

Honors 2302: Topics in Mathematics

***Course description (from catalog):*** This course focuses on quantitative literacy in logic, patterns, and relationships. Students will interpret key mathematical concepts and apply quantitative tools to everyday experience.

Honors 2302B: Graph Theory and Its Applications

**Academic Semester**: Fall 2015

***Course description (from catalog):*** This course engages students in the study of important topics in graph theory through its applications and through proofs designed to strengthen mathematical techniques. The course will emphasize developing critical thinking and applications to modern problems.

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Office hours: TBA

**General Education Core Curriculum (Code 020)**

Mathematics Component Outcomes:

* Students will articulate quantitative literacy in logic, patterns and relationships.
* Students will explain/apply/interpret key mathematical concepts and apply appropriate quantitative tools to everyday experience.

Core Objectives/Competencies Outcomes:

* **Critical Thinking**
	+ Students will demonstrate creative thinking, innovation, inquiry, and analysis, evaluation and synthesis of information.
* **Communication**
	+ Students will effectively develop, interpret and express ideas through written, oral and visual communication .
* **Empirical and Quantitative Skills**
	+ Students will manipulate and analyze numerical data or observable facts resulting in informed conclusions.

Additional department or instructor course outcomes (optional):

* Students will express basic concepts and ideas in graph theory.
* Students will develop problem-solving skills through selected homework.
* Students will describe mathematical ideas appropriately both orally and in writing.
* Students will construct mathematical models for real life situations.
* Students will practice making conjectures and explaining mathematics.
* Students will apply creative and critical-thinking through the initiation of independent research.

Other syllabi elements:

Assigned reading, instructor’s grading policy, attendance policy, Texas State University Honor Code, date & time for final examination, statement for students with special needs, statement on civility in classroom (optional), brief course outline and schedule of assignments for semester. Click here to enter text.

Required Textbook:

Barabasi, Albert-Laszlo. *Linked: How Everything Is Connected to Everything Else and What It Means for*

 *Business, Science, and Everyday Life,* Basic Books, 2014.

Chartrand, Gary. *Introductory Graph Theory*, Dover Publications, 2012.

Course Outline:

Graph theory is used today in physical sciences, social sciences, computer science and other areas. Therefore, some knowledge in the field is essential for students with any major. Graph Theory has grown dramatically during the past fifty years nurtured from the large number of its applications. This nature makes Graph Theory a very suitable perspective to incorporate mathematics into interdisciplinary studies. Curricular courses in Mathematics often present applications of results in other fields, but very seldom explain how the need of solutions to present real life problems shapes the development of Mathematics. As a consequence, students do not perceive Mathematics as a living science whose advancement is determined by interdisciplinary work. This course intends to prepare students in different majors for interdisciplinary work, emphasizing the communication of ideas and the relationship between concepts in different fields. The use of a problem centered and research-based approach will provide an environment as close as possible to real world situations.

# Contents

* + 1. Mathematical Models

Nonmathematical and mathematical models Graphs and modeling

Networks

* + 1. Transportation Problems

The Königsberg Bridge Problem: An Introduction to Eulerian Graphs

The Salesman's Problem: An Introduction to Hamiltonian Graphs

* + 1. Connectivity Problems

The Minimal Connector Problem: An Introduction to Trees

Trees and Probability

Evolutionary Networks in Sciences

Project Management: PERT and the Critical Path Method

* + 1. Party Problems

The Problem of Eccentric Hosts: An Introduction to Ramsey Numbers

The Dancing Problem: An Introduction to Matching

* + 1. Games and Puzzles

The Problem of the Four Multicolored Cubes: A Solution to "Instant Insanity"

The Knight's Tour

The Tower of Hanoi

The Three Cannibals and Three Missionaries Problem

* + 1. Digraphs as mathematical models

A Traffic System Problem: An Introduction to Oriented Graphs

Tournaments

Paired Comparisons and How to Fix Elections

* + 1. Graphs and Sociology models The Problem of Balance

The Problem of Clustering

Graphs and Transactional Analysis

* + 1. Planar graphs and colorings

The Three Houses and Three Utilities Problem: An Introduction to Planar Graphs

A Scheduling Problem: An Introduction to Chromatic Numbers

The Four Color Problem

* + 1. Graphs and other fields in Mathematics Graphs and Matrices

Graphs and Topology

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| **Class Meeting** | **Topic** |
| 1 | Introduction. Mathematical models. |
| 2 | Graphs and modeling. |
| 3 | Transportation Problems. The Königsberg Bridge Problem: Eulerian Graphs. |
| 4 | The Salesman's Problem: Hamiltonian Graphs. |
| 5 | Connectivity Problems. The Minimal Connector Problem and Trees. |
| 6 | Trees and Probability. |
| 7 | Evolutionary Networks in Sciences. |
| 8 | Interconnection Networks. Design and Modeling. |
| 9 | Interconnection Networks. Routing and Algorithms. |
| 10 | Project Management: PERT and the Critical Path Method. |
| 11 | Party Problems. The Problem of Eccentric Hosts: Ramsey Numbers. |
| 12 | The Dancing Problem: An Introduction to Matching. |
| 13 | Games and Puzzles. |
| 14 | Chessboard problems. The Knight's Tour. |
| 15 | Domination in Graphs. Project proposals due. |
| 16 | Stable marriage problem and Gale-Shapley algorithm. |
| 17 | The Tower of Hanoi. The Three Cannibals and Three Missionaries Problem. |
| 18 | Digraphs as mathematical models. A Traffic System Problem: Oriented Graphs. |
| 19 | Tournaments. Paired Comparisons and How to Fix Elections. |
| 20 | Graphs and Sociology models. The Problem of Balance. |
| 21 | The Problem of Clustering. Graphs and Transactional Analysis. |
| 22 | The Three Houses and Three Utilities Problem: Planar Graphs. |
| 23 | Planar graphs and colorings. |
| 24 | A Scheduling Problem: Chromatic Numbers. |
| 25 | The Four Color Problem. |
| 26 | Graphs and Matrices |
| 27 | Graphs and Topology. |
| 28 | Presentations. |
| 29 | Presentations. |
| 30 | Presentations. |

Course Requirements:

**Research Project Proposal:** Students will select a topic of their choice to elaborate an individual research project. The proposed project should include one or more problems in graph theory and its relationship to problems in other fields, and mention at least one real life situation where the graph problem applies. The project proposal is a two-page description of the project a student intends to work on, specifying goals, methodology and resources to be used. A grade will be assigned depending on the quality of the research, as well as the interpretation and the presentation of the material. **The Research Project Proposal will count as 5% of the final grade.**

**Research Project:** The Project does not have a maximum number of pages as the ideal length varies depending on the nature of the project. A grade will be assigned depending on the quality of the research, as well as the interpretation and the presentation of the material. The Research Project will demonstrate students’ ability to master **Mathematical Component Area Outcomes** through mastery of key mathematical concepts and applications to modern problems. The Research Project will also demonstrate students’ **critical thinking skills** in analysis, evaluation and synthesis of information, and **communication skills** in how they effectively develop, interpret and express ideas through written communication. The Research Project will require students to demonstrate **empirical and quantitative skills** as they manipulate and analyze numerical data to make informed conclusions. Guidelines and samples of both project proposals and projects will be posted on the TRACS site. **The Research Project will count as 70% of the final grade.**

**Problem Folder:** Each student must submit a selection of his/her favorite 20 homework problems. Students will be assessed based on the choice of problems, the originality of their solutions and the quality of their writing. **The Problem Folder will count as 20% of the final grade.**

**Oral Presentation:** A 10-minute oral presentation will accompany each research project. Presentations will be scheduled during the last days of classes. The goal of the presentation is to provide an overview of the work involved in the project and the results obtained. The Oral Presentation will demonstrate students’ **communication skills** in how they effectively develop, interpret and express ideas orally. **The Presentation will count as 5% of the final grade.**

**Grading:**Students will be graded based on their scores on the following:

* Research Project Proposal (5%)
* Research Project (70%)
* Problem Folder (20%)
* Oral Presentation (5%)

# Grading Policy:

If a student drops the class within the university deadline to withdraw, the instructor will assign a W grade, even in the cases when the deadline for an automatic W has passed. However, once the dropping deadline has passed, the instructor cannot assign a W grade.

Incomplete grades are extremely rare and limited to special circumstances. Applications for an I grade have to be presented at the Math Office (MCS 470), and will only be considered for the instructor’s approval if the student average over the part of the course he/she has taken corresponds to a grade of A or B.

Cheating and/or plagiarism during tests, exam or extra credit homework assignments will result in an automatic F grade and the Chair of the Honor Code Council will be informed of any incidence following the procedure outlined in:

<http://www.txstate.edu/effective/upps/upps-07-10-01.html>

# Academic Integrity:

Cheating and/or plagiarism during tests, exam or extra credit homework assignments will result in an automatic F grade and the Chair of the Honor Code Council will be informed of any incidence following the procedure outlined in:

<http://www.txstate.edu/effective/upps/upps-07-10-01.html>

The document indicated above contains explicit definitions of what constitutes cheating and plagiarism.

# Dropping/withdrawing:

To drop a class means removing that class from your schedule, but having at least one class left. Withdrawing means dropping all classes. To drop a class, log on to Texas State Self- Service menu and select the option Registration/Schedule Changes.

There is a university deadline to drop a class with full refund, another deadline to drop with an automatic W, and a third deadline to withdraw a class. If a student drops the class within the university deadline to withdraw, the instructor will assign a W grade, even in the cases when the deadline for an automatic W has passed. However, once the dropping deadline has passed, the instructor cannot assign a W grade. Therefore, it is important to check the deadlines posted in:

http://www.registrar.txstate.edu/persistent-links/academic-calendar.html