Department of Computer Science and Engineering
IIT Kharagpur
Mid-semester examination: Spring 2013

Computational Geometry (CS60064) 3-0-0 : 3 credits
Instructor: S P Pal: Maximum marks: 100: Time : 2 hours
There is limited choice.

1. Given a *triangulation* of an n-sided simple polygon P, we define a graph that has the triangles as vertices and pairs of adjacent traingles as edges. What is the number of vertices of this graph? Is this a connected graph? How many edges does this graph have?

   [5+5+5 marks]

2. Given a *segment* tree T and a leaf node s, state the information that can be gathered by traversing T from the root node r to s. What are the minimum and maximum space complexities of the information stored along any such root to leaf path of the tree?

   [7+8 marks]

3. Show that an *interval tree* for n intervals can be built in $O(n \log n)$ time.

   [15 marks]

4. We are given two simple polygons A and B of n and m vertices, respectively. The polygon A is convex and the polygon B is *star-shaped.* We are also given a point k inside the *kernel* of B. Show that the convex hull of the union of A and B can be computed in $O(m + n)$ time.

[15 marks]

5. In Kirkpatrick's *triangulation refinement* method for planar point location, the preprocessing step involves building a data structure that permits $O(\log n)$ time query processing, where the planar subdivision under consideration for planar point location has n vertices. Prove that the query processing time is $O(\log n)$.

   [15 marks]

6. Outline the (i) invariants, and (ii) the main cases occuring in the incremental steps in the linear time algorithm for computing the *kernel* of a simple polygon.

   [7+8 marks]

7. State the various cases that arise in the incremental step of the linear time computation of the *convex hull* of a simple polygon.

   [15 marks]

8. Show that the number of vertices in the intersection of an n-vertex convex polygon and and m-vertex convex polygon is $O(m + n)$. Can you compute this intersection in $O(m + n)$ time? Explain.

   [7+8 marks]

9. Given a set S of n horizontal line segments, show how we may preprocess these segments creating $O(n \log n)$ space data structures so that given any query vertical line segment q, we can print the segments in S intersecting q in $O(k + \log n)$ time, where k is the number of segments in S intersecting q.

   [5+5 marks]
