UNIVERSITY OF CALIFORNIA AT BERKELEY
Department of Civil and Environmental Engineering
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Structural Engineering,
Mechanics and Materials
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Lab 6: 03/03/04
Time Harmonic Heat Conduction

1. Time dependent heat conduction is governed by the PDE
$$\rho c\dot{T} + k\nabla^2 T = h_{tran}(T_{ext} - T) \quad . \tag{1}$$
We are interested in a harmonic solution of the form $T(x,t) = \hat{T}(x)e^{i\omega t}$. Plugging this into (1) gives
$$\rho c i\omega\hat{T} + k\nabla^2\hat{T} = h_{tran}(\hat{T}_{ext} - \hat{T}) \quad . \tag{2}$$
Thus we can use the linear stationary heat equation to do a time harmonic analysis. Let the material be steel and consider having no convective terms in the domain. What should be our model parameters?

2. Consider the plate shown in figure 1 below. The curved boundary is subjected to the harmonic temperature $T(x,t) = 100C\ e^{i\omega t}$. Modell and solve the problem in femlab. How does the frequency ω affect the solution?

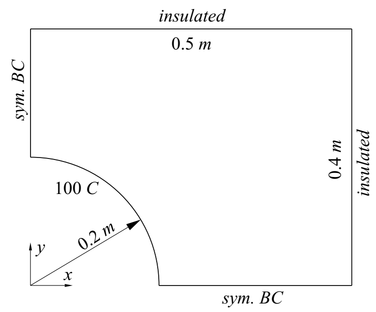

Figure 1: Heated Plate

3. Take $\omega = 0.01$ and use the command *postsurf(fem,'real(T)')* to visualize the real part of the solution. Also visualize *'imag(T)'*, *'abs(T)'* and *'angle(T)'*. Make proper annotations for your plots.

4. Plot $\hat{T}(x)$ along the line through points (0.15,0.15) and (0.5,0.4) for the frequencies $\omega = 0.0001, 0.001, 0.01, 0.1, 1$.

5. Take the point $\mathbf{x} = (0.3, 0.3)$ and plot $\log|T(\mathbf{x})|$ versus $\log\omega$. Can you interpret the curve?

6. Do you have an idea what we are doing here?