FLORIDA ATLANTIC UNIVERSITY

NEW COURSE PROPOSAL
Undergraduate Programs

Department Mathematical Sciences

College Science

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

UUPC Approval 11/6/23
UFS Approval _____
SCNS Submittal _____
Confirmed _____
Banner Posted _____
Catalog _____

Prefix MAP

Number 2483

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

Lab Code

Type of Course: Lecture

Course Title: Mathematics for Biological Sciences 1

Credits *(See Definition of a Credit Hour)*: 3

Effective Date *(TERM & YEAR)*: Summer 2024

Grading *(Select One Option)*

Regular ◉

Sat/UnSat ○

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

An introduction to the fundamental mathematical methods in differential and integral calculus, and introductory concepts in differential equations and dynamical systems with an emphasis on modeling dynamic processes in the biological sciences. Topics include limits, continuity, derivatives of basic functions in mathematics, differentiation rules, vector fields and changes in states, the Riemann integral and area under a curve, Euler's method for computing solutions to differential equations, and optimization problems. Theory is complemented with basic programming to aid visualization, modeling, and simulation.

Prerequisites, with minimum grade*: MAC1105 C or better; or ALEKS PPL (score 45 or higher); or Math Placement Multi-Factor 2 (score 40 or higher)

Corequisites

Registration Controls *(Major, College, Level)*

Default minimum passing grade is D-.** **Prereqs., Coreqs. & Reg. Controls are enforced for all sections of course

WAC/Gordon Rule Course

☑ **Yes** ☐ **No**

Gordon Rule, Computational

WAC/Gordon Rule criteria must be indicated in syllabus and approval attached to proposal. See WAC Guidelines.

Intellectual Foundations Program (General Education) Requirement *(Select One Option)*

Math/Quantitative Reasoning — Requesting

General Education criteria must be indicated in the syllabus and approval attached to the proposal. See Intellectual Foundations Guidelines.

Minimum qualifications to teach course

PhD in Mathematics or related fields

Faculty Contact/Email/Phone

Francis Motta / fmotta@fau.edu

List/Attach comments from departments affected by new course

Approved by	***Date***
Department Chair: [signature]	10/05/2023
College Curriculum Chair: [signature]	10/09/23
College Dean: [signature]	10/09/23
UUPC Chair: Korey Sorge	11/6/23
Undergraduate Studies Dean: Dan Messroff	11/6/23
UFS President	
Provost	

Email this form and syllabus to mjenning@fau.edu seven business days before the UUPC meeting.

MAP 2483-001
Mathematics for Biological Sciences 1

MWF XXXX – XXXX
3 credits

Summer, 2024
Prof. XXXX
Office: SE43, XXXX
Office hours: XXXX
Classroom: XXXX
Telephone: 561-297-XXXX
Email: XXXX

TA name	xxxxxx xxxxxxxxx
Office	xxxxxxxx
Office hours	MWF xx:xx – xx:xx
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Course Description

This course is an introduction to the fundamental mathematical methods in differential and integral calculus, and introductory concepts in differential equations and dynamical systems with an emphasis on modeling dynamic processes in the biological sciences. Topics include limits, continuity, derivatives of basic functions in mathematics, differentiation rules, vector fields and changes in states, the Riemann integral and area under a curve, Euler's method for computing solutions to differential equations, and optimization problems. Theory is complemented with basic programming to aid visualization, modeling, and simulation. This is a General Education course and counts toward the Gordon Rule computational requirement. Students cannot receive credit for both this course and Methods of Calculus (MAC 2233).

Instructional Method

In-Person. There is no remote option for this course.

Prerequisites/Corequisites

College Algebra (MAC 1105) or equivalent (with a minimum grade of C); or ALEKS PPL assessment (score of 45 or better); or Math Placement Multi-Factor 2 (score of 40 or better).

Intellectual Foundation (General Education) Program Outcomes.

Mathematics is a peculiarly human endeavor that attempts to organize our experience in a quantitative fashion. It aids and supplements our intuitions about the physical universe and about human behavior. The Mathematics and Quantitative Reasoning requirement is intended to give students an appreciation of mathematics and prepare them to think precisely and critically about quantitative problems.

Students who satisfy the Mathematics and Quantitative Reasoning requirement will be able to:

- SLO 1 - Identify and explain mathematical theories and their applications.

- SLO 2 - Determine and apply appropriate mathematical and/or computational models and methods in problem solving.
- SLO 3 - Display quantitative literacy.

Course Objectives/Student Learning Outcomes.

Students will gain a deep conceptual understanding of mathematical topics in a traditional first-semester calculus course (e.g., differentiation of functions of 1 real variable) through the study of a wide range of dynamic processes in various biological sciences including biology, physiology, neuroscience, and ecology (SLO 1). Students will understand how mathematical methods that model changes in the states of a biological system can elucidate biological phenomena and solve problems by the application of appropriately chosen mathematical and computation methods and models (SLO 2 & 3). Specifically, students will be able to

- Evaluate and explain the meaning of the derivative of a function (SLO 1 & 3).
- Apply physical and geometrical meanings of the derivatives to solve problems (SLO 2).
- Determine the relative and absolute extreme values of a function and solve applied optimization problem (SLO 3).
- Quantify and interpret changes in behaviors of dynamic systems (SLO 1 & 3).
- Explain how vector fields describe dynamic processes (SLO 1).
- Propose and compare different mathematical models that may explain an observed dynamic phenomenon (SLO 1 & 2).
- Explain how perturbations to systems can lead to different dynamic behaviors (SLO 1).
- Explain mechanisms that can give rise to observed behaviors, including homeostasis (SLO 1 & 2).
- Explain the meaning of the fundamental theorem of calculus through examples of estimating the area under a rate of change curve (SLO 1 & 3).
- Solve basic differential equations (SLO 2 & 3).
- Apply Euler's method to estimate trajectories of dynamical systems (SLO 2 & 3).
- Compute and explain stability properties of equilibrium points in 1- and 2-variables (SLO 1 & 3).

Students will learn the rudiments of a programming language to plot functions and data, simulate differential equations, and model dynamic processes (SLO 2 & 3).

Gordon Rule, Computational

This course satisfies the Gordon Rule, Computational requirements. Computational skills will be developed and assessed throughout the entire course by worked examples provided during lectures, and homework and exam questions, that require calculation of mathematical quantities by hand or with the aid of computers.

Required Texts/Readings

Modeling Life: The Mathematics of Biological Systems, Alan Garfinkel, Jane Shevtsov, Yina Guo, Springer International Publishing AG 2017

ISBN 978-3-319-59730-0 ISBN 978-3-319-59731-7 (eBook)
DOI 10.1007/978-3-319-59731-7
Library of Congress Control Number: 2017943196

Course Evaluation Method

A final grade percentage will be determined for each student based on the grades earned on weekly homework, 3 in-class exams, and the cumulative final. Weights toward to the final grade for assignment categories are:

Homework – 30%
Exams 1, 2, & 3 – 50%
Final Exam – 20%

Homework and Exams throughout the semester will include questions which assess the IFP SLOs defined above, including requiring students to explain mathematical theories in the context of applications (SLO 1), develop and apply mathematical models to understand a biological system (SLO 2), and computational questions assessing quantitative literacy (SLO 3). For example, students may expect questions on exams and homework like:

SLO 1

- "A DNA codon codes for exactly one amino acid, but there are amino acids that are coded by several different codons. Is there a function that takes amino acids to DNA codons? Justify your answer."
- "The graph below shows the amount of power generated by the solar panels. Assume you have the data used to generate the graph, sampled so frequently that it may be regarded as continuous. Describe how you would compute the total amount of electricity generated between 9 a.m. and 11 a.m."
- The growth of cells in a petri dish slows down over time. Is the second derivative of the function giving the number of cells positive or negative?

SLO 2

- "Kelp (K), sea urchins (U), and sea otters (S) form a food chain off the coast of northern California. Use the following assumptions to write a differential equation model of the food chain: …"
- "You are studying a new blood-pressure-lowering drug. You find that blood pressure is not very sensitive to the drug at low doses, very sensitive at intermediate doses, and not very sensitive at high doses. Rephrase this statement in terms of dP/dM, where P is blood pressure and M is the drug dosage."

SLO 3

- "Use vector addition and multiplication by scalars to compute the difference of two vectors [5,1]-[3,2], justifying each step."
- "Find the instantaneous rate of change of the function $f(x) = 3\sin(x) + \ln(x)$ at $x = \pi$.
- "The rate of change of a mouse population is given by the differential equation $N' = 0.5N(1-N/1000)$. The population at $t = 0$ is 400. Using Euler's method with a step size of 0.1, find the (approximate) population at $t = 0.3$."

Course Grading Scale

This course uses a standard grading scale to assign final letter grades. Thresholds for letter grades will not be higher than: ≥90% (A), ≥80% (B), ≥70% (C), ≥60% (D), <60% (F)

Policy on Makeup Tests, Late Work, and Incompletes

Students are responsible for arranging to make up work missed because of legitimate reasons, such as illness, family emergency, military obligation, court-imposed legal obligations or participation in University-approved activities, such as participating on an athletic or scholastic team, musical and theatrical performances and debate activities. It is the students' responsibility to give the instructor notice prior to any missed work. Any student missing an exam without an official excuse will receive a zero grade. Any excusable absence must be documented by a verifiable source, the instructor must be provided with the FAU-approved documents, and the instructor must be notified AT LEAST THREE DAYS prior to the due date. Except in extraordinary circumstances, all make-up exams must be taken within 48 hours of the due date of the missed work. In an emergency the student must inform the instructor about their missed work within 2 days of the due date of the missed work, along with university-approved documents to be allowed to make-up the missed work. The FAU-approved documents should be from a third party, who are not related to the student. All make-ups, if approved, must be completed within 48 hours of the due date. There are no make-ups for final exam. There are no make-ups for any homework and worksheets, since all homework and worksheets for this course will be open and available to the students from the beginning of the semester.

The grade of I (incomplete) can only be given under the conditions specified in the "Incomplete Grades" section of the FAU Catalog, and supporting documentation will be required.

Classroom Etiquette Policy

Disruptive behavior is defined in the FAU Student Code of Conduct as "... activities which interfere with the educational mission within classroom." Students who disrupt the educational experiences of other students and/or the instructor's course objectives in a face-to-face or online course are subject to disciplinary action. Such behavior impedes students' ability to learn or an instructor's ability to teach. Disruptive behavior may include but is not limited to non-approved use of electronic devices (including cellular telephones); cursing or shouting at others in such a way as to be disruptive; or, other violations of an instructor's expectations for classroom conduct. For more information, please see the FAU Office of Student Conduct.

Policy on the Recording of Lectures

Students enrolled in this course may record video or audio of class lectures for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach students about a particular subject. Recording class activities other than class lectures, including but not limited to student presentations (whether individually or as part of a group), class discussion (except when incidental to and incorporated within a class lecture), labs, clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, and private conversations between students in the class or between a student and the lecturer, is prohibited. Recordings may not be used as a substitute for class participation or class attendance and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct and/or the Code of Academic Integrity.

Attendance Policy

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.

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/

Disability Policy

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 www.fau.edu/sas/.

Code of Academic Integrity

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.

Grade Appeal Process

You may request a review of the final course grade when you believe that one of the following conditions apply:

- There was a computational or recording error in the grading.
- The grading process used non-academic criteria.
- There was a gross violation of the instructor's own grading system.

Chapter 4 of the University Regulations contains information on the grade appeals process.

RELIGIOUS ACCOMMODATION POLICY STATEMENT

In accordance with rules of the Florida Board of Education and Florida law, students have the right to reasonable accommodations from the University in order to observe religious practices and beliefs regarding admissions, registration, class attendance, and the scheduling of examinations and work assignments. For further information, please see Academic Policies and Regulations.

DROPS/WITHDRAWALS

You are responsible for completing the process of dropping or withdrawing from a course. Please click on the following link for more information on dropping and/or withdrawing from a course. Please consult the FAU Registrar Office for more information.

Course Topical Outline

Week 1 - Introduction to Modeling: Functions, state of a system, state space, model examples, 1- and 2-variable systems (Sections 1.1 – 1.3).

Week 2 - Modeling Change: Tangent space, change vectors, change and behavior in 1 and 2 variables (Sections 1.4 – 1.5).

Week 3 - Modeling Change: Trajectories in state space, vector fields, change in more than 2 variables, Euler's method in 1 and 2 variables (Sections 1.6 – 1.7).

Week 4 - Review and Exam 1.

Week 5 - Derivatives: Concept of derivatives, rate of changes, geometric interpretation of secant line and tangent line (Sections 2.1 – 2.3).

Weeks 6 & 7 - Derivatives: Linear approximation, linear functions, tangent line equation, differentiable functions, higher-order derivatives, derivatives of famous functions (Sections 2.4 – 2.5).

Week 8 - Min/Max: Optimization in 1 dimension (Section 7.7).

Week 9 - Review and Exam 2.

Weeks 10 & 11 - Integration: Euler and Riemann, integration as the area under curve, fundamental theorem of calculus, exponential growth and decay, linear differential equations (Sections 2.6 –2.7).

Week 12 - Equilibrium points: The concept of stability of equilibrium points, assessing stability in 1-D (Sections 3.1 – 3.2).

Week 13 - Equilibrium points: types of equilibrium points in 2-D (Sections 3.3 – 3.4).

Week 14 - Bifurcations of equilibria: Changes in parameters, and bifurcations in 1-D, basins of attraction, biological examples (Section 3.5).

Week 15 - Review and Exam 3.