16-2c
~~15-7~~
14-12

LSC Use Only Proposal No:	UWUCC Use Only Proposal No: ~~13-46~~
LSC Action-Date: AP - 10/23/14	UWUCC Action-Date: App - 2/21/17 Senate Action Date: App - 3/7/17

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) Frederick Adkins	Email Address fadkins@iup.edu
Proposing Department/Unit Mathematics Department	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 341 Differential Equations

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)	Frederick A Adkins	4-30-2013
Department Chairperson(s)		4/30/13
College Curriculum Committee Chair		5/14/13
College Dean		5/15/13
Director of Liberal Studies (as needed)	Edel Reilly	6/2/17
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail Sechrist	2/21/17

Received
MAY 16 2013
Liberal Studies

Part II. Description of Curriculum Change

1. New Syllabus of Record

I. Catalog Description

MATH 341 Differential Equations

3 class hours
0 lab hours
3 credit hours
3c-0l-3cr

Prerequisites: MATH 122 or MATH 126

Emphasizes techniques of solution and applications of differential equations. Topics include first-order differential equations, equations of second-order linear equations, systems of linear equations, and series solutions of differential equations.

II. Course Outcomes and Assessment: Expected Undergraduate Student Learning Outcomes - EUSLO

The student will:

Objective 1:
Investigate and be able to describe differential equations analytically, graphically, and numerically.
Expected Student Learning Outcomes 1, 2, and 3:
Informed, Empowered, and Responsible Learners
Rationale:
Given applied differential equation problems, students will be expected to model phenomena using various representations. Solving problems such as these will enable students to see relationships among representations and assign mathematical meaning to a variety of real-world situations. Impact of models on solving significant world issues will be discussed as well as contributions by persons of ethnic and racial minorities and of women. Technology can be used to verify observations and exhibit the correspondence between numerical and analytical information.

Objective 2:
Use differential equations to model applications such as: predator-prey, harmonic oscillation, mixing problems, and population dynamics.
Expected Student Learning Outcomes 1, 2, and 3:
Informed, Empowered, and Responsible Learners
Rationale:
Model phenomena by investigating the connection to rate of change of dependent variables. Solving problems such as these will enable students to assign mathematical meaning to a variety of real-world situations. Students will convert written applied problems into mathematical models. Students may model phenomena such as the size of a population, competition between species, speed of a falling object, vibration of systems, as well as many others. This will give students the opportunity to interpret, analyze, and use numerical data and graphs, and develop simple mathematical models to solve problems. While addressing problems and models, students will be asked to consider how personal choices impact social issues such as utilization and allocation of world resources, contribution to anthropomorphic changes to our planet, and influence on the health condition of individuals and groups. Technology may be used to gain deeper insight into the phenomena and make predictions about future behavior.

Objective 3:
Solve certain types of differential equations such as: Bernoulli equations, exact equations, linear first-order equations, constant-coefficient linear systems, and linear higher-order equations.
Expected Student Learning Outcomes 1 and 2:
Informed and Empowered Learners
Rationale:
Familiarity with solution techniques for broad classes of differential equations is a foundational skill. Students will learn primary solution techniques as well as methods to classify differential equations in order to determine appropriate solution methods. Students will recognize patterns and apply methods in novel situations. To do so, the student must have a thorough understanding of the problem, define functions to model the phenomena, and apply the methods of differential equations. This content is covered with an ethnic and gender neutral perspective.

Objective 4 :
Apply series solution techniques to differential equations.
Expected Student Learning Outcomes 1 and 2:
Informed and Empowered Learners
Rationale:
Students will explore application of series solution techniques to differential equations. Through this exploration, the association between initial value problems and representation of functions by series is reinforced. Students will gain a deeper understanding of mathematics, as the relationship between limits, continuity, and differentiability is exhibited. Integrating these key concepts will increase confidence and ability to understand mathematics.

Objective 5:
Use technology appropriately as an aid to problem solving.
Expected Student Learning Outcomes 1 and 2:
Informed and Empowered Learners
Rationale:
Students will use technology to build skills in quantitative reasoning. Technology is useful for reinforcement and clarification of many topics in differential equations. For examples, refer to Objectives 1, 2, 3 and 4. One of the Mathematics Department's overall objectives is to improve students' skills in utilizing technological tools for quantitative analysis.

Objective 6:
Communicate mathematical ideas and solutions through well-written narrative.
Expected Student Learning Outcomes 1 and 2:
Informed and Empowered Learners
Rationale:
Students will communicate mathematical ideas by writing. This is developed as objectives 1 through 5 are accomplished. One of the Mathematics Department's overall objectives is to improve students' skills in communicating outcomes of quantitative analysis.

III. Detailed Course Outline

1: Introduction — 3 hours
- 1.1 Definition and Terminology
- 1.2 Initial-Value Problems
- 1.3 Differential Equations as Mathematical Models

2: First Order Differential Equations — 7 hours
- 2.1 Solutions Curves Without a Solution (Qualitative Methods)
- 2.2 Separable Differential Equations
- 2.3 Linear Equations
- 2.4 Exact Equations
- 2.5 Solutions by Substitution
- 2.6 A Numerical Method

3: Modeling with First-Order Differential Equations — 4 hours
- 3.1 Linear Equations
- 3.2 Nonlinear Equations
- 3.3 Systems of First-order Linear Differential Equations

4: Higher-Order Differential Equations — 10 hours
- 4.1 Preliminary Theory: Linear Equations
- 4.2 Reduction of Order
- 4.3 Homogeneous Constant-Coefficient Linear Equations
- 4.4 Undetermined Coefficients
- 4.5 Variation of Parameters
- 4.6 Cauchy-Euler Equation
- 4.7 Solving Systems of Linear Equations by Elimination
- 4.8 Nonlinear Differential Equations

5: Modeling with Higher-Order Differential Equations — 4 hours
- 5.1 Linear Models: Spring/Mass Systems
- 5.2 Nonlinear Models

6: Series Solutions of Linear Equations — 3 hours
- 6.1 Solutions about Ordinary Points
- 6.2 Solutions about Singular Points

7: Systems of First-Order Differential Equations — 5 hours
- 7.1 Preliminary Theory
- 7.2 Homogeneous Linear Systems (Constant Coefficient)
- 7.3 Nonhomogeneous Linear Systems

This syllabus leaves 3 class periods for tests and 3 class periods for review and optional topics.

Final Exam—During Final Exam Week. 2 hours

IV. Evaluation Methods

Grades will be based on homework assignments, tests, and a comprehensive final examination.

The final grade will be determined as follows:

Homework assignments	30%
Tests	50%
Final Exam	20%

V. Example Grading Scale

90% - 100%	A
80% - 89%	B
70%-79%	C
60% - 69%	D
Below 60%	F

VI. Undergraduate Attendance Policy

The attendance policy will follow that outlined in IUP's Undergraduate Catalog.

VII. Required Textbooks, Supplemental Books and Readings

Required Textbook
Zill, D.G., *A First Course in Differential Equations with Modeling Applications*, 10th ed., Brooks/Cole, 2012.

Supplemental Readings
Instructors are encouraged to select and assign a set of readings from the following or to utilize an appropriate supplemental article:
CoMAP: Consortium for Mathematics and Its Applications, The UMAP Journal: Undergraduate Mathematics and Its Applications. Published quarterly, see: http://www.comap.com/product/samples/sampledownloads.html

Riddle, L. "Biographies of Women Mathematicians." Agnes Scott College, n.d. Web. 23 Apr. 2013. <http://www.agnesscott.edu/lriddle/women/women.htm>.

VIII. Special Resource Requirements

Students should have access to a calculator with graphical and symbolic capabilities. Mathematical software may be used, such as Mathematica which is available from IUP's Information Technology Support Center, or MATLAB which is available in the IUP Mathematics Department computer laboratories.

IX. Bibliography

Anton, H., Bivens, I., and Davis, S., *Calculus: Early Transcendentals, Single and Multivariable*, 11th ed., John Wiley & Sons, 2011.

Blanchard, P., Devaney, R.L., and Hall, G.R., *Differential Equations*, 3rd ed., Brooks/Cole, 2006.

Boyce, W.E., and DiPrima, R.C., *Elementary Differential Equations*, 10th ed., Wiley, 2012.

Kohler, W. and Johnson, L., *Elementary Differential Equations*, 2nd ed., Pearson, 2005.

Nagle, R.K., Saff, E.B., and Snider A.D., *Fundamentals of Differential Equations*, 8th ed., Pearson/Addison Wesley, 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 newer edition of the textbook.

4. Added suggested sources for supplemental readings. This is a new suggestion to instructors as the current syllabus does not require any supplemental readings.

3. Justification/Rationale for the revision

The course is a currently approved Liberal Studies elective course and is being revised to meet the new curriculum criteria for this category. This course is taken by students in economics and the sciences and fulfills the spirit of a Liberal Studies elective course.

As indicated in objectives 1, 2, and 3, students will demonstrate knowledge and understanding of the ways of modeling the natural, social, and technical worlds. MATH 241 reinforces critical thinking by having students demonstrate intellectual agility and creativity through analysis, application, and evaluation of the methods of differential equations applied to numerical and graphical data. As indicated in objective 6, students will improve their communication skills. The study of differential equations requires employment of different strategies to solve problems, including use of a variety of quantitative techniques, methods, and tools as described in objectives 3, 4, and 5. Students are empowered through mastery of both theoretical and practical skills as they develop non-deductive and deductive reasoning across the course curriculum.

4. Old syllabus of record

I. Catalog Description

MATH241 Differential Equations — 3 class hours, 0 lab hours, 3 credit hours (3c-0l-3cr)

Prerequisites: MATH 122 or MATH 126

Emphasizes techniques of solution and applications of differential equations. Topics include first-order differential equations, equations of second-order linear equations, systems of linear equations, and series solutions of differential equations.

II. Course Objectives

Students will be able to:

1. Investigate differential equations analytically, graphically, and numerically.
2. Use differential equations to model applications such as: predator-prey, harmonic oscillation, mixing problems, population.
3. Solve certain types of differential equations such as: Bernoulli equations, exact equations, linear first-order equations, constant-coefficient linear systems, linear higher-order equations.
4. Apply series solution techniques to differential equations.

III. Course Outline

Chapter 1: Introduction — 3 classes
- 1.1 Definition and Terminology
- 1.2 Initial-Value Problems
- 1.3 Differential Equations and Modelling

Chapter 2: First Order Differential Equations — 7 classes
- 2.1 Solutions Curves Without the Solutions (Qualitative Methods)
- 2.2 Separable Differential Equations
- 2.3 Linear Equations
- 2.4 Exact Equations
- 2.5 Solutions by Substitution
- 2.6 A Numerical Solution

Chapter 3: Modeling with First-Order Differential Equations — 4 classes
- 3.1 Linear Equations
- 3.2 Nonlinear Equations
- 3.3 Systems of Linear and Nonlinear Differential Equations

Chapter 4: Higher-Order Differential Equations — 10 classes
- 4.1 Preliminary Theory: Linear Equations

4.2 Reduction of Order
4.3 Homogeneous Constant-Coefficient Linear Equations
4.4/4.5 Undetermined Coefficients
4.6 Variation of Parameters
4.7 Cauchy-Euler Equation
4.8 Solving Systems of Linear Equations by Elimination
4.9 Nonlinear Equations

Chapter 5: Modeling with Higher-Order Differential Equations — 4 classes
5.1 Linear Equations-Spring/Mass Systems
5.3 Nonlinear Equations

Chapter 6: Series Solutions of Linear Equations — 3 classes
6.1 Solutions about Ordinary Points
6.2 Solutions about Singular Points

Chapter 8: Homogeneous Linear First-Order Systems — 5 classes
8.1 Preliminary Theory
8.2: Homogeneous Constant Coefficient

This syllabus leaves 3 class periods for tests and 3 class periods for review and optional topics.

Final Exam—During Final Exam Week.

IV. Evaluation Methods

Grades will be based on homework assignments, tests, and a comprehensive final examination.

The final grade will be determined as follows:

Homework assignments	30%
Tests	50%
Final Exam	20%

Grading Scale: A: 90-100%; B: 80-89%; C: 70-79%; D: 60-69%; F: below 60%

V. Attendance Policy:

The course attendance policy is consistent with the University policy.

VI. Required Textbook(s), Supplemental Books and Readings

Dennis G. Zill (2001), *Differential Equations with Boundary-Value Problems*, 5th ed., Brooks/Cole.

VII. Special Resources or Requirements

None.

VIII. Bibliography

Paul Blanchard, Robert L. Devaney, and Glen R. Hall (2006) *Differential Equations*, 3rd ed., Brooks/Cole.

R. Kent Nagle, Edward B Saff, and Arthur David Snider (2004) *Fundamentals of differential Equations,* 6th ed., Pearson/Addison Wesley.

Werner Kohler and Lee Johnson (2005) *Elementary Differential Equations,* 2nd ed., Pearson/Addison Wesley.

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

The majority of graded content for this course is daily homework, 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, frequency, and grading criteria on an individual basis. Grading rubrics are typically based on mastery with partial credit given for progress on fundamentals.

The projects cover rates of change and applications where rates of change are integrated to yield quantities.

Possible projects include case studies where students work on small "contractor teams" to address a problem related to course content. A sample project is included on the next page.

The grading rubric would assess 70% on accuracy and completion of solution, 20% on format and appearance of report, 5% on references and documentation, and 5% on uniform group participation.

Assignment MATH 241 Differential Equations

Each group of three students should submit one typed report from the group. This report should be well-written, describing the problem, your group's solution, and any pertinent intermediate steps required to obtain that solution. Include mathematical equations and diagrams where relevant. Computations and graphs should be created on your calculator. Your report should include screen shots of graphs, where appropriate. List all group members' names on your report.

See http://diabetes.webmd.com/guide/type-2-diabetes for background information on diabetes.

The fasting blood sugar test is most commonly used to diagnose diabetes, but the glucose tolerance test (GTT) is more accurate. For the GTT, blood and urine samples are taken from a patient during a fasting state to measure the equilibrium levels of blood glucose concentration (G_0) in mg/mL, insulin-regulating hormones (H_0), and glycosuria levels. The patient is then given 100 g of glucose. Blood and urine samples are taken after 1 hour, 2 hours, 3 hours, and 4 hours. Let $G(t)$ denote the level of glucose in the blood and $H(t)$ denote the level of hormones, such as glucagon, epinephrine, cortisone, and thyroxin, affecting insulin production. Let $g(t) = G(t) - G_0$ and $h(t) = H(t) - H_0$ represent the deviation of glucose and hormones from equilibrium. Suppose that $J(t)$ is the external rate at which the blood glucose concentration is being increased. Then

$$g'(t) = f_1\big(g(t), h(t)\big) + J(t)$$
$$h'(t) = f_2\big(g(t), h(t)\big)$$

After the glucose injection is complete, $J(t) = 0$. If we approximate f_1 and f_2 with linear functions, then the system of differential equations becomes

$$g' = -ag - bh$$
$$h' = -ch + dg$$

where a, b, c, and d are positive constants. Explain why the plus and minus signs are appropriate in the above linear system of differential equations. Eliminate h from the system to obtain a second order differential equation in g. Write down the auxiliary equation. Glucose levels tend to oscillate. What condition does this impose on a, b, c, and d? Find the general solution of the second order differential equation in g.

Let $\omega = \frac{1}{2}\sqrt{4bd - (a-c)^2}$. Laboratory research has shown that $\frac{2\pi}{\omega} > 4$ hours indicates a mild case of diabetes. Which of the following four patients, if any, have a mild case of diabetes? Explain why.

	José	Kalila	Longwei	Marisa
G_0	80.00	90.00	100.00	110.00
t = 1 hour	85.32	91.77	103.35	114.64
t = 2 hours	82.54	85.69	98.26	105.89
t = 3 hours	78.25	92.39	96.59	108.14
t = 4 hours	76.61	91.13	99.47	113.76

6. Answers to Liberal Studies Questions

A. This is a single-section course. The syllabus content should be covered by the instructor each semester. Calculus instructors typically meet at the end of each year to discuss the textbook for the following year. This course is governed by the Mathematics Department Mathematics/Applied Mathematics Curriculum Committee. Periodically faculty on the committee meet to compare the pace of the course, check what students are finding difficult, and compare outcomes and assessments. Flexibility and encouragement is given to professors develop their courses in ways which contribute to imaginative, committed teaching and capitalizes on the strengths of individual faculty.

B. Whenever appropriate, information will be introduced into the classroom discussion which will reflect the contributions made to the development and application of differential equations by women and minorities as noted in objectives 1 and 2. Also, instructors will be sensitive to gender and ethnic balancing with respect to language in problem construction on homework, quizzes, and tests.

C. In this differential equations course, we are concentrating on developing the foundational quantitative skills. Instructors are encouraged to require a reading that exposes students to the historical development of concepts or involvement of women and minorities in modern application of differential equations to issues of world significance.

D. This course is an introduction to differential equations, but for a specific audience: mathematics, economics, and science students. It does not differ from what is provided to beginning mathematics majors. Differential equations serve as an important tool in modeling both mathematics and science applications, and students in these majors benefit from a shared core course. Mathematics majors benefit by understanding the science applications inherent in the course. Differential equations 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.