**Fall '10**
**1.044J, 2.66J, 4.42J**
**Homework Set #3**

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**1)** Simmons Hall, the newest MIT student dorm on campus should be operated to minimize energy use. One proposed strategy to reduce air conditioning energy in the summer is night cooling. At 8 p.m. the windows are opened and cool night air is circulated through the room. By 8 a.m. the room air and the concrete floor slab have a temperature close to that of the outside air, 18 degrees Centigrade. The slab is four inches thick. At 8 a.m. the windows are closed and heat transfer to the cooled floor slab helps to maintain a comfortable interior temperature. Neglect any heat transfer through the closed windows. Assume that the average rate of electrical and solar energy into the room totals 500 watts over the 12 hours.

a)Sketch the room temperature vs. time for the 12 hour period between 8 a.m. and 8 p.m. What is the maximum room temperature? Assume as a limiting case that the slab and the air temperature are always equal. In reality, do you expect the slab to be at a lower or higher temperature than the air?
b) Can you suggest an improved strategy for window opening and closing during the day?

**2)** To supplement the night cooling strategy described above, it is proposed to spray liquid water droplets into the air. If the room air at 8 a.m. is completely dry what is the maximum amount of liquid water that can be evaporated into the room air at 18 degrees Centigrade? Assume that the room is closed up and there is no air circulation from the outside into the room.

**3)** Using both night cooling and the maximum amount of liquid water evaporation in the room, estimate the room temperature at 8 p.m. From 8 a.m. to 8 p.m. the windows are closed and the average electrical and solar energy into the room totals 500 watts. To solve, write an energy balance for a system including the floor slab, the water and the air. Take state 1 as liquid water, floor slab and air at 18 degrees Centigrade, the conditions at 8 a.m. Take state 2 as the slab and saturated air at 8 p.m.

**4)** What do you think about the feasibility of the proposed solutions?

**5)** You are interested in investigating the thermal stratification in your dorm room, which directly impacts our assumption that the slab and air temperatures are equal. Chose 4 locations in your room, 2 of which are in the immediate vicinity of your highest power consuming appliances identified in the first problem set. At each location, use the Vernier LabQuest and temperature probe to measure the floor temperature and air temperature at the following heights (1 in, 2 ft, 4 ft, 6 ft, 8 ft above floor). Allow enough time at each height for the temperature reading to reach steady state (ie to settle on a value and not change).

How justified is our assumption about the slab and air temperatures? Is the thermal stratification different at each location? If so, please justify any differences.

4.42J / 1.044J / 2.45J Fundamentals of Energy in Buildings
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