Exam 2 – 2019/2020: Problem 3

1. (4.0 points) Consider a cylindrical rod with a diameter equal to 0.02 m and at 1000 K that is placed horizontally in the middle of a large furnace filled with quiescent air at 600 K. The internal furnace walls are at a constant temperature of 1100 K. Assume that the stated temperatures are the corresponding equilibrium (steady-state) temperatures. Consider the cylindrical rod surface as opaque and diffuse with the spectral, hemispherical emissivity at 1000 K given by the following equation.

$$\varepsilon_\lambda = \begin{cases} 0.1, & 0 < \lambda < 6\,\mu\text{m}. \\ 0.8, & \lambda > 6\,\mu\text{m}. \end{cases} \tag{1}$$

   (a) (1.5 points) Determine the steady-state total, hemispherical emissivity of the cylindrical rod surface, ε. (If you did not solve this question, consider $\varepsilon = 0.3$ for the following question.)

   (b) (2.5 points) Determine the irradiation on the rod surface, G, due to the emission from the furnace walls. Consider the total, hemispherical absorptivity for the rod surface, α, equal to 0.25. Note that the rod is quite hotter than the quiescent surrounding air.