PMATH 365: Differential Geometry [Winter 2026]

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- **Office:** MC 5326
- **Office Hours:** Tue/Thu 1:30pm–2:20pm
- **Lecture Room:** MC 2054
- **Lecture Times:** Mon/Wed/Fri 9:30am–10:20am

Calendar course description: Curves and hypersurfaces in Euclidean space; integration and Stokes' Theorem; Gaussian and mean curvatures; Frenet-Serret frames and geodesics; Gauss-Bonnet Theorem.

Prerequisites: (MATH 235 or MATH 245) and (MATH 237 or MATH 247)

Brief outline of topics (tentative and subject to change):

- review of the fundamental theorem of ordinary differential equations
- curves in $\mathbb{R}^n$; the generalized Frenet-Serret formulas
- submanifolds of $\mathbb{R}^n$; examples using the inverse and implicit function theorems
- hypersurfaces in $\mathbb{R}^n$; orientability; boundary; normal vector field
- integration of vector fields along curves and flux integrals through hypersurfaces
- the fundamental theorem of line integrals; Stokes's theorem and the divergence theorem
- physical interpretations of the fundamental theorems in terms of fluid dynamics and electromagnetism
- (if time allows) a short detour into harmonic function theory and its applications
- the second fundamental form of a hypersurface in $\mathbb{R}^n$; the mean curvature; variation of area
- curves on hypersurfaces; geodesics; normal curvature
- Gauss's Remarkable Theorem (Theorema Egregium)
- The Gauss-Bonnet Theorem and its applications

Textbook: There is no required textbook for this course. I will *attempt* to supply typeset course notes throughout the term, but I cannot guarantee that I'll have time to do this consistently. There are many excellent books that cover curves and surfaces in $\mathbb{R}^3$, such as:

- do Carmo, M.P.; *Differential Geometry of Curves and Surfaces*, Prentice-Hall, 1976.
- Kuhnel, W., "Differential Geometry: Curves - Surfaces - Manifolds", Second Edition, A.M.S., 2006.
- O'Neill, B., "Elementary Differential Geometry", Second Edition, Academic Press, 1997.

I will put these books on reserve in the Davis Library. We will be considering curves in $\mathbb{R}^n$ and *hypersurfaces* in $\mathbb{R}^n$, which are more general than curves and surfaces in $\mathbb{R}^3$, but are treated in a very similar way. I can provide more references to the literature later in the course. The material on the fundamental integration theorems can be found in any good text on vector analysis.

If you attend all the lectures (*and you should*) then you can get by without needing to purchase a textbook.

Marking Scheme and Course Policies: Your course mark will be determined as follows:

- Assignments: 24% (six assignments, one every second week, worth 4% each)
- Midterm test: 16% (Friday, February 13, 2026, in-class)
- FINAL EXAM: 60% (date and time TBD)

- You *cannot pass this course* if you do not score at least 50% on the final exam. If your score on the final exam is less than 50%, then your final mark will be the *lesser* of your mark as determined above, or 45%.
- No books, notes, or electronic devices of any kind are permitted for the midterm test or the final exam.
- You are *strongly encouraged* to work together with *your classmates* on the assignments, but you must write up and turn in your own solutions. [The use of AI is *not permitted*.] You should expect more than half of your learning in this course to come from working on the assignments, so everyone should take them very seriously. I am not sympathetic to requests for leniency after the exam if you have not done the assignments.
- Do not attempt to submit work that you have simply copied (or generated) from other sources. The TAs and I can easily identify if you do not understand what you have written. It is not in your best interests.
- Requests for a regrade on an assignment or midterm test must be made *within 7 days* of its return to you.
- Late assignments are *not* accepted, and extensions are *not* given, as solutions are posted the following day.
- There is no opportunity for a make-up midterm test. If you miss the midterm without a valid, acceptable reason (accompanied by documented proof, such as a medical note), you will get a score of zero on the test.
- If you miss an assignment or midterm for valid reasons, the missed points are transferred to the final exam.

NOTE: For information on academic offences and accessibility services, please see the detailed version of the course outline available at: https://outline.uwaterloo.ca/viewer/view/nmubht