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Prince of Songkla University
Faculty of Engineering

Final Examination

3 October 2006

215-663 Energy Management in Buildings

Semester 1/2549

Time 9:00-12:00

Room: A401

Directions

- This is an open book examination.
- All types of calculator and dictionary are permitted.
- Attempt all 4 questions (11 pages)
- Students may not borrow books and note, nor talk to each other.

Juntakan Taweekun
Instructor

Problem	Marks
1	15
2	15
3	20
4	20
Total	70

Name _____

ID _____

Name ID

Question 1 (15 marks)

At the design condition, an air-conditioner is rated at $100 \text{ kW}_{\text{th}}$. It is expected to supply air at 14°C , RH 90%, 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 $T_o 35^\circ\text{C}$, $\text{RH}_o 60\%$

Name ID

Question 2 (15 marks)

The reflectance values of the surfaces of a room of length 7 m, width 7 m and height 3.5 m are ceiling 80%, wall 50% and floor 20%. The work plane 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 20 m² and 22 m², 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

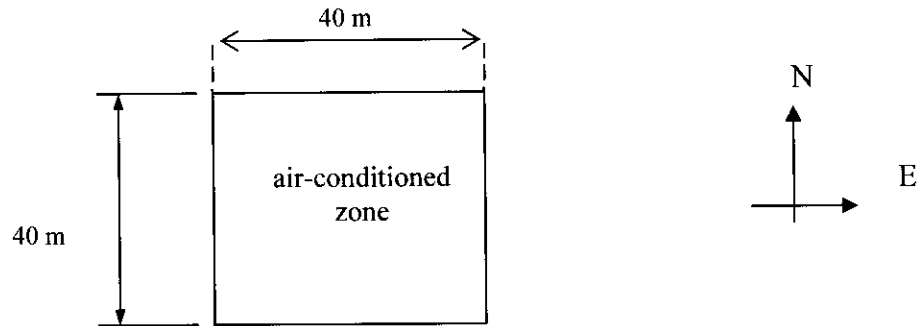
The efficacy of lamp is 60 lm/W. If the uniform illuminance of visual task of 500 lux is required, calculate

- (2.1) Total electric power required (in unit of Watt)
- (2.2) Power intensity for this room
- (2.3) Compare result from (2.2) with the maximum allowable power for illumination in building interior which recommended by ASHRAE for office

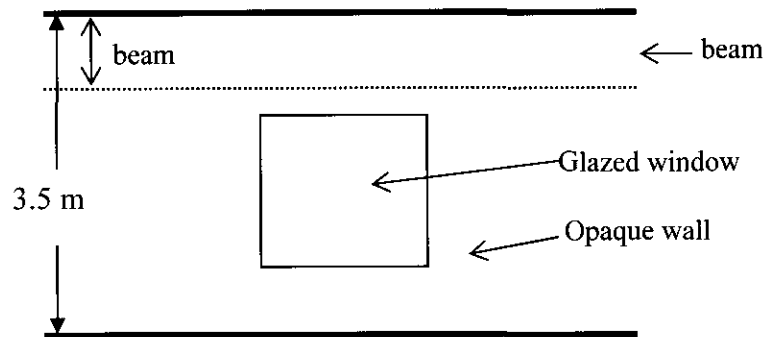
Name ID

Question 3 (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 0.38

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 0.38. 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, Medium-color exterior ($\alpha_b=0.5$) 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 Medium-color exterior ($\alpha_w=0.5$) 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}

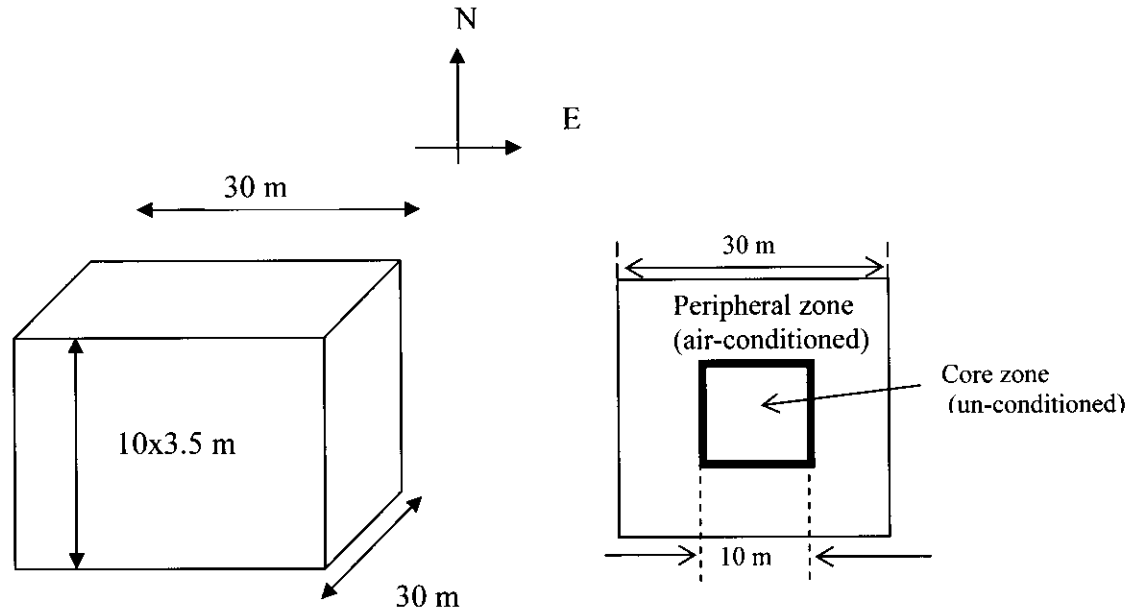
Here, the columns are neglected. The value of h_o is 22 $Wm^{-2}K^{-1}$ and h_i is 8 $Wm^{-2}K^{-1}$.

- (3.1) Calculate U value of each wall component
- (3.2) Calculate the wall OTTV of this building

Name ID

Question 4 (20 marks)

A office building has a square shape as shown. The building comprises 10 floors.



The following information are applicable.

- OTTV = 45 Wm^{-2}
- RTTV = 8 Wm^{-2} .
- Uniform lighting is used
 - Office space 23 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.m²), 25 W/(l/s)
- Total average power taken by lifts are 55 kW during office hours.
- System COP of air-conditioning system is 2.5.
- Security lighting during night time totals 50 kW
- Day time operating hours 2,500 per annum
- Night time operating hours 4,200 per annum

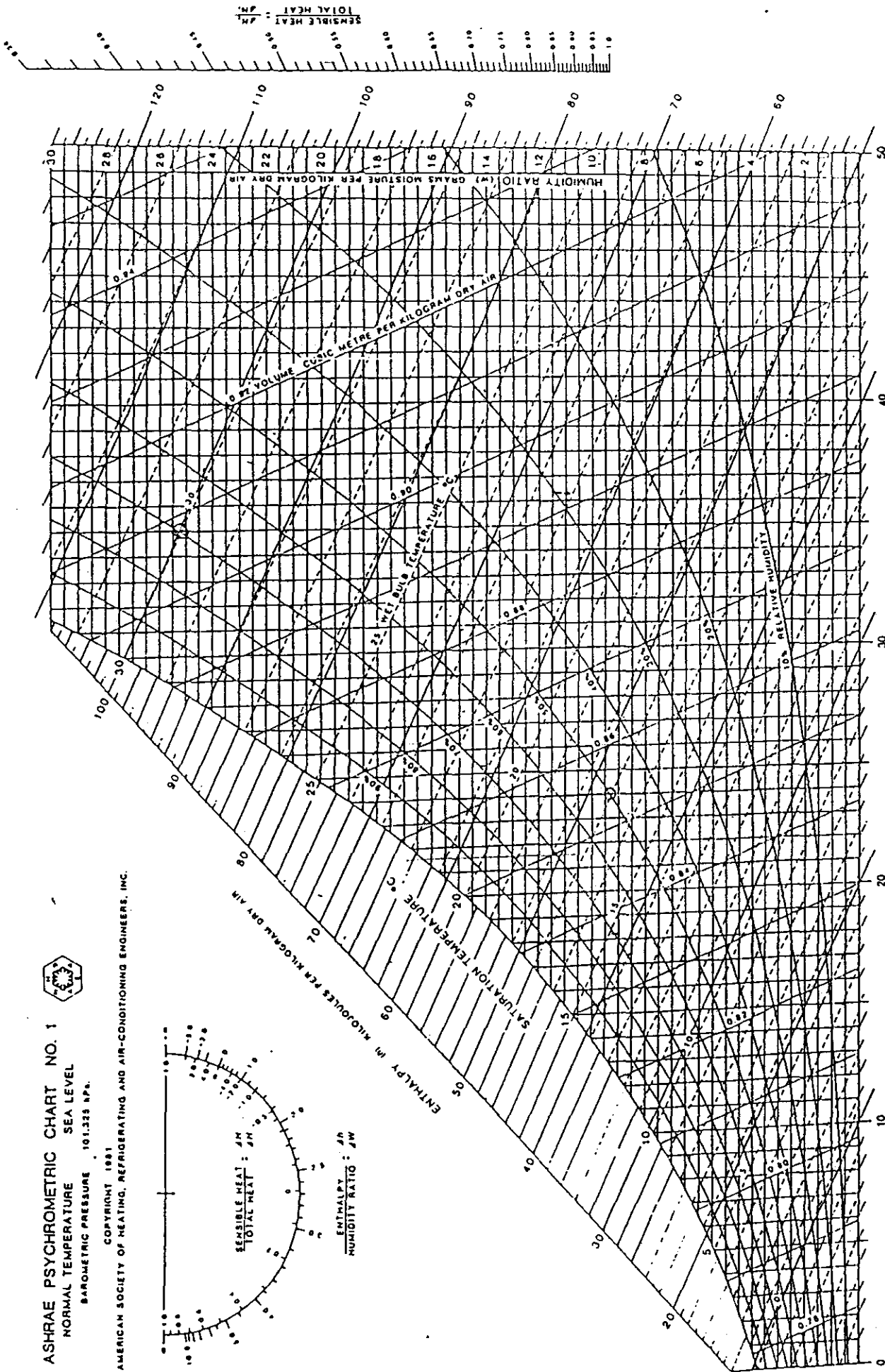
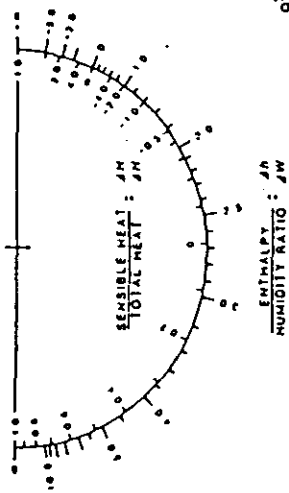
Compute the followings

- 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 ($\text{kWhm}^{-2}\text{Yr}^{-1}$)

ASHRAE PSYCHROMETRIC CHART NO. 1

NORMAL TEMPERATURE SEA LEVEL
 BAROMETRIC PRESSURE 101.325 kPa.

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Fig. 4 ASHRAE Psychrometric Chart