MATH 475 SYLLABUS, Fall Semester, 2005-06 Academic Year
Lec. 1, TR 9:30–10:45 AM, B113 Van Vleck Hall

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Text is:
Introductory Combinatorics
4th ed., by R.A. Brualdi

Two copies of the text are on reserve in the Math Library (level B2 of Van Vleck Hall) if you prefer not to purchase the book. There is now a second printing of the 4th edition with some corrections. In case you have the first printing, the corrections are appended at the end of this document.

Course Description As the title *Introduction to Combinatorics* suggests, Math 475 is a first course with emphasis on the basics of combinatorial counting techniques, number sequences, patterns, and ordered sets. It is not however a course on what is traditionally called discrete mathematics. But we will discuss algorithms for some of the combinatorial problems considered.

Briefly, the topics covered in the course this semester include: pigeon-hole principle and applications; permutations and combinations; generating permutations and combinations; properties of binomial coefficients (combination numbers); partial orders, equivalence relations, and Dilworth's theorem; the inclusion-exclusion principle; recurrence relations and generating functions; difference sequences, Catalan numbers, Stirling numbers, partition numbers, and other counting sequences; systems of distinct representatives; and counting equivalence classes in the presence of symmetries.

Study Habits This course does require considerable work. You should be devoting at least 6 hours a week outside of class to it; reading the book, thinking about the ideas, concepts, and techniques, talking with some of your classmates about them, doing all the assigned exercises etc.

There will be regular reading (see below). It is expected that students will read the book - not everything you should learn and know will be discussed in class. Of course, I will write stuff on the chalkboard but I will not write the book on the board! The class and the book will reinforce each other, and neither is a replacement for the other. Questions and comments from students are very much encouraged. It's best to do the reading assignments **before** the class in which they are discussed. In the class, we (you and I) will discuss the material - class participation is encouraged and expected.

Exercises There will be two kinds of exercises: some to do and check your answers (after you've done them!) with those given in the back of the book; in addition, there are exercises to be handed in (after we finish each chapter) for marking (by a graduate student grader assigned to me). It is essential that you do both kinds of exercises with the not-to-be-handed-in exercises completed **before** you do the to-be-handed-in exercises. The assignments to be

handed-in have a **due date in class**; no late assignments will be accepted but the lowest assignment will be dropped. Your work on these exercises - **not just the answers** - should be well-presented in good English, and not written carelessly. While you can discuss the exercises with classmates, **the work you hand in should be your own write-up and not copied from someone else.** The assigned homework will be worth 80 points. I allow myself the possibility to increase someone's scaled homework score based on class participation.

Exams There will be **two in-class exams** during the semester, **each worth 100 points**, and a **final exam**, **worth 120 points** - see the accompanying schedule. I do not intend to give make-up exams.

Exam Schedule

- Exam 1 on Chapters 1–6: Thursday, October 20 (in class).
- Exam 2 on Chapters 7–9: Thursday, December 1 (in class).
- Final Exam: Thursday, December 22, 2:45 PM.

Proposed Weekly Schedule

- Week of September 5: Chapters 1 and 2
- Week of September 12: Chapters 2 and 3
- Week of September 19: Chapters 3
- Week of September 26: Chapters 4
- Week of October 3: Chapter 5
- Week of October 10: Chapter 6
- Week of October 17: Chapter 6 (not section 6.6) plus Exam I
- Week of October 24: Chapter 7 (parts will be skipped)
- Week of October 31: Chapter 8
- Week of November 7: Chapter 8 (not section 8.5)
- Week of November 14: Chapter 9 (9.3. and 9.4 only)
- Week of November 21: Chapter 14
- Week of November 29: Chapter 14 plus Exam II

- Week of December 6: Chapter 14
- Week of December 13: Chapter 14 plus review

Grades These will be based on a **total of 400 points** according to the following standard (and exams will be constructed with this standard in min; if necessary I will adjust exam scores by adding points):

Grade	Accomplishment level	Points
A	**superior**	370 ↑
AB	**excellent**	355 ↑
B	**proficient**	330 ↑
BC	**good**	310 ↑
C	**acceptable**	275 ↑
D	**mediocre**	240 ↑
F	**unacceptable**	0 ↑

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Because of this absolute standard, you are not in competition with your classmates nor does their performance influence positively or negatively your performance. You are encouraged to form study/problem groups with your classmates; things not clear to you may become obvious when you try to explain them to others or when you hear other points of view. Sometimes just verbalizing your mathematical thoughts can deepen your understanding. As already mentioned, if you discuss with others the exercises, each person should write up her/his own version of the solution.

Calculator Policy: It is acceptable to use calculators on exams to do arithmetic computations, but the computations are to be exact. So an answer which has $\sqrt{2}$ in it is to be presented as such and not as 1.414.

Attendance: It is expected that each student will be present at all of the classes. Office hours are for students who need additional help beyond that given in the class; they are not substitutes for class.

Note to McBurney Disability Resource Center students: Students of the Center who are recommended for some accommodation (e.g., extended time on exams) should contact the instructor about this no later than September 16, 2005.

Exercises

Each Hand-in assignment is worth 10 points, each problem is worth the number of *'s you see.

- Chapter 1: 3, 26, 27, 30, 31, 32, 35

- Chapter 2: 4, 5, 8, 9, 10, 11, 14, 15, 16, 17, 18, 20, 23, 27.

  Hand-in assignment # 1: Due Tuesday, September 20: Chapter 1: 31* and Chapter 2: 11*, 15**, 16**, 20**, 23**

- Chapter 3: 1, 2, 3, 4b, 5a, 7, 8, 9, 10, 11, 13, 15, 17, 18, 19, 20, 21, 25, 26, 30, 31, 32, 37, 39, 40, 42, 45, 46, 47.

  Hand-in assignment # 2: Due Thursday, September 29: 9*, 13*, 25*, 26*, 37*, 42*, 45*, 46*, 47*, 50*

- Chapter 4: 6, 7b, 8, 9, 15 c,d, 16 c, d, 17, 23 b, 24 b, 27, 28, 29, 33, 36, 37, 38, 39, 44, 45, 46, 47a, 48, 49.

  Hand-in assignment # 3: Due Thursday, October 6 8*, 15 (c,d)*, 16(c,d)*, 27*, 29*, 33*, 37*, 45*, 47a*, 49*

- Chapter 5: 5, 7, 8, 11, 12, 13, 15, 16, 18, 23, 24, 29, 31, 38, 40, 47.

  Hand-in assignment # 4: Due Thursday, October 13: 12**, 13*, 16**, 23**, 29**, 38*.

- Chapter 6: 2, 5, 6, 8, 11, 12, 13, 16 17, 24, 25, 26, 29.

  Hand-in assignment # 5: Due Thursday, October 20 5**, 8*, 13**, 16*, 24a*, 24c*, 26**

- Chapter 7: 30c, 32, 34, 35, 36, 37, 40, 43, 44, 45.

  Hand-in assignment # 6: Due Thursday, November 3: 30c*, 32*, 35**, 37**, 44**, 45**

- Chapter 8: 4, 7, 8, 11, 12, 13, 15, 17, 19. 25, 26 a, b, 27.

  Hand-in assignment # 7: Due Thursday, November 17: 7**, 8**, 12***, 19***

- Chapter 9: 13, 15, 16, 20, 22, 25, 26.

- Chapter 14: 1, 12, 13, 18, 18, 22, 26.

  Hand-in assignment # 8: Due Tuesdayy, Decdember 14: Chapter 9: 13*, (20,25)**, 22*, 26* and Chapter 14: 1 (a,b,d)*, 13**, 26**.

Errata for Introductory Combinatorics, 4th edition, first printing
Author: Richard A. Brualdi

1. Page ix, line −8 (Preface): Louis Dea**e**tt.

2. Page 43, line 6-7 (Exercise 28): What is the smallest sum $a_1 + a_2 + \cdots + a_{100}$ that will generate this?

3. Page 67, Theorem 3.4.3: The second assertion in the theorem is not correct, since (considering the 'proof' given), not all the $k!$ permutations are possible if not all the n_i are equal. The second assertion is true if $n_1 = n_2 = \cdots = n_k$. (Thanks to Joel Brawley of Clemson University for pointing this out.)

4. Page 67, line 1: **Delete** "For instance, we have"

5. Page 122, Exercise 50: The answer 42 give on page 609 is incorrect; the correct answer is 48.

6. Page 143, running head: Sec. 5.4: Unimodality of binomial coefficients

7. page 152, line 2: the s should be m.

8. Page 185, line −3, −2: A **not** is missing (... counts the number of elements that belong to all of the sets A_j with j not in K and possibly other sets as well).

9. Page 189, line 4: the C should be a B (... as there are subsets of cardinality k contained in the set $B \setminus A$ of cardinality p)

10. Page 190, Corollary 6.6.2: The first displayed equation should be for $G(K)$ (not $G(L)$), the f should be F, and the last L should be K:

$$G(K) = \sum_{L \subseteq K} F(L), \quad (K \subseteq X_n).$$

    (Thanks to Walter Morris of George Mason University for these last three items.)

11. Page 203, Exercises 29 and 30: The answer given on page 611 for Exercise 30 is the answer for Exercise 29.

12. Page 203-4, Exercise 32. The displayed 6-by-6 board is incorrect, the ×'s and the blanks should be interchanged (so there are 4 ×'s in each row and column. Also the formula for $a(n, k)$ should be

$$a(n, k) = \frac{2n}{2n - k} \binom{2n - k}{k}.$$

    (Thanks to John B. Little of the College of Holy Cross for pointing this out.)

13. Page 213, line -8: The second f_n should read

$$f_n = \left(\frac{1-\sqrt{5}}{2}\right)^n.$$

14. Page 262, lines 5-9 (Exercise 21): Let a_n equal the number of ternary strings of length n made up of 0's, 1's, and 2's, such that the substrings 00, 01, 10, 11 never occur.

15. Page 283, line -1: For c_2 read c_1.

16. Page 285, line 5: $c(p,0) = 0$ for $p \geq 1$.

17. Page 319, Exercise 15, The last term in the displayed formula should be:

$$\binom{k}{n} n! S(n,n).$$

18. Page 320, Exercise 22: $p(6)$ and $p(7)$ should be p_6 and p_7.

19. **The above corrections were requested for the 2nd printing of the 4th edition.**