5. **(30 pt)** Answer the following questions.

5.1 **(20 pt)** The thickness of the catalytically active area in a SOFC electrode is determined by a subtle balance between ionic resistance, electronic resistance, gas transport resistance and charge transfer resistance. Please answer the following questions.

a) When the gas transport resistance of the electrode increases (due to smaller electrode pores, a thicker electrode, etc.), does the catalytically active area become a)thicker, b)thinner, or is it c)unaffected? Why?

a) to reduce transport resistance, reaction area shifts to flow channel, which results in thicker reaction area.

b) When the ionic resistance of the electrode increases, does the catalytically active area become a)thicker, b)thinner, or is it c)unaffected? Why?

b) to reduce ionic resistance, reaction area shifts to electrolyte, which results in thinner reaction area

c) When the electronic resistance of the electrode increases, does the catalytically active area become a)thicker, b)thinner, or is it c)unaffected? Why?

a) to reduce transport resistance, reaction area shifts to flow channel, which results in thicker reaction area.

d) When the charge transfer resistance of the electrode increases, does the catalytically active area become a)thicker, b)thinner, or is it c)unaffected? Why?

b) to reduce charge transfer resistance, reaction use more catalyst. Thus reaction area thickness increases.

(Note) If the catalyst layer is too thin and there's no room for active layer expansion, the thickness would not change, but simply the fuel cell performance will degrade

5.2 **(5 pt)** Based on the observation of typical SOFC j-V curves, discuss which one of the resistances mentioned above usually dominates and therefore determines the thickness of the catalytically active area.

At high operating temperatures, SOFCs are generally less affected by mass transport and charge transfer, but they generally have low ionic conductivity. Therefore, the extent to which the electrochemically active area extends into the electrode is limited by the ionic conductivity of the electrode.

5.3 **(5 pt)** Most PEMFCs are designed with a thicker catalyst layer on the cathode side. Why?

PEMs are more commonly limited by charge transfer resistance, while ionic conductivity is generally high. Therefore increasing the thickness of catalyst layer increases the electrochemically active area.

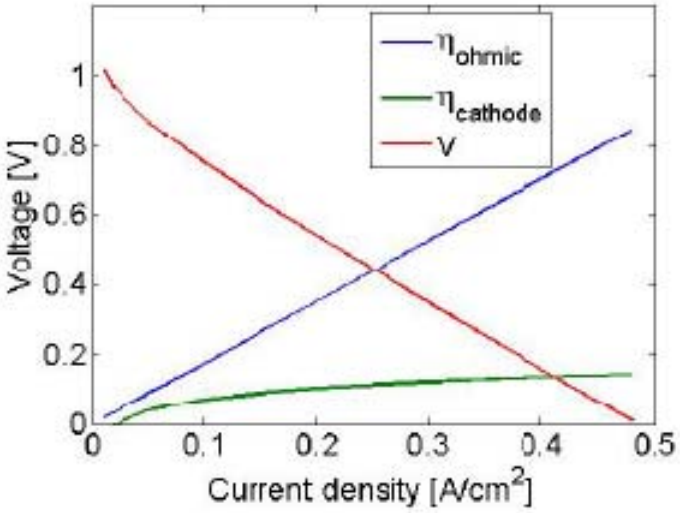


Figure 13: IV plot of the SOFC model at $T = 1073\ K$ for problem 6.10

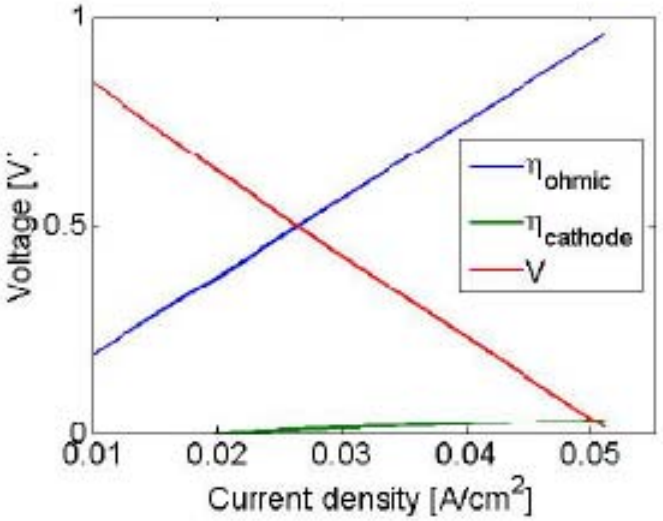


Figure 14: IV plot of the SOFC model at $T = 873\ K$ for problem 6.10