INSTRUCTIONS: Please be sure to read and follow the instructions given for HW1.

1. (12 points) Let $P$ be any polygon, possibly with holes.

   (a) Prove that there always exists a triangulation of $P$. (Consider reducing $P$ to a polygon with one fewer hole and applying induction.)

   (b) Derive exact expressions for the number of triangles and the number of diagonals in any triangulation of $P$, as a function of the number, $n$, of vertices and the number, $h$, of holes in $P$. (Consider making an educated guess for the expressions and verifying these by induction on $h$. Alternatively, and more instructively, consider using Euler’s formula for connected planar subdivisions.)

   *Limit your answer to 2 pages.*

2. (10 points) Ex. 5.13, page 120, all parts.

   Describe carefully the transformation to an orthogonal range search problem and state the data structure you would use; pseudocode is not required. Be sure to establish the space and query time bounds. (For part (c), it is sufficient to describe briefly, in black-box fashion, the approach you would use.)

   *Limit your answer to 2 pages.*

3. (14 points) Ex. 5.5, page 118, parts (a) and (b).

   For part (a), establish the indicated worst-case query time for the point-set described in the hint.

   For part (b), you must (i) describe your construction and query algorithms briefly, but clearly, in words (pseudocode is not required), (ii) justify the correctness of your approach, and (iii) analyze the space and query time. (Analyze the query time from first principles rather than simply appealing to the known $O(n^{1-1/d} + k)$ bound for a kd-tree in the standard $d$-dimensional space.)

   *Limit your answer to 3 pages.*