

PROPOSAL NUMBER: 99- 703  
99-00-703

# CURRICULUM PROPOSAL FORM

(R)

**DEADLINES:**

ANNUAL COURSE PROPOSALS: OCTOBER 23, 1998 FOR FALL, 1999 AND FEBRUARY 19, 1999 FOR SPRING, 2000  
 SHORT-TERM COURSE PROPOSALS: DECEMBER 11, 1998 FOR FALL, 1999 AND MARCH 26, 1998 FOR SPRING 2000

**PROPOSAL TITLE:** Differential Geometry

**SPONSOR/S:** Drs. Hieu Nguyen and Marcus Wright,

**DEPARTMENT:** Department of Mathematics

1761.507

**CHECK ALL THAT APPLY:**

UNDERGRADUATE       GRADUATE

**COLLEGE:** Liberal Arts and Sciences

**If LAS:**       History/Humanities  
                    Math/Sciences  
                    Social/Behavioral Sciences

\* \* \* \* \*

**TYPE OF PROPOSAL (Check ALL that Apply)**

<input type="checkbox"/> General Education	<input checked="" type="checkbox"/> New Course (NOT Gen. Ed.)
<input type="checkbox"/> New Course in _____ Bank	<input type="checkbox"/> Name Change (Dept., School, Major)
<input type="checkbox"/> Existing course, Add To _____ Bank	<input type="checkbox"/> Changes in Degree Requirements
<input type="checkbox"/> Multicultural/Global Designation	<input type="checkbox"/> Changes Involve Gen. Ed. requirements
<input type="checkbox"/> Writing Intensive Designation	
	<input type="checkbox"/> Minor Changes to Existing Courses
<input type="checkbox"/> New Minor/Concentration/Specialization	<input type="checkbox"/> Course is NOT General Education
<input type="checkbox"/> New Major/Degree Program	<input type="checkbox"/> Course IS General Education
<input type="checkbox"/> Short Term Course Proposal	

**DEPARTMENT**  
 (SIGNATURE INDICATES APPROVAL)

Alicia Abay 10/12/98      Ronald J. Fisher 10/12/98

**DEPT. CURRICULUM CHAIR / DATE**      **DEPT. CHAIRPERSON / DATE**

**COLLEGE CURRICULUM COMMITTEE**  
 DATE OF OPEN HEARING (if necessary) \_\_\_\_\_

APPROVED  
 NOT APPROVED

COMMENTS: Consent letter received 1/21

R. Nancy [Signature]      2-4-99

**SIGNATURE**      **DATE**

**ACADEMIC DEAN (& GRADUATE DEAN, for New Graduate Programs Only)**

APPROVED  
 NOT APPROVED

COMMENTS: \_\_\_\_\_

[Signature]      [Date]

**SIGNATURE (Academic Dean)**      **DATE**

[Signature]      [Date]

**SIGNATURE (Graduate Dean)**      **DATE**

**UNIVERSITY CURRICULUM COMMITTEE**

DATE OF OPEN HEARING (if necessary) 11/24/98 (college level only)

APPROVED

NOT APPROVED

COMMENTS:

Francis Rivers 2/21/99  
SIGNATURE DATE

**SENATE**

Date announced at Senate 12/8/98

Voted upon at Senate:            **Approved**            **Not Approved**            **Date:**

**EXECUTIVE VICE PRESIDENT/PROVOST**

FEB 8 1999

APPROVED

NOT APPROVED If no, reasons are as follows:

STUDENT CREDIT HOURS 3    FACULTY LOAD HOURS 3    EQUALIZED CREDIT HOURS \_\_\_\_\_

OFFICIAL COPY & APPROVAL SHEET FILED (DATE): \_\_\_\_\_

DATE/SIGNATURE EXECUTIVE VICE PRESIDENT/PROVOST [Signature]

**REGISTRAR**

DATE APPROVED COURSE DESCRIPTION RECEIVED \_\_\_\_\_

HEGIS TAXONOMY & COURSE NUMBER ASSIGNED 1701.507

DATE/SIGNATURE OF REGISTRAR Robert A. Kulat 2/23/99

**NOTIFICATION FORWARD:**

\_\_\_\_\_ SENATE CURRICULUM COMMITTEE CHAIRPERSON

\_\_\_\_\_ DEPARTMENT CHAIRPERSONS

\_\_\_\_\_ ACADEMIC DEAN(S)

\_\_\_\_\_ REGISTRAR

\_\_\_\_\_ SPONSOR(S)

TAM  
2/23/99

## COURSE PROPOSAL

### Differential Geometry

#### 1. Details

- a. Course Title: Differential Geometry
- b. Sponsors: Drs. Hieu Nguyen and Marcus Wright, Department of Mathematics
- c. Credit Hours: 3
- d. Course Level: Graduate (advanced undergraduates may enroll with the permission of the instructor)
- e. Prerequisites: 1701.210 Linear Algebra and 1701.230 Calculus III or permission of instructor.
- f. Suggested Time, Implementation: One section of the course to be offered every other year as needed.
- g. Curricular Effect: Elective course for all students in the Master of Arts Program in Mathematics and for advanced undergraduate math and physics majors.
- h. Resources: Faculty, computer equipment and library resources are adequate.

#### 2. Rationale:

The subject of geometry has seen many significant developments in the 20<sup>th</sup> century. Historically, this should not come as a surprise as human beings are highly spatial by nature. It has been shown consistently in the past that a geometric approach towards the investigation of nature is deemed a fruitful one. For example, geometry has and continues to play a major role in the study of a variety of surfaces such as hyperbolic space and physical applications such as general relativity. This is especially true in differential geometry, a branch of mathematics that applies the ideas of calculus to understand the geometry of spatial objects.

Currently, the geometry courses offered at Rowan University, namely Geometry I and II (both undergraduate) and Modern Geometry (graduate), provide only a classical treatment of non-Euclidean geometry that was developed in the 19<sup>th</sup> century. These courses were originally designed to teach secondary education students basic principles of spherical and hyperbolic geometry in two-dimensions. They, however, do not teach students geometrical concepts and applications developed in the 20<sup>th</sup>-century and do not keep students abreast of current research in geometry. Therefore, with the Math Department now running a Masters of Arts program and awaiting approval for its Bachelor of Science program, it is urgent that a modern differential geometry course be offered. Such a course would be vital to our graduate students who wish to do research in differential geometry and to our undergraduate students who wish to prepare themselves for graduate school or even for industrial jobs that demand an expertise in geometry, such as computer graphics and animation.

#### 3. Essence of the Course

##### a. Objectives in Relation to Student Outcomes

Students in this course will learn how the concepts of calculus can be applied to understand the geometry of mathematical surfaces such as planes, spheres, hyperbolic spaces and manifolds in general. Topics include geodesics, tangent space, directional derivative, Riemannian metrics,

isometries, Gaussian curvature, first and second fundamental forms, Gauss-Bonnet Theorem, minimal surfaces, differential manifolds, connections, and Riemannian curvature tensors. Special topics (at the discretion of the instructor) may include Lie groups, symmetric spaces, general relativity, cohomology, and complex geometry. Students will be required to use a computer algebra system to solve problems and gain geometric intuition.

b. Topical Outline:

- I. Surfaces and Straightness
  - I.1. Geodesic
  - I.2. Surfaces of revolution
  - I.3. Geodesics on the Sphere
  - I.4. Geodesics on the Hyperbolic Plane
  - I.5. Geodesics on the Hyperbolic Disk
  
- II. Surfaces and Curvature
  - II.1. Tangent space
  - II.2. Extrinsic Curvature
  - II.3. Intrinsic (Geodesic) Curvature
  - II.4. Directional Derivative
  - II.5. Riemannian Metrics
  - II.6. Isometries
  - II.7. Stereographic Projection
  
- III. Surfaces and Area
  - III.1. Parallel Transport
  - III.2. Holonomy
  - III.3. Gaussian Curvature
  - III.4. First and Second Fundamental Form
  - III.5. Gauss-Bonnet Theorem
  - III.6. Mean Curvature and Minimal Surfaces
  - III.7. Surfaces of Constant Curvature
  
- IV. Manifolds and Curvature
  - IV.1. Atlas and Local Coordinates
  - IV.2. Differentiable Manifolds
  - IV.3. Covariant Derivative and Connections
  - IV.4. Christoffel Symbols
  - IV.5. Lie brackets and Vector Fields
  - IV.6. Riemannian Curvature Tensors
  
- V. Special topics (at the discretion of the instructor)
  - V.1. Lie Groups and Symmetric Spaces
  - V.2. Lorentz Metrics and General Relativity
  - V.3. Differential Forms and Cohomology
  - V.4. Complex Geometry
  - V.5. Foliations

c. Evaluation and Grading:

Students will be evaluated by the traditional methods of grading homework problems and through written tests. In addition, students will prepare computer solutions of assigned problems.

d. Course Evaluation:

This course will be evaluated through customary student evaluations as well as regular departmental review.

4. Results of Consultation

The Department of Chemistry & Physics was consulted. A letter of support is enclosed.

5. Additional Information:

a. Recommended Texts:

- 1) Henderson, David W., Differential Geometry: A Geometric Introduction, Prentice-Hall, 1998.
- 2) Boothby, William M., An Introduction to Differential Manifolds and Riemannian Geometry, Academic Press, 1986.

6. Catalogue Description:

1701-5XX **Differential Geometry** 3 s.h.

(Prerequisites: 1701.210 and 1701.230 or permission of instructor)

This course explores the application of calculus towards the study of higher-dimensional surfaces and their geometry. Topics include geodesics, tangent space, directional derivative, Riemannian metrics, isometries, Gaussian curvature, first and second fundamental forms, Gauss-Bonnet Theorem, minimal surfaces, differential manifolds, connections, and Riemannian curvature tensors. Special topics (at the discretion of the instructor) may include Lie groups, symmetric spaces, general relativity, cohomology, and complex geometry. Students will be required to use a computer algebra system to gain geometric intuition.



*Department of Chemistry & Physics*

Dr. Hieu Nguyen  
Department of Mathematics  
Rowan University  
Glassboro, NJ 08028

July 6, 1998

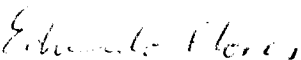
Dear Dr. Nguyen,

The Department of Chemistry and Physics supports the proposed new course in differential geometry. This subject is an essential tool in the study of several branches of theoretical physics including Cosmology, solid state physics and elementary particle physics. There are other applications outside of physics such as engineering where differential geometry is also an important tool.

The course proposal presented by your Department is quite complete and appropriate for a first course in differential geometry. The applications that you propose are relevant to physics. This course will be a benefit to our advanced undergraduates who are interested in theoretical physics, thus, we will strongly recommend that they take this course.

In summary, we believe that your course, Differential Geometry, will be an important addition to the present list of courses that your department offers.

Sincerely,

  
Dr. Eduardo Flores



Department of Chemistry and Physics  
256-4856

To: Hieu Nguyen, Department of Mathematics  
From: Robert Newland, Chair  
Subject: Course proposal  
Date: December 15, 1998

The Department of Chemistry and Physics supports the proposed new course in differential geometry. This subject is an essential tool in the study of several branches of theoretical physics including Cosmology, solid state physics and elementary particle physics. There are other applications outside of physics such as engineering where differential geometry is also an important tool.

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In summary, we believe that your course, Differential Geometry, will be an important addition to the present list of courses that your department offers.