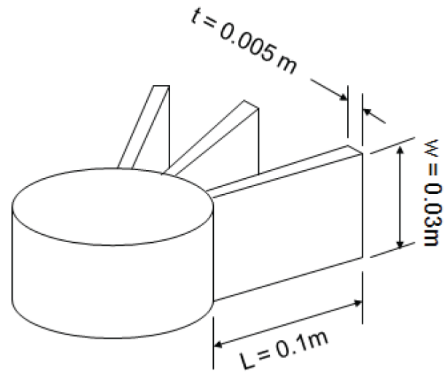
me263 – Fluids & Heat Transfer

Extended Surface Heat Transfer (Heat Sinks)

Question 1

The figure shows part of a set of radial aluminium (k = 180 W/m·K) fins that are to be fitted to a small air compressor. The device dissipates 1 kW by convecting to the surrounding air which is at 20°C. Each fin is 100 mm long, 30 mm high and 5 mm thick. The heat transfer coefficient that acts around each fin and over the remaining surface is h = 15 W/m²·C.

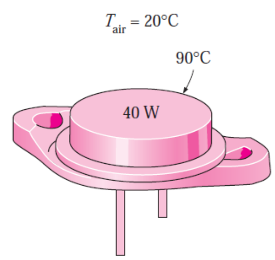


a. Estimate the number of fins required to ensure the base temperature does not exceed 120°C?
b. For your finished design what is the actual heat transfer output? (Include all your fins and the exposed surface of the base. Note that the cylinder in the center has an OD of 75 mm.)

Question 2

The case-to-ambient **thermal resistance** of a power transistor (similar to the one shown below – but with a different power rating) that has a maximum power rating of 10 W is given to be 25°C/W.

If the case temperature of the transistor is not to exceed 70°C, determine the power at which this transistor can be operated safely in an environment at 35°C.



Question 3

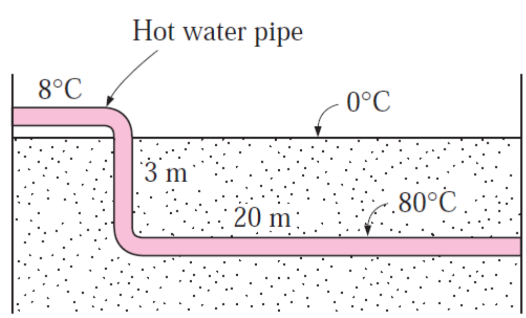
A 40-W power transistor is to be cooled by attaching it to one of the commercially available heat sinks shown in the class notes on Finned Cooling.

a. Select a heat sink that will allow the case temperature of the transistor not to exceed 90°C in the ambient air at 20°C. (You may notice that the answer to this has already been done and appears in the Finned HT Example problems.)

b. Now select a heat sink to will allow the transistor to operate when the case temperature does not exceed 60°C.

Question 4

Hot water at an average temperature of 80°C and an average velocity of 1.5 m/s is flowing through a 25 m section of a pipe that has an outer diameter of 5 cm. The pipe extends 2 m in the ambient air above the ground, dips into the ground (k_{GROUND} = 1.5 W/m · °C) vertically for 3 m, and continues horizontally at this depth for 20 m more before it enters the next building.



The first section of the pipe is exposed to the ambient air at 8°C, with a heat transfer coefficient of 22 W/m2 · °C.

If the surface of the ground is covered with snow at 0°C, determine:

a. the total rate of heat loss from the hot water; and,
b. the temperature drop of the hot water as it flows through this 25-m-long section of the pipe. (You may recall: $\dot{Q} = \dot{m}C_P\Delta T$) (Also … assume the pipe has **<u>zero wall thickness</u>** Magic!)