Course Specification

(Postgraduate Programs)

Course Title:	**CS 726(0911726)**
Course Code:	**Computational Geometry**
Program:	**Master of Science in Computer Science**
Department:	**Computer Science**
College:	**Computer Sciences and Information technology**
Institution:	**King Faisal University**
Version:	*Course Specification Version Number*
Last Revision Date:	*Pick Revision Date.*

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A. General information about the course:

1. Course Identification:

1. Credit hours: 3(3-0-6)					
2. Course type					
A.	☐University	☐College	☐Department	☐Track	
B.	☐Required		☒ Elective		
3. Level/year at which this course is offered: Level 2, 3 or 4					
4. Course General Description:					
This course gives an understanding of the theoretical foundations of geometric algorithms. The course also analyses the complexity of geometric problems followed by implementation of geometric algorithms using programming languages like Python or C++. The course gives an understanding on the use of geometric data structures for efficient computation. Finally the course also applies computational geometry techniques to real-world applications such as robotics, GIS, and image processing.					
5. Pre-requirements for this course (if any)**:**					
Advanced Algorithms (CS 611) Advanced Software Engineering (CS 614)					
6. Pre-requirements for this course (if any)**:**					
None					
7. Course Main Objective(s):					
This course covers fundamental geometric algorithms, geometric data structures, and their computational complexity. Students will learn to design, analyze, and implement efficient geometric algorithms..					

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom		
2	E-learning		
3	Hybrid • Traditional classroom • E-learning	45	100%

No	Mode of Instruction	Contact Hours	Percentage
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
5.	**Others (specify)……**	
	Total	45

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Understand the relationship between **geometry, algorithms, and computational complexity**.	K3	Lectures	Assignment Quiz
1.2	Understand applications in **computer-aided design (CAD), virtual reality (VR), and medical imaging**.	K3	Lectures	Mid Term Final Exam
…				
2.0	**Skills**			
2.1	Implement and use **geometric data structures** (e.g., **Kd-trees, Quad-trees, and BSP-trees**) for efficient computation.	S2,S3	Lectures	Midterm Final Exam Quiz Project

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.2	Design and implement **efficient geometric algorithms** for fundamental problems.	S2, S3	Lectures	Midterm Final Exam Quiz Project
2.3	Apply convex hulls in **pattern recognition, image processing, and collision detection**.	S2, S3		
3.0	**Values, autonomy, and responsibility**			
3.1	Work on a **real-world computational geometry project** to strengthen problem-solving and implementation skills.	V1, V2	Project	Project presentation
3.2				
...				

C. Course Content:

No	List of Topics	Contact Hours
1.	Introduction to Computation Geometry- What is computational geometry-Applications in computer graphics, GIS, robotics, and more-Basic geometric operations.	3
2.	Geometric Primitves and Representations- Points, lines, segments, and polygons-Vector operations, dot product, and cross product.-Convex and concave polygons	6
3	Convex Hull Algorithm- Gift Wrapping Algorithm (Jarvis March)-Graham's Scan-QuickHull Algorithm-Applications of convex hulls in pattern recognition and image processing.	6
4	Line Segment Intersection- Brute force approach.- Sweep Line Algorithm- Applications in CAD and GIS	6
5	Polygon Triangulation- Ear Clipping Method.- Delaunay Triangulation.-Applications in finite element methods and mesh generation.	6

6	Voronoi Diagrams & Delaunay Triangulation- Definition and Properties of Voronoi Diagrams.- Fortune's Sweep Line Algorithm for Voronoi diagrams.- Applications in spatial data analysis and machine learning	6
7	Range Searching & Geometric Data Structures- Kd-Trees and Quad Trees.-Range queries and nearest neighbor search.-Applications in spatial databases and nearest-neighbor search.	6
8	Point Location Problems- Plane-sweep algorithms.-Trapezoidal decomposition.Kirkpatrick's Algorithm	3
9	Geometric Algorithm in Motion Planning- Pathfinding in 2D/3D spaces.Visibility Graphs.Applications in robotics and autonomous navigation.	6
10	Computation Geometry in 3D- Convex hulls in 3D.Intersection of 3D objects.Applications in 3D modeling, virtual reality (VR), and graphics.	6
12	Boolean operation in polygons- Computational topology basics-Geometric optimisation problems	3
Total		**45**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Assignment**	**Week-3**	**10**
2.	**Quiz**	**Week-5**	**10**
3.	**Mid Term**	**Week-12**	**25**
4	**Review Paper**	**Week-15**	**15**
5	**Final exam**	**End Semester**	**40**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars Computational Geometry: Algorithms and Applications, Third Edition, Springer, 2018.

Supportive References	J E Goodman and J O'Rourke, "Handbook of Discrete and Computational Geometry", CRC Press, 2004.
Electronic Materials	
Other Learning Materials	

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Sufficient seats (typically 20) as per student registration required in the lecture
Technology equipment (Projector, smart board, software)	Sufficient computer terminals with required setup having the necessary software installed and configured for the students to complete assignments and projects. Data show is needed to demonstrate in the class
Other equipment (Depending on the nature of the specialty)	Not Required

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	Indirect Assessment through Teaching Evaluation
Effectiveness of students' assessment	Faculty	Indirect assessment through Course Evaluation Survey
Quality of learning resources	Students	Indirect Assessment through Learning Resources Survey
The extent to which CLOs have been achieved	**Faculty**	Direct assessment through Rubrics analyses
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	
REFERENCE NO.	

DATE	