LSC Use Only Proposal No:	UWUCC Use Only Proposal No: 12-26f:
LSC Action-Date: AP-2/7/13	UWUCC Action-Date: AP-5/7/13 Senate Action Date: APP-9/10/13

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) Francisco Alarcon	Email Address falarcon@iup.edu
Proposing Department/Unit Mathematics	Phone 724-357-2608

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or program proposal.

1. Course Proposals (check all that apply)

- ☐ New Course
- ☐ Course Prefix Change
- ☐ Course Deletion
- ☑ Course Revision
- ☐ Course Number and/or Title Change
- ☐ Catalog Description Change

Current course prefix, number and full title: MATH 122 Calculus II Natural and Social Sciences

Proposed course prefix, number and full title, if changing:

2. Liberal Studies Course Designations, as appropriate

This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

- ☑ Learning Skills
- ☐ Knowledge Area
- ☐ Global and Multicultural Awareness
- ☐ Writing Across the Curriculum (W Course)
- ☑ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)
  - ☐ Global Citizenship
  - ☐ Information Literacy
  - ☐ Oral Communication
  - ☑ Quantitative Reasoning
  - ☐ Scientific Literacy
  - ☐ Technological Literacy

3. Other Designations, as appropriate

- ☐ Honors College Course
- ☐ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

- ☐ Catalog Description Change
- ☐ Program Revision
- ☐ Program Title Change
- ☐ New Track
- ☐ New Degree Program
- ☐ New Minor Program
- ☐ Liberal Studies Requirement Changes
- ☐ Other

Current program name:

Proposed program name, if changing:

5. Approvals	Signature	Date
Department Curriculum Committee Chair(s)		4/20/12
Department Chairperson(s)	Edel Reilly	4/20/12
College Curriculum Committee Chair	Anne Kadas	4/20/12
College Dean		4/20/12
Director of Liberal Studies (as needed)		5/24/13
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail Stechrist	8/28/13

Received AUG 28 2013 Liberal Studies

Received MAY 3 2013 Liberal Studies

Received APR 22 2012 Liberal Studies

Part II: Description of Curriculum Change

1. New Syllabus of Record

I. Catalog Description

MATH 122 Calculus II for Natural and Social Sciences

4c-0l-4cr

Prerequisites: MATH 121 or equivalent.

Applications of integrals to natural and social sciences, functions of several variables, trigonometric functions, sequences and series, numerical methods, differential equations.

II. Course Outcomes and Assessment (Expected Undergraduate Student Learning Outcomes – EUSLO)

The student will:

Objective 1:
Study and apply pattern recognition in various areas of mathematics.
Expected Student Learning Outcomes 1 and 2:
Informed and Empowered Learners
Rationale:
Given a set of data, students will be expected to recognize certain mathematical patterns in order to make informed decisions on how that data is related, if at all. The students will be expected to use these relationships to solve a wide variety of problems. Technology will be used to gain deeper insight into the phenomena and make predictions about future behavior.

Objective 2:
Study and apply trigonometric functions and functions of several variables to the natural and social sciences.
Expected Student Learning Outcomes 1 and 2:
Informed and Empowered Learners
Rationale:
Theory and assignments require students to develop the skills of extending the principals of trigonometry, as well as limit, derivative and integration to multidimensional spaces. Assignments will require students to apply critical thinking skills of analysis and application in multidimensional spaces that include, but are not limited to, 2D and 3D spaces where students can visualize theory in applications

Objective 3:
Interpret these functions expressed analytically and graphically and use them to model real world situations.
Expected Student Learning Outcomes 1 and 2

Informed and Empowered Learners

Rationale:

Students will be expected to assess information that is disseminated analytically and/or graphically, and use the tools obtained from their study of functions to gain insight on the relationships exhibited. Technology will be used to gain deeper insight.

Objective 4:

Analyze the limit of sequences and series and apply them to problems in the natural and social sciences.

Expected Student Learning Outcome 1:

Informed Learners

Rationale:

Assignments will require students to apply a variety of techniques in order to determine the convergence or divergence of sequences and series. Students will also understand the close relationship between a series and its underlying sequence. In particular, the students will learn of Taylor series can be used to model applied problems understand the underlying connection between definite integrals and areas and volumes.

Objective 5:

Calculate the partial derivative of a function and interpret its meaning.

Expected Student Learning Outcome 1:

Informed Learners

Rationale:

Basic concepts of partial derivatives are used to explore the rates of change of a function in multiple directions.

Objective 6:

Calculate multiple integrals and interpret their meaning.

Expected Student Learning Outcome 2:

Empowered Learners

Rationale:

Students will model physical problems using multiple integration techniques. These applications will range from computation of mass and center of gravity to generating complex surfaces/solids using computers.

Objective 7:

Study and address issues concerning behavioral consequences of decisions on society and the physical world using mathematics.

Expected Student Learning Outcomes 3:

Responsible Learners

Rationale:

Students will use a variety of calculus techniques, in particular differentiation and integration, to solve applied problems at the discretion of the instructor. These problems include but are not limited to pollution control, population growth, energy consumption, emission control, health insurance premiums, nutrition, earthquake intensity, etc.

III. Detailed Course Outline

It is expected that six (6) hours will be spent reviewing differentiation and integration techniques before proceeding.

A. Calculus of Several Variables (12 hours)
   1. Functions of Several Variables
   2. Partial Derivatives
   3. Optimizing Functions of Several Variables
   4. Least Squares
   5. Lagrange Multipliers and Constrained Optimization
   6. Total Differentials and Approximate Changes
   7. Multiple Integrals

B. Trigonometric Functions (10 hours)
   1. Triangles, Angles, and Radian Measure
   2. Sine and Cosine Functions
   3. Derivatives of Sine and Cosine Functions
   4. Integrals of Sine and Cosine Functions
   5. Other Trigonometric Functions

C. Differential Equations (8 hours)
   1. Separation of Variables
   2. Further Applications of Differential Equations
   3. First-Order Linear Differential Equations
   4. Approximate Solutions of Differential Equations

D. Sequences and Series (6 hours)
   1. Geometric Series
   2. Taylor Polynomials
   3. Taylor Series
   4. Newton's Method

E. Probability (6 hours)
   1. Discrete Probability
   2. Continuous Probability
   3. Uniform and Exponential Random Variables
   4. Normal Random Variables

This syllabus covers 48 hours, leaving 8 hours for testing and/or review.

There are also 2 hours for a final exam or concluding activity.

IV. Evaluation Methods

The final grade for the course will be determined as follows:

50% Tests. Tests will include problems on basic competency and critical thinking.
20% Final Examination. The final examination will be comprehensive and cover both basic competency and critical thinking.
30% Homework, Quizzes, and Projects. These will cover textbook assignments and applications.

V. Example Grading Scale

A: 90%-100%
B: 80%-89%
C: 70%-79%
D: 60-69%
F: 0%-59%

VI. Undergraduate Attendance Policy

Although there is no formal attendance policy for this class, student learning is enhanced by regular attendance and participation in class discussions.

[Note: It is recommended that an attendance policy be developed by individual faculty and included in student syllabi. (See undergraduate catalog for Undergraduate Course Attendance Policy.)]

VII. Required Textbooks, Supplemental Books and Readings

Lial, M., Greenwell, R., Ritchey, N., *Calculus with Applications*, Ninth Edition, Addison Wesley, 2007

Switkes, Jennifer, *A Quotient Rule Integration by Parts Formula,* College Mathematics Journal, Vol 36, No. 1, pp. 58-60, 2005.

Austin, B., Barry, D., and Berman, D., *The Lengthening Shadow: The Story of Related Rates,* Mathematics Magazine, Vol. 73, No. 1, pp. 3-12, 2000.

Cooney, M., *Celebrating Women in Mathematics,* The National Council of Teachers of Mathematics, 1996.

VIII. Special Resource Requirements

Some instructors may require students to purchase a graphing calculator.

IX. Bibliography

Berresford, Geoffrey and Andrew Rockett. *Applied Calculus*, Second Edition, Houghton Mifflin, 2000.

Committee on the Mathematical Sciences in the Year 2000. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education,* Washington, DC : National Academy Press, 1989.

Hughes-Hallet, Deborah., et al. *Applied Calculus*, John Wiley & Sons, Inc., 1999.

Ostebee, Arnold and Paul Zorn. *Calculus from Graphical, Numerical, and Symbolic Points of View*, Harcourt, 1997.

Stewart, James. *Calculus.* 7th ed., Brooks\Cole, 2011

2. Summary of the proposed revisions

1. Objectives – the course objectives were revised from the original syllabus of record and aligned with the Expected Undergraduate Student Learning Outcomes (EUSLO) and Common Learning Objectives found in the criteria for a mathematics course.

2. Common Learning Objectives for a mathematics course are met in the content portion of the course (not necessarily a specific revision but it should be noted that the objectives for the new curriculum have been met). These objectives are:

    - understand deductive reasoning and apply it in the problem-solving process.
    - apply appropriate techniques to solve a variety of problems.
    - interpret, understand, and apply mathematical formulas appropriate to the course.
    - interpret, analyze, and use numerical data and graphs.
    - develop simple mathematical models to solve problems.

3. Updated the required textbook to reflect the textbook currently being used in the course.

4. Objective 7 from the old syllabus of record was removed, as it was determined to be vague and not measurable. The idea behind this objective is already covered by Objectives 1 – 6.

3. Justification/Rationale for the revision

The course is a currently approved Liberal Studies mathematics course and is being revised to meet the new curriculum criteria for this category.

4. Old Syllabus of Record

I. Catalog Description

MATH 122 Calculus II for Natural and Social Sciences — 4 credits, 4 lecture hours (4c-0l-4sh)

Prerequisites: MATH 121 or equivalent.

Applications of integrals to natural and social sciences, functions of several variables, trigonometric functions, sequences and series, numerical methods, differential equations.

II. Course Objectives

1. Students will understand and take advantage of pattern recognition in the study of mathematics.
2. Students will make a careful study of trigonometric functions, functions of several variables, and their application to the natural and social sciences.
3. Students will understand how to interpret these functions expressed analytically and graphically.
4. Students will understand the limit of sequences and series and how they pertain to the natural and social sciences.
5. Students will be able to calculate the partial derivative of a function and interpret its meaning.
6. Students will be able to calculate the multiple integral of a function and interpret its meaning.
7. Students will leave the course with a solid set of skills and a conceptual framework to equip the students for future study.

III. Course Outline

It is expected that six (6) hours will be spent reviewing differentiation and integration techniques before proceeding.

A. Calculus of Several Variables (12 hours)
   1. Functions of Several Variables
   2. Partial Derivatives
   3. Optimizing Functions of Several Variables
   4. Least Squares
   5. Lagrange Multipliers and Constrained Optimization
   6. Total Differentials and Approximate Changes
   7. Multiple Integrals

B. Trigonometric Functions (10 hours)
   1. Triangles, Angles, and Radian Measure
   2. Sine and Cosine Functions
   3. Derivatives of Sine and Cosine Functions

4. Integrals of Sine and Cosine Functions
5. Other Trigonometric Functions

C. Differential Equations (8 hours)
1. Separation of Variables
2. Further Applications of Differential Equations
3. First-Order Linear Differential Equations
4. Approximate Solutions of Differential Equations

D. Sequences and Series (6 hours)
1. Geometric Series
2. Taylor Polynomials
3. Taylor Series
4. Newton's Method

E. Probability (6 hours)

F. Discrete Probability

G. Continuous Probability

H. Uniform and Exponential Random Variables

I. Normal Random Variables

The remaining eight hours are for four review classes and four tests.

IV. Method of Instruction

This course is taught in a traditional classroom setting involving lecture, student participation in class, homework assignments, and written in class evaluations. Instructors are free to assign optional projects that may or may not involve graphing technology.

V. Evaluation Methods

The final grade for the course will be determined as follows:

50% Tests. Tests will include problems on basic competency and critical thinking.
20% Final Examination. The final examination will be comprehensive and cover both basic competency and critical thinking.
30% Homework, Quizzes, and Projects. These will cover textbook assignments and applications.

Grades will be assigned as follows:

A: 90%-100%

B: 80%-89%
C: 70%-79%
D: 60-69%
F: 0%-59%

VI. Required Textbook

Berresford, Geoffrey C. and Andrew M. Rockett. Applied Calculus (2nd edition). Boston: Houghton Mifflin Publishing Company, 2000.

VII. Special Resource Requirements

Some instructors may require students to purchase a graphing calculator.

VIII. Bibliography

Committee on the Mathematical Sciences in the Year 2000. Everybody Counts: A Report to the Nation on the Future of Mathematics Education. Washington, DC : National Academy Press, 1989.

Hughes-Hallet, Deborah, et al. Applied Calculus. New York: John Wiley & Sons, Inc., 1999.

Ostebee, Arnold, and Paul Zorn. Calculus from Graphical, Numerical, and Symbolic Points of View. Stamford, CT: Harcourt, 1997.

IX. Student Enrollment

This course is offered every semester and the average enrollment is 20 students.

5. Assignment instructions for one major course assignment and a grading rubric for that assignment

Major assignments for this course consist of chapter tests and final exams. Although the tests and exams cover the same content from the same chapters, instructors for each section determine their test structures and grading criteria on an individual basis.

6. Answers to Liberal Studies Questions

A. This will be a multiple-section course. Because this is the second course (of three) in a sequence, it is essential that there is basic equivalency among the sections because students could schedule a different instructor for the last course in the sequence. There will be a common syllabus that should be covered by each of the instructors. Calculus instructors typically meet at the end of each year to discuss the textbook for the following year. Throughout the semester instructors typically meet to compare their pace in the course, check what students are finding difficult, and compare tests. The calculus sequence is governed by the Mathematics Department Mathematics/Applied Mathematics Curriculum Committee.

B. Whenever appropriate, information will be introduced into the classroom discussion which will reflect the contributions made to the development of the mathematics involved by women and minorities. These discussions, for instance, can be based on content from the supplemental readings. Also, instructors will be sensitive to gender and ethnic balancing with respect to language in problem construction on homework, quizzes, and tests. The construction of contextual problems will be used to facilitate learning by making the material culturally relevant.

C. In this course we would like to exercise the exception to the use of a work of fiction or non-fiction because the primary purpose is the development of quantitative skills. We do make use of readings in this course, but they are typically from anthologies or from articles in scientific disciplines. These readings are at a level that introductory students can understand.

D. This course is an introductory course, but for a specific audience: mathematics and science students. It does not differ from what is provided to beginning mathematics majors. Calculus is a core discipline in both mathematics and science, and students in these majors benefit from a shared core course. Mathematics majors benefit by understanding the science applications inherent in the course. Calculus was developed to solve certain problems, some inherent to science, and some inherent to mathematics itself. Science students get an appreciation for mathematics as the language of science. The scientific method is the process by which scientists, collectively and over time, endeavor to construct an accurate, reliable, consistent and non-arbitrary representation of the world. Mathematics is a tool to write, analyze, and convey these representations.

25 total points

MATH 122 - Spring 2011
Learning Activity # 7

Name:_____

Complete each of the following problems. Be sure to show all relevant work.

(7 pts) 1. Evaluate $\iint_R (6xy^2)\,dA$ where R is the rectangle $R = \{(x, y) : 1 \le x \le 3, 0 \le y \le 2\}$.

$$\iint_R (6xy^2)\,dA = \int_1^3 \int_0^2 6xy^2\,dy\,dx = \int_1^3 (2xy^3)\Big|_0^2\,dx = \int_1^3 16x\,dx$$

(iterated integral, 2 pts) (dy integral, 2 pts)

$$= 8x^2\Big|_1^3 \quad \text{(dx integral, 2 pts)}$$

$$= 72 - 8$$

$$= 64.$$

So, $\iint_R (6xy^2)\,dA = 64.$ (Final solution, 1 pt)

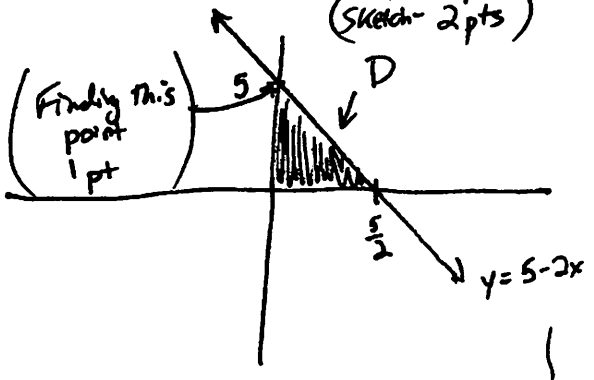
(7 pts) 2. Rewrite the order of integration in the following integral so that the order of integration is reversed. DNETI.

$$\int_0^{5/2} \int_0^{5-2x} f(x, y)\,dy\,dx$$

$\Rightarrow$ $0 \le x \le \frac{5}{2}$, $0 \le y \le 5-2x$.

↑ Translating given information into intervals (1 pt)

Sketch on xy-plane: (Sketch - 2 pts)



(Finding this point, 1 pt)

Rewrite region D as

$$D = \left\{(x,y) : 0 \le y \le 5,\ 0 \le x \le \tfrac{5}{2} - \tfrac{1}{2}y\right\}$$

↑ rewriting region (2 pts)

$y = 5 - 2x$

$y - 5 = -2x$

$-\frac{1}{2}y + \frac{5}{2} = x$

So,

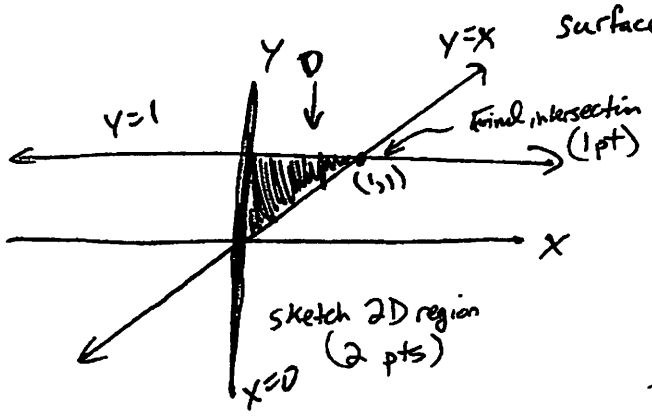
$$\int_0^{5/2} \int_0^{5-2x} f(x,y)\,dy\,dx = \int_0^5 \int_0^{\frac{5}{2}-\frac{1}{2}y} f(x,y)\,dx\,dy.$$

(Final answer, 1 pt)

(11 pts) 3. Find the volume of the solid enclosed by $z = x^2 + 3y^2$ and the planes $x = 0$, $y = 1$, $y = x$, $z = 0$.

surface (function)

Plot on xy-plane.



sketch 2D region (2 pts)

Region D is region of integration. We can write D as

D: region of integration

$$D = \{(x,y) : 0 \le x \le 1,\ x \le y \le 1\}.$$ (2 pts)

$$\text{Volume} = \iint_D (x^2+3y^2)\,dA = \int_0^1 \int_x^1 (x^2+3y^2)\,dy\,dx$$

Set-up iterated integral (1 pt)

$$= \int_0^1 (x^2y + y^3)\Big|_x^1\,dx$$

dy integral (2 pts)

$$= \int_0^1 \left[(x^2+1) - (x^3+x^3)\right]dx$$

$$= \int_0^1 (x^2+1-2x^3)\,dx$$

dx integral (2 pts)

$$= \left(\tfrac{1}{3}x^3 + x - \tfrac{1}{2}x^4\right)\Big|_0^1$$

$$= \tfrac{1}{3} + 1 - \tfrac{1}{2} - 0$$

$$= \frac{5}{6} \text{ cubic units}$$

Final solution (1 pt)