MIDDLE EAST TECHNICAL UNIVERSITY
Graduate School of Natural and Applied Sciences
Department of Computer Engineering

NEW COURSE PROPOSAL

1. Course Code[1]

5710773

2. Course Title

Computational Geometry

3. Course Category

☐ Undergraduate	☒ Graduate	☐ Doctorate
☐ Seminar	☐ Laboratory	☐ Term Project
☐ M.S. Thesis	☐ Ph.D. Thesis	☐ Thesis Studies
☐ Summer Term Practice		

4. Credit

Credits[2*]	(3-0)3
ECTS Credits[*]	8
Lecture Credits[*]	3
Laboratory Credits[*]	0

5. Catalog Description

Introduction to algorithms and data structures for geometric problems in two and three dimensions. Convex hulls; triangulations and planar subdivisions; geometric search and intersection; Voronoi diagrams; Delaunay triangulations; line arrangements; visibility.

6. Frequency

☒ Fall Semesters	☐ Fall/Alternate Years	☐ Fall/Upon Request
☒ Spring Semesters	☐ Spring/Alternate Years	☐ Spring/Upon Request

7. Can be given by:

Tolga Can, Adnan Yazıcı, İsmail Hakkı Toroslu, Faruk Polat, Göktürk Üçoluk, Veysi İşler

8. Background Requirements(s)

Data structures. Algorithms.

9. Complementing/Overlapping Courses

CENG 315 Algorithms – The proposed course is a continuation of the undergraduate Algorithms course by focusing on analysis of advanced algorithms on a more specific domain of computational geometry. There is no overlap with this course.
CENG 567 Design and Analysis of Algorithms – The proposed course is an algorithms course but it does not overlap with 567. These two courses complement each other by focusing on different aspects.

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[1] Choose a course code which does not appear on "View Course Archieve 151".
[2] Give credit rating and distribution, credit rating should comply with one of the following : (3-0)3, (2-2)3, (1-4) 3, (0-6) 3, (1-0)1
[*] These areas **must be filled**.

10. Course in relation to the programs

The course is proposed as a Theory track graduate course. It complements the undergraduate and graduate Algorithms courses by covering the theory and applications of advanced geometric algorithms.

Undergraduate students will also be able to take the course as a technical elective course.The course will also contribute to the Undergraduate Program Outcomes by providing the students a) the ability to apply knowledge of mathematics, b) the ability to identify, formulate, and solve engineering problems, and c) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The course will also contribute to the Undergraduate Program Educational Objectives 1 and 4 by providing depth in a state-of-the-art topic and by focusing on a) analysis of problems from a computational viewpoint, b) algorithmic solutions, and c) implementation of algorithmic solutions correctly and efficiently.

11. Course Objectives

At the end of the course, the students will have learned advanced data structures and algorithms for dealing with geometric problems. Students will increase their knowledge about algorithm complexity and correctness analysis by studying advanced geometric algorithms. Students will learn to apply theory on practical real-life geometric problems such as robot motion planning, locating a point on a map.

12. Course Outline

WEEKS	SUBJECT	DETAILS
1	Introduction	Course introduction. Syllabus. Mathematics and geometry review. Representation of basic geometric primitives.
2	Convex hulls	Degeneracy and robustness concepts. Various convex hull algorithms. Lower bounds. Convex hull in d-space.
3	Line segment intersection	Plane sweep algorithm. Doubly-Connected edge list. Computing the overlay of two subdivisions.
4	Polygon triangulation	Triangulation of a monotone polygon. Partitioning a polygon into monotone pieces.
5	Linear programming	Geometry of casting. Half-plane intersections. Incremental and randomized algorithms. Smallest enclosing discs.
6	Orthogonal range searching	1D range searching. Kd-trees. Range trees. Higher-dimensional range trees.
7	Orthogonal range searching	Interval trees. Priority search trees. Segment trees.
8	Point location	Trapezoidal maps. A randomized incremental algorithm for point location.
9	Voronoi diagrams	Definition and basic properties. Fortune's plane sweep algorithm.

10	Delaunay triangulations	Triangulation of planar point sets. Guibas' randomized incremental algorithm.
11	Arrangements	Line, hyperplane, and line segment arrangements. Incremental construction techniques. Complexity of lower envelopes, duality.
12	Binary space partitions	Constructing BDP trees. Size of BSP trees in 3-space.
13	Motion planning	Minkowski sums. Translational motion planning. Motion planning with rotations.
14	Visibility graphs	Rotational sweep algorithm.

13. Textbooks

M. de Berg, M. van Kreveld, M. Overmars, O. Schwarzkoph, "Computational Geometry: Algorithms and Applications, 3rd edition," Springer, 2008, ISBN: 978-3-642-09681-5

14. Reference Material

Computational Geometry Algorithms Library. CGAL-3.8. http://www.cgal.org , 2011.
J. O'Rourke, "Computational Geometry in C, 2nd edition," 1998, ISBN: 978-0521649766

15. Course Conduct

Formal lectures, written and programming assignments.

16. Grading

Written and programming assignments 40%
Midterm Exam 30%
Final Exam 30%

17. Effective Date

Fall 2011-2012

18. Proposed by:

Tolga Can

19. Prerequisite Courses

None.

20. Equivalent courses

None.

Course accepted by Graduate Committee / Departmental Academic-Board in meeting held on……../……../……

Signature
Head of Department