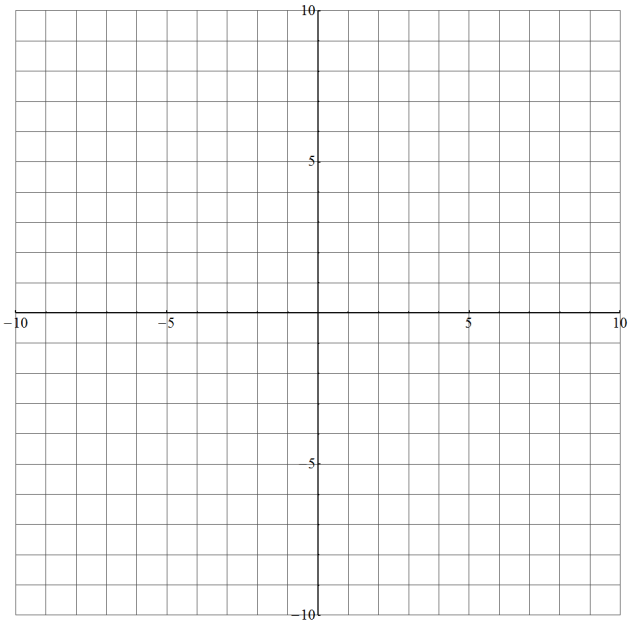
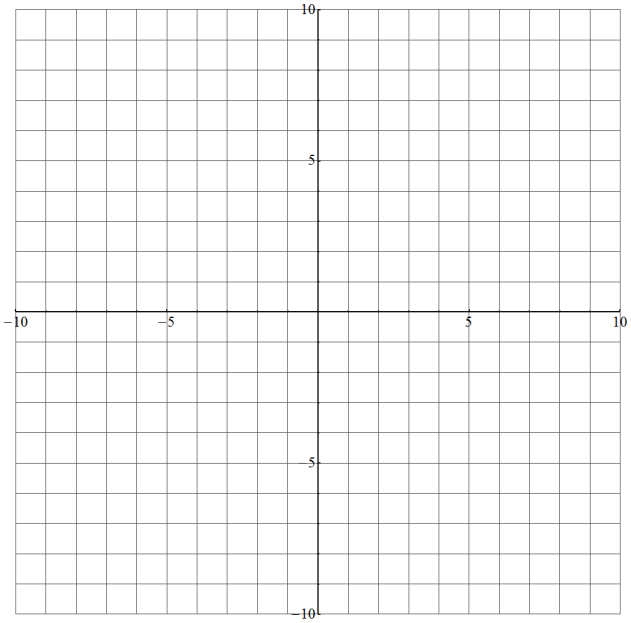
6 pages. 9 problems. 100 points. No calculators. Show all work.

Problem 1 (10 points each)**.** *In each geometry, draw a disk centered at* $(3, 0)$ *with radius* 4*.*

(a) Taxicab geometry



(b) Paris geometry



Problem 2 (5 points each)**.** *Think of the DC metro map as a graph.*

(a) What are the vertices of the graph?

(b) What are the edges of the graph?

(c) What is the valence of most points?

(d) Suppose the Metro Center station is closed to all traffic. Is the graph still connected?

Problem 3 (5 points each)**.** *Suppose you have a surface that has 8 vertices, 6 faces, and 12 edges.*

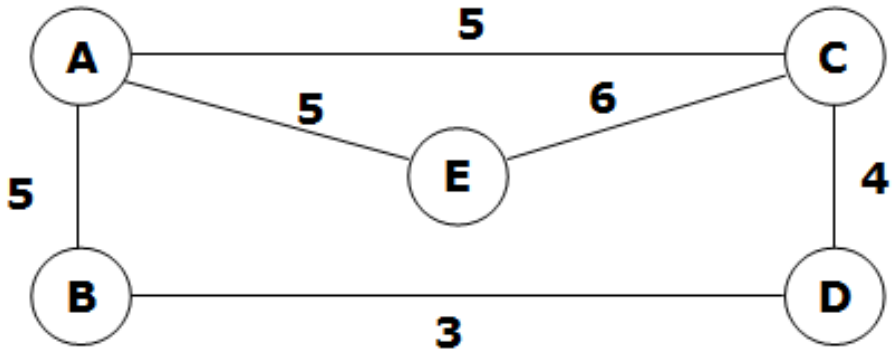
(a) Find the Euler characteristic of the surface.

(b) Find the genus of the surface.

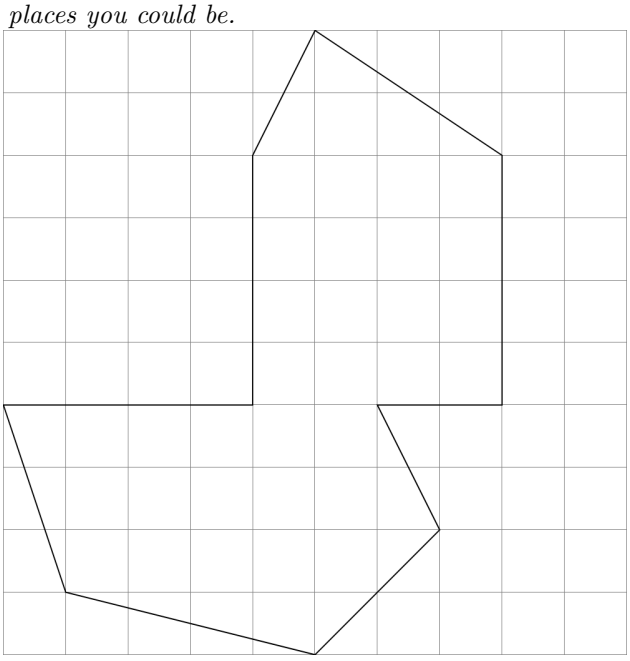
(c) Draw the surface in 3D just based on information about its genus (don't show the vertices, faces, and edges).

(d) Draw the same surface in 3D in a way that shows the vertices, faces, and edges - and with flat faces.

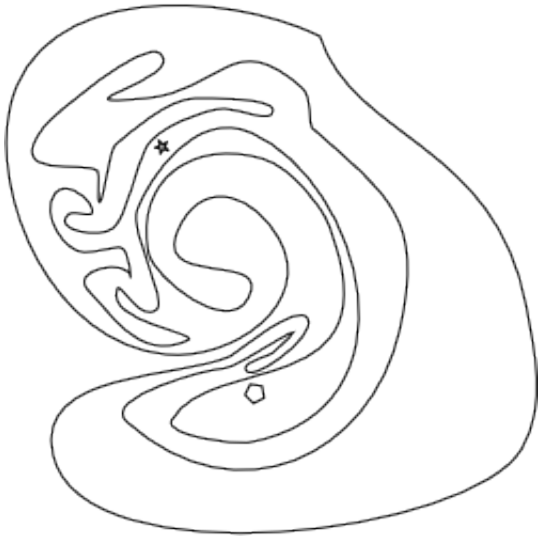
Problem 4 (5 points)**.** *Use Dijkstra's algorithm to find the distance from B to C. Make sure to show all work and tell me the answer.*



Problem 5 (5 points)**.** *Suppose you are inside the following curve and have to stay one unit away from the boundary. Shade in all the places you could be.*



Problem 6 (10 points)**.** *Answer without shading the picture, and make sure to explain your answer using numbers.*

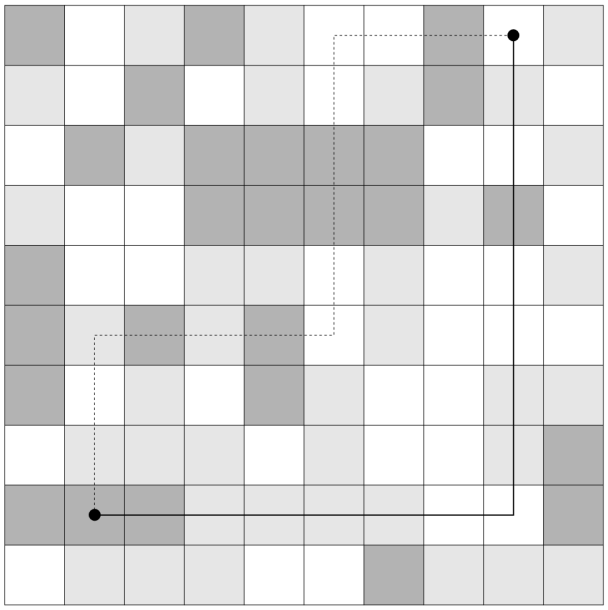


(a) Is the star inside or outside the loop? Why?

(b) Is the pentagon inside or outside the loop? Why?

Problem 7 (10 points)**.** *Draw the Sierpinski gasket, with enough detail to convince me you know what you're doing.*

Problem 8 (5 points)**.** *Suppose you are trying to travel between the two points in the map below. The light gray tiles are twice harder to travel on than the white ones, and the dark gray ones are three times harder to travel on than the white ones.*



If each turn costs the same as going through a white square, which path is more efficient?

Problem 9 (5 points)**.** *Out of all the semester projects (except your own), which was your favorite? Describe it in 10-20 words.*