Title **99 Problems (And How to Solve Them!)**

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Office hours: Mondays 3:30-5:00 in Physics 220 (TA room) and by appointment
Course Meeting Time: Tuesdays 4:00-5:50
Location: Physics Building 218

Prerequisites: None. All majors welcome.

Course Description

99 Problems (And How to Solve Them!) is an introduction into the methods, tools, and mindset of problem solving. There are many more applications for analytical problem solving than just math and science. For example, how would you best play a game that you have just been taught? Or decipher the meaning of a word you have never seen before? We will explore methods of approaching, attacking, and ultimately solving a wide variety of problems, from basic math and science to games and puzzles to language and art.

We will spend one to two weeks covering each of a few topics, including (but not limited to) games and creative thinking, logic and puzzles, language dissection, and computer science. In this course you will see several types of problems and approaches for solving them. You will learn to see patterns and commonalities between problems of very different natures, for example a basic computer science problem might follow the same broad steps as creating a work of origami. In this course we will dissect, discuss, and analyze a selection of problems that will teach you, through an examination of their parts and solutions, to use a similar broad, step-by-step approach to solve problems in almost any other discipline.

This course is designed for all students who want to improve their problem solving skills, regardless of prior experience or major. We will show how solving a problem in one discipline can be extremely beneficial for solving a problem in a seemingly unrelated discipline. You will also be able to appreciate how fun and enjoyable problem solving - either academic, professional, or recreational - can be.

Course Objectives

- *Improve your ability to solve problems by learning problem solving techniques, including how to approach a problem and what questions to ask while looking for a solution*
- *See how widely applicable and useful problem solving is across numerous subjects and in everyday life*
- *Become confident in your abilities by practice, practice, practice!*
- *Have a lot of fun!*

Required Text

How to Solve it: A New Aspect of Mathematical Method by George Polya, *ISBN 9781400828678*

Recommended Texts (These will not be needed for class but may help you and are great problem solving books)

The Colossal Book of Mathematics: Classic Puzzles, Paradoxes, and Problems by Martin Gardner, *ISBN 9780393020236*

The Art of Problem Solving, Vol. 1: The Basics by Sandor Lehoczky and Richard Rusczyk, *ISBN 9780977304561*

The Art of Problem Solving, Vol. 2: And Beyond by Sandor Lehoczky and Richard Rusczyk, *ISBN 9780977304585*

Gödel, Escher, Bach: An Eternal Golden Braid by Douglas R. Hofstadter, *ISBN 9780465026562*

Evaluation and Course Components

This course is two credits and is evaluated as credit/no credit for all students. In order to receive credit, students must complete the course with a minimum of 80%, evaluated through the following criteria:

Attendance and Participation (30%)

As a significant portion of this course will be in-class activities and lectures, it is crucial that students attend every class and participate actively. Students must email the instructors *before* class begins if they are going to be absent one week, and a make-up activity will be provided. Students with more than one unexcused absence will receive a score of zero for the attendance and participation portion of the grade, and therefore will not receive credit for the course.

Homework (40%)

Learning problem solving techniques takes practice, so homework activities are an important component of the course. Homework is not intended to be tedious or especially challenging, but rather as an enjoyable supplement that allows students to practice and reinforce concepts introduced in class. Unless otherwise specified, all homework assignments will be due at the beginning of class the week after they are assigned. Graded homework to be completed outside of class fall into two categories:

(W) Worksheets/activities (20%): A worksheet of problems, puzzles, and/or activities to be completed outside of class. Worksheets will sometimes require the use of online resources.

(R) Reflections (20%): Reflections are a valuable component of the course because they ask students to assess themselves. Through reflections, students will pinpoint their own strengths and weaknesses throughout the course. They will also reflect on readings they have done in order to better understand the reading. The instructors will use students' reflections to determine how well the students are grasping concepts and to improve the course as the semester progresses. Reflections will be graded on completion.

Final Project (30%)

Students will work on a creative problem solving project based on their own interests. These projects can be about exploring different problems in a mathematical topic, engineering a solution to an everyday problem, or anything that interests the student and demonstrates how the student would go about solving a problem. Projects will be presented on the last

day of the course. In presenting their projects, students will explain what challenges they encountered and how they went about solving them. Every presentation will be followed by a discussion of the solution(s). Final project grades will be determined based on both presentation of the project and participation in discussions of other projects.

Calendar

Class meeting day	**Class topic**	**Homework assigned this week**
Aug 25	**Introduction:** Importance of problem solving, course outline, nine dots problem **Game:** Sprouts **Activity worksheet**	Read How to Solve It: Part 1 and 2 **Go to the Assignments tab on Collab and do Reflection 1,** which will be a reflection of the reading you did. (Not required, but interesting) Read c.36 "Sprouts and Brussel Sprouts" in The Colossal Book of Mathematics
Sep 1	**Book discussion** **Analyze Sprouts** **Traffic Jam** (team activity)	**Do last week's homework if you didn't get a chance to or if you added the class late.** **Do Reflection 2 on Collab.** This will be writing a reflection on the similarities in Sprouts and Traffic Jam, and what problem solving methods you used or could have used to solve them.
Sep 8	**Talk about reflections** **Analyze Traffic Jam** **Computational linguistics problems** **Start logic puzzles**	Please **do Reflection 1 on Collab if you haven't! This counts as a homework completion grade and we are reading all of these!** **Finish the two worksheets on linguistics problems** that were handed out in class. For this assignment, you can look online, email and/or discuss it with us, and talk with your peers. Just make sure you **understand the solution.**
Sep 15	**Review and do more logic problems** **Eleusis game** **Work on extra problems**	**Finish the Knights and Knaves worksheet** if you didn't in class. Once again, use any resources available including the internet, peers, and us! Don't be afraid to email us or come to office hours for help. Finish until at least **level 15 on gameaboutsquares.com** and email or bring a screenshot of it to class.

Sep 22	**Introductory computer science problems** **Turing machines**	**Finish the Turing Machine problems** if you didn't get a chance to in class. **Do Reflection 3 on Collab.**
Sep 29	**Review material** **Feedback for us**	If you would like to improve your homework grades, please redo problems you got wrong and write a short explanation of the solution for each of those problems. Please ask us for help if you need it! **Finish two of the four review worksheets** and bring it to class. Again, these are tough problems, so ask us or a friend for help if you get stuck!
Oct 6	**NO CLASS- FALL BREAK**	Sleep.
Oct 13	**Computer science problems** **Tech interview questions**	**Do the Python tutorial and worksheet** from class. Read **five sections** from How to Solve It: Part 3
Oct 20	**Review computer science problems** **Python worksheet** **Engineering design problems**	Go to challenge.gov and pick an active challenge of your choice. These are actual contests that are currently running with monetary prizes. If you get a chance, write up a solution that satisfies the requirements of the contest so you could submit it (but don't submit it yet). However, if that is too ambitious for your contest, write up a 2-3 page double spaced solution to the problem. **Submit this in Reflection 4.** Use the tips we discussed in class when coming up with a solution.
Oct 27	**Discuss solutions from homework** **Redo solutions** **More design problems**	Submit your solution online if you can and want to! Come to class with an **origami figure and instructions for you or memorized instructions on how to make it**. We will send an email with details on sites you can use and how difficult to make it. Please use square paper (or if you don't, let us know).
Nov 3	**Origami** **Hexaflexagons, hexahexaflexagons, and others**	Do one of the eight options we will email you and discuss in class.

Nov 10	**Review problems** **Discuss final projects**	**Do Reflection 5 on Collab.** This reflection is a 2-3 page double spaced description of your project idea—specifically what problem you're going to explore or solve and what methods you will use from class to do so. We encourage you to work in pairs, but no groups larger than two people. Only one proposal per group is needed. Extra credit worksheets (optional)
Nov 17	**Review problems** **Work on projects**	Work on final project
Nov 24*	**NO CLASS - THANKSGIVING**	Work on final project
Dec 1	**Gabriel Robins guest lecture on computer science problems** **Work on projects**	Work on final project
Dec 8	**Presentation of final projects**	

Revisions to Syllabus

The instructors for this course reserve the right to modify any part of this syllabus at any time, with the exception that due dates for homework that has already been assigned will not be moved up. Additionally, the instructors will inform students whenever a change has been made to the syllabus, and they will distribute an updated version promptly following any change.