Fall'08
1.044J, 2.66J, 4.42J
Homework Set #2

1. True story: an inventor has a new device to heat a room. It consists of a heater, a coil of electrically heated resistance wire, and a fan to force air across the heater coil. The heater and the fan are on separate circuits. The inventor is surprised to find that the air temperature passing through the device is increased even when the heater is shut off. Newspapers run the story and proclaim a new way to heat a room without the use of heating energy. A reporter finds out that you are a building energy expert, a graduate of 4.42. You are asked for your opinion.

2. One means proposed to conserve energy for space heating is the use of night setback; the interior temperature of a building is reduced during the evening. The heat transferred from the building to the outside air is directly proportional to the temperature of the building for a fixed outdoor temperature.

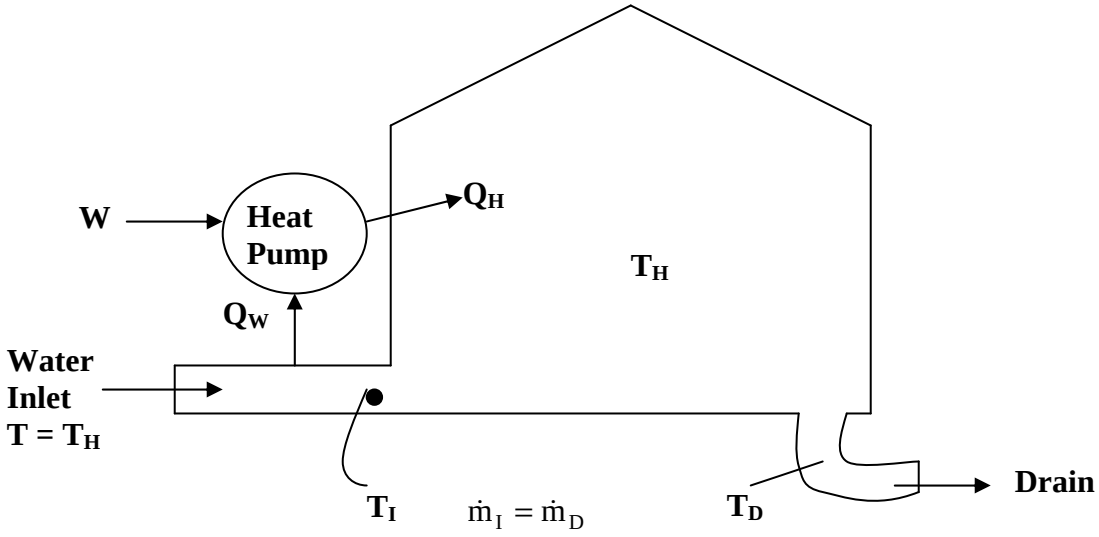
a) For a massive building and for a very light frame building, sketch the temperature time behavior between day and night with night setback controls. Which of these two will be more effective for saving energy with night setback? Consider the energy balance for a 24 hour period.

b) Some people have questioned this strategy claiming that the total energy saved by night setback is reduced because of the additional energy needed to raise the interior temperature in the morning. Consider a 24-hour period for a building. The internal energy of the building is proportional to the temperature. Be careful in defining the system and the heat and work interactions at the boundaries. What is the net energy change for the system over the 24-hour period? How much impact does the reheating energy in the morning have on the savings due to the night setback?

3. The door to an ordinary electric home refrigerator is left open by accident (with the power on) while the people are away for the weekend. If the kitchen doors are closed and the room is thermally well insulated, will the room be hotter than, colder than, or at the same temperature as the rest of the house when the unhappy people return? Why?

4. An investigator suggests use of a heat pump to provide winter heating to a building. Instead of using the outside air as the low temperature heat source, she proposes to use the domestic water system which enters the house at a higher temperature than the outside air. This raises the heat pump average coefficient of performance Q_H/W from 2.5 to 3.0. As the heat pump operates, Q_w is transferred from the water, lowing T_I, the inlet water temperature to the house. To simplify the consideration assume the initial water temperatures is T_H same as the interior temperature. The house temperature is constant at T_H. Evaluate the net energy electrical savings under two conditions:

- **(a)** The water quickly flows through the house and there is no heat transfer between the water and the interior of the house. T_D the water drain temperature equals T_I with or without the heat pump.
- **(b)** The water remains in the house for a long time. Heat transfer to the water in the house raises it temperature to the interior temperature T_H, so that T_D is equal to T_H no matter how much T_I changes.
- **(c)** Comment on the feasibility of such a system.



4.42J / 1.044J / 2.66J Fundamentals of Energy in Buildings
Fall 2008