FLORIDA ATLANTIC UNIVERSITY

NEW COURSE PROPOSAL
Graduate Programs

Department Mathematical Sciences

College Science

*(To obtain a course number, contact **erudolph@fau.edu**)*

UGPC Approval _____
UFS Approval _____
SCNS Submittal _____
Confirmed _____
Banner _____
Catalog _____

Prefix MTG

Number 6256

(L = Lab Course; C = Combined Lecture/Lab; add if appropriate)
Lab Code

Type of Course Lecture

Course Title
Applied Differential Geometry

Credits *(Review Provost Memorandum)*
3

Effective Date *(TERM & YEAR)*
Fall 2021

Grading *(Select One Option)*
Regular
Sat/UnSat

Course Description *(Syllabus must be attached; see Guidelines)*

Differentiable manifolds, affine connections, tensor analysis, Riemannian geometry, and Lie groups, with applications to physics and complex variables.

Prerequisites
MAA 5105 Multivariable Analysis

Prerequisites, Corequisites and Registration Controls are enforced for all sections of course.

Academic Service Learning (ASL) course
Academic Service Learning statement must be indicated in syllabus and approval attached to this form.

Corequisites
none

Registration Controls *(For example, Major, College, Level)*
none

Minimum qualifications needed to teach course:
Member of the FAU graduate faculty and has a terminal degree in the subject area (or a closely related field.)

List textbook information in syllabus or here
T. Frankel. The geometry of physics: An introduction, 3rd edition. Cambridge, 2011. ISBN 978-1107602601.

Faculty Contact/Email/Phone
Yuan Wang/ ywang@fau.edu / (561)297-3340

List/Attach comments from departments affected by new course
Physics

Approved by		***Date***
Department Chair	Stephen C Locke	March 4/2021
College Curriculum Chair	Christopher Beetle Date: 2021.03.15 11:59:43 -04'00'	
College Dean	William David Kalie	03/15/21
UGPC Chair		
UGC Chair		
Graduate College Dean		
UFS President		
Provost		

Email this form and syllabus to UGPC@fau.edu 10 days before the UGPC meeting.

Fall 2021

Applied Differential Geometry

MTG 6256
3 credit hours
2:00 – 3:20 TΘ
Science & Engineering 319A

Photograph by Henry Segerman.

This course begins with a review of the theory of functions of a complex variable, building quickly to an elementary discussion of the geometry and topology of Riemann surfaces. It then uses insights from Riemann surface theory to motivate and define differentiable manifolds of arbitrary dimension, and the differential and integral calculus of fields thereon. Finally, it deploys the methods of differential geometry in two applications of practical interest, namely Riemannian geometry and the geometry of Lie groups. The focus of the course throughout is on applications, particularly in contemporary theoretical physics. Time permitting, these will include applications to fiber bundles, gauge theories, and monopoles.

Instructor

Prof. Chris Beetle
Science & Engineering 448
(t) 561.297.4612
(f) 561.297.2662
(m) 561.306.3234
cbeetle@fau.edu

Office hours: by appointment.

Required Text

- T. Frankel. *The Geometry of Physics: An Introduction*, Third Edition. (Cambridge, 2012.) ISBN 978-1-107-60260-1

Recommended Text

- M.J. Ablowitz and A.S. Fokas. *Complex Variables: Introduction and Applications*, Second Edition. (Cambridge, 2003.) ISBN 0-521-53429-1

Prerequisite

MAA 5105 Multivariable Analysis.

The main background students should have for the course is calculus in several real variables. This includes the differential calculus of mappings from one real vector space to another (possibly having a different dimension), and integration in several dimensions. Students will also benefit from some prior experience with first order differential operators, such as the momentum and angular momentum operators in elementary quantum mechanics, and differential and integral calculus in the complex plane.

Any student who is concerned about his or her preparation should meet with me as soon as possible to discuss the matter.

Course Description and Objectives

The main topics to be covered in this course are:

- a review of the differential and integral calculus of single- and multi-valued functions of a complex variable, with applications,
- Riemann surfaces,
- differentiable manifolds, affine connections, and integration,
- elementary Riemannian geometry, and
- fiber bundles, connections, and gauge theory (time permitting).

The course will follow a traditional lecture format, with an emphasis on solving specific problems. Computer demonstrations will be used if and when possible.

Evaluation

Grades in this course will be calculated using a statistical curve based on a weighted average of several factors. These weights and factors include

- 30% assigned homework sets.

  Homework assignments will be due every 10 days or so throughout the semester. Students are allowed, and indeed encouraged, to discuss the homework problems with one another. However, each student should prepare his or her own written solutions independently to be handed in for grading. Copying is not allowed.

- 20% written lecture notes and in-class participation.

  One student will serve as a recording secretary during each lecture period. That student will scan his or her notes for that lecture and distribute them to all of the other students through the course's Canvas site. This will free the other students in each lecture to focus on broader issues and ask questions.

- 30% two written, take-home, midterm exams.

  Collaboration on exams is not allowed.

- 20% one written, in-class, final exam.

  The final exam will be held in the regular classroom during the period scheduled by the University: **TBA**. It will cover all material from the course. Students may consult the textbook and their course notes, but no other resources, during the exam period.

Course Policies

Late Assignments All assigned coursework must be ready at the beginning of the lecture on the date it is due. If a student has a family emergency or illness, he or she may request an individual extension *by email at least twenty-four hours in advance* of the the lecture during which the assignment is due. The instructor may approve or deny such requests at his discretion. Exceptions can also be made for students' participation in University-approved activities and religious observances. Please advise the instructor as early as possible about any such conflicts.

Extra Credit No extra credit will be offered.

Collaboration Students are encouraged to collaborate on homework assignments, but copying is not allowed. Collaboration on the exams is also not allowed.

Incomplete Grades Grades of Incomplete (I) are reserved for students who are passing the course, but unable to complete all assigned course work on time due to exceptional circumstances such as those outlined above for late homework. Unless such circumstances can be documented, work not completed at the end of the semester will be assessed as a zero in the final grades.

Important Dates

- TBA.

Attendance Policy Statement

Students are expected to attend all of their scheduled University classes and to satisfy all academic objectives as outlined by the instructor. The effect of absences upon grades is determined by the instructor, and the University reserves the right to deal at any time with individual cases of non-attendance.

Students are responsible for arranging to make up work missed because of legitimate class absence, such as illness, family emergencies, military obligation, court-imposed legal obligations or participation in University-approved activities. Examples of University-approved reasons for absences include participating on an athletic or scholastic team, musical and theatrical performances and debate activities. It is the student's responsibility to give the instructor notice prior to any anticipated absences and within a reasonable amount of time after an unanticipated absence, ordinarily by the next scheduled class meeting. Instructors must allow each student who is absent for a University-approved reason the opportunity to make up work missed without any reduction in the student's final course grade as a direct result of such absence.

Disability Policy Statement

In compliance with the Americans with Disabilities Act Amendments Act (ADAAA), students who require reasonable accommodations due to a disability to properly execute coursework must register with Student Accessibility Services (SAS) and follow all SAS procedures. SAS has offices across three of FAU's campuses — Boca Raton, Davie and Jupiter — however disability services are available for students on all campuses. For more information, please visit the SAS website at http://www.fau.edu/sas/.

Counseling and Psychological Services (CAPS) Center

Life as a university student can be challenging physically, mentally and emotionally. Students who find stress negatively affecting their ability to achieve academic or personal goals may wish to consider utilizing FAU's Counseling and Psychological Services (CAPS) Center. CAPS provides FAU students a range of services — individual counseling, support meetings, and psychiatric services, to name a few — offered to help improve and maintain emotional well-being. For more information, go to http://www.fau.edu/counseling/.

Code of Academic Integrity Policy Statement

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see University Regulation 4.001.

Applied Differential Geometry (MTG 6256)

Date	Lecture Topic
Tue 20 Aug	1 Functions on the Complex Plane
Thu 22 Aug	2 Topology of the Complex Plane and Riemann Surfaces
Tue 27 Aug	3 The Cauchy–Riemann Complex
Thu 29 Aug	4 Integration and Series Expansions
Tue 3 Sep	5 Calculus of Residues
Thu 5 Sep	6 Applications of the Residue Calculus
Tue 10 Sep	7 Conformal Mapping
Thu 12 Sep	8 Riemann Surfaces
Tue 17 Sep	9 Discussion and Problem Session
Thu 19 Sep	10 Smooth Manifolds
Tue 24 Sep	11 Differential Forms
Thu 26 Sep	12 Integration on Manifolds
Tue 1 Oct	13 Diffeomorphisms
Thu 3 Oct	14 Lie Derivatives
Tue 8 Oct	15 Covariant Derivatives
Thu 10 Oct	16 Curved Geometries
Tue 15 Oct	17 Geometry of Surfaces
Thu 17 Oct	18 de Rham Cohomology
Tue 22 Oct	19 Discussion and Problem Session
Thu 24 Oct	20 Lie Groups and Lie Algebras
Tue 29 Oct	21 Fiber Bundles
Thu 31 Oct	22 Connections on Principal Bundles
Tue 5 Nov	23 Associated Bundles and Induced Connections
Thu 7 Nov	24 Bundles and Topology in Physics
Tue 12 Nov	25 The Dirac Equation
Thu 14 Nov	26 Electrodynamics as a Gauge Theory
Tue 19 Nov	27 Yang–Mills Theory
Thu 21 Nov	28 Monopoles and Instantons
Tue 26 Nov	29 Discussion and Problem Session
Thu 28 Nov	30 No Class — Thanksgiving Recess
Tue 3 Dec	31 Optional Review Session (Reading Day)
Tue 10 Dec	32 Final Exam Period (1:15 – 3:45)

From: Luc Wille <willel@fau.edu>
Sent: Thursday, March 4, 2021 12:37 PM
To: Christopher Beetle <cbeetle@fau.edu>
Cc: Hongwei Long <hlong@fau.edu>; Stephen Locke <lockes@fau.edu>; Yuan Wang <YWANG@fau.edu>
Subject: Re: Math Course Proposal

Dear Chris:

With this email I would like to affirm the Physics Department's full support for the cross-listing of "Mathematical Physics 2" (PHZ 5156) as "Applied Differential Geometry" (MTG 6256) in the Department of Mathematical Sciences. We welcome these interdisciplinary initiatives and do not foresee any difficulty with enrollment caps for the cross-listed course.

Thank you for being a leader in this initiative and also thank you to our colleagues in the math department for their cooperation and support.

Warmest regards, --Luc

Luc T. Wille
Professor and Chair
Department of Physics
Florida Atlantic University

From: Christopher Beetle <cbeetle@fau.edu>
Sent: Thursday, March 4, 2021 9:23 AM
To: Luc Wille <willel@fau.edu>
Cc: Hongwei Long <hlong@fau.edu>; Stephen Locke <lockes@fau.edu>; Yuan Wang <YWANG@fau.edu>
Subject: Re: Math Course Proposal

Hi Luc:

I copied you a couple weeks ago when I reached out to Math to see if they would like to cross list the Math Physics 2 course on differential geometry that I expect we will run next Fall. They have been enthusiastic about the idea, and would like to move forward with that. We have also discussed building the course out a bit in future years, and perhaps turning it into a team-taught, interdisciplinary course, though next Fall's iteration will retain its currently planned form.

The proposal will move forward, assuming you have no objection, at next Tuesday's meeting of the College grad programs committee. It would help if we could attach an email from you stating, for example, that "The Department of Physics welcomes the cross-listing of Mathematical Physics 2 (PHZ 5156) as Applied Differential Geometry (MTG 6256) in the Department of Mathematical Sciences, and does not foresee any difficulty with enrollment caps for the cross-listed course." The email should go to myself and the Math faculty CC'd above.

I am of course happy to discuss if you have any questions or concerns.

Best Regards,

Chris

On March 2, 2021 at 12:55:17 PM, Yuan Wang (ywang@fau.edu) wrote:
Hello Chris,
The course proposal was approved by our department. I believe our graduate director, Dr. Long, will submit the proposal to the college committee when our chair, Dr. Locke, signs the proposal.
Please let us know if more steps or items are needed from Math. You mentioned that Luc will come up with a letter to go with the proposal, right?
Thank you very much.
Yuan
On 3/1/2021 3:29 PM, Christopher Beetle wrote:
Hi Yuan:

This looks very good. No concerns. Thanks for the quick turnaround.

Cheers,

Chris

On March 1, 2021 at 1:56:04 PM, Yuan Wang (ywang@fau.edu) wrote:
Hello Chris,
It was nice to chat with you on Zoom the other day. After some communications with some of math colleagues, I've done some modifications on the course documents. Here are some main changes:
- We added MAA 5105 Multivariable Analysis as prerequisite. MAA 5105 is a required course for our PhD students before they are admitted to candidacy. Knowing and feeling more comfortable with the background for some of the mathematics in the course should allow the math students to have time to pick up the Physics they need to understand the lectures. Students (especially undergrad) who don't have the prereq can always ask for special permissions from the professor.
- We coded the course at 6xxx level so to attract the students to take it.
- I took the liberty to sign the course proposal form just to make it more formal that it would be from Math.
The changes were made on the course form and the syllabus. The course outline was not touched (but I reformatted it for easy reading.)
We will bring the proposal to our dept meeting tomorrow for a dept approval. But I'd like you to take a look for your comments or concerns. Please let me know.
Thank you very much.
Yuan