(Homework problems on free/natural convection

1. A 30 cm× 30 cm circuit board contains 121 square chips on one side is to be cooled by combined natural convection and radiation by mounting it on a vertical surface in a room at 25°C. Each chip dissipates 0.05 W of power, and the emissivity of the chip is 0.7. Assuming that the heat transfer from the back side of the circuit board to be negligible, and the surrounding surfaces are also at the room temperature, determine the surface temperature of the chip.   [33.4°C]

2. What would be the chip surface temperatures if the circuit board is place horizontally with (a) chips facing up, and (ii) chips facing down?

3. An incandescent lightbulb of approximately spherical in shape converts only 10% of its input to light energy and the remaining part is converted to heat and is dissipated by radiation and natural convection. Find the surface temperature of a 60 W bulb of 8 cm diameter that is hung in a quiescent air medium of 25° C. Assume the room where the bulb is housed is also at 25°C and the glass has an emissivity of 0.9.   [169°C]

4. A 15×20 cm² PCB has its electronic components on one side. The PCB is placed in a room at 20°C. The heat loss from the back of the house is negligible. If the circuit board is dissipating 8W of power in steady operation, determine the average temperature if the board is mounted (a) vertical, (b) horizontal with hot surface facing up, (c) horizontal with hot surface facing down.

    [46.6° C, 42.6°C, 50.7°C]

5. A long horizontal pipe of 200 mm diameter passes thropugh a room where the air is t 25°C. The pipe surface temperature is 130°C. Neglecting radiation, find the heat transfer per unit length of the pipe.

+ Incropera Dewitt Example 9.2, 9.4 and Problems 9.18 and 9.36