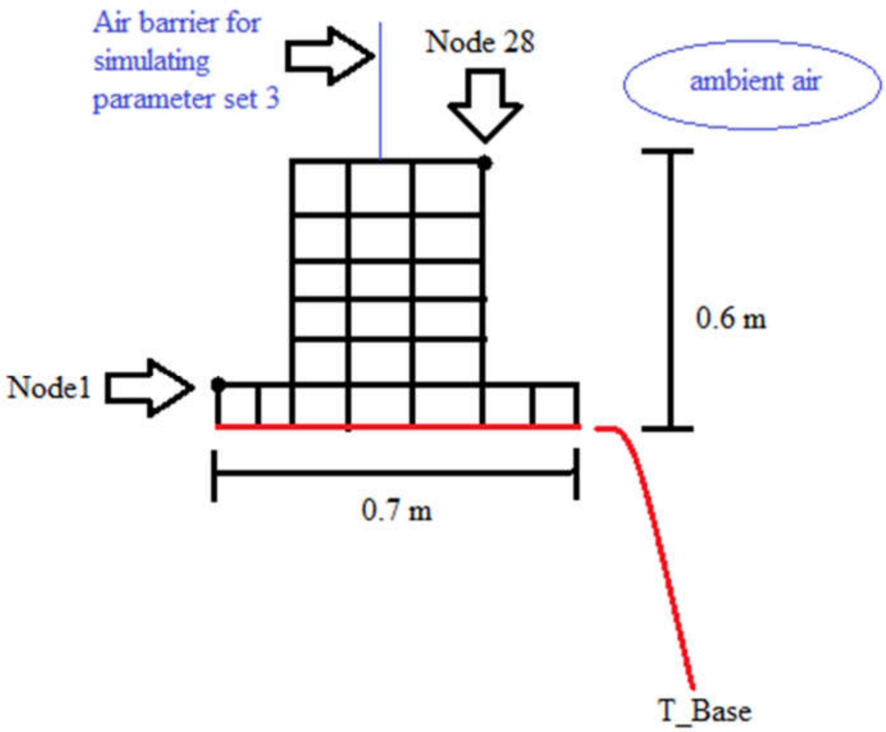

Figure 1

Above is the geometry used for parts 3-5 (it is a fin). There is a fixed temperature along the base of the fin, and all of the nodes (excluding the fin) are exposed to the ambient air. There are three conditions that will be tested on this geometry, summarized below.

- T_base = 400 C for all tests.
- Spacing between nodes is 0.1 m

Test 1		
k	10	W/m-K
h	100	W/m^2-K
T_ambient	100	deg C

Test 2		
k	10	W/m-K
h	125	W/m^2-K
T_ambient	125	deg C

Test 3		
k	10	W/m-K
h1	125	W/m^2-K
h2	75	W/m^2-K
T_ambient_1	100	deg C
T_ambient_2	100	deg C

The rationale behind these values is found in Discussion.

Results

Fin Temperature Distribution for Test #1								
base	400	400	400	400	400	400	400	400
	210.6958	242.7831	246.0029	281.5131	281.5131	246.0029	242.7831	210.6958
	0	0	162.2141	198.5364	198.5364	162.2141	0	0
	0	0	130.2087	151.882	151.882	130.2087	0	0
	0	0	115.2741	126.901	126.901	115.2741	0	0
	0	0	107.6338	113.5468	113.5468	107.6338	0	0
tip	0	0	103.4349	106.1057	106.1057	103.4349	0	0

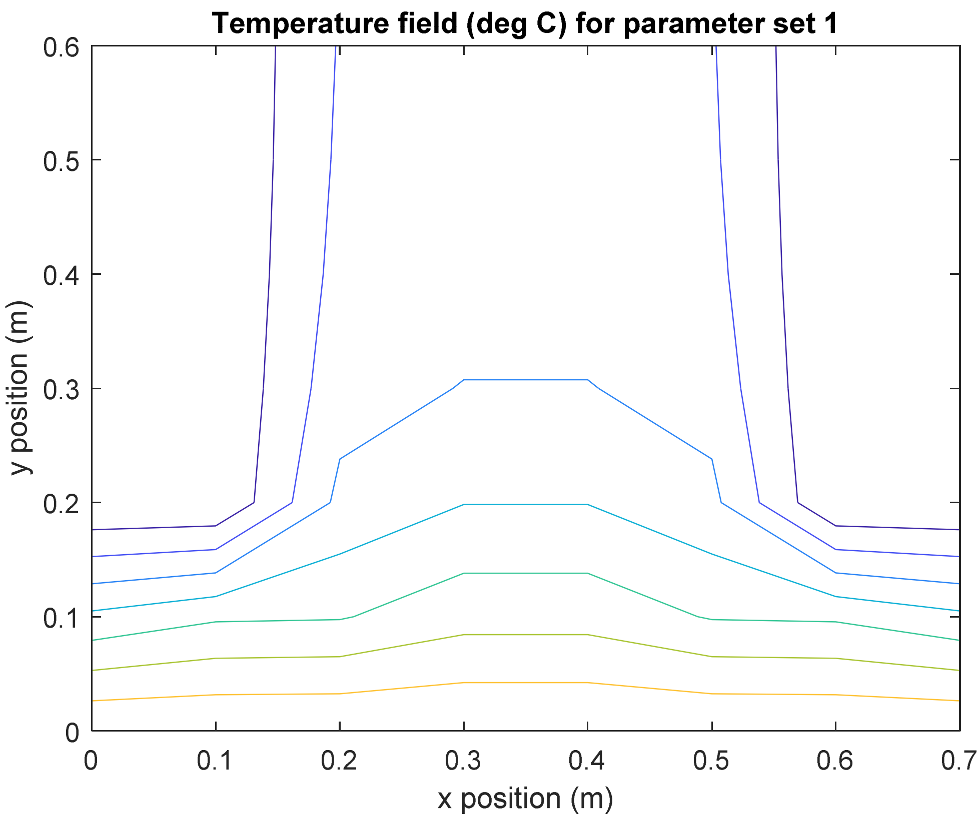

Figure 2

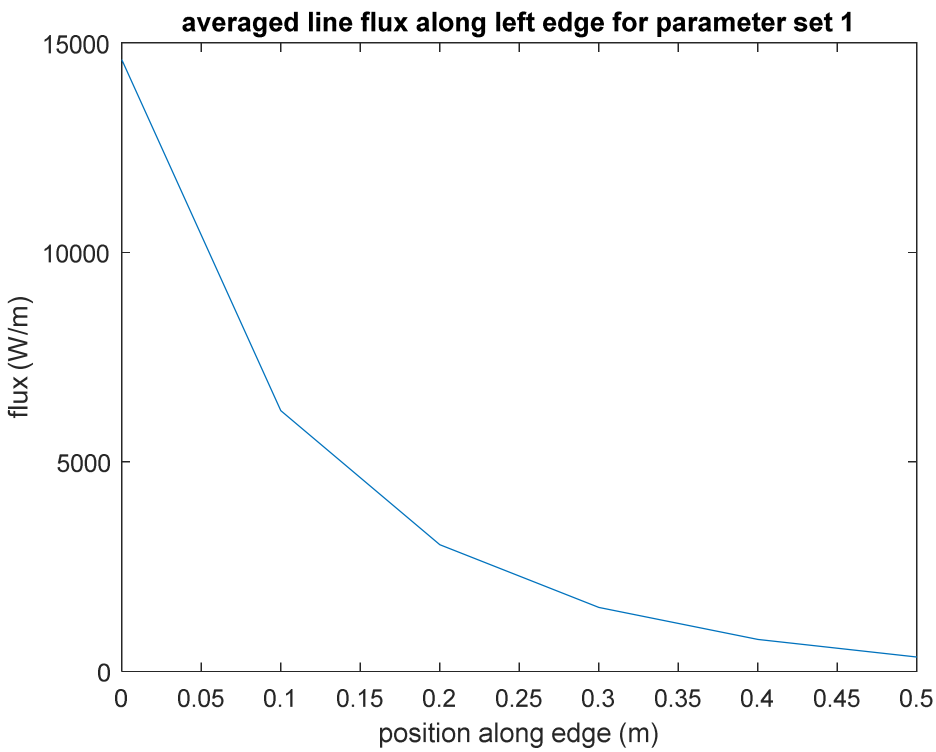

Figure 3

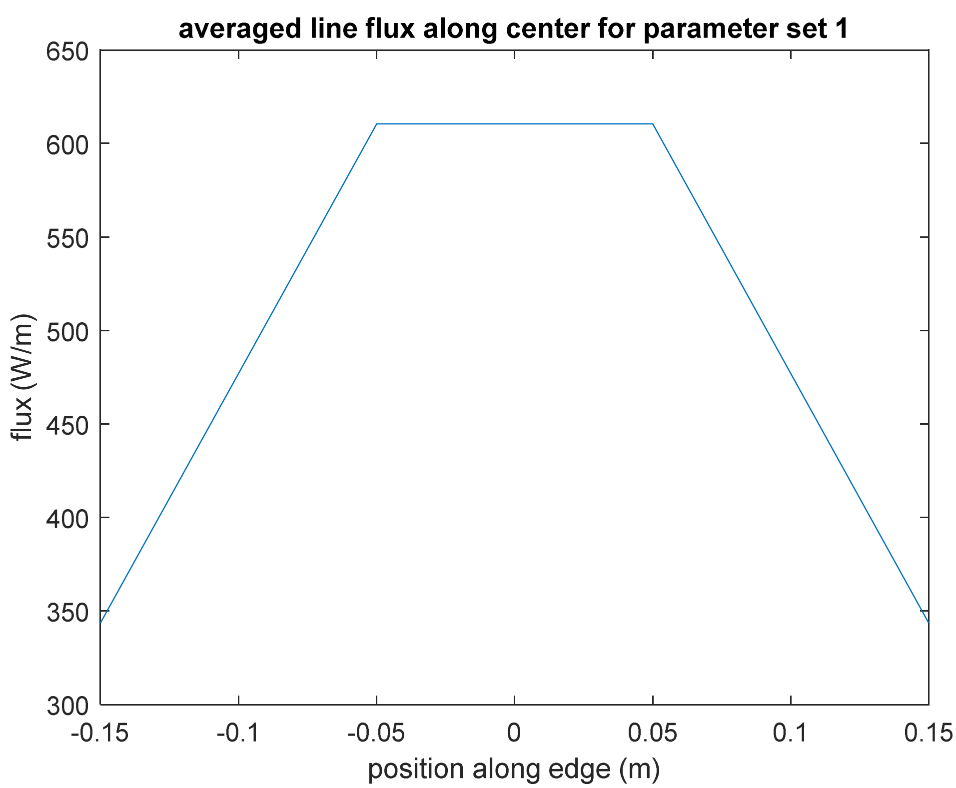

Figure 4

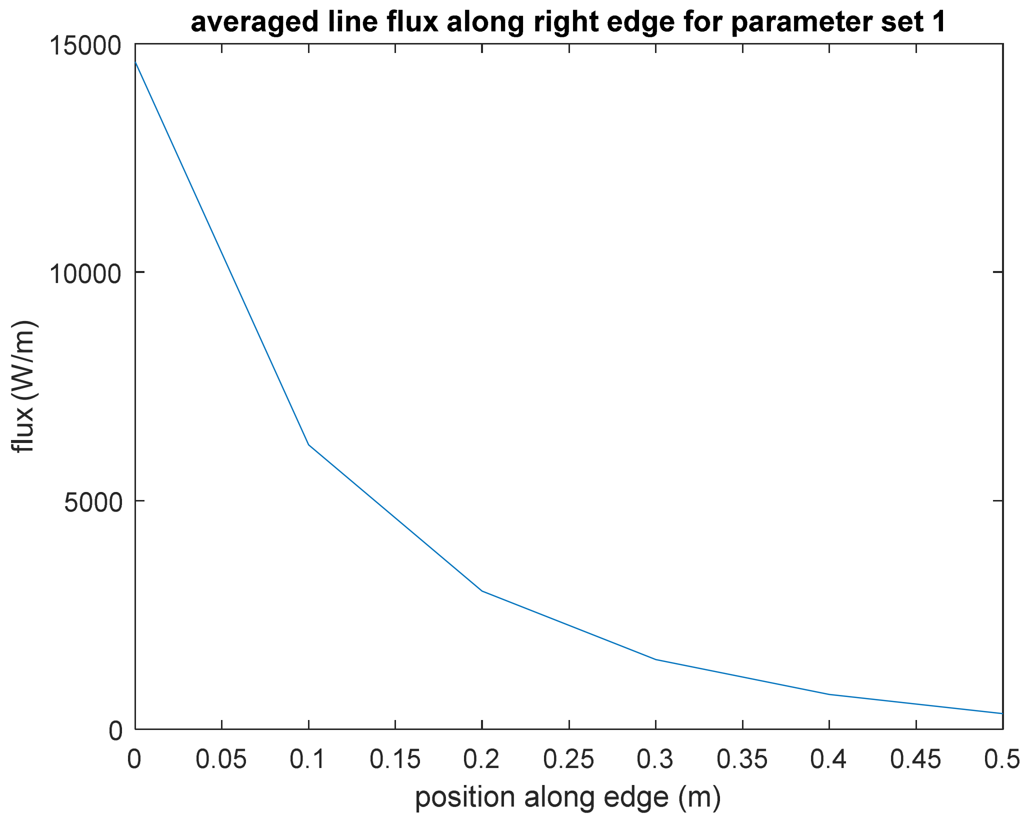

Figure 5

Fin Temperature Distribution for Test #2								
base	400	400	400	400	400	400	400	400
	212.0509	241.7289	246.687	284.9627	284.9627	246.687	241.7289	212.0509
	0	0	172.6854	208.2012	208.2012	172.6854	0	0
	0	0	146.8655	166.9554	166.9554	146.8655	0	0
	0	0	135.5293	145.7996	145.7996	135.5293	0	0
	0	0	129.9761	134.914	134.914	129.9761	0	0
tip	0	0	126.9872	128.9664	128.9664	126.9872	0	0

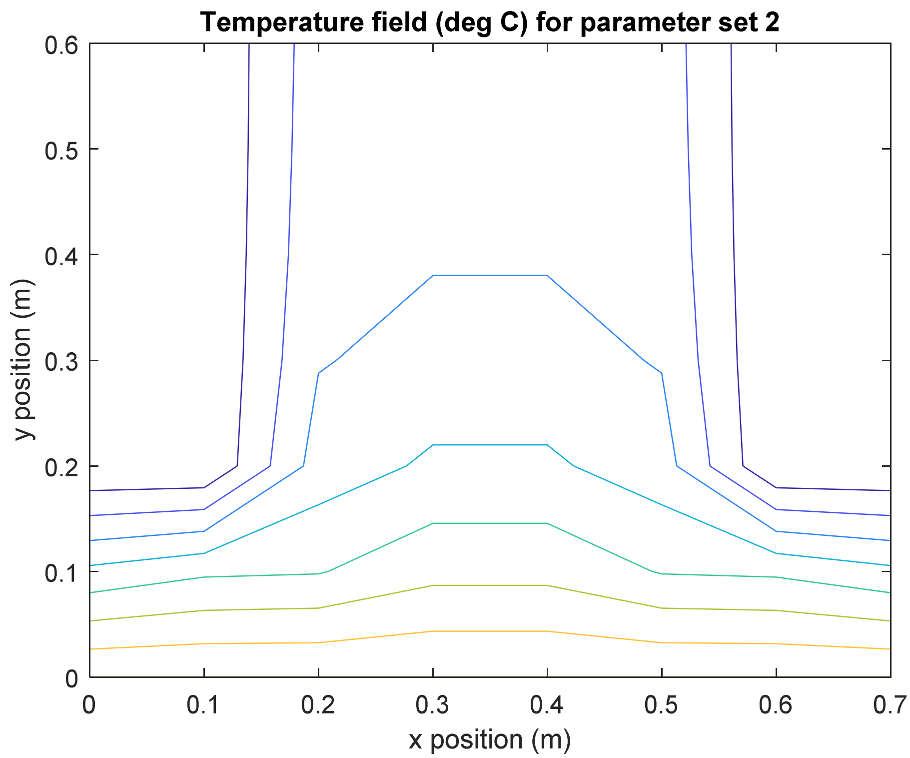

Figure 6

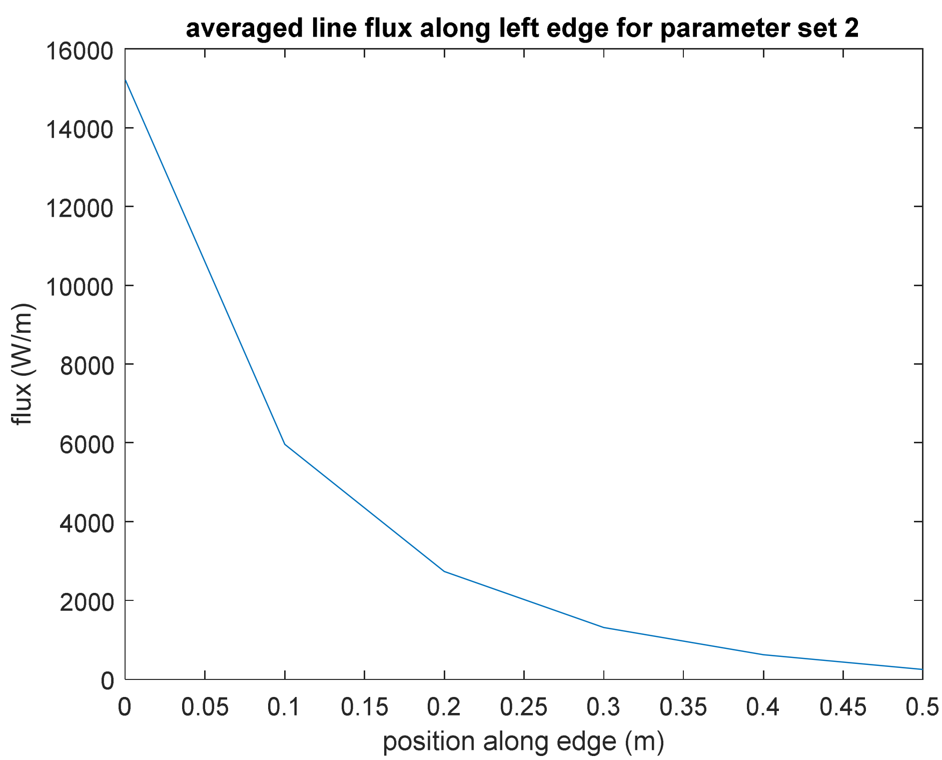

Figure 7

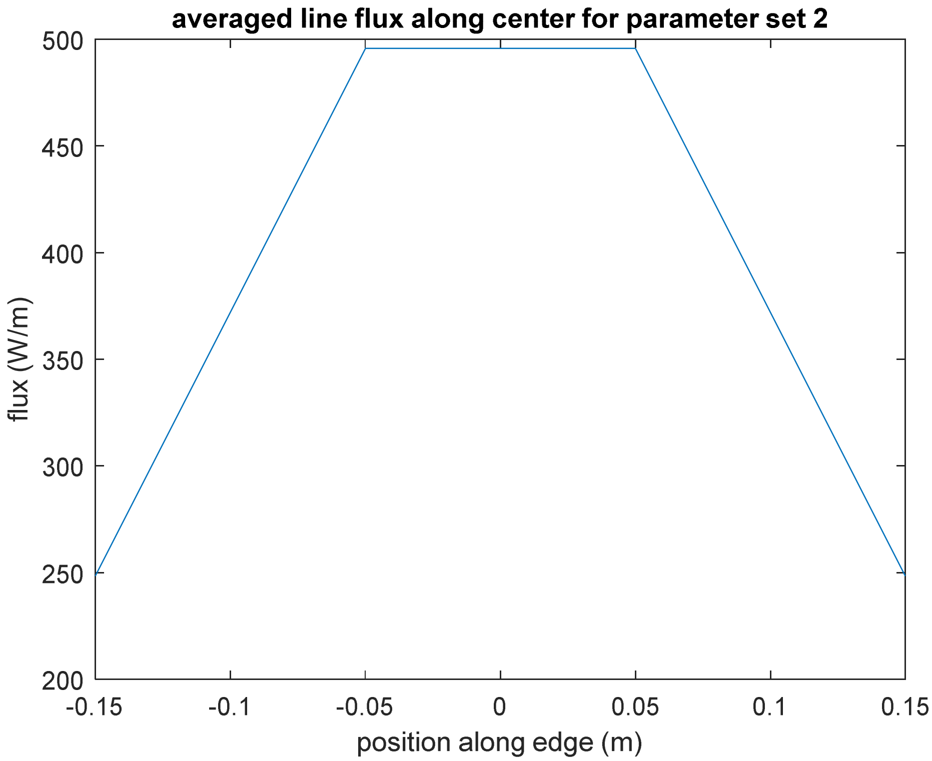

Figure 8

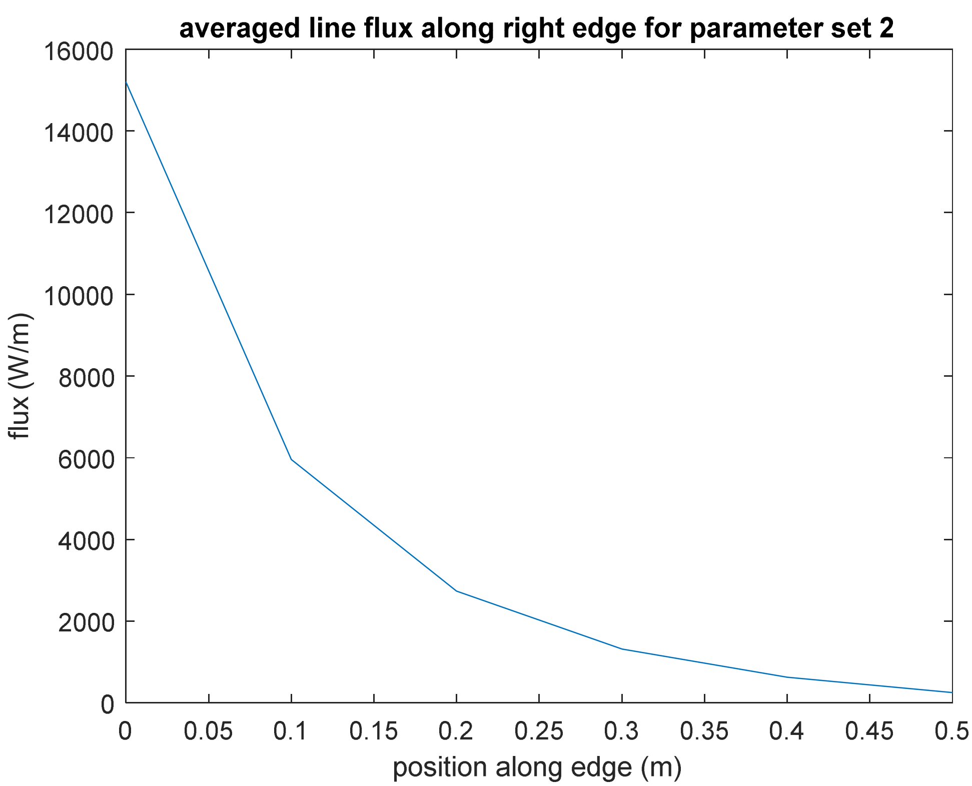

Figure 9

Fin Temperature Distribution for Test #3								
base	400	400	400	400	400	400	400	400
	195.0146	227.5657	234.1623	279.1758	285.6908	260.935	262.3711	232.106
	0	0	154.462	196.85	202.6525	173.2596	0	0
	0	0	126.1404	151.1097	154.8097	136.6877	0	0
	0	0	113.2313	126.6388	128.789	118.9035	0	0
	0	0	106.5855	113.4252	114.8038	109.7034	0	0
tip	0	0	102.724	105.6726	107.2978	104.8575	0	0

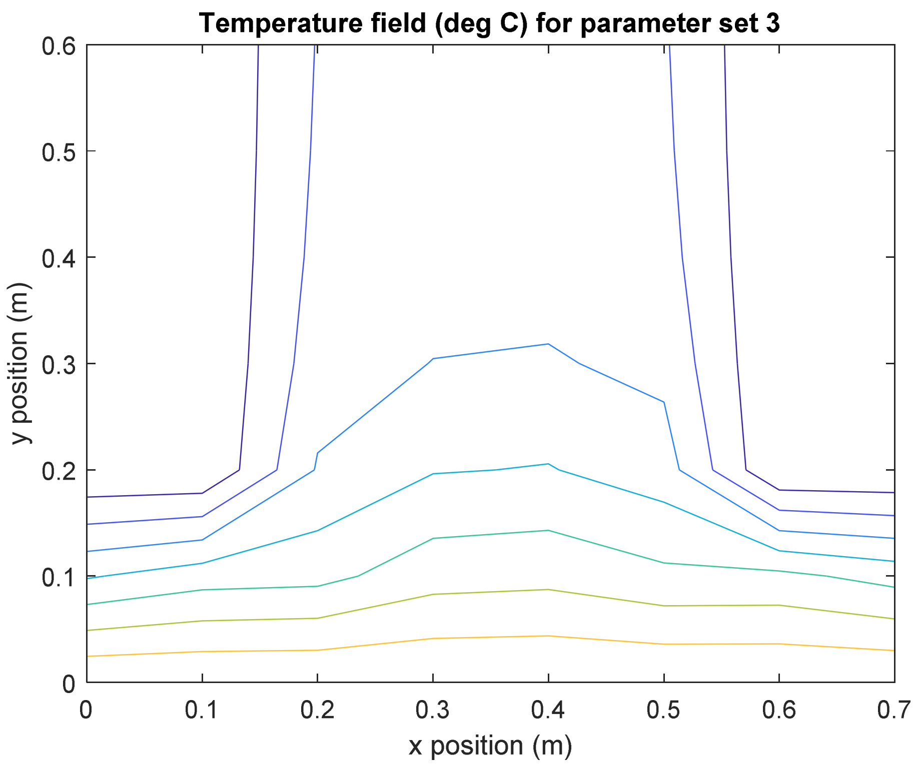

Figure 10

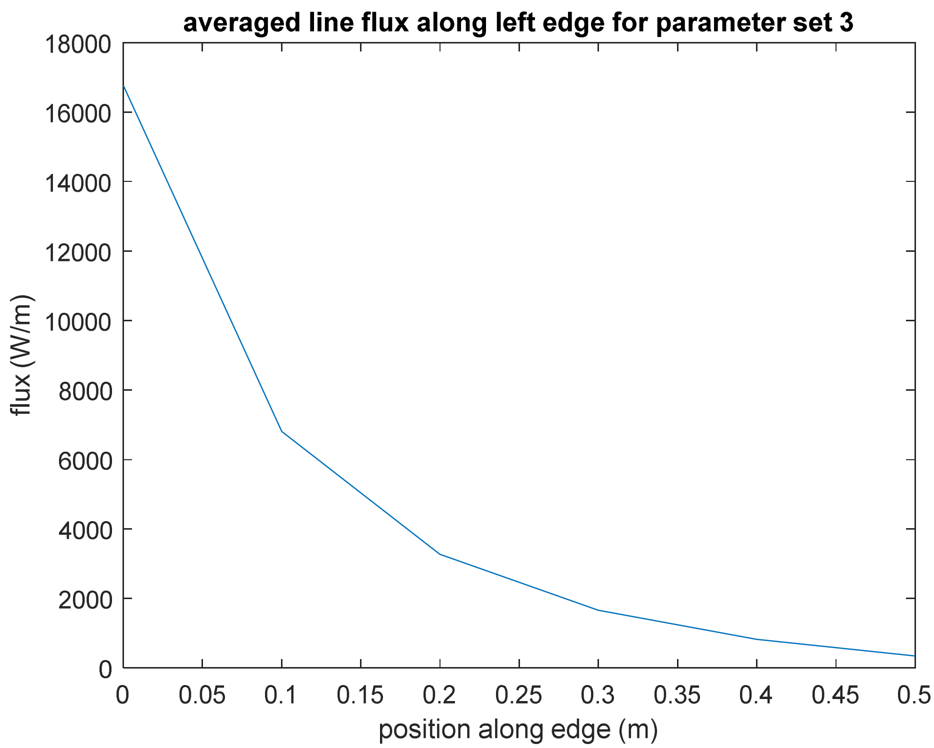

Figure 11

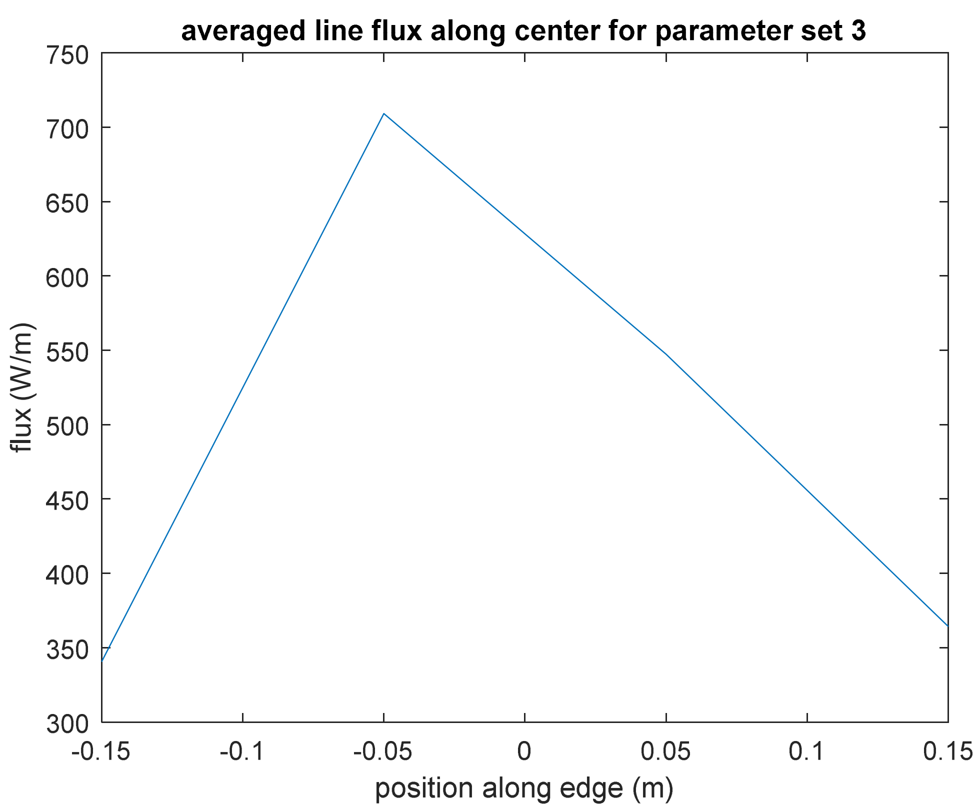

Figure 12

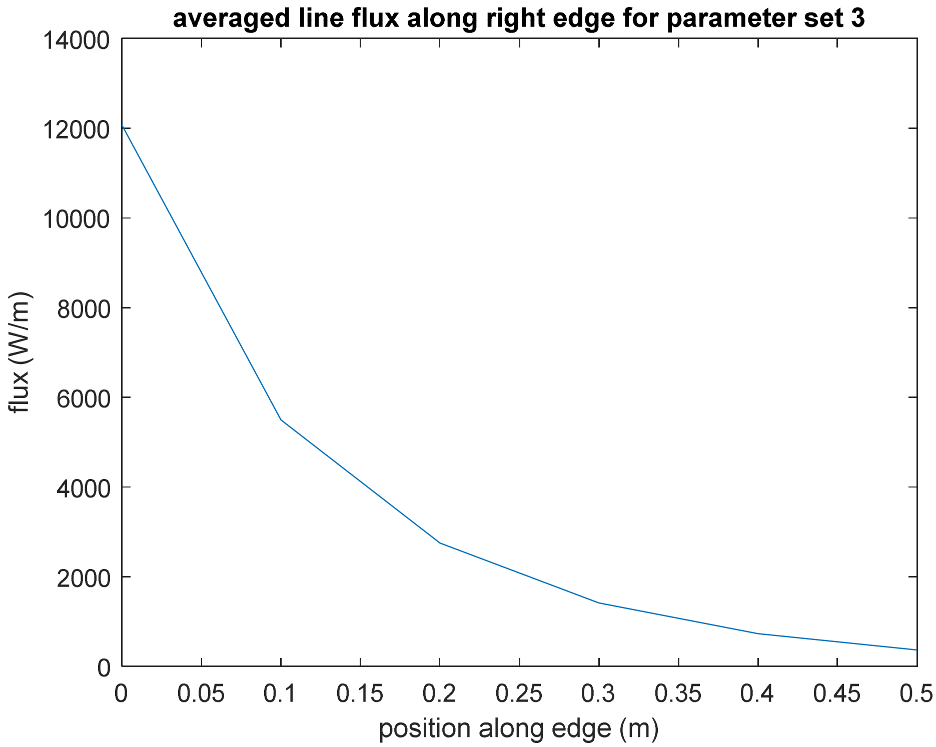
averaged line flux along right edge for parameter set 3
flux (W/m)
14000
12000
10000
8000
6000
4000
2000
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
position along edge (m)

Figure 13

Discussion

The geometry that I used for this project is a standard fin. I created this geometry out of 28 nodes, not including the eight nodes of known temperature at the base.

Fins are useful in many applications, such as on computer chips which generate heat continuously. Fins have a large amount of surface area that is exposed to the ambient air, which is at a lower temperature than the base of the fin. The base of the fin is connected to the heat generating object, like a computer chip. Heat will then be transferred from the base of the fin to the ambient air across the length of the fin via conduction. This will help remove heat from the system attached to the fin.

The three line-fluxes of interest are the ones between the fin and the ambient air. Three sets of parameters tested three different cases:

1) Uniform T_ambient and heat transfer coefficient at 100 (with relevant units).
2) Increased heat transfer coefficient by 25% and increased T_ambient by 25% to see if the overall effectiveness of the fin is increased or decreased. These two changes work against each other since the heat transfer is better with a higher h value, but worse with a lower temperature difference (the air is cooling the fin).
3) Non-uniform ambient conditions. For this case, consider that there is an air-tight barrier separating the fin into two equal parts (see figure 1). Each part has ambient air with different heat transfer coefficient. This may not lead to any useful results, but it is interesting to see the temperature distribution.

The depth of the fin into the plane of the paper is assumed to be 1m for the calculations. The base of the fin was kept to a minimum size since it does not convey any meaningful results.

The first test case yielded the expected results. The temperature and heat fluxes decreased along the length of the fin, as shown in figures 3 and 5. For the second case, it turned out that the heat flux was worsened with higher heat transfer coefficient and correspondingly higher ambient temperature. In the contour plot for the second case, the contours protrude further into the shaft of the fin, which means that the overall temperature of the fin is higher. This means that the fin is less effective at transferring heat. Consider the case where the heat transfer coefficient is zero. Here, the contours would show that nearly all of the fin is at the base temperature. Thus, the better the fin, the lower the temperature of the fin. This way, there is more conduction through the fin due to a larger temperature gradient.

For the third case, the heat transfer coefficient on the left side was higher than the one on the right. As shown in figures 11 and 13, the left side expectedly had more heat flux to the surroundings. Also, overall temperatures were slightly lower on the left side (see results table 3), which means that the higher heat transfer coefficient is better for fin efficiency. Due to heat conduction within the fin, the differences in temperature for the two sides are less pronounced.