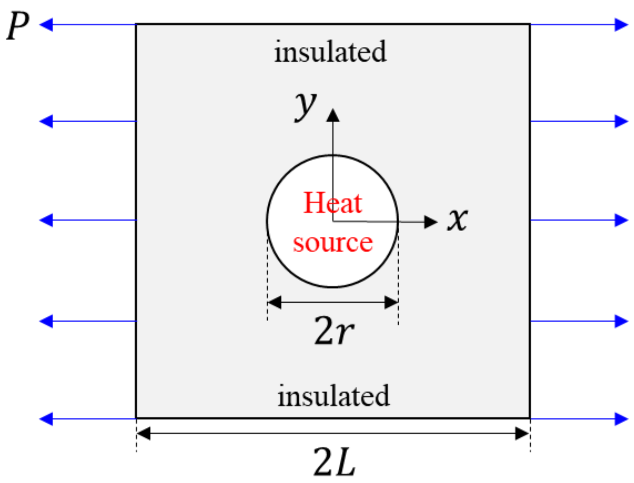
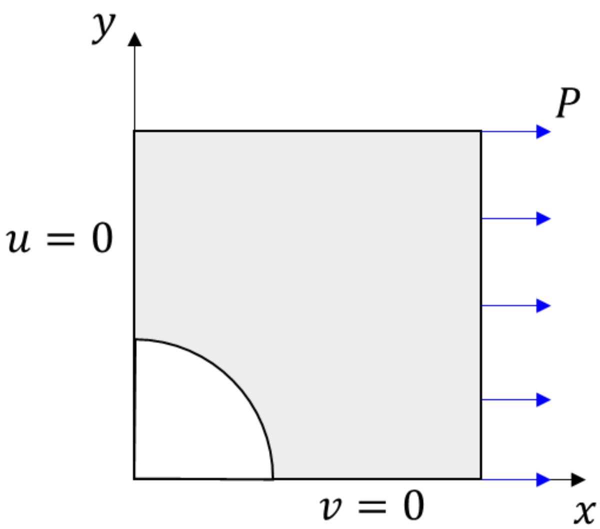
Term project



The above square plate with a circular hole is under tensional load on the right and left surfaces. The thickness is 1mm, the half-length L is 10mm, the radius r is 1mm, and the magnitude of tensile load P is 25N/mm^2. In the hole, there is a heat source which conducts a constant heat flux $q_o = 1.5W/mm^2$ to the plate. Assume that the heat source is mechanically too soft to affect the deformation of the plate. Submit both *Python* codes and a report.

[1]

First, ignore the thermal interaction and only calculate the plane-stress deformation due to the tension. Considering only the upper right quarter due to the symmetry of the plate, the following geometries and mechanical boundary conditions are defined. Here, $E = 7 \times 10^4 N/mm^2, \nu = 0.25$.

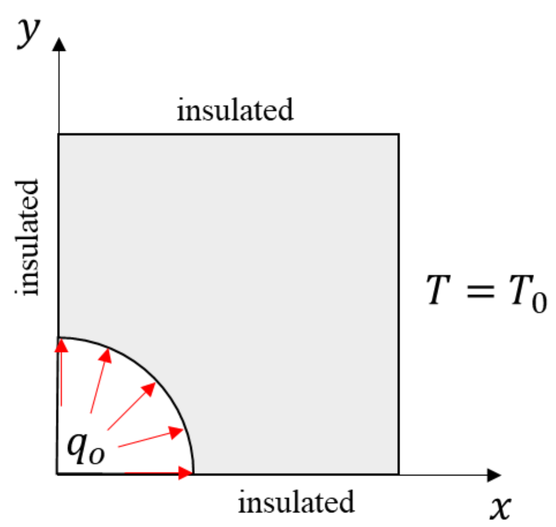


a. Determine the number of integration points, hidden layers, and hidden nodes by comparing various candidates.

b. Compute and plot the distribution of displacements, displacement magnitude, strains, and stresses.

[2]

At this time, ignore the mechanical interaction and only calculate the steady-state heat conduction. The temperature on the right surface is fixed at a reference temperature $T_0 = 300K$. Considering only the upper right quarter due to the symmetry of the plate, the following geometries and thermal boundary conditions are defined. Here, $k = 0.384W/mm \cdot K$.



a. Determine the number of integration points, hidden layers, and hidden nodes by comparing various candidates.

b. Compute and plot the distribution of temperature and temperature gradients.

[3] (bonus)

Assuming that the deformation of the plate does not affect heat conduction, the temperature distribution of the plate is the same as calculated in [2]. When the tension is applied to the plate, both tension and thermal stresses should be considered to compute the deformation. The internal energy is given as

$$\mathrm{U} = \int_V \left[\frac{1}{2}\lambda\left(\varepsilon_{xx}^2 + \varepsilon_{yy}^2\right) + \mu\left(\varepsilon_{xx}^2 + \varepsilon_{yy}^2 + \frac{1}{2}\gamma_{xy}^2\right) - \gamma(T - T_0)\left(\varepsilon_{xx} + \varepsilon_{yy}\right)\right] dV$$

where, $\gamma = 2\alpha(\lambda + \mu)$

Here, $\alpha = 5 \times 10^{-6} K^{-1}$. Note that since the temperature is fixed, the external work has only the term due to tension.

(*Hint*: use `.detach()` not to update the temperature network)

a. Obtain the formulation of stress components

b. Compute and plot the distribution of displacements, displacement magnitude, strains, and stresses.

c. Discuss the results in comparison to those of [1].