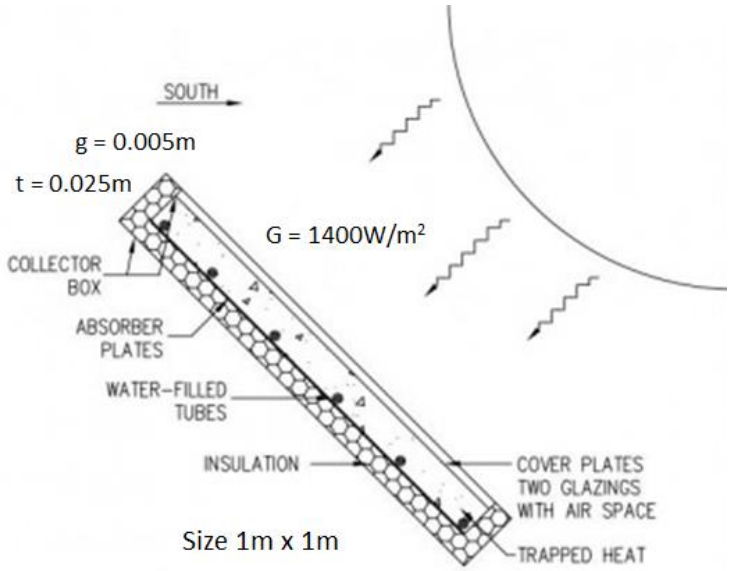
DESIGN PROJECT **ME3345** **Spring 2015** **Hesketh**

Assigned March 2nd Due April 24th

1. Select one project
2. You may use a combination of analytical and numerical methods to solve the problem.
3. Indicate in a short paragraph what makes your solution to the problem a good design.
4. Individual work only permitted on this project.
5. Hand in your MatLab code or COMSOL or ANSYS with the solution.

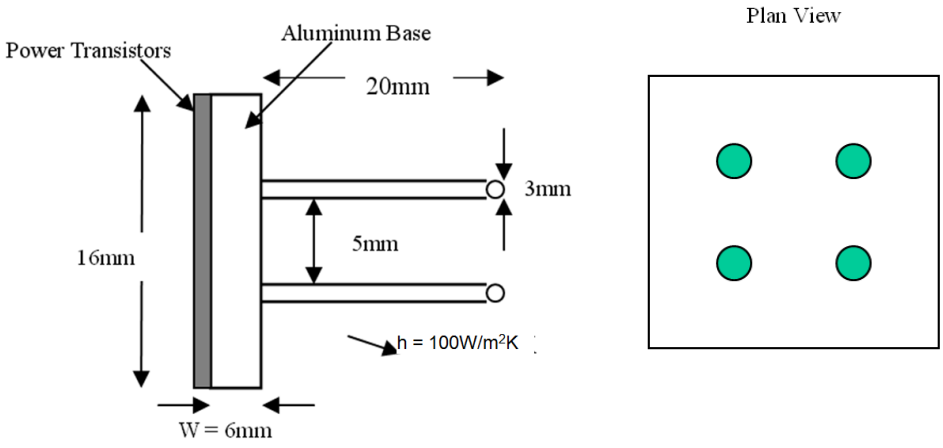
(SELECT ONE ONLY)

Problem 1:



Solar panel is receiving radiation from the sun and heating water at a constant rate flowing in the channel over the collector. The question is should the designer use one or two panes of glass for the front of the collector. The dimensions are given in the figure. Calculate the temperature of the collector plate assuming it is insulated on the back. Estimate the increase in water temperature as a function of the sun angle to the normal. Assume the transmission of the glass is 100% in the visible, but opaque to the infrared with emissivity 0.7, and diffuse and gray in the infrared range. Finally calculate the temperature of each pane of glass under steady-state conditions.

Problem 2:



Consider the electronic cooling of a power transistor which generated 4W of heat. The heat sink has 4 identical fins in a square array, spaced 5mm apart. Assuming the heat transfer coefficient is uniform and the heat flux provided by the generation in the chip is uniform. There is a thermal contact resistance between the power transistors and the heat sink base of 10^{-3} m^2K/W.

identify symmetry in this problem
Write out the finite difference code for the nodes you will use for the solution
Plot the temperature distribution in the heat sink
Determine the location of the highest temperature.

Alternatively you can use COMSOL or ANSYS

Problem 3:

During a manufacturing process, a ceramic slab of 2cm x 2cm x 1mm has to be heated to 550°C, and cooled down to 50°C. This process is done in two different stages. The ceramic slab travels on conveyor belt of width equal to that of the slab, and at a constant speeds of 0.1m/sec.

The ceramic slab is initially at an ambient temperature of 20°C, when it starts traveling into a radiant heater. This heater surrounds the whole slab and emits heat as a black body at 1100°C. Since the heater surrounds the slab completely, all the energy that leaves the heater is absorbed by the slab. The slab has an emissivity of 0.85 below 177°C, and changes above 177°C using the following function:

$\varepsilon = 0.85 \cdot \frac{450^4}{T^4}$, where *T* is in °K

The heating stops when the slab reaches a temperature of 550°C and the slab has to be cooled down by blowing air at a speed of 35 m/sec from the top of the conveyor onto the slab. Ambient temperature is 20°C. This process will last until the slab cools dawn to 50°C. There is no heat transfer to the conveyor and only consider the top area of the slab for heat exchange with the heater and environment.

Plot the slab temperature versus time and temperature versus distance, from the moment it enters stage 1 until it cools down to 50°C. How long stage 1 and 2 have to be in order to reach the prescribed temperatures ?

Slab properties,

$Cp = 1500 J/Kg \cdot °K$

$\rho = 900 Kg/m^3$

$k = 2.5 W/m \cdot °K$