Course code	Course Name	L-T-P Credits	Year of Introduction
CS461	**COMPUTATIONAL GEOMETRY**	**3-0-0-3**	**2016**

Course Objectives:

- To introduce techniques for designing efficient algorithms for geometric problems.
- To discuss data structures used for geometric problems
- To introduce combinatorial complexity of geometric problems.
- To study rigorous algorithmic analysis of geometric problems.

Syllabus:

Geometric preliminaries, Plane sweep technique, Line segment intersection, Point location, Searching, Triangulation, Art Gallery theorem, Linear programming, Arrangements of lines, Convex Hulls and Verona Diagrams.

Expected Outcome:

The Students will be able to :

i. Develop efficient algorithms by exploiting geometric properties, and using appropriate data structures and geometric techniques.
ii. Apply techniques and algorithms for solving problems in diversified fields like database searching, data mining, graphics and image processing, pattern recognition, computer vision, motion planning and robotics.
iii. Perform complexity analysis of algorithms
iv. Identify properties of geometric objects, express them as lemmas or theorems, and prove their correctness
v. Implement geometric algorithms.

Text Books:

1. Franco P. Preparata and Michael Ian Shamos, *Computational Geometry an Introduction.* Texts and Monographs in Computer Science, Springer Verlag.
2. Joseph O'Rourke, *Computational Geometry in C*. Cambridge University Press 2nd Edn.
3. Mark. de Berg, Marc. van Kreveld, Mark. Overmars and Otfried Cheong, *Computational Geometry- Algorithms and Applications.* Springer- Verlag 3rd Edn.

References:

1. Herbert Edelsbrunner, *Algorithms in Combinatorial Geometry,* EATCS Monographs on Theoretical Computer Science, Springer Verlag.
2. Joseph O' Rourke, *Art Gallery Theorems.* Oxford Press publications.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Geometric Preliminaries, DCEL (Doubly Connected Edge List) data structure, Polygon, Planar Straight Line Graph (PSLG) Area of a triangle, area of a polygon, Determinant used to test position of a point with respect to a directed line. Convex polygons, properties and point location in convex polygon (inside-outside test) Plane sweep algorithm, Algorithm for Line segment intersection problem using plane sweep technique.	6	15%

II	Point location in PSLG – Slab method, Chain method and complexity analysis. Range Searching – 1D Range search, Kd Trees.	6	15%
FIRST INTERNAL EXAM			
III	Polygon Triangulation: Regularization of polygons, properties of triangulations –Proofs, triangulation of monotone polygon – algorithm and complexity analysis. Linear Programming – Half plane intersection, Incremental algorithm and Randomized algorithm	8	15%
IV	Art Gallery Theorem, Guarding Art Gallery, Fisk's proof using three colouring. Arrangements of Lines – Duality, Combinatorics of arrangements, Zone Theorem, Algorithm for Constructing arrangements of lines.	6	15%
SECOND INTERNAL EXAM			
V	Convex Hulls- Convex Hull Algorithms in the Plane -Graham's Scan Algorithm, Jarvi's March, Divide and Conquer Algorithm.	6	20%
VI	Voronoi Diagrams- Properties and applications in the plane. Proofs of properties related to vertices and edges of voronoi diagrams Algorithm for constructing voronoi diagram. Delaunay Triangulation.	8	20%
END SEMESTER EXAM			

Question Paper Pattern End semester exam)

1. There will be ***FOUR*** parts in the question paper – **A, B, C, D**
2. **Part A**
   a. **Total marks : 40**
   b. ***TEN*** questions, each have **4 marks**, covering **all the SIX modules** (***THREE*** questions from **modules I & II**; ***THREE*** questions from **modules III & IV**; ***FOUR*** questions from **modules V & VI**).
   All the TEN questions have to be answered.
3. **Part B**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question ***uniformly*** covers **modules I & II**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
4. **Part C**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question ***uniformly*** covers **modules III & IV**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.

5. **Part D**
    a. **Total marks : 24**
    b. ***THREE*** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question ***uniformly*** covers **modules V & VI**.
    c. ***Any TWO*** questions have to be answered.
    d. Each question can have ***maximum THREE*** subparts.
6. There will be ***AT LEAST* 60%** analytical/numerical questions in all possible combinations of question choices.