Course Change Request

New Course Proposal

Date Submitted: 02/09/26 11:52 am

Viewing: MATH 742 : Differential Geometry

Last edit: 02/10/26 11:16 am

Changes proposed by: esander

Are you completing this form on someone else's behalf?

No

In Workflow

1. **MATH Chair**
2. **SC Curriculum Committee**
3. SC Assistant Dean
4. Assoc Provost-Graduate
5. Registrar-Courses
6. Banner

Approval Path

1. 02/09/26 1:22 pm Maria Emelianenko (memelian): Approved for MATH Chair

Effective Term: Fall 2026

Subject Code: MATH - Mathematics

Course Number: 742

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Differential Geometry

Banner Title: Differential Geometry

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable:

May be only taken once for credit, limited to 3 attempts (N3)

Max Allowable Credits: 3

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s):

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Differential Topology (MATH 740) or equivalent

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description:

Riemannian geometry was created by Bernhard Riemann in his remarkable 1854 Habilitationsschrift. It provides the mathematical foundation for Einstein's general theory of relativity. In the early 1920's Elie Cartan generalized Riemann's geometry to include the revolutionary program of Felix Klein understanding geometry through the lens of Sophus Lie's theory of symmetry groups. Topics covered in this course vary, but will include: Riemannian metrics and/or their generalizations, connections, curvature, and geodesics.

Justification:

What: Creating a new course.

Why: Differential geometry is a standard course that is taught in most mathematics graduate programs, and we feel that this course will strengthen our PhD program. Furthermore, the material will be of interest to both student so mathematics and students of physics.

Does this course cover material which crosses into another department? No

Learning Outcomes:

At the end of the course students will be able to:
(1) read proofs in differential geometry,
(2) write proofs in differential geometry,
(3) participate in conversations about differential geometry, and
(4) present ideas to others in differential geometry.

Will this course be scheduled as a cross-level cross listed section? No

Attach Syllabus

DifferentialGeometrySyllabusGeneric.pdf

Additional Attachments

Staffing:

As of Spring 2026, the following faculty can teach this course: Tyrus Berry, Harrison Bray, David Carchedi, Rebecca Goldin, Sean Lawton, Yiannis Loizides, Anton Lukyanenko.

Relationship to Existing Programs:

This course will enhance the math MS and PhD programs. It will fulfill an elective credit for either degree.

Relationship to Existing Courses:

This course is a natural followup to the course Differential Topology (740), and it fits nicely in field with Lie Groups (741).

Have you reached out to the Libraries to determine whether there are adequate resources to support your course? If not, please email Meg Meiman, Associate University Librarian for Learning, Research, and Engagement at mmeiman2@gmu.edu.

No

Additional Comments:

Reviewer Comments

Key: 19245

GEORGE MASON UNIVERSITY

SYLLABUS
(Generic Sample)

Department of Mathematical Sciences

Differential Geometry

Possible Texts:

1. *Differential Geometry: Cartan's Generalization of Klein's Erlangen Program* by R.W. Sharpe (used successfully in Fall 2024)
2. *Riemannian Manifolds: An Introduction to Curvature* by John Lee
3. *Riemannian Geometry* by Manfredo do Carmo

General Description:

Fall 2024 based on Sharpe's book:

A *Klein* geometry is one based on a homogeneous space G/H where G is a Lie group. The geometric objects (classes in G/H) are those invariant under G. Given a differential manifold M it is natural to ask if it can be modeled on a Klein geometry. For example, Euclidean geometry concerns the objects invariant under the group of rigid motions (rotations and translations) of n-dimensional Euclidean space and a Euclidean structure on a manifold M is equivalent to a flat Riemannian metric. A *Cartan* geometry is a structure infinitesimally modeled on a Klein geometry. For example, all manifolds M with Riemannian metrics are infinitesimally modeled on Euclidean geometry. On the other hand, a Riemannian structure is locally Euclidean if and only if the metric is globally flat. The latter occurs if and only if the Riemann curvature tensor vanishes. In general, a Cartan geometry possesses an infinitesimal invariant (like the curvature tensor) whose vanishing detects whether the infinitesimal model (the Cartan geometry) is a local model of a global geometry (the Klein geometry). This invariant can be understood as a connection on a certain principal bundle over M. The general theme of this course will be to understand the question: "Why is differential geometry the study of a connection on a principal bundle?".

Alternative (traditional Riemannian Geometry course):

A standard rigorous course in Riemannian geometry covering Riemannian metrics, connections and parallel transport, curvature, geodesics, Riemannian submanifolds, Jacobi fields, and comparison theorems. This course will be of interest to both students of mathematics and students of physics.

(Catalog) Description: Riemannian geometry was created by Bernhard Riemann in his remarkable 1854 Habilitationsschrift. It provides the mathematical foundation for Einstein's general theory of relativity. In the early 1920's Elie Cartan generalized Riemann's geometry to include the revolutionary program of Felix Klein understanding geometry through the lens of Sophus Lie's theory of symmetry groups. Topics covered in this course vary, but will include: Riemannian metrics and/or their generalizations, connections, curvature, and geodesics.

Prerequisite: Differential Topology (MATH 740)

Course Number: MATH 742 (it comes after 740 and 741 is Lie Groups which also comes after 740)

Rotation: Offered every Spring of odd year. This comes after Fall even year when the prerequisite (MATH 740) is offered. This will increase enrollment.

Faculty who can teach this course: As of Spring 2026, the following faculty can teach this course: Tyrus Berry, Harrison Bray, David Carchedi, Rebecca Goldin, Sean Lawton, Yiannis Loizides, Anton Lukyanenko.

Learning Outcomes: At the end of the course students will be able to:

(1) read proofs in differential geometry,
(2) write proofs in differential geometry,
(3) participate in conversations about differential geometry, and
(4) present ideas to others in differential geometry.

Assessment: There will be regularly assigned HW based on the lectures and readings. There will be in exams (based on the HW) every couple weeks. Your final grade will be determined by your scores on exams and HW.

Grading: Your grade for the course will be calculated based on Exams (50%) and HW (50%).

The grading scale will be: A: 90-100%; B: 80-89%; C: 70-79%; D: 60-69%; F: below 60% .

+ or – *may* be attached to the grade for the upper or lower 2 points in each range.

Sample Week by Week for course based on Sharpe with Math 740 as a prerequisite:

1 Foliations
2 Non-Abelian Calculus
3 Non-Abelian Calculus
4 Klein Geometries
5 Klein Geometries
6 Klein Geometries
7 Cartan Geometries
8 Cartan Geometries
9 Cartan Geometries
10 Riemannian Geometry
11 Riemannian Geometry
12 Riemannian Geometry
13 Mobius Geometry
14 Mobius Geometry

Sample Week by Week for a traditional Riemannian Geometry course with Math 740 as a prerequisite:

1 Riemannian Metrics
2 Riemannian Metrics
3 Connections
4 Connections
5 Geodesics and Exponential
6 Geodesics and Exponential
7 Geodesics and Distance
8 Curvature
9 Curvature
10 Submanifolds and the Second Fundamental Form
11 Submanifolds and the Second Fundamental Form
12 Gauss-Bonnet Theorem
13 Jacobi Fields
14 Comparison Theorems

Common Policies Affecting All Courses at George Mason University

These four policies affect students in all courses at George Mason University. This Course Policy Addendum must be made available to students in all courses (see Catalog Policy AP.2.5).

Additional policies affecting this course, and additional resources or guidance regarding these policies, may be provided to students by the instructor.

Academic Standards: Academic Standards exist to promote authentic scholarship, support the institution's goal of maintaining high standards of academic excellence, and encourage continued ethical behavior of faculty and students to cultivate an educational community which values integrity and produces graduates who carry this commitment forward into professional practice.

As members of the George Mason University community, we are committed to fostering an environment of trust, respect, and scholarly excellence. Our academic standards are the foundation of this commitment, guiding our behavior and interactions within this academic community. The practices for implementing these standards adapt to modern practices, disciplinary contexts, and technological advancements. Our standards are embodied in our courses, policies, and scholarship, and are upheld in the following principles:

4. **Honesty:** Providing accurate information in all academic endeavors, including communications, assignments, and examinations.
5. **Acknowledgment:** Giving proper credit for all contributions to one's work. This involves the use of accurate citations and references for any ideas, words, or materials created by others in the style appropriate to the discipline. It also includes acknowledging shared authorship in group projects, co-authored pieces, and project reports.
6. **Uniqueness of Work:** Ensuring that all submitted work is the result of one's own effort and is original, including free from self-plagiarism. This principle extends to written assignments, code, presentations, exams, and all other forms of academic work.

Violations of these standards—including but not limited to plagiarism, fabrication, and cheating—are taken seriously and will be addressed in accordance with university policies. The process for reporting, investigating, and adjudicating violations is outlined in the university's procedures. Consequences of violations may include academic sanctions, disciplinary actions, and other measures necessary to uphold the integrity of our academic community.

The principles outlined in these academic standards reflect our collective commitment to upholding the highest standards of honesty, acknowledgment, and uniqueness of work. By adhering to these principles, we ensure the continued excellence and integrity of George Mason University's academic community.

Student responsibility: Students are responsible for understanding how these general expectations regarding academic standards apply to each course, assignment, or exam they participate in; students should ask their instructor for clarification on any aspect that is not clear to them.

Accommodations for Students with Disabilities: Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit https://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu. Phone: (703) 993-2474.

Student responsibility: Students are responsible for registering with Disability Services and communicating about their approved accommodations with their instructor **in advance** of any relevant class meeting, assignment, or exam.

FERPA and Use of GMU Email Addresses for Course Communication: Student privacy is governed by the Family Educational Rights and Privacy Act (FERPA) and is an essential aspect of any course. **Students must use their GMU email account** to receive important University information, including communications related to this class. Instructors will not respond to messages sent from or send messages regarding course content to a non-GMU email address.

Student responsibility: Students are responsible for checking their GMU email regularly for course-related information, and/or ensuring that GMU email messages are forwarded to an account they do check.

Title IX Resources and Required Reporting: As a part of George Mason University's commitment to providing a safe and non-discriminatory learning, living, and working environment for all members of the University community, the University does not discriminate on the basis of sex or gender in any of its education or employment programs and activities. Accordingly, all non-confidential employees, including your faculty member, have a legal requirement to report to the Title IX Coordinator, all relevant details obtained directly or indirectly about any incident of Prohibited Conduct (such as sexual harassment, sexual assault, gender-based stalking, dating/domestic violence). Upon notifying the Title IX Coordinator of possible Prohibited Conduct, the Title IX Coordinator will assess the report and determine if outreach is required. If outreach is required, the individual the report is about (the "Complainant") will receive a communication, likely in the form of an email, offering that person the option to meet with a representative of the Title IX office.

For more information about non-confidential employees, resources, and Prohibited Conduct, please see University Policy 1202: Sexual and Gender-Based Misconduct and Other Forms of Interpersonal Violence. Questions regarding Title IX can be directed to the Title IX Coordinator via email to TitleIX@gmu.edu, by phone at 703-993-8730, or in person on the Fairfax campus in Aquia 373.

Student opportunity: If you prefer to speak to someone **confidentially**, please contact one of Mason's confidential employees in Student Support and Advocacy (SSAC), Counseling and Psychological Services (CAPS), Student Health Services (SHS), and/or the Office of the University Ombudsperson.