

Differential Geometry

Math 5334-001 – Spring 2011

Time: Tuesday, Thursday 5:30 – 4:50 PM

Classroom: Pickard Hall 302

Instructor: Prof. Barbara Shipman (Distinguished Teaching Professor ☺)

Office: Pickard Hall 437

Office Hours: Mon. 9:30 – 11:30 AM, Wed. 2 – 4 PM

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Website: www.uta.edu/faculty/shipman – go to the Student Center, Math 5334, to view the weekly assignments and schedule.

Prerequisite: Basic principles of linear algebra and multi-dimensional calculus and good skill in writing proofs.

Textbook (required): Modern Differential Geometry of Curves and Surfaces with Mathematica, by Alfred Gray, Elsa Abbena, and Simon Salamon. ISBN: 1-58488-448-7

Optional reference: Differential Geometry and Its Applications, by John Oprea.
ISBN: 9-780883-857489

Course Content: Modern differential geometry encompasses sufficient foundational material to easily fill a two-year graduate sequence. This course takes a broad view of the subject, beginning with the geometry of curves and surfaces in two and three dimensions in Chapters 1 and 2 and extending it to curves and surfaces in manifolds of arbitrary dimension in Chapters 7 – 13, where related notions of curvature are developed and compared, including normal, principal, Gaussian, and mean curvatures, described in terms of the metric and shape operator. These are used in studying classic types of surfaces, including nonorientable surfaces, ruled surfaces, minimal surfaces, and surfaces of constant positive and negative curvature, drawing on material from Chapters 14 – 16 and 22. Chapter 17 introduces the Christoffel symbols, and Chapter 24 the general theory of differential manifolds, both foundational to the abstract concepts of modern Riemannian geometry, treated in Chapters 25 – 27. Our study will also include the famous Theorema Egregium (Chapter 17) and the Gauss-Bonnet Theorem (Chapter 27) and a look at classic types of curves on surfaces, including asymptotic curves, principal curves, and geodesics, from Chapters 18 and 19. To treat these topics well in a one-semester course, selected materials from these chapters will be covered and others omitted, as time allows.

Mathematica Notebooks: Guided computations using Mathematica are provided in a Notebook at the end of each chapter. These visualization and enhanced computational capabilities provided in these notebooks allow one to visualize curves and surfaces in a more hands-on setting that sheds light on some of the abstract concepts in the course. Mathematica is available on the computers in the Computer Lab in PKH 315. Homework activities based on the Mathematica Notebooks will be periodically assigned.

Learning Outcomes: Upon completion of Math 5334, students should be able to analyze both conceptually and computationally the foundational principles of differential geometry in the course content above, in the contexts of concrete examples and abstract formulations, and should recognize and appreciate the interconnections, relationships, and differences among the concepts and measures of curvature studied in the course.

Seminar-Style Classes: This course will be conducted in a seminar style in which you will take an active part in the development and explanations of the material, via class preparations and participation. This is the style in which mathematicians work and carry out their research – analyzing concepts via questions and examples, unraveling proofs and explanations in books and research papers with each other, and studying the results of computations. Bring your textbook to every class. I will not simply re-write what is in the textbook on the board for you to copy again in your notes. Rather, we will analyze the material, ask questions about, add to it, and view it through illustrative examples in a collaborative seminar setting in which you will take an active part.

Class Preparations and Participation: At the end of almost every class, you will be given a class preparation to complete and bring to the next class. You may be called on to explain your solutions to these preparations, and sometimes they will be collected and viewed on the opaque projector for discussion. An attendance/participation score will be taken at each class meeting, as follows:

- 2: for prepared attendance with good participation (well-explained answers when called upon and good participation in the seminar-style discussions)
- 1: if you arrive after class has begun, leave at any time during class, come unprepared, or if your participation is less than as described above
- 0: if you miss the class

Team Homework: Homework problems will be assigned periodically as new concepts are introduced. You will work on the homework with a team member from the class and hand it in as a joint effort. The teamwork will help you continue discussions about differential geometry outside of class and benefit from an exchange of ideas and different viewpoints on the problems. Teams may be changed over the course of the semester. Work on the homework problems weekly as they are assigned and keep your work until homework is collected in four installments on the dates listed below.

Guidelines for Team Homework:

- Each team submits one paper, prepared by the team.
- Each team member must work on and discuss all of the problems with the team and approve of the final submitted explanations and solutions.
- Each team should meet for at least six hours outside of class to work on the problems (in addition to time spent working individually). On the cover sheet, record the team's meeting dates and times.
- Your work should be complete and clear in the explanations, calculations, and proofs.
- Write in complete sentences written in clear English with correct punctuation.
- Write clearly in dark writing (pen or dark pencil) or type your work.

Quizzes: Five 20-minute quizzes will be given at the beginning of class on the dates listed below to test your knowledge and understanding of basic definitions, statements, and concepts. This will help keep you fluent on the vocabulary and concepts used daily in class as we progress through the material. One lowest quiz score will be dropped.

Final Team Project: A final project for teams of two will take the place of a final exam. During the time of the scheduled final exam, the teams will present their project to the class and hand in their written project.

Grading: Your work will be graded on correctness, completeness, and clarity.

Class preparation and participation:	20%
Team Homework:	30%
Quizzes:	30%
Final team project:	20%

A course average of at least 90% guarantees an A, at least 80% a B, at least 70% a C, and at least 60% a D.

Important dates:

Jan 18	First class
Jan 27	Quiz 1
Feb 10	Homework 1 due
Feb 24	Quiz 2
Mar 3	Homework 2 due
Mar 14 - 18	Spring Break
Mar 24	Quiz 3
Mar 31	Homework 3 due
Apr 1	Last day to drop (automatic W)
Apr 14	Quiz 4
Apr 21	Homework 4 due
Apr 28	Quiz 5
May 5	Last class
May 10	Final Projects due -- Presentations 5:30 – 8 PM

Policies of the University of Texas at Arlington:

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance.** Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. Contact the Financial Aid Office for more information.

Americans with Disabilities Act: The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the *Americans with Disabilities Act (ADA)*. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

Academic Integrity: It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. According to the UT System Regents' Rule 50101, §2.2, "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts."

Student Support Services Available: The University of Texas at Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. These resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals to resources for any reason, students may contact the Maverick Resource Hotline at 817-272-6107 or visit www.uta.edu/resources for more information.

Electronic Communication Policy: The University of Texas at Arlington has adopted the University "MavMail" address as the sole official means of communication with students. MavMail is used to remind students of important deadlines, advertise events and activities, and permit the University to conduct official transactions exclusively by electronic means. For example, important information concerning registration, financial aid, payment of bills, and graduation are now sent to students through the MavMail system. All students are assigned a MavMail account. **Students are responsible for checking their MavMail regularly.** Information about activating and using MavMail is available at <http://www.uta.edu/oit/email/>. There is no additional charge to students for using this account, and it remains active even after they graduate from UT Arlington.

To obtain your NetID or for login assistance, visit <https://webapps.uta.edu/oit/selfservice/>. If you are unable to resolve your issue from the Self-Service website, contact the Helpdesk at helpdesk@uta.edu.