ARIZONA STATE UNIVERSITY

GENERAL STUDIES COURSE PROPOSAL COVER FORM

Course information:

*Copy and paste **current** course information from Class Search/Course Catalog.*

Academic Unit: **School of Sustainability** Department: **School of Sustainability**

Subject: **SOS** Number: **210** Title: Mathematical Tools and Modeling for the Life and Social Sciences Units: 3

Is this a cross-listed course? Yes
If yes, please identify course(s): **AML 253**

Is this a shared course? No If so, list all academic units offering this course

Course description:
Introduces the evaluation and construction of mathematical models used in the life and social sciences. Includes the basic steps in developing a model, analyzing it, and testing it with actual data. Covers the first steps concerning how to use formal mathematical techniques including developing equation-based relationships, plotting graphs, linear regression, and solving equations using computer software.

Requested designation: Mathematical Studies–CS

*Note– a **separate** proposal is required for each designation requested*

Eligibility:

Permanent numbered courses must have completed the university's review and approval process.
For the rules governing approval of omnibus courses, contact the General Studies Program Office at (480) 965-0739.

Area(s) proposed course will serve:

A single course may be proposed for more than one core or awareness area. A course may satisfy a core area requirement and more than one awareness area requirements concurrently, but may not satisfy requirements in two core areas simultaneously, even if approved for those areas. With departmental consent, an approved General Studies course may be counted toward both the General Studies requirement and the major program of study.

Checklists for general studies designations:

Complete and attach the appropriate checklist

- Literacy and Critical Inquiry core courses (L)
- Mathematics core courses (MA)
- Computer/statistics/quantitative applications core courses (CS)
- Humanities, Fine Arts and Design core courses (HU)
- Social and Behavioral Sciences core courses (SB)
- Natural Sciences core courses (SQ/SG)
- Global Awareness courses (G)
- Historical Awareness courses (H)
- Cultural Diversity in the United States courses (C)

A complete proposal should include:

- ☒ Signed General Studies Program Course Proposal Cover Form
- ☒ Criteria Checklist for the area
- ☒ Course Syllabus
- ☒ Table of Contents from the textbook, and/or lists of course materials

Contact information:

Name: Caroline J Harrison Phone: 480-965-8645

Mail code: 5502 E-mail: caroline.harrison@asu.edu

Department Chair/Director approval: *(Required)*

Chair/Director name (Typed): Christopher G. Boone Date: Oct 10, 2013

Chair/Director (Signature): [signature]

Rev. 1/94, 4/95, 7/98, 4/00, 1/02, 10/08, 11/11/ 12/11, 7/12

Arizona State University Criteria Checklist for

MATHEMATICAL STUDIES [CS]

Rationale and Objectives

The **Mathematical Studies** requirement is intended to ensure that students have skill in basic mathematics, can use mathematical analysis in their chosen fields, and can understand how computers can make mathematical analysis more powerful and efficient. The **Mathematical Studies** requirement is completed by satisfying both the **Mathematics [MA]** requirement and the **Computer/Statistics/Quantitative Applications [CS]** requirement explained below.

The **Mathematics [MA]** requirement, which ensures the acquisition of essential skill in basic mathematics, requires the student to complete a course in College Mathematics, College Algebra, or Precalculus, or demonstrate a higher level of skill by completing a mathematics course for which any of the first three courses in a prerequisite.

The **Computer/Statistics/Quantitative Applications [CS]** requirement, which ensures skill in real world problem solving and analysis, requires the student to complete a course that uses some combination of computers, statistics, and mathematics.

Approved: Feb. 2000

Proposer: Please complete the following section and attach appropriate documentation.

ASU--[CS] CRITERIA

A COMPUTER/STATISTICS/QUANTITATIVE APPLICATIONS [CS] COURSE MUST SATISFY ONE OF THE FOLLOWING CRITERIA: 1, 2, OR 3

YES	NO		Identify Documentation Submitted
		1. Computer applications*: courses must satisfy both **a** and **b**:	
☐	☐	**a.** Course involves the use of computer programming languages or software programs for quantitative analysis, modeling, simulation, animation, or statistics.	Course Syllabus Text Contents
		b. Course requires students to analyze and implement procedures that are applicable to at least one of the following problem domains **(check those applicable)**:	
☐	☐	**i.** Spreadsheet analysis, systems analysis and design, and decision support systems.	Course Syllabus Text Content
☐	☐	**ii.** Graphic/artistic design using computers.	
☐	☐	**iii.** Music design using computer software.	
☐	☐	**iv.** Modeling, making extensive use of computer simulation.	
☐	☐	**v.** Statistics studies stressing the use of computer software.	Course Syllabus Text Content

***The **computer applications** requirement **cannot** be satisfied by a course, the content of which is restricted primarily to word processing or report preparation skills; learning a computer language or a computer software package; or the study of the social impact of computers. Courses that emphasize the use of a computer software package or the learning of a computer programming language are acceptable, provided that students are required to understand, at an appropriate level, **the theoretical principles embodied in the operation of the software and are required to construct, test, and implement procedures that use the software to accomplish tasks in the applicable problem domains.**

		2. Statistical applications: courses must satisfy both **a** and **b**.	
☐	☐	**a.** Course has a minimum mathematical prerequisite of College Mathematics, College Algebra, or Precalculus**,** or a course already approved as satisfying the MA requirement.	
☐	☐	**b.** The course must be focused principally on developing knowledge in statistical inference and include coverage of all of the following:	

ASU--[CS] CRITERIA			
YES	**NO**		**Identify Documentation Submitted**
☐	☐	**i.** Design of a statistical study.	
☐	☐	**ii.** Summarization and interpretation of data.	
☐	☐	**iii.** Methods of sampling.	
☐	☐	**iv.** Standard probability models.	
☐	☐	**v.** Statistical estimation	
☐	☐	**vi.** Hypothesis testing.	
☐	☐	**vii.** Regression or correlation analysis.	
		3. Quantitative applications: courses must satisfy both **a** and **b**.	
☒	☐	**a.** Course has a minimum mathematical prerequisite of College Mathematics, College Algebra, or Precalculus**,** or a course already approved as satisfying the MA requirement.	Syllabus
		b. The course must be focused principally on the use of mathematical models in quantitative analysis and design making. Examples of such models are:	
☐	☐	**i.** Linear programming.	
☐	☐	**ii.** Goal programming.	
☐	☐	**iii.** Integer programming.	

ASU--[CS] CRITERIA			
YES	**NO**		**Identify Documentation Submitted**
☐	☐	**iv.** Inventory models.	
☐	☐	**v.** Decision theory.	
☐	☐	**vi.** Simulation and Monte Carlo methods.	
☒	☐	**vii.** Other (explanation must be attached)	Color coded key with Syllabus and Text table of contents.

Course Prefix	Number	Title	Designation
SOS	210	Math Tools & Modeling	CS

Explain in detail which student activities correspond to the specific designation criteria. Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	How course meets spirit (contextualize specific examples in next column)	Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)
3a. Course has a minimum mathematical prerequisite of College Mathematics, College Algebra, or Precalculus, or a course already approved as satisfying the MA requirement	Prerequisite of SOS 210 (MA)..	See attached color coded syllabus pre-requisity list.
3b. vii. Other (explanation must be attached):	Quantitative analysis of dynamical models. • The models make extensive use of differential equations •Analyses covered in class include long-term behaviors of the system and stability analysis • Examples of modeled systems: predator-prey systems, disease spreading, competition model..	See attached color coded syllabus description, couse goals, and list of topics as well as textbook table of contents.
	.	

Caroline Harrison

From: Alissa Ruth
Sent: Thursday, October 17, 2013 11:33 AM
To: Caroline Harrison
Cc: Candice Carr Kelman; Alexandra Brewis Slade
Subject: RE: ChangeMaker - SOS 210 Introduction to Mathematical Tools and Modeling for the Life and Social Sciences 3 - 2151: Spring 2015

Hi Caroline,
SHESC has no objection to the proposed change in name for SOS 210/AML 253. I am copying our Director, Alex Brewis Slade on this as proof of this approval. Great news on the CS, please let us know if it gets approved.
Best,
Alissa

ALISSA RUTH
Director of Student and Academic Services School of Human Evolution and Social Change College of Liberal Arts and Sciences Arizona State University | P.O. Box 872402 | Tempe, Arizona 85287-2402 | SHESC Bldg. #204
480.965.4628 | Fax: 480.965.7671 | e-mail: alissa.ruth@asu.edu |webpage: www.shesc.asu.edu

-----Original Message-----
From: Caroline Harrison
Sent: Thursday, October 17, 2013 11:20 AM
To: Alissa Ruth
Cc: Candice Carr Kelman
Subject: FW: ChangeMaker - SOS 210 Introduction to Mathematical Tools and Modeling for the Life and Social Sciences 3 - 2151: Spring 2015

Hi Alissa,

Candice suggested that you could help us get a statement of support for changes we would like to make to SOS 210 (crosslisted with AML 253) Mathematical Tools and Modeling for the Life and Social Sciences .

We would like to change the name of the course by removing the "Introduction to". We will be suggesting that students take this after SOS 211 (Calculus and Probability) and believe that removing that part of the course name would help avoid confusion.

Also, we have submitted a request to have this course approved for General Studies CS credit. It is on the agenda for the GS Council meeting on 10/22.

If you need any other information or have any questions, please let me know.

Caroline J. Harrison, Ph.D.
Curriculum Developer
School of Sustainability
PO Box 87550

Arizona State University
Tempe, AZ 85287-5502
480-965-8645

-----Original Message-----
From: CurriculumQuestions@asu.edu [mailto:CurriculumQuestions@asu.edu]
Sent: Wednesday, October 16, 2013 8:23 PM
To: Caroline Harrison
Subject: ChangeMaker - SOS 210 Introduction to Mathematical Tools and Modeling for the Life and Social Sciences 3 - 2151: Spring 2015

DO NOT REPLY TO THIS SYSTEM-GENERATED EMAIL.

The following ASU course NEEDS REVISIONS.

Please log on to Curriculum ChangeMaker and submit your feedback:
https://webapp4.asu.edu/changemaker-sso/authn

Form Type: Modify Course Form
Summary: SOS 210 Introduction to Mathematical Tools and Modeling for the Life and Social Sciences 3 - 2151: Spring 2015
Routing: Sustainability
Status: Pending Revisions
Current Review Group: University Review
Comments: Need statement of support from Human Evolution and Social Change to change the title of AML 253, crosslisted as SOS 210.

SOS 210: Mathematical Tools and Modeling for the Life and Social Sciences

Introduces students to the evaluation and construction of mathematical models used in the life and social sciences. Students learn the basic steps in developing a model, analyzing it, and testing it with actual data. They also learn the first steps concerning how to use formal mathematical techniques including developing equation-based relationships, plotting graphs, linear regression, and solving equations using computer software.

General Studies Review Color Key to CS Criteria:

3a Course has a minimum mathematical prerequisite of College Mathematics, College Algebra, or Precalculus, or a course already approved as satisfying the MA requirement.

3b. The course must be focused principally on the use of mathematical models in quantitative analysis and design making. Examples of such models are:

vii. Other (explanation must be attached):

Quantitative analysis of dynamical models.

- The models make extensive use of differential equations
- Analyses covered in class include long-term behaviors of the system and stability analysis
- Examples of modeled systems: predator-prey systems, disease spreading, competition model.

SOS 210: Mathematical Tools & Modeling Course Syllabus

3 Units

The goals of this course are to introduce the student to the evaluation and construction of mathematical models in the life and social sciences. A model is a simplified and formal representation of reality which attempts to identify what matters (and conversely, what doesn't matter) when it comes to explaining why some phenomena occurs. A model specifies that relationships exist between features (or characteristics) of the phenomenon or system under consideration. A mathematical model makes these putative relationships precise by expressing them in the form of equations. And crucially, mathematical models make quantitative predictions which can be matched and compared with evidence. Mathematical models are used not only to advance scientific understanding but to find solutions for many practical problems. Students will learn the basic steps in developing a model, analyzing it, and testing it with actual data.

This course will provide a broad overview of different methods used to develop models and how they can be applied to study and think about practical problems. For each method, basic principles are provided and you will learn the first steps concerning how to use formal mathematical techniques including developing equation-based relationships, plotting graphs, linear regression, and solving equations using computer software. Examples and applications will be drawn from the biological and ecological sciences, as well as from energy systems. Software packages such as Matlab, Excel, or other analysis software will be used.

Pre-requisites: Students should have proficiency with algebra and have taken SOS 101 (or a course with equivalent content).

Required Course Texts/ Readings: Adler (2013), *Modeling the Dynamics of Life: Calculus and Probability for Life Scientists*, ISBN-13*: 978-0840064189*.[1]

Goals of the Course:

- to gain experience thinking in an evidence-based manner,
- to learn about probabilistic reasoning,
- to learn what is a model and what does modeling consist of,
- to learn what is a mathematical model and what is a statistical model,
- to examine how to fit data to models.
- to become familiar with using computer software for analysis and modeling

Blackboard site: the instructor will often use the course's blackboard web site to communicate information and updates to the students so they are advised to visit the website frequently. Assignments will be made available through the blackboard site, and the answers to the assignments and the quizzes will be posted in the site.

[1] Notwithstanding the title of the textbook, the course does not require, nor does it cover, calculus.

Homework will be assigned weekly and "graded" throughout the course.

Students are encouraged to work together on homework, but each individual student is required to write up and turn in his own work.

Attendance: Attendance is required. If you miss more than three classes, there will be a penalty of 5 percentage points of your final grade.

Examinations: There will be two exams given during the course. The examinations will cover material as indicated in the schedule, and will involve a mix of mechanical skills and conceptual reasoning. Each exam will consist of a number of problems, which are similar to homework, but they may also represent applications of principles in entirely different circumstances. The best possible preparation for the exams is regular attendance and completion of assigned homework. The exams will be open book and open notebook (as will the final); students will need to use a calculator during quizzes (and the final examination) but will not be permitted to use a laptop or cell phone as a calculation device. Memorization of formulas is not necessary and will not be sufficient for obtaining high grades on examinations.

Requests to reschedule examinations due to religious holidays or for other legitimate reasons must be made via e-mail two weeks before the examination's scheduled date. Makeup exams are given at the instructor's discretion and only in the case of verified medical or other emergencies, which must be documented. The instructor must be notified before the test is given. It is best to discuss scheduling conflicts as soon as possible.

Examinations are governed by the following policies:

1. There will be **no make-up examinations**.
2. **Academic dishonesty** on an examination will result automatically in a failing grade for the course and referral to the Dean for further sanctions. *Cheating in any form will not be tolerated!*
3. The use of **hand calculators** of any kind is permitted. Students may not wear headphones of any kind during the exam. All cell phones and other electronic devices must be put away and may not be used during the examination.
4. Examination paper (including scratch paper) will be provided. Bring only your pencils and calculators.
5. **Partial credit** is given. Arithmetical errors will be treated charitably, but for answers that do not make sense (wrong dimensions, deviation by several orders of magnitude, etc.) no credit will be awarded. Always examine your solutions for reasonableness.
6. In the event of a **fire alarm** occurring during an examination, students will be asked to close their examination booklets, gather their belongings and leave the room as expeditiously as possible, leaving their examination booklets on the tables where they were working. The booklets will be gathered and graded as they are. Unless the alarm proves to represent a *bona fide* emergency, there will be no make-up examination.

If a student believes there to have been an **error in grading** his or her examination, the complaint should be put in writing and handed, together with the examination, to the course instructor. The problem will be re-graded by the individual who graded it originally. If the student is not satisfied with the grader's response to the complaint, he or she may appeal to the course instructor. In this event, the instructor reserves the prerogative to re-grade the entire examination. (Simple errors, such as point addition, can be corrected by the student's recitation section instructor without the need for a written appeal.)

Final Grades: the final course grades will be based on the homeworks and examinations with the following weights.

Homework assignments	50 %
Midterm exam	20 %
Final exam	30 %

Your final grade will be computed to the nearest whole number (For example, 87.4 = 87, not 88) and your final letter grade will be based on the following table:

A+	>95%	B+	79-83%	C+	64-68%	E	<47%
A	88-94%	B	74-78%	C	58-63%		
A-	84-87%	B-	69-73%	D	47-57%		

There will be no "grading under the curve" in the course. Students' final grade will be strictly and solely based on the weighted sum of these three components.

Incompletes: a mark of "I" (incomplete) is given by the instructor when you are otherwise doing acceptable work but are unable to complete the course because of illness or other conditions beyond your control. You are required to arrange with the instructor for the completion of the course requirements. The arrangement must be recorded on the Request for Grade of Incomplete form (http://students.asu.edu/forms/incomplete-grade-request).

Late Assignments: unexcused late assignments will not be accepted. Excuses for an assignment must be made and approved in advance of the due date of the assignment. Requests for excuses must be communicated via email one week before the assignment's due date. In order to receive credit for the excused late assignment you must turn in a copy of the email approval or signed written excuse.

Course Policies: cell phones, ipods, MP3 players, any other electronic media (as well as percussion instruments) cannot be used, and must be turned off, during the lectures, exams and final examination. You may use a laptop during lectures only as a means to take notes. A student found to be texting during the lecture will be asked to leave the classroom.

Student Standards: students are required to read and act in accordance with university and Arizona Board of Regents policies, including:

> The ABOR Code of Conduct: Arizona Board of Regents Policies 5-301 through 5-308: http://www.abor.asu.edu/1_the_regents/policymanual/chap5/5Section_C.pdf

Academic Integrity: all students are responsible for reviewing and following ASU's policies on academic integrity: http://provost.asu.edu/academicintegrity. If you fail to meet the standards of academic integrity in any of the criteria listed on the university policy website, sanctions will be imposed by the instructor, school, and/or dean. Academic dishonesty includes borrowing ideas without proper citation, copying others' work (including information posted on the internet), and failing to turn in your own work for group projects. Please be aware that if you follow an argument closely, even if it is not directly quoted, you must provide a citation to the publication, including the author, date and page number. If you directly quote a source, you must use quotation marks and provide the same sort of citation for each quoted sentence or phrase. You may work with other students on assignments; however, all writing that you turn in must be done independently. If you have any doubt about whether the form of cooperation you contemplate is acceptable, ask the TA's or the instructor in advance of turning in an assignment. Please be aware that the work of all students submitted electronically can be scanned using SafeAssignment, which compares them against everything posted on the internet, online article/paper databases, newspapers and magazines, and papers submitted by other students.

Student Support and Disability Accommodations: ASU offers support services through Counseling (students.asu.edu/counseling), the Learning Resources Center (www.asu.edu/lrc), and the Disability Resource Center (www.asu.edu/studentaffairs/ed/drc/). If you are a student in need of special arrangements for we will do all we can to help, based on the recommendations of these services. For the sake of equity for all students, we cannot make any accommodations without formal guidance from these services.

Email Communications: all email communication for this class will be done through your ASU email account. You should be in the habit of checking your ASU email regularly, as well as the course's blackboard site, as you will not only receive important information about your class(es), but other important university updates and information. You are solely responsible for reading and responding if necessary to any information communicated via email.

TA/Tutoring Support: students are encouraged to ask questions during lectures, and to avail themselves of the Instructor's and Teaching Assistants' office hours to discuss questions in depth and clarify issues. Note that office hours are a complement to lectures and are not meant to substitute for attending them. As an ASU student you have access to many resources on campus. This includes tutoring, academic success coaching, counseling services, financial aid, disability resources, career and internship help and many opportunities to get involved in student clubs and organizations.

- Tutoring: http://studentsuccess.asu.edu/node/24
- Learning Support Services: http://www.asu.edu/studentaffairs/lss/
- Counseling Services: http://students.asu.edu/counseling
- Financial Aid: http://students.asu.edu/financialaid
- Disability Resource Center: http://www.asu.edu/studentaffairs/ed/drc/
- Major/Career Exploration: http://uc.asu.edu/majorexploration/assessment
- Career Services: http://students.asu.edu/career
- Student Organizations: http://www.asu.edu/studentaffairs/mu/clubs/

Withdrawal: withdrawal policies are established by the University. Please check the University's website for the relevant deadlines.

List of Topics

Week 1:	***Models and Modeling I***
Week 2:	***Models and Modeling II***
Week 3:	***Growth Rates***
Week 4:	***Growth Accounting***
Week 5:	***Probability***
Week 6:	***Random Variables***
Week 7:	***Probability Distributions***
Week 8:	***Normal Distribution***
Week 9	***Line Fitting -- Regression***
Week 10:	***Dynamical systems***
Week 11:	***Difference equations I***
Week 12:	***Difference equations II***
Week 13:	***1st Order Differential Equations I***
Week 14:	***1st Order Differential Equations II***
Week 15:	***Modeling Examples I***
Week 16:	***Modeling Examples II***

Modeling the Dynamics of Life: Calculus and Probability for Life Scientists, 3rd Edition

Frederick R. Adler University of Utah

Features:

- The first chapter includes a review of functions, units, and linear functions before beginning with the new topic of discrete-time dynamical systems.
- Partial solutions to all the odd problems are included in the back of the book, providing valuable guidance for students at no additional cost.
- The text integrates mathematical content with modeling, following the process of describing a system, translating appropriate aspects into equations, and interpreting results in terms of the original problem.
- The text introduces and develops mathematical methods to analyze three kinds of models: discrete-time dynamical systems, differential equations, and stochastic processes.
- Three dynamical principles that underlie diverse biological processes are woven throughout: growth, diffusion, and selection. Each theme is studied in turn with the three kinds of models.
- The final three chapters teach probability and statistics from a dynamical perspective.
- The author emphasizes the link between models of key processes and the fundamental statistical notions of likelihood, estimation, and hypothesis testing, so that students learn the principles of statistics rather than learning how to choose the correct formulas.
- Graphical and computer techniques are introduced and used throughout to support the text's focus on reasoning and interpreting models.
- Approximately 30 algorithms are clearly identified so that students can use them throughout the course.
- Several extended explorations are included to show students how to combine a set of processes into a coherent whole, and how to use models to clarify and answer specific questions.
- Each section of the text includes a wide variety of modeling problems, in addition to review problems.
- Each chapter includes at least two projects, suitable for group work, and concludes with supplementary application problems.
- The text contains more than 100 graphing calculator or computer exercises, designed to help students visualize and conceptualize key concepts.

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3.3 Maximization.
3.4 Reasoning About Functions.
3.5 Limits at Infinity.
3.6 Leading Behavior and L'Hopital's Rule.
3.7 Approximating Functions with Lines and Polynomials.
3.8 Newton's Method.
3.9 Panting and Deep Breathing.

4. Differential Equations. Integrals. and Their Applications.

4.1 Differential Equations.
4.2 Solving Pure-Time Differential Equations.
4.3 Integration of Special Functions. Integration by Substitution. by Parts. and by Partial Fractions.
4.4 Integrals and Sums.
4.5 Definite and Indefinite Integrals.
4.6 Applications of Integrals.
4.7 Improper Integrals.

5. Analysis of Autonomous Differential Equations.

5.1 Basic Differential Equations.
5.2 Equilibria and Display of Autonomous Differential Equations.
5.3 Stable and Unstable Equilibria.
5.4 Solving Autonomous Differential Equations.
5.5 Two Dimensional Differential Equations.
5.6 The Phase Plane.
5.7 Solutions in the Phase Plane.
5.8 The Dynamics of a Neuron.

6. Probability Theory and Descriptive Statistics.

6.1 Introduction to Probabilistic Models.
6.2 Stochastic Models of Diffusion and Genetics.
6.3 Probability Theory.
6.4 Conditional Probability.
6.5 Independence and Markov Chains.
6.6 Displaying Probabilities.
6.7 Random Variables.
6.8 Descriptive Statistics.
6.9 Descriptive Statistics for Spread.

7. Probability Models.

7.1 Joint Distributions.
7.2 Covariance and Correlation.
7.3 Sums and Products of Random Variables.
7.4 The Binomial Distribution.
7.5 Applications of the Binomial Distribution.
7.6 Waiting Times: Geometric and Exponential Distributions.
7.7 The Poisson Distribution.
7.8 The Normal Distribution.
7.9 Applying the Normal Approximation.

8. Introduction to Statistical Reasoning.

8.1 Statistics: Estimating Parameters.
8.2 Confidence Limits.
8.3 Estimating the Mean.
8.4 Hypothesis Testing.
8.5 Hypothesis Testing: Normal Theory.
8.6 Comparing Experiments: Normal Theory.
8.7 Analysis of Contingency Tables and Goodness of Fit.
8.8 Hypothesis Testing with the Method of Support.
8.9 Regression.