Sample Project Proposal for MATH 492

# Title: MATH 492: Special Study I in Applied Combinatorics and Graph Theory

The proposed special study course serves to provide foundations in applied combinatorics and graph theory at an intermediate to senior level, as a natural extension of the course MATH 309: Discrete Mathematics offered by AU.

**Topics and Learning Outcomes**

The special study in applied combinatorics and graph theory will make use of the textbook *Applied Combinatorics*, by Mitchel T. Keller and William T. Trotter and cover Chapters 1–15. The table below outlines topics covered in each chapter, with corresponding learning outcomes.

[Note: As this is a sample of a proposal, the table below merely serves to provide an example of the presentation of topics and learning outcomes; it has been left incomplete intentionally.]

|  |  |  |
| --- | --- | --- |
| Chapter | Topics | Learning Outcomes |
| Chapter 1  An Introduction to Combinatorics | * Enumeration * Combinatorics and Graph Theory * Combinatorics and Number Theory * Combinatorics and Geometry * Combinatorics and Optimization * Sudoku Puzzles | Upon completion of this unit, the student will be able to provide an overview of the field of mathematics known as combinatorics and provide simple examples of how combinatorics is used in other fields of mathematics. |
| Chapter 2 Strings, Sets, and Binomial Coefficients | * Strings: A First Look * Permutations * Combinations * Combinatorial Proofs * The Ubiquitous Nature of Binomial Coefficients * The Binomial Theorem | Upon completion of this unit, the student will be able to   * define strings and their characteristics. * differentiate between permutations and combinations, and use each appropriately. * explain the core concepts used to develop combinatorial proofs, and construct simple combinatorial proofs.   state and prove the binomial theorem. |
| … | … | … |
| Chapter 15 | Etc. | Etc. |

**Course Materials**

Keller, Michael T., and William T. Trotter. *Applied Combinatorics*. Self-published. 2017.

This is an open educational resource (OER) available online at <http://www.rellek.net/appcomb/>.

**Study Plan**

Course start date: March 1, 2019

Chapters 1–15 will be completed at a pace of one chapter per week from the start date.

**Proposed Evaluation Scheme**

*Assignments*

Assessment for the course will be based on assignments. For each chapter, an assignment will be submitted that comprises 1) solutions to the even-numbered textbook exercises and 2) a concept map that illustrates the core concepts learned in the chapter and shows how those concepts relate to each other and to concepts from previous chapters.

*Grading of Assignments*

On each assignment, each exercise will be graded out of 5 marks: 3 marks to assess the correctness of the answer, and 2 marks to assess the presentation of the answer. The concept map will be graded out of 10 marks: 5 marks to assess the student’s understanding of the core concepts and their relationships, and 5 marks to assess the student’s ability to communicate mathematical concepts and ideas.

*Submission of Assignments*

All assignments are to be submitted one at a time in succession as per the study plan, unless an allowance to deviate from the study plan is approved by the supervisor.

Sample Project Proposal for MATH 493

# Title: MATH 493: Special Study II in Adaptive Dynamics and Evolutionary Theory

The proposed special study course serves to develop the student’s understanding of the application of mathematical modelling in evolutionary biology at the senior level, as a natural extension of the course MATH 480: Mathematical Modeling I offered by AU.

**Topics and Learning Outcomes**

This special study in adaptive dynamics and evolutionary theory will make use of the textbook *Game-Theoretical Models in Biology* by Mark Broom and Jan Rychtar The following chapters will be included:

Chapter 1 - Introduction

Chapter 2 - What is a game?

Chapter 3 - Two approaches to game analysis

Chapter 4 - Some classical games

Chapter 5 - The underlying biology

Chapter 6 - Matrix Games

Chapter 7 - Nonlinear games

Chapter 8 - Asymmetric games

Chapter 13 - Adaptive dynamics

Learning Outcomes

After the completion of this course, the student will be able to

* Describe the foundational concepts of evolutionary game theory
* Discuss the relationship between evolutionary game theoretical approaches and other modelling approaches used in evolutionary biology, such as population and quantitative genetics models
* Describe how adaptive dynamic models expand on those of evolutionary game theory.
* Analyze both static game theoretical and adaptive dynamic models of evolutionary systems.
* Define and conduct analyses to locate the following equilibrium concepts: ESS and CSS.

In addition, the student will demonstrate proficiency in

* technical writing and scientific research skills
* construction of proofs and application of theories
* use of LaTeX document preparation system

**Course Materials**

* Broom, Mark, and Jan Rychtář. *Game-Theoretical Models in Biology*. Mathematical Computational Biology Series. Boca Raton, FL: Chapman and Hall/CRC, 2013.
* Relevant primary literature

**Study Plan**

Course start date: March 1, 2019

Chapters 1–5 will be completed at a pace of one chapter per week from the start date.

**Proposed Evaluation Scheme**

*Written Report*

Assessment for the course will be based on the submission of a paper written in the form of a literature review detailing the development of evolutionary game theory and its progression into adaptive dynamics. The paper will be written at a level appropriate to serve as a “how-to guide” for senior undergraduate and graduate biologists with capable background in mathematics who are interested in learning the mathematical modelling techniques of game theory and adaptive dynamics that are used in evolutionary biology.

*Grading of Report*

The report will be assessed against the outlined learning outcomes. Each outcome will be scored out of 10 marks, and the overall grade will be scored out of 80 marks.

*Submission of Report*

The report is to be submitted iteratively, allowing the supervisor to provide feedback to the student and to allow for discussion and expansion of ideas and concepts. The writing of the report will pass through the following milestones: outline, first draft of section(s) covering static evolutionary games, first draft of section(s) covering adaptive dynamics, first draft of completed paper, and final paper.