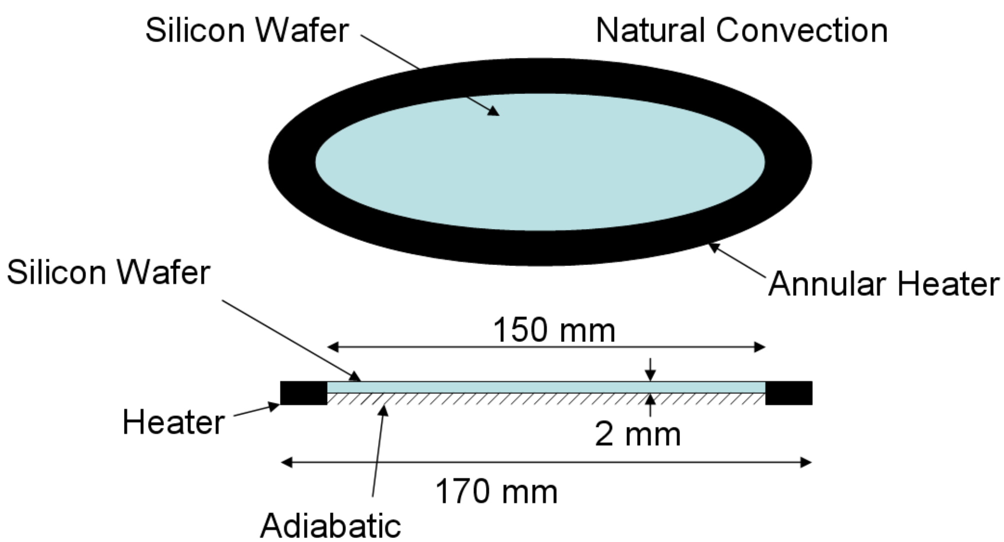
Question



Consider a silicon wafer of diameter 150mm heated by an annular heater, as shown in the figure above. The wafer is insulated on the back.

1. Starting from energy balance derive the heat diffusion equation with no energy generation within the wafer.
2. Develop an expression for the temperature distribution in the wafer as a function of radius.
3. Determine the steady-state heat flux required to maintain the surface temperature at the center of the wafer equal to $100^{o}C$.

Given the heat transfer coefficient is $20 W/m^2K$, ambient temperature is $20^{o}C$ and the thermal conductivity of silicon is 100 W/mK. Assume the heat flux from the heater is uniform.

Clearly state any assumptions you make.

Consider laminar flow of a liquid in a circular tube with a uniform wall temperature T_s. The fluid enters the pipe with a mean temperature $T_{m,i}$. Assume constant properties.

1. Show the expected variation of the mean fluid temperature $T_m(x)$ along the pipe length.
2. Determine an equation and any boundary conditions needed to solve for the cross-sectional temperature profile of the fluid at a given location a long distance from the inlet. Do not solve.
3. If the fluid is a high-viscosity oil and viscous heating is significant, determine the cross-sectional temperature profile a long distance from the inlet.

Radiation Problem.

Consider a cylindrical enclosure of diameter *D* and height *H*. The sides are insulated. The bottom is a black body at T_{hot}. The top of the enclosure is a very thin sheet of metal that has an emissivity of ε on both sides.

The surroundings are air at T_0. Heat is lost to the environment through both convection and radiation.

Air is blown over the (outside) top of the enclosure at with convection coefficient *h*.

Show how you would calculate the temperature at the top of the enclosure, T_{top}.