PMATH 465/665: Differential Geometry
Course outline − Fall 2011

Instructor: Ruxandra Moraru
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Office hours (MC 5170): W 13:00—15:00, F 13:00—14:30, or by appointment.

Lectures: MWF 10:30 - 11:20 (MC 4040).

Course webpage: can be found at http://uwace.uwaterloo.ca.

Description from the course calendar: An introduction to differentiable manifolds. The tangent and cotangent bundles. Vector fields and differential forms. The Lie bracket and Lie derivative of vector fields. Exterior differentiation, integration of differential forms, and Stokes's Theorem. Riemannian manifolds, affine connections, and the Riemann curvature tensor.

Textbook: John. M. Lee, *Introduction to smooth manifolds,* Springer-Verlag.

Books on reserve at the Davis Center Library:

1. John M. Lee, *Introduction to smooth manifolds.*
2. John M. Lee, *Introduction to topological manifolds*.
3. Frank W. Warner, *Foundations of differentiable manifolds and Lie groups.*
4. William M. Boothby, *An introduction to differentiable manifolds and Riemannian geometry*.
5. John M. Lee, *Riemannian manifolds: an introduction to curvature.*
6. Manfredo P. do Carmo*, Differential forms and applications.*
7. James R. Munkres, *Analysis on manifolds*.
8. James R. Munkres, *Topology.*
9. Manfredo P. do Carmo, *Differential geometry of curves and surfaces.*
10. Chris J. Isham, *Modern differential geometry for physicists*.

Outline of topics (chapters refer to the textbook):

1. Topological manifolds; smooth manifolds (Chapter 1)
2. Smooth functions and smooth maps; partitions of unity (Chapter 2)
3. Tangent vectors; the tangent bundle; vector fields on manifolds (Chapters 3 & 4)
4. Covectors; the cotangent bundle; conservative vector fields (Chapter 6)
5. Submersions, immersions, and embeddings; submanifolds (Chapters 7 & 8)
6. Tensors; Riemannian metrics; differential forms (Chapters 11 and 12)
7. Orientations of manifolds; integration on manifolds; Stokes's Theorem (Chapters 13 & 14)
8. The de Rham cohomology groups (Chapter 15)
9. Integral curves; global flows and complete vector fields (Chapter 16)
10. Lie derivatives; commuting vector fields (Chapter 18)
11. Integrable submanifolds; tangent distributions; the Frobenius Theorem (Chapter 19)
12. *Time permitting:* affine connections; the Riemann curvature tensor; vector bundles

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Prerequisites: AMATH 333/PMATH 365 – Elementary Differential Geometry.

Method of evaluation: Your final grade will be based on 6 assignments, to be handed in class every two weeks, a 2.5-hour final exam, and (possibly) a research project, to be presented in the form of a talk at the end of the semester. Note that the research project is mandatory for graduate students and optional for undergraduate students.

Grading scheme: **(**Assignments 40%, Final 60%) OR (Assignments 40%, Final 40%, Project 20%).

Assignments schedule: Monday, 26 Sept.: Assignment 1.
Wednesday, 12 Oct.: Assignment 2.
Monday, 24 Oct.: Assignment 3.
Monday, 7 Nov.: Assignment 4.
Monday, 21 Nov.: Assignment 5.
Monday, 5 Dec.: Assignment 6.

Note: Assignments will be posted on the course webpage. Marked assignments will be returned in class, or will be available for pick up during office hours.

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check http://www.uwaterloo.ca/academicintegrity/for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals, http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Note for students with disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.