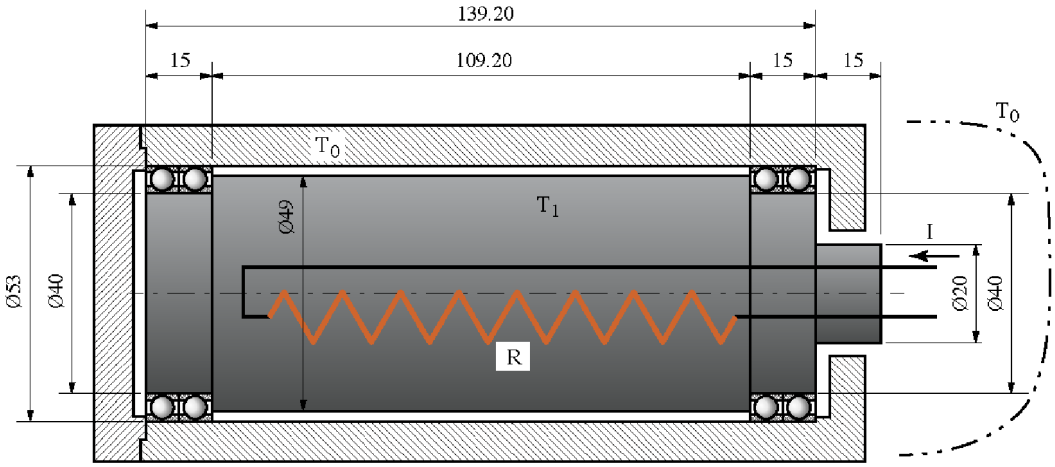
EE-580 Space Mechanisms

Exercise 4.4 - Thermal Equilibrium

v.01

Problem Statement

The thermal model of a mechanism is given by the following picture



The temperatures of the axis (T_1) and of the housing (T_0) are considered to be homogeneous and in steady state equilibrium.
A heater with an electrical resistance R is mounted on the axis.
The axis and the housing are in Aluminum with an Alodine coating (Emittance = 0.15).
The temperature is in steady state.
The thermal conductivity of a ball-bearing is 0.013 W/K.

Questions

With an electrical resistance of 5 Ω and a current of 1 A. calculate the temperature of the axis, taking into account that the housing is maintained at a constant temperature of 35°C:

- In the case where the axis and the housing are considered as black bodies
- Optional: in the case where the housing and axis are in aluminum (surface treatment Alodine 1200, emittance $\epsilon = 0.15$)

Hint: for the last question take a look at doc. [4.6] in the Moodle (Radiation Heat Transfer Between Planar Surfaces http://web.mit.edu/16.unified/www/FALL/thermodynamics/notes/node136.html)