SEMESTER S4

COMPUTATIONAL GEOMETRY

(Common to CS/CM)

Course Code	**PECST418**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GAMAT101, PCCST303	**Course Type**	Theory

Course Objectives:

1. To develop a solid understanding of the fundamental principles, techniques, and algorithms used in computational geometry, including geometric data structures, convex hulls, Voronoi diagrams, and Delaunay triangulations.
2. To equip students with the skills to apply computational geometry algorithms and techniques to address real-world problems in areas such as computer graphics, robotics, and geographic information systems (GIS).

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Computational Geometry:-** Basics of Computational Geometry - Introduction and applications of computational geometry, Geometric objects, and their representations, Basic geometric primitives: points, lines, segments, polygons (Text 1, Chapters 1, 2) Convex Hulls - Definition and properties of convex hulls, Graham's scan algorithm, Jarvis's march (gift wrapping) algorithm, Divide and conquer algorithm for convex hulls (Text 2, Section 33.3) Line Segment Intersection - Problem definition and applications, Plane	**9**

	sweep algorithm, Bentley-Ottmann algorithm (Text 3, Chapter 7)	
2	**Polygon Triangulation and Voronoi Diagrams:-** Polygon Triangulation - Definition and applications, Triangulation of monotone polygons, Ear clipping method, Chazelle's algorithm (Text 1, Chapter 3) Voronoi Diagrams - Definition and properties, Incremental construction algorithm, Fortune's sweep line algorithm (Text 1, Chapter 7) Delaunay Triangulations - Definition and properties, Relationship with Voronoi diagrams, Bowyer-Watson algorithm, Lawson's flip algorithm (Text 1, Chapter 9)	**9**
3	**Range Searching and Point Location :-** Range Searching - Problem definition and applications, 1-dimensional range searching, K-dimensional range trees, Fractional cascading (Text 1, Chapter 5) Point Location - Problem definition and applications, Trapezoidal map and randomized incremental algorithm, Kirkpatrick's point location algorithm (Text 1, Chapter 6) Binary Space Partitioning - Definition and applications, BSP trees construction and properties, Use in computer graphics and collision detection (Text 1, Chapter 12)	**9**
4	**Advanced Topics and Applications :-** Arrangements of Lines and Duality - Arrangements of lines and complexity, Zone theorem, Duality transform and its applications (Text 1, Chapter 8) Motion Planning and Geometric Optimization - Problem definition and applications, Visibility graphs and shortest path problems, Art gallery problem, Linear programming in geometry (Text 1, Chapters 10, 11) Computational Geometry in Practice - Computational geometry libraries and software, Applications in robotics, computer graphics, GIS (Text 3, Chapters 9, 10)	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand Fundamental Concepts and Applications of Computational Geometry	**K2**
CO2	Apply Algorithms for Convex Hulls and Line Segment Intersection Algorithms	**K3**
CO3	Perform Polygon Triangulation and Understand Voronoi Diagrams	**K3**
CO4	Build Delaunay Triangulations and Range Searching Techniques	**K3**
CO5	Apply Advanced Computational Geometry Techniques and Algorithms	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3									3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3		3							3
CO5	3	3	3	3	3							3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computational Geometry: Algorithms and Applications	Mark de Berg, Otfried Cheong, Marc van Kreveld, and Mark Overmars	Springer India	3/e, 2011
2	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein	MIT Press	4/e, 2022
3	Computational Geometry in C	Joseph O'Rourke	Cambridge University Press	2/e, 1998

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Discrete and Computational Geometry Hardcover	Joseph O'Rourke , Satyan L. Devadoss	Princeton University Press	1/e,2011
2	Computational Geometry: An Introduction	Franco P. Preparata, Michael I. Shamos	Springer-Verlag New York Inc	5/e, 1993
3	Geometric Algorithms and Combinatorial Optimization	Martin Grötschel, Laszlo Lovasz, Alexander Schrijver	Springer-Verlag Berlin and Heidelberg GmbH & Co. K	2/e, 1993

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/102/106102011/
2	https://archive.nptel.ac.in/courses/106/102/106102011/
3	https://archive.nptel.ac.in/courses/106/102/106102011/
4	https://archive.nptel.ac.in/courses/106/102/106102011/