

Prince of Songkla University
Faculty of Engineering

Final Examination
6 October 2009
215-663 Energy Management in Buildings

Semester 1/2552
Time 9:00-12:00
Room: R201

Directions

- A4 paper is allowed and can be written two sides of the A4 paper.
- All types of calculator are permitted.
- Attempt all 5 questions.
- The exam paper has 9 pages.

Juntakan Taweekun
Instructor

Problem	Marks	
1	15	
2	20	
3	20	
4	20	
5	20	
Total	95	

Name _____

ID _____

Name-Surname _____ ID _____

Question 1 (15 points)

A sedentary person generates CO₂ at a rate of 0.009 g/s. If the ventilation rate for a room in which the person resides is 10 l/s, and if the ventilation air contains:

- 0.5 g/m³ of CO₂,
- 10 mg/m³ of CO and
- 360 µg/m³ of SO₂

What would be the concentration of CO₂, CO and SO₂ in the room? Assume 1 m³ of air weighs 1.2 kg.

Question 2 (20 points)

The reflectance values of the surfaces of a room of length 5 m, with 5 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 10 m² and 12 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 55 lm/W. If the uniform illuminance of visual task of 480 lux is required, calculate

- a) **Total electric power required (in unit of Watt) and power intensity for task area, general area and non-critical area**
- b) **Power intensity for this room**
- c) **Is the calculated power intensity for this room in the acceptable range? If the answer is “No”, explain at least 3 methods how to minimize the power intensity of this room.**

Name-Surname _____ ID _____

Question 3 (20 points)

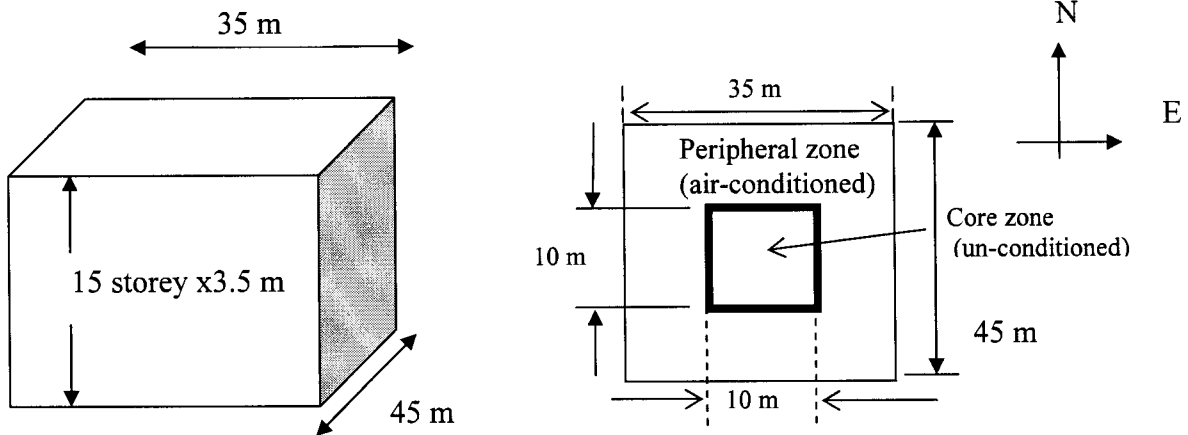
For a given time of a given day, the temperature and relative humidity of the air outside of an air-conditioning space are $T_o = 30\text{ }^\circ\text{C}$ and $RH_o = 80\%$, respectively. The space houses 100 occupants. The space cooling load at the time is given in the followings.

Item	External Source (kW)		Internal Source (kW)		Total (kW)	
	Sensible, S	Latent, L	Sensible, S	Latent, L	Sensible, S	Latent, L
Space Cooling Load	22	-	20	12	42	12

The air-conditioning system is rated at 100 kW (thermal). It draws 0.5 kg/s of outside air for ventilation. The cooling effect provided by the air-conditioner varies with load. At a steady and balance condition it supplies cool air at 15 °C. At the outlet of the system the air is saturated and the flow rate supply air is 3 kg/s. **Find the ventilation load and the condition of the air in the space. Also mark the values obtained in the Psychrometric Chart as attachment.**

Question 4 (20 points)

The arrangement of a typical floor in a office building is as shown. The building comprises 15 floors.



The following information are applicable.

- OTTV = 45 Wm^{-2}
- RTTV = 12 Wm^{-2} .
- Uniform lighting is used
 - Office space 23 Wm^{-2}
 - Circulation area 10 Wm^{-2}
- Office equipment 9 Wm^{-2}
- Number of people: 7 person/ 100 m^2 of office space
- Ventilation in office space $0.8 \text{ l/(s.m}^2)$, 24 W/(l/s)
- Total average power taken by lifts are 70 kW during office hours.
- System COP of air-conditioning system is 2.5.
- Security lighting during night time totals 30 kW
- Day time operating hours 2,400 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 ($\text{kWhm}^{-2}\text{Yr}^{-1}$)

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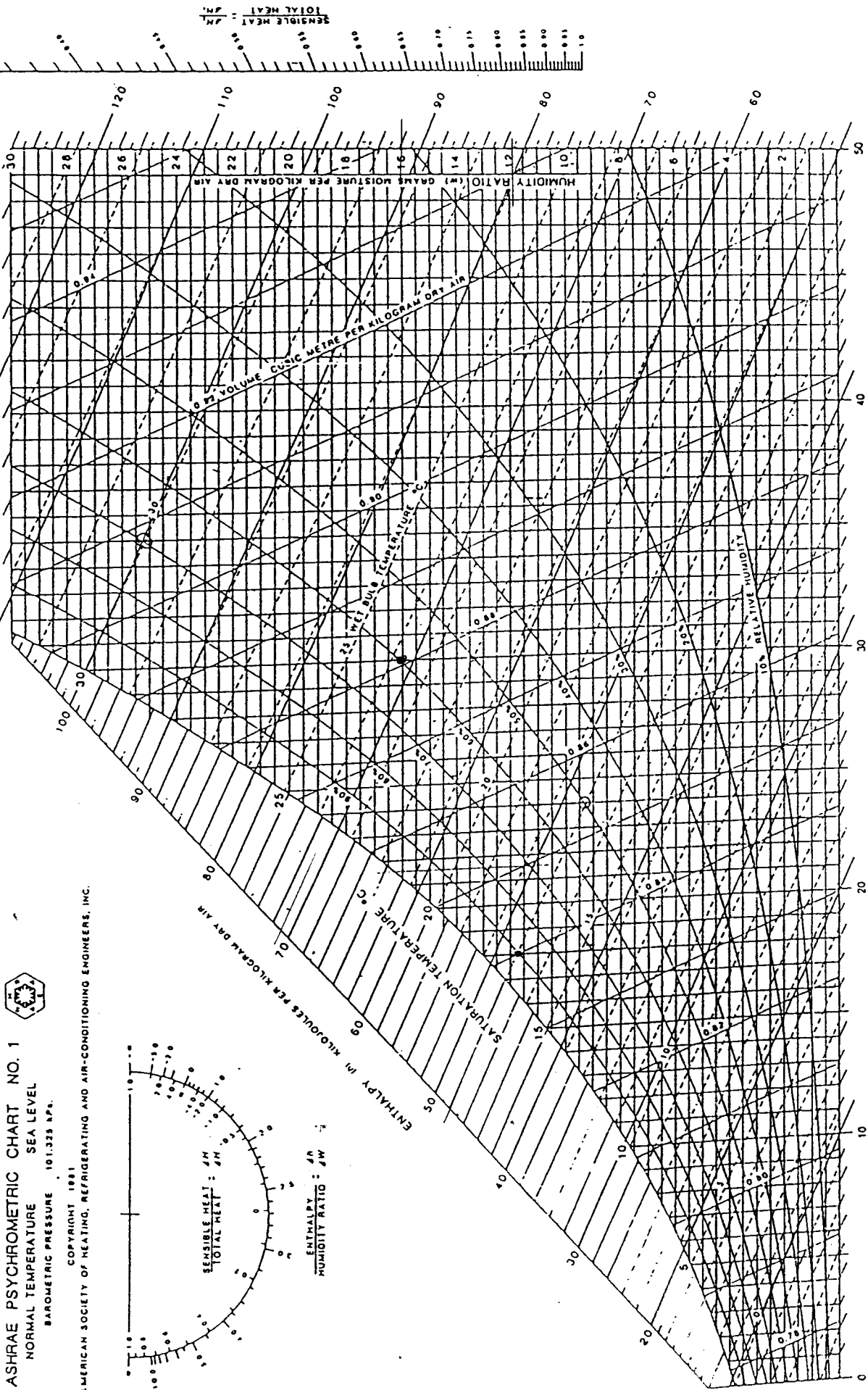
Question 5 (20 points)

An air stream flowing at 1 kg/s, with dry-bulb temperature of 30 °C and RH of 50 %, 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?**

ASHRAE PSYCHROMETRIC CHART NO. 1
 NORMAL TEMPERATURE SEA LEVEL
 BAROMETRIC PRESSURE 101.325 kPa.

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Prepared by Climate Control Institute, Inc. (formerly known as the University of Houston)

Fig. 4 ASHRAE Psychrometric Chart