Graphics Exam

This is a 90 minute exam.

1. Consider the fractal formed by the following process: An open polygon with three vertices P_0, P_1, P_2 (P_0 and P_2 are endpoints) is split into a pair of open polygons with vertices $P_0, \frac{P_0+P_1}{2}, \frac{P_0+2P_1+P_2}{4}$ and $\frac{P_0+2P_1+P_2}{4}, \frac{P_1+P_2}{2}, P_2$ respectively. Applying this splitting process recursively n times yields a sequence of 2^n polygons. The limit of this process as $n \to \infty$ is the desired fractal.

   (a) What is the fractal dimension of the resulting curve?

   (b) Prove that the resulting curve has a continuous tangent line (i.e. it is C^1).

2. Explain the term "homogeneous coordinates". Mathematically describe the relationship between cartesian coordinates and homogeneous coordinates. Give at least two reasons why homogeneous coordinates are useful in computer graphics.

3. Given a convex polygonal viewport V with vertices $(v_1, ..., v_n)$, develop an algorithm that determines which of a sequence of point $p_1, ..., p_m$ lies inside V. To receive one half credit credit, develop an algorithm that processes all of the points in total time $O(mn)$. To receive full credit, develop an algorithm that processes all of the points in total time $O(n + m \; log \; n)$.

4. Give a brief description of an "octtree". Describe an an algorithm for computing the intersection of two octtrees that share the same intial cube.