MAT 118: Mathematical Thinking
Fall 2009

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Welcome to MAT 118

Your final grade was based on the following scheme: Homeworks - 25%; midterms - 20% each; Final exam - 35%, where the score for each item is out of a possible 100.

Grades were calculated according to the following procedure:

A = 75 and up
B = between 60 and 75
C = between 40 and 60
D = between 35 and 40

In some cases, adjustments were made according to factors such as class participation and extra credit.

Important Announcements:

- **Final Exam time and place**: Monday, December 14, 11:15am-1:45pm, Old Chemistry Room 116
- A review for the final exam is available **here**.
- November 16: The syllabus has been updated to point out that Mini-Excursion 3 (population growth) will be covered on the final exam.
- October 10: Some changes to the syllabus have been made. In particular, midterm 2 will cover chapters 5,6 and 9.

There is much more to mathematics than just calculations and solving equations. In this course we will examine several mathematical topics accessible to students with an understanding of high-school mathematics. These will be selected from among the following: voting methods; the mathematics of money; probability; graphs, paths, and networks; tilings and polyhedra; game theory; and other topics.

For more information, please select General information link in the menu to the left.

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Place and time:

Lecture	MWF	9:35am-10:30am	Light Engineering Lab 102	Andrew Bulawa
Rec 01	M	3:50pm-4:45pm	Earth & Space Science 79	Shane D'Mello
Rec 02	W	3:50pm-4:45pm	Library E4315	Shane D'Mello
Rec 03	Tu	9:50am-10:45am	Physics P112	Travis Waddington
Rec 04	Th	9:50am-10:45am	Physics P112	Travis Waddington

Instructors and Office Hours:

email addresses are @math.sunysb.edu

Andrew Bulawa

email:	abulawa	
office hours:	Math 4-103	Monday, Wednesday 12-1
	MLC: Math S-240A	Monday 1-2

Shane D'Mello

email:	shane	
office hours:	Physics D-126	Wednesdays 10:30 - 11:30am
	MLC: Math S-240A	Monday, Wednesday 2-3

Travis Waddington

email:	ratatosk	
office hours:	Math 3-122	Thursday 2:15-3:15
	MLC: Math S-240A	Tuesday, Thursday 11:30-12:30

When sending an email, please begin the subject line with "mat118".

Course description:

There is much more to mathematics than just calculations and solving equations. In this course we will examine several mathematical topics accessible to students with an understanding of high-school mathematics. These will be selected from among the following: voting methods; the mathematics of money; probability; graphs, paths, and networks; tilings and polyhedra; game theory; and other topics.

Textbook:

Excursions in Modern Mathematics, seventh edition by Peter Tannenbaum.

Homeworks:

You can not learn mathematics without doing mathematics. Each week a homework assignment will be posted online. These will be due the following week in recitation. While you may work together with other students on the homework assignments, write up your own solutions in your own words. The goal of the homework is for you to understand the material, not to merely hand in some paper. Late homeworks will generally not be accepted.

Exams:

There will be two in-class midterms and a final exam. The midterm dates are October 5 and November 2. There will be no makeup exams; if one midterm exam is missed because of a serious (documented) illness or emergency, the semester grade will be determined based on the balance of the work in the course.

Grading policy

Final grade will be based on the following scheme: Homeworks - 25%; midterms - 20% each; Final exam - 35%.

Information for students with disabilities

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact Disability Support Services at (631) 632-6748 or **http://studentaffairs.stonybrook.edu/dss/**. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.
Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: **http://www.sunysb.edu/ehs/fire/disabilities.shtml**

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Syllabus

Topics	Sections	Dates	Homework (due the following week)
C1. Mathematics of Voting	1.1-1.4	8/31-9/4	Chapter 1: 2,8,14,20,30,63,64 click **home** on the left if you do not have the text
Voting Methods fairness criteria Arrow's impossibility theorem	1.5,1.6,2.1	9/9, 9/11	Chapter 1: 36,40,44,50 Chapter 2: 1,4,7,9,10 click **home** on the left if you do not have the text
C2. Weighted Voting Systems	2.2,2.3,3.1-3.3	9/14-9/18	Chapter 2: 12,20,21,42,52,55,72(a) Chapter 3: 3,7,10,19,29,30 click **home** on the left if you do not have the text
Banzhaf power index	3.4-3.7,5.1	9/21-9/25	Chapter 3: 25,27,32,33,34,44,50,55,62,69,77
C3. Fair Division concepts and definitions fair-division methods			
C5. Euler Circuits routing problems language and concepts of graph theory graph modeling	5.1-5.3	9/30,10/2	No homework for next week.
Midterm 1 (Chapters 1-3)		10/5	.

C5. Euler Circuits	5.3-5.7	10/7,10/9	Chapter 5: 7,10,11,13,17,23,28,30,48,64,66
C6. The Mathematics of Touring Hamilton paths and circuits complete graphs TSP (traveling salesman problem) TSP algorithms	6.1-6.8	10/12-10/16	Chapter 5: 39,40 Chapter 6: 2,10,14,17,27,34,35,40,41,45,48,55
C9. Spiral Growth in Nature Fibonacci numbers the golden ratio gnomons	9.1-9.4	10/19-10/23	Chapter 9: 1,3,14,26,28,37,38,41,48,68
Review for 2nd midterm and C10. The Mathematics of Money	10.1-10.3	10/26-10/30	Chapter 10: 1,3,7,9,14,24,28,32,37,48,84
Midterm 2 (Chapters 5,6,9)		11/2	.
C10. The Mathematics of Money (continued)	10.4-10.6 Mini-	11/4,11/6,11/9	Chapter 10: 56,60,63,69,70 Mini-Excursion 3: 9,13,17,19,22,24,26,28,31

The Mathematics of Population Growth	Excursion 3		
C11. The Mathematics of Symmetry rigid motions	11.1-11.5	11/10,11/13	Chapter 11: 3,4,6,13,18,21,24,27,30,56,58,68
C11. The Mathematics of Symmetry (continued) symmetries as rigid motions patterns	11.6-11.7	11/16-11/20	Chapter 11: 35,37,40,42,48,50,75-80
C15. Chances Probabilities and Odds random experiments and sample spaces counting permutations and combinations probability spaces	15.1-15.6	11/20,11/23, 11/30-12/4	Chapter 15: 2,10,13,20,24,35,37,41,45,51,55,56,70,78,84
Review		12/7-12/11	.
Final Exam Monday, December 14 11:15am-	1,2,3,5,6, 9,10,11,Mini-Excursion	12/14	.

	1:45pm Old Chemistry 116	3,15	

MAT118 Final Exam Review

Chapter 1: Voting Methods

- preference ballots & schedules
- fairness criteria
- voting methods

Chapter 2: Weighted Voting

- weighted voting systems
- quota, dictators, veto power
- Banzhaf power
  - winning coalitions
  - critical players
  - Banzhaf power index

Chapter 3: Fair Division

- fair share
- lone chooser method
- lone divider method
- last diminisher method
- method of sealed bids
- method of markers

Chapter 5: Euler Circuits

- graphs, modelling
- Euler paths and Euler circuits
- Euler's path and circuit theorems
- Euler's sum of degrees theorem

Chapter 6: Travelling Salesman Problems

- Hamilton paths and circuits
- weighted graphs
- exhaustive search (brute force) method
- nearest neighbor/repetative nearest neighbor methods
- cheapest link method

Chapter 10: Mathematics of Money

- percentages
- simple and compound interest
- fixed deferred annuities

Mini-Excursion 3: Population Growth

- linear growth, common difference
  - arithmetic sum formula
- exponential growth, common ratio
  - geometric sum formula
- logistic growth
  - relative population
  - complimentary seeds

  - logistic equation
  - attracting points, 2- and 4-cycle patterns

Chapter 11: Symmetry

- rigid motions
- proper vs improper rigid motions
- finding translation vectors, rotocenters, reflection axes
- symmetry types
  - for finite shapes
  - for border patterns
  - for wallpaper patterns

Chapter 15: Probability

- counting: factorials, permutations, combinations
- sample spaces
- probability
- tallying in equiprobable spaces
- multiplicative property of independent events
- complimentary events

1. Chapter 1, #41, question 1 on exam 1.

2. Consider the weighted voting system [10: x,3,2,1,1,1].
(a) For what values of x, does the first player have veto power?
(b) For what values of x, is the first player a dictator?

3. Consider the weighted voting system [7: 5,4,2,2].
(a) Write down all of the winning coalitions.
(b) Circle the critical players in each of the winning coalitions you just wrote down.
(c) Write the Banzhaf power distribution for this voting system.

$3\frac{1}{2}$. Chapter 3: 23,35,45,59,65

4. #34 in Chapter 5.

5. #37 in Chapter 5.

6. In a graph with x vertices of even degree and y vertices of odd degree,
(a) for what values of x and y does the graph admit an Euler circuit? Where must the circuit begin and end?
(b) for what values of x and y does the graph admit an Euler path? Where must the path begin and end?

7. #37 and #43 in Chapter 6.

8. Let the figure F be a square with sides of length 5 inches. What are the dimensions of the L shaped piece(s) which are gnomons to F?

9. Express the sum $F_N + F_{N+1} + F_{N+2} + F_{N+3}$ of four consecutive terms in the Fibonacci sequence in terms of the first two.

10. Let ϕ denote the golden ratio. Simplify

$$\sqrt{1+\sqrt{1+\sqrt{1+\phi}}}$$

11.
(a) Find c and n so that

$$1.11111 = \frac{c^n - 1}{c - 1}$$

(b) Add the numbers 23 through 547.

12. Suppose that you invest \$5000 in an account which earns 6% annual interest compounded quarterly. What is the amount in your account after 10 years?

13. Suppose that you invest \$50 at the beginning of every month in an account which earns 6% annual interest compounded monthly. What is the amount in your account at the end of 20 years?

14. Suppose a population of 50 termites grows according to a linear growth model. Suppose that after one month, the population is 75. What will the population be after one year?

15. Suppose the number of people infected by a cold virus increases exponentially. If the number of people infected increased from 3000 to 4000 in one month, how many people will be infected at the end of the year?

16. A population of rabbits is measured on a monthly basis and is found to obey a logistic growth model with growth parameter $r = 3$.
(a) If the initial population is at 40% capacity, then how many rabbits will there be after 3 months?
(b) After 20 months the population is at approximately 63.63% of capacity? What would you expect the population to be after 20 months if the initial population were instead at 60% capacity?

17. Chapter 11: 7,15,25,31,35,49,75-80

You may express your answers to the following questions using factorials and exponents.

18. Carlos brings with him on a trip two pairs of shoes, three pairs of pants, and five shirts. How many outfits can carlos create?

19.
(a) How many ways can 6 people line up in a queue?
(b) How many ways can 6 people arrange themselves evenly around a round table?

20. Kermit wants to pick up a half-dozen donuts from the local bakery, each of a different variety. Assuming the bakery is well stocked with 15 different varieties, how many different donut selections can Kermit make? What if his selection need not consist of distinct varieties?

21. A child has a collection of 20 building blocks, each with a distinct color. How many different towers can he form a tower by stacking 7 blocks, one on top of the other.

22. Suppose a slice of bread with jelly on one side is twice as likely to land jelly side down than jelly side up.
(a) What is the probabilty that it lands jelly side up?
(b) If 10 jelly sided slices are dropped simultaneously, what is the probabilty that half of them land jelly side up?
(b) If 10 jelly sided slices are dropped simultaneously, what is the probabilty that at least 2 of them land jelly side up?