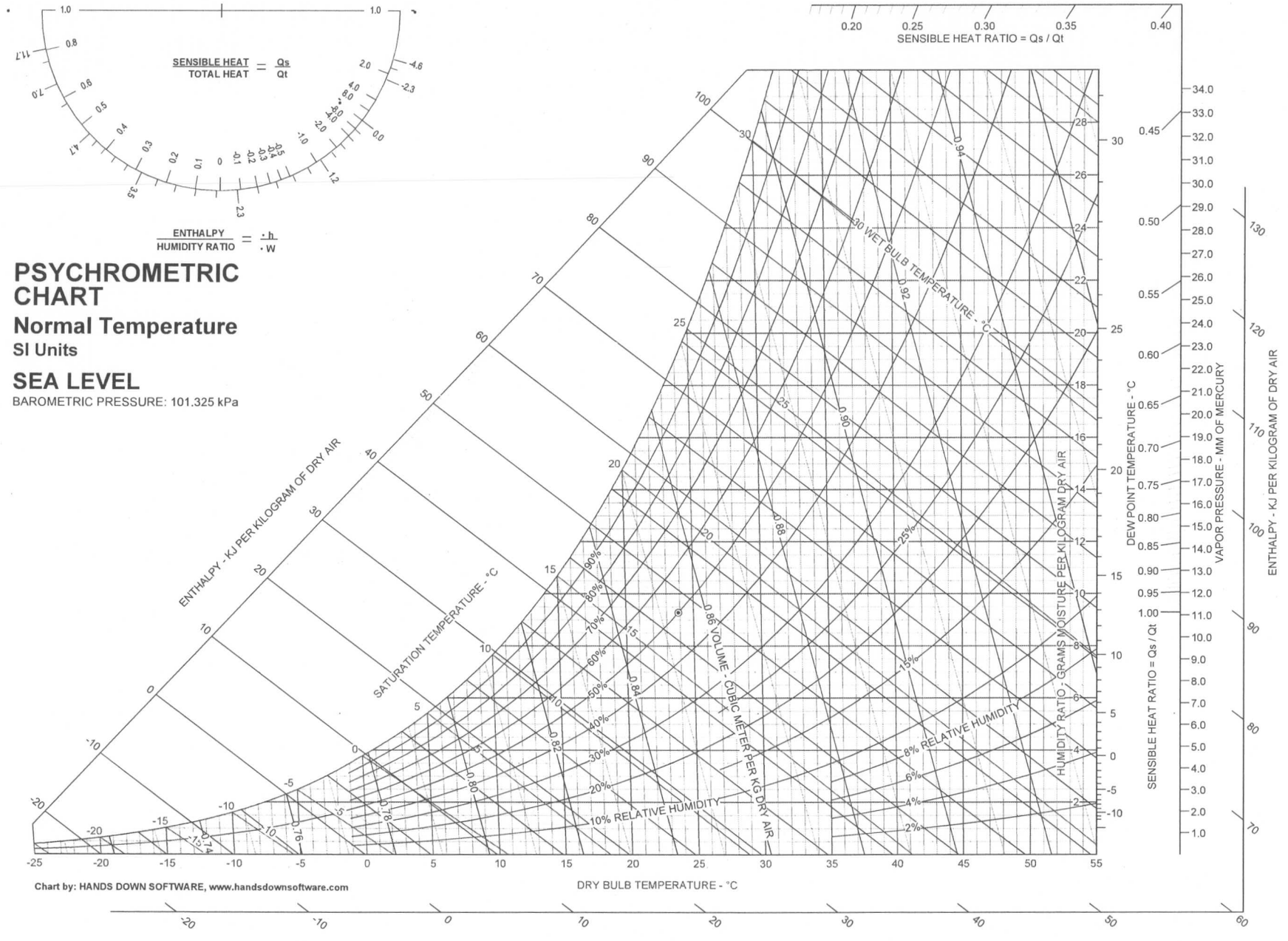
Appendix

Table 1 The values for TD_{eq} for wall in the Thai Standard.

Wall Mass kg/m^2		TD_{eq} (°C)				
		Level of solar absroptivity, α_w				
		0.1	0.3	0.5	0.7	0.9
Light,	< 125	14	15	16	17	18
Medium,	125-195	11	12	13	14	15
Heavy,	>195	9	10	11	12	13

Table 2 Value for Correction Factor (CF).

Plane Inclination	N	N-E	E	S-E	S	S-W	W	N-W
70°	1.06	1.24	1.52	1.63	1.63	1.60	1.48	1.22
75°	0.96	1.14	1.42	1.52	1.50	1.48	1.38	1.12
80°	0.87	1.05	1.32	1.40	1.37	1.37	1.28	1.02
85°	0.78	0.96	1.22	1.29	1.27	1.25	1.17	0.93
90°	0.70	0.87	1.12	1.17	1.11	1.13	1.03	0.84


SENSIBLE HEAT / TOTAL HEAT = Qs / Qt
ENTHALPY / HUMIDITY RATIO = ·h / ·W
PSYCHROMETRIC CHART
Normal Temperature
SI Units
SEA LEVEL
BAROMETRIC PRESSURE: 101.325 kPa
SENSIBLE HEAT RATIO = Qs / Qt
ENTHALPY - KJ PER KILOGRAM OF DRY AIR
SATURATION TEMPERATURE - °C
WET BULB TEMPERATURE - °C
VOLUME - CUBIC METER PER KG DRY AIR
RELATIVE HUMIDITY
HUMIDITY RATIO - GRAMS MOISTURE PER KILOGRAM DRY AIR
DEW POINT TEMPERATURE - °C
VAPOR PRESSURE - MM OF MERCURY
SENSIBLE HEAT RATIO = Qs / Qt
ENTHALPY - KJ PER KILOGRAM OF DRY AIR
DRY BULB TEMPERATURE - °C
Chart by: HANDS DOWN SOFTWARE, www.handsdownsoftware.com