**Fayetteville State University**
**College of Basic and Applied Sciences**
**Department of Mathematics and Computer Science**

## I. LOCATOR INFORMATION

Semester: Spring 2011
Course Number and Name: MATH612-01, Abstract Algebra II
Number of Semester Hours of Credit: 3
Day/Time Class Meets: Tuesday and Thursday, 7:30 p.m.-8:45 p.m.
Room/Bldg Where Class Meets: SBE 213
Instructor: Dr. Vassil Yorgov E-mail address: vyorgov@uncfsu.edu
Office Location: SBE 342 Office Phone: 672-1675
Office Hours: MW 9 a.m.-1 p.m.

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## II. COURSE DESCRIPTION

The second course of a two-semester sequence devoted on fundamental concepts and proof techniques used in abstract algebra and including the following topics: commutative rings, ideals, principal ideal domains, Euclidean domains, factor rings, ring homomorphisms, unique factorization domains, polynomial rings, module homomorphisms, quotient modules, free modules, tensor products of modules, field extensions, affine algebraic sets, radicals, Hilbert Nullstellensatz, localization, and modules over group rings.
Prerequisite: Math511.

## III. TEXTBOOK

David S. Dummit, Richard M. Foote, Abstract Algebra, John Wiley & Sons, Third Edition, 2004.

## IV. STUDENT LEARNING OUTCOMES

Upon the completion of this course, the student shall:

1. Demonstrate understanding and be able to prove various theorems for rings, fields, polynomial rings, field extensions and Galois Theory.
2. Be able to classify a given ring as commutative, with identity, with zero divisors, being a field.
3. Know the properties of integral domains.
4. Employ the concept of an ideal and a factor ring.

5. Recognize prime and maximal ideals and know the corresponding theorems for factor rings.
6. Employ the concepts of ring homomorphisms and isomorphisms.
7. Know the basic properties of polynomial rings, principal ideal domains, Euclidean domains, and unique factorization domains.
8. Comprehend radicals and affine varieties.

## V. COURSE COMPETENCIES

DPI Standards

The DPI standards covered in this course are listed below. Students shall:

5.0 Show knowledge of elementary number theory and the fundamental structures of modern algebra – groups, rings, and fields.

5.1 Understand elementary number theory including modular arithmetic, fundamental theorem of arithmetic, and the basic theorems pertaining to primes, composites, multiples, and divisors.

5.4 Demonstrate knowledge of the basic concepts of group theory including subgroups, quotient groups, cyclic groups, and the order of groups and their elements.

5.5 Determine whether a mathematical system possesses group properties and whether two groups are isomorphic.

5.6 Generate finite groups through the use of mathematical models, modular arithmetic, rigid motions of geometric figures, and permutations.

6.4 Demonstrate knowledge of the basic concepts of group theory including subgroups, quotient groups, cyclic groups, the order of groups and elements, and group isomorphisms

6.5 Demonstrate familiarity with specific examples of groups of rigid motions, permutations, and matrices.

8.5 Posses a thorough knowledge of the role of proof in the study and development of mathematics.

8.6 Create original proofs in the various branches of mathematics including direct proofs, indirect proofs, and proofs using mathematical induction.

9.1 Use the set theoretic operations, intersection and complementation.

9.3 Demonstrate a thorough knowledge of the concept of a set theoretic relation.

9.4 Demonstrate a thorough knowledge of the concept of function including knowledge of the concepts: range, domain, one-to-one, into, onto, and inverse.

NCATE Standards

The NCATE standards covered in this course are listed below. Students shall:

1.1.1 Use a problem-solving approach to investigate and understand mathematical content.

1.1.2 Formulate and solve problems from both mathematical and everyday situations.

1.2.1 Communicate mathematical ideas in writing, using everyday and mathematical language, including symbols.

1.2.2 Communicate mathematical ideas orally, using both everyday and mathematical language.

1.3 Evaluate of mathematical conjectures and arguments and validate of their own mathematical thinking.

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| 1.4.1 | Shaw an understanding of the interrelationship within mathematics. |
| 1.4.2 | Connect of mathematics to other disciplines and real-world situations. |
| 1.5.1 | Understand and apply of concepts of number, number theory, and number systems. |
| 1.5.14 | Understand the major concepts of abstract algebra. |

## VI. EVALUATION CRITERIA

There will be three in term take-home tests and a final exam. For the final exam every student gives a power point or other computer aided presentation on the proof of a major theorem and one application of that theorem. The presentation topic has to be approved by the instructor. The computer file of the talk has to be submitted in advance to the instructor for the class records. In arriving at a test average, all in-term tests are weighted the same. A letter grade will be assigned using the following weights:
Tests Average: 70%; Participation: 10%; Final Exam: 20%.
Grading Scale: **A:** 90-100 **B:** 80-89 **C:** 70-79 **F:** below 69

## VII. COURSE OUTLINE WITH ASSIGNMENT SCHEDULE

| Week | Topics |
|---|---|
| 01.09 | 7.2 Polynomial Rings, Matrix Rings, and Group Rings |
| | 7.3 Ring Homomorphisms and Quotient Rings |
| 01.11 | 7.4 Properties of Ideals |
| 01.18 | 7.6 The Chinese Remainder Theorem |
| 01.23 | 8.1 Euclidean Domains |
| | 8.2 Principal Ideal Domains |
| 01.25 | 8.3 Unique Factorization Domains |
| 01.30 | 9.1 Polynomial Rings: Definitions and Basic Properties |
| | 9.2 Polynomial Rings over Fields |
| | 9.3 Polynomial Rings That Are UFD |
| 02.01 | **Test 1** |
| 02.06 | 9.4 Irreducibility Criteria |
| 02.08 | 9.5 Polynomial Rings over Fields II |
| 02.13 | 9.6 Polynomials in Several Variables Over a Field and |
| 02.15 | Groebner Basis |
| 02.20 | 6.3 A Word on Free Groups |
| 02.22 | 10.1 Basic Definitions and Examples of Module Theory |
| 02.27 | 10.2 Quotient Modules and Module Homomorphisms |
| 02.29 | **Test 2** |
| 03.12 | 10.3 Generation of Modules, Direct Sums, and Free Modules |
| 03.14 | 10.4 Tensor Product of Modules |
| 03.19 | 10.4 Tensor Product of Modules |
| 03.21 | 13.1 Basic Theory of Field Extensions |
| 03.26 | 13.2 Algebraic Extensions |
| 03.28 | 13.3 Classical Straightedge And Compass Constructions |
| 04.02 | 13.4 Splitting Fields and Algebraic Closures |
| 04.04 | |
| 04.09 | **Test 3** |

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|---|---|
| 04.11 | 15.1 Noetherian Rings and Affine Algebraic Sets |
| 04.16 | 15.2 Radicals and Affine Varieties |
| 04.18 | 15.3 Integral Extensions and Hilbert's Nullstellensaltz |
| 04.23 | 15.4 Localization |
| 04.25 | 18.1 Linear Actions and Modules over Group Rings |
| **05.02 8 a.m. - 9:50 a.m.** | **Final Exam** |

## VIII. COURSE REQUIREMENTS

The emphasis in this course will be more on proofs and less on computations.
Proofs could be as short as a line and as long as several pages. Write your proofs with a reader in mind. The proof should not only convince you, but it must convince others.
Write your proofs in complete English sentences and provide clear transitions.
Students are encouraged to ask questions of the instructor in class and to respond to those posed by the instructor. They should not discourage others from raising or answering questions. Often, other students have the same question which they wish to ask, but are hesitant to do so.

## IX. TEACHING STRATEGIES

The teaching strategies for this course will be lectures and group discussions.

## X. BIBLIOGRAPHY

Aigli Papantonopoulou, Algebra: Pure and Applied, Prentice Hall, First Edition, 2002.
Joseph Rotman, First Course in Abstract Algebra, Prentice Hall, Second Edition, 2000.
Thomas Hungerford. Algebra, New York: Springer-Verlag, 2000