ME 491 THERMAL SYSTEMS DESIGN

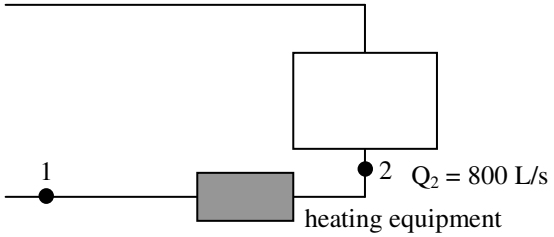
Final Exam

December 11, 2004 (Time: 3 hours)

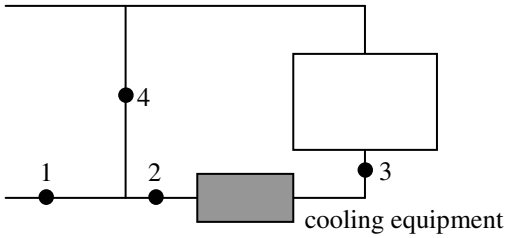
This is an **open book** exam (text, notes and any other relevant material are allowed).
Answer **all 5 questions** and please note that psychrometric charts for sea level are attached.
State all **assumptions** and justify, where possible.
Reference all data used.

Marks

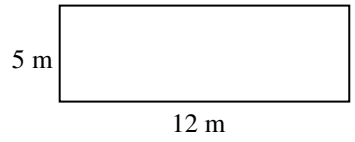
1. A small building in Edmonton, Alberta has a space heating load of 18000 W. If the volume flow rate of air to the space is 800 L/s, what must the temperature of the supply air delivered to the building be? (10)



2. A space in a hot dry climate has a total cooling load of 40 kW with a SHF of 0.75. If the maximum outdoor ventilation rate that the fan can supply is 0.7 kg/s, what is the minimum relative humidity that can be maintained in the space when the indoor temperature is 24°C and the outdoor conditions are 33°C and 5% RH? (10)



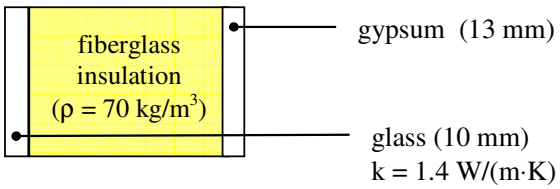
3. Determine the design heating load and annual energy consumption for a 3 m high insulated detached garage in Saskatoon (shown below). The garage has walls with a U-value of 0.40 W/(m^2·K) and a roof with a U-value of 0.30 W/(m^2·K). It also has 2 double-pane windows (0.5 m x 0.5 m each), 3 insulated steel overhead doors (3 m x 3 m each) and one insulated steel door (1 m x 2m). Assume that the infiltration is 1 ach and the efficiency of the natural gas furnace is 90%. (15)



Marks

4. A building in Phoenix, Arizona has an insulated curtain wall with an area of 600 m^2 and a construction as shown below. Determine the thickness of fiberglass insulation (density = 70 kg/m^3) needed to keep the cooling load due to conduction through the wall below 10 kW. The values of total solar radiation and the radiant time factors for the building are given below. (15)

time	G_t (W/m^2)	time	G_t (W/m^2)
1:00	0	13:00	950
2:00	0	14:00	800
3:00	0	15:00	700
4:00	0	16:00	450
5:00	0	17:00	300
6:00	0	18:00	150
7:00	30	19:00	30
8:00	150	20:00	0
9:00	300	21:00	0
10:00	450	22:00	0
11:00	700	23:00	0
12:00	800	24:00	0



Radiant time factors	r_0	r_1	r_2
Non-solar	0.7	0.3	0.0
Solar	0.5	0.4	0.1

5. A gymnasium with a total space cooling load of 180 kW is being built in Williston, North Dakota. The maximum load occurs when 1000 fans are watching two simultaneous volleyball matches (i.e., 4 teams with 6 players per team). Design the ventilation and cooling system to condition this gymnasium with and without an air-to-air energy recovery system. Would you recommend the owner to install an air-to-air energy recovery system? Explain. (10)

TOTAL 60