Name:

Directions: Show all work. No credit for answers without work.

- 1. [4 points] Recall:
 - A graph is *outerplanar* if it can be drawn in the plane without edge crossings so that all vertices are on the outer face.
 - The vertices of every planar graph can be colored with 4 colors so that adjacent vertices receive different colors. (So, every map requires at most 4 colors.)

Prove that the vertices of every outerplanar graph can be colored with 3 colors so that adjacent vertices receive different colors. *Hint:* given an outerplanar graph G that we want to color, use G to make a planar graph H in such a way that a 4-coloring of the vertices of H will give a 3-coloring of the vertices of G.

2. [2 parts, 3 points each] Consider the following directed graph. (Two copies for your convenience.)



(a) Use Dijkstra's algorithm to find the distance from a to all other vertices.

(b) Give a shortest path from a to c.