Ma 401 Number Theory
Fall 2023

Instructor:	James A. Knisely, PhD
Office:	Alumni 64
Office Hours:	MWF 8:00 – 8:50 a.m.; TTH 1:30 – 2:45 p.m.
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Comm. Policy:	Feel free to email or contact me via Microsoft Teams for questions and/or extended help. You may text where appropriate (not during class).
Classroom:	AL 301
Meeting:	MWF 9:00 – 9:50 a.m.
Credit/Load:	3/3
Textbook:	*Elementary Number Theory, 2nd ed., by Vanden Eynden; McGraw Hill*
Calculator:	TI-89 and/or TI n-Spire with CAS

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 55 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)

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)

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

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. 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

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 (2.6 is grouped with chapter 3)
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

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. 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

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

Chapter 5

pp. 164

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

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. 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. 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
5ts each	45-50

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

Chapter 6

pp. 199

2pts 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_I 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 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 ll)

Extra Credit:

1. Listen to the Panopto and the PowerPoints on Excursions 1 and 2 and do the homework exercises at the end of the PowerPoints: 10 points extra credit each.

2. For extra credit you may read section 6.2 and do the problems on pages 199 and 209. They will be added to your homework grade

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

Test 1(about)	100	
Test 2(about)	90	
Test 3(about)	100	
Final 4 and5a (about)	100	
Homework 1	100	(150 pts including 55 from 5 pt prob.)
Homework 2	100	(150 pts including 55 from 5 pt prob)
5 pt. HW 1	55	
5 pt HW 2	55	
Quizzes	150	
Total	**850**	