Department of Mathematics

Maths 190 Assignment 3

May 3, 2010 Due: 4pm, Wednesday May 12, 2010

- Put your completed assignment in the appropriate box in the basement of the Mathematics/Physics Building **before** 4pm on the date due.
- Late assignments or assignments placed in the wrong box will not be marked.
- Your assignment **must** be accompanied by a blue Mathematics Department coversheet. Copies of the coversheet are available in the basement.

1. (4 marks) Recall that the *dual* of a regular solid is obtained by drawing a vertex in the center of each face, and adding edges between vertices whenever the corresponding faces meet at an edge.

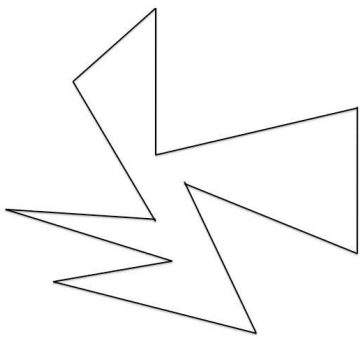
   (a) Explain why the dual of the tetrahedron is a tetrahedron. Use a picture to illustrate your working.

   (b) Recall that a *regular polygon* is a shape in the plane with all edges being lines of the same length and all angles being equal.

   The dual of a regular polygon is the shape obtained by drawing a vertex in the center of each edge of the polygon and by drawing a line between two vertices in the dual if the corresponding edges of the polygon meet at a vertex.

   What is the dual of a regular polygon of n vertices? Explain your answer.

2. (4 marks) The following picture shows the floor plan for an art gallery.



   (a) Find the minimum number of guards required so that when the guards are placed at appropriate vertices, each point of the gallery can be viewed by at least one guard. Your answer should include a drawing that shows one possible way in which this minimum number of guards can be used to keep watch on the whole gallery.

   (b) Show how, for any integer $n \geq 6$, one can design an art gallery with n vertices which cannot be guarded by one guard but which can be guarded by 2 guards.

3. (4 marks)

   (a) Explain the meaning of the word *supertile* for a tiling.

   Explain the meaning of the phrase *symmetry of scale* for a tiling.

   (b) The image on the next page is a tiling using an "L-shaped" tile. Draw the smallest two supertiles in the tiling which contain the coloured shape. (Detach the sheet and submit it with your answers.)

4. (3 marks) Draw (roughly) the next two steps for the following process to generate a fractal. What is the fractal dimension?

Tutorial write up: Remember to hand in with your assignment your written solutions to Question 4 on Tutorial 6 (5 marks), Question 5 on Tutorial 7 (5 marks) and Question 5 on Tutorial 8 (5 marks).