جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Applied Geometry - AMCS 271

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	AMCS 271
Course Title	Applied Geometry
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Mon Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
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Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	The course introduces into main areas of applied geometry: Differential geometry of curves and surfaces, kinematical geometry, projective geometry and basic notions of algebraic geometry. It develops the theory based on knowledge from undergraduate math courses (especially Calculus and Linear Algebra), but also shows the additional considerations which are necessary to apply these results on real-world problems and data. It applies the theory to selected problems in geometric modeling, geometry processing, Computer Graphics, Computer Vision and Robotics. Those include basics on curves and surfaces in Computer-Aided Design, geometric optimization and approximation algorithms, curve and surface matching (registration), 3D reconstruction and motion design.
Course Description from Program Guide	Differential Geometry: selected topics from the classical theory of curves and surfaces, geometric variational problems, robust computation of differential invariants, discrete differential geometry. Projective Geometry: computing with homogeneous coordinates, projective maps, quadrics and polarity. Algebraic Geometry: algebraic curves and surfaces, rational parameterizations, basic elimination theory. Kinematical Geometry: geometry of motions, kinematic mappings. The practical use of these topics is illustrated at hand of sample problems from Geometric Modeling, Computer Vision, Robotics and related areas of Geometric Computing.
Goals and Objectives	The theoretical part aims at a very solid understanding of the key concepts in the differential geometry of curves and surfaces and in projective geometry. It also provides basic insight into kinematical geometry and concepts of algebraic geometry. The students should be able to understand most literature on applied geometry, especially in areas of Visual Computing such as Geometry Processing, Computer Graphics and Computer Vision. As the course includes some assignments requiring programming, they will also acquire skills in the implementation of algorithms in applied geometry. The course should also be of great help in solving real-world problems which have a link to geometry. In particular, it will provide a solid basis for research in Visual Computing.
Required Knowledge	Most important is solid knowledge in Calculus and Linear Algebra.
Reference Texts	Course notes will be provided during the course.
Method of evaluation	**30.00**% - Tests **40.00**% - Homework /Assignments **30.00**% - Final exam

Nature of the assignments	Assignments come in two types: (1) Assignments which concern solutions of specific exam-like problems which have to be submitted in written form; they should demonstrate understanding of the theoretical concepts. (2) To demonstrate an understanding of geometry in applications, there will also be projects, where small groups work on the solution of slightly more complex problems. This will require the actual mathematical formulation of the problem, turning it into an algorithm and performing a test implementation and demonstration.
Course Policies	Attendance of lectures is highly recommended, but not checked. Assignments have to be submitted in time. In case of unforeseen events which do not allow the student to attend a test or to hand in an assignment, the lecturer wishes to be informed before that event through email. The effect of a delay in submitting work or taking a test will depend on the specific situation and be discussed with the student.
Additional Information	

Tentative Course Schedule
(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 01/28/2019 Wed 01/30/2019	curves; osculating spaces; classification of points
2	Mon 02/04/2019 Wed 02/06/2019	Bezier curves, polar forms, Frenet equations
3	Mon 02/11/2019 Wed 02/13/2019	order of contact, planar curves, support function
4	Mon 02/18/2019 Wed 02/20/2019	envelopes; first test
5	Mon 02/25/2019 Wed 02/27/2019	discrete curves; implicit representation
6	Mon 03/04/2019 Wed 03/06/2019	distance functions, geometric approximation problems
7	Mon 03/11/2019 Wed 03/13/2019	kinematical geometry, registration problems
8	Mon 03/18/2019 Wed 03/20/2019	surfaces; first fundamental form, mappings between surfaces
9	Mon 03/25/2019 Wed 03/27/2019	Spring Break
10	Mon 04/01/2019 Wed 04/03/2019	conformal maps, curvature theory of surfaces
11	Mon 04/08/2019 Wed 04/10/2019	shape operator, strip theory, envelopes of surfaces
12	Mon 04/15/2019 Wed 04/17/2019	developable surfaces, discrete surfaces
13	Mon 04/22/2019 Wed 04/24/2019	2nd test; projective geometry: homogeneous coordinates and duality
14	Mon 04/29/2019 Wed 05/01/2019	projective maps, polarity and quadrics
15	Mon 05/06/2019 Wed 05/08/2019	surfaces in projective geometry, link to algebraic geometry
16	Mon 05/13/2019 Wed 05/15/2019	basic facts on algebraic curves and surfaces; some elimination theory
17	Mon 05/20/2019 Wed 05/22/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.