

Ma 401 Number Theory Fall 2019

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Office Hours: MWF 9:00 to 9:45, T: 2:00 (I will leave at 2:15 if no one come,
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Textbook: *Elementary Number Theory, 2nd ed., by Vanden Eynden;*
McGraw Hill.
Calculator: TI 89.

Catalog Description: MA 401 Elementary Number Theory: Divisibility, congruences, theorems of Fermat and Wilson, primitive roots, indices, and quadratic reciprocity.

Context: The faculty of the Division of Mathematical Sciences has developed five broad goals and has aligned these goals with the Bob Jones University Institutional Goals (IG) and the goals of the Bible and Liberal Arts Core (BLA). We believe these goals support the IG/BLA of the University. These Division Goals (DG) are to:

1. Mature the student in the theory and applications of mathematics and computer science.
2. Provide the student the required mathematical and computing background to function and contribute effectively in today's technological society.
3. Provide the student a platform for continued learning and development of his God-given abilities.
4. Instill in the student a desire to use his abilities in service to Christ.
5. Provide an appropriate liberal arts complement to a wide variety of majors.

Course Goal (CG):

1. To develop a Christian perspective of Number Theory and related real world applications such as use in cryptography (DG 4, 5)
2. To develop a greater appreciation for the beauty and power of the most basic of counting systems(positive integers) and see how it can be developed into the most useful of tools (DG 1, 3)
3. To develop mathematical maturity and independent thinking (DG 1)
4. To develop Christ like qualities such as perseverance, diligence, and dependence on God. (DG 3, 4)
5. To develop a greater interest in exploring mathematical ideas independent of the teacher (DG 1, 3)
6. To develop the ability to present mathematics in written and oral form(DG 5)

Course Goal:

The primary goal of all math classes at Bob Jones University is to develop a Christian perspective of mathematics and related scientific endeavor. Included in such a goal is the development of Christ-like qualities such as perseverance, diligence, and dependence on God.

The primary educational goal of all 500-level classes is both to prepare the upper level undergraduate math major for graduate school and to mature the graduate mathematics-education major mathematically so that he can better relate the goals, the development, and the beauty of mathematics to his secondary-education students.

Course Policies:

Cell Phones and Laptops: Cell phones are not permitted to be out during class. Make sure they are muted and do not ring during class. There is little reason why a laptop should be used during a math class. You should have pencil, paper, and your textbook out and ready to use in class. If for some reason you have a legitimate need of a laptop in class, please see me and we will discuss this need.

Attendance Policy: You are expected to be in class every day and to come to class on time. In keeping with official university policy if you are marked late three times, you will be levied a personal absence. If you are more than twenty minutes late, you will be marked absent. The burden of proof will be on the late student to prove that he was not more than twenty minutes late and that he was actually present.

For *planned absences*, you are expected to notify the instructor a week ahead of time; you can do so by e-mail. It is your responsibility to make up tests and quizzes before you leave and to get notes from your classmates and discuss the missed material with them after you return. You should not expect your teacher to privately re-teach you the material you missed. For *absences due to incapacitating illness or emergency*, you should contact the instructor as soon as you realize you will not be in class and make arrangements for making up any tests without penalty for the first occurrence. Each subsequent time a test is missed because of incapacitating illness or emergency, an additional 10 percent grade penalty for that test will be incurred.

For *test absence due to not being prepared* there will be no make-up available and you will receive a 0 on the test.

Naturally, if you are absent on a day when you have been informed in advance that work is due, then late-work policies apply **regardless** of the nature of the absence.

In keeping with official BJU policy, if you exceed the four personal absences or the five University-authorized absences allowed in this course, then you may be automatically withdrawn.

Absences other than for illness and cuts (such as for music or speech performances) must be approved by the dean of the school requesting your absence and your teacher must be officially notified no later than one week **before** the scheduled absence. This applies even if only part of the class period will be missed. Without this permission, your absence will count as personal and not university authorized.

Cheating: Cheating is defined as any use of unauthorized helps. In today's age of technology, this includes getting unapproved help from a source on the internet and/or using your calculator to store formulas or information that you are to know from memory.

If you have a question about any source you are considering using, please gain teacher approval before using it. The presence of any material on your desk containing formulas, notes, etc. (except for those allowed by the instructor) while taking a test, will be construed as cheating and will be dealt with as such. Cheating on a test will result in a zero on the test plus any penalties imposed by the discipline committee.

Grading System: The grading system will be based on nearly weekly quizzes, 4 unit(chapter) tests, and homework. The final will be just a unit test. Homework Problems will count the equivalent of two tests. There will be a grade for homework for both the first half and second half of the semester. Each homework grade will be based on a 150 point test. For example a 135 out of 150 will be recorded as a 90%. The most I will give on any homework test is 110%. Additionally each half of the semester will have a separate 50 point assignment based on the 5 point problems. Thus 5 point problems count twice. After you accumulate 50 points on 5 points problems you can continue to accumulate as many as you want at 1 point each)

Example: For example purposes we will have 1 quiz worth about 150 points.

Test 1	90	
Test 2	94	
Test 3	78	
Test 4	82	
Homework 1	90	(135 pts includeing 52 from 5 pt prob.)
Homework 2	88	(132 pts including 44 from 5 pt prob)
5 pt. HW 1	52	
5 pt HW 2	44	
Quizzes	135	
Total	753	(out of 850)
Course Grade:	88.5%	or a B

Homework:

Note: On homework, some answers are in the back of the book, therefore work **must** be shown. Also on True-False questions, an answer alone is **never** satisfactory. If true, then prove it; and if false, give a counterexample.

Chapter 1

pp. 16

2 pts each 2, 4, 6, 8, 10, 12
3 pts each 15, 16, 18 (in 15, 16, and 18 give a short reason why), 32
5 pts each 19, 20, 22-24, 27 (recall all true must be proven and all false must be shown false by counterexample)

pp. 21

2 pts each 4, 8, 12, 14, 16, 17
3 pts each 28, 32, 34
5 pts each 18, 20, 22 (use books def of [c,d]), 28, 29, 30, 31, 35, 36

pp. 25

2 pts each 2, 4, 6, 7, 8, 9, 10, 12, 13, 14, 16, 18, 20
3 pts each 21, 28
5 pts each 29, see extra problems (below)

pp. 31

2 pts each 2, 4, 8, 10, 11, 12, 14, 18,
3 pts each 22, 24, 25, 26, 27, 28, 30, 32, 34
5 pts each 20, 21, 36, 38, 39

pp. 36

1 pt each 2, 4, 6, 8, 37, 39, 41
2 pts each 10, 14, 18, 22, 26, 28, 30, 32, 34, 36
3 pts each 38, 40, 42, 43, 44
5 pts each 46, 48

pp. 43

2 pts 2, 4, 6, 59, read page 46
3 pts each 16, 18, 28, 29, 30, 31, 32, 37
5 pts each 20, 22, 24, 27, 33, 35, 36, 38, 39, 43, 44, 48, 49, 52

For extra credit you may read section 6.2 and do the problems on page 209

Chapter 2:

pp. 50

2 pts each 2, 4, 6, 8, 10, 18, 20,
3 pts each 22, 24, 25, 26
5 pts each 27, 29, 30, 33, 36, 37, 38, 39

pp. 54

2 pts each 2, 4, 8, 10, 12, 14, 16, 18
3 pts each 22, 23
5 pts each 24, 25, 26

p. 57

2 pts each 2, 4, 6, 8, 10, 14,
3 pts each 17, 18, 22, 24, 34, 37, 40, 41
5 pts each 28, 38, 42

pp. 63

2 pts each 8, 14, 16, 20, 28, 32
 3 pts each 22, 34(and why), 42
 5 pts each 49, 50, 51

pp.67

2 pts each 2, 4
 3 pts each 14, 20
 5 pts each 10, 11, 13, 16, 17, 22, 23, 24, 25, 27, 28

pp.73

2 pts each 4, 8, 14, 16, 17, 29 (why), 32, 44: read page 75
 3 pts each 18-30 Show work and clearly answer why or why not and why true or false, 34, 44, 46, 52
 5 pts each 36, 37, 38, 39, 40*, 41*, 42, 45, 49, 51(show work), 52

Chapter 3**pp. 81**

2 pts each 6, 10, 14, 18, 22, 28, 30
 3 pts each 31, 32, 33, 34, 40, 41
 5 pts each 38, 39, 42

pp. 88

2 pts each 4, 6, 8, 9, 10, 17, 22, 23, 24
 3 pts each 14, 15
 5 pts each 12, 16, 18, 20, 28, 29 (turn in before I do in class)

pp. 93

2 pts each 1,10, 12, 29
 5 pts each 24, 25, 26, 30, 31

pp. 100

2 pts each 2, 6 – 13
 3 pts each 16-19, 22
 5 pts each 21, 24, 25

pp. 105

2 pts each 4,10, 12,14, 16, 18, 20, 22, 24, 26, 28, 30
 3 pts each 36, 38, 41, 42, 50
 5 pts each 40, 44, 51, 54, 55, 56, 57, 58, 60, 62

pp. 113

2 pts each 1, 2, 4, 6, 8, read pp. 115
 3 pts each 10, 12, 14, 15, 17, 18, 19, 22
 5 pts each 21, 23-30

Chapter 4**pp. 123**

2 pts each 2, 8, 10, 14, 16, 20, 22, 26, 30, 32, 34, 36, 38
 3 pts each 52
 5 pts each 39, 40, 41, 42, 44, 46, 48

pp. 129

2 pts each 2, 4, 8, 14, 16
 3 pts each 20, 21, 23, 40, 42, 44
 5 pts each 24, 32, 34, 46, 48, 51

138

2 pts each 2, 4, 6, 10, 12, 18, 20, 30, 46
 3 pts each 35, 36, 37, 41, 43, 44
 5 pts each 47, 48

pp. 146

2 pts each 2, 6, 8, 10, 12, 14, read pp 158.
 3 pts each 16, 18, 20
 5 pts each 23 - 30

Chapter 5**pp. 164**

2 pts each 2, 6, 10, 12,
 3 pts each 14, 16, 20, 24, 26, 28, 34, 36

pp. 170

2 pts each 8, 12, 16,
 3 pts each 22, 26, 27, 38
 5 pts each 19, 28, 29, 30, 32, 43, 44, 46

pp. 169

2 pts each 2, 6, 12, 14
 3 pts each 20, 24, 26, 32, 38
 5 pts each 37, 38, 39, 40, 42, 44, 45, 46, 47

pp. 176

2 pts each 2, 6, 8, 12, 14, 18, 20, 22, 24, 28, 32, 34
 5 pts each 37 - 40, 42, 44 - 47

pp. 184

2 pts each 2, 4, 6, 8, 10, 12, 18, 20, 22, 26, 30, 32, 34, read pp. 194
 3 pts each 37, 40, 41, 42
 5 pts each 45-50

Chapter 6**pp. 199**

2 pts each 2, 4, 6, 10, 12, 14, 16, 18, 20, 24, 26, 28
 3 pts each 29
 5 pts each 30, 31, 32, 33, 34, 36, 37, 38

pp. 209

2 pts each 2, 4, 6, 8, 10, 12, 14, 17, 18, 19, 20

Additional Problems:

Section 1.3

1. Write a computer(calculator) problem that calculates (a,b) and x and y so that $ax + by = (a,b)$ Hint: instead of keeping track of the q 's and r 's and solving the equations backwards, write r_1 as a linear combination of a and b when computed.

Section 1.4

1. Find the GCD(,)
2. Write the GCD(,) as a linear combination of
3. Give all solutions to

Section 1.5

1. For what integers m , is $\text{mod } m$ a field??
2. Construct the addition and multiplication tables for a field of 9 elements.
3. At McDonalds you can order Chicken McNuggets in boxes of 6, 9, and 20. What is the largest number such that you can not order any combination of the above to achieve exactly the number you want?

Section 2.5

1. Two brothers share a flock of x sheep. They take the sheep to the market and sell each sheep for $\$x$. At the end of the day they put the money from the sales on the table to divide it equally. All money is in $\$10$ bills, except for less than ten excess $\$1$ bills. One at a time they take out $\$10$ bills. The brother who draws first also draws last. The second brother complains about getting one less $\$10$ bill so the first brother offers him all the $\$1$ bills. The second brother still received a total less than the first brother so he asks the first brother to write him a check to balance the things out. How much was the check?

Section 3.2 Let $f = g$ in the notation of problem 25 in section 3.2. Show that $f = g$ (hint use Induction II)

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