

## Kent Pearce

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HomePage: [www.math.ttu.edu/~pearce](http://www.math.ttu.edu/~pearce)

Syllabus: [3360-20101\(001\)-syl.pdf](#)

Schedule: [3360-20101\(001\)-cal.pdf](#)

Homework: [3360-20101\(001\)-hwk.pdf](#)

Office Hours: MW 2:00 - 4:00 or  
By Appointment

## Foundations of Algebra I

MATH 3360-001

### Text

Papantonopoulou, A.

*Algebra, Pure & Applied*

Prentice-Hall

### Lecture

Room: MA 012

Time: MWF 11:00-11:50

## Learning Objectives

Learning Outcomes: Students learn how to think and reason abstractly in the context of algebraic structures, and learn how to write correct and clear mathematical arguments in this context.

Concepts to be mastered by the students include but are not limited to the following:

- a. Groups and group homomorphisms
- b. Group actions
- c. Rings and ring homomorphisms
- d. Polynomials

## Assessment of the learning outcomes

Assessment will be achieved through one or more activities, non-graded and graded, such as: class attendance, class discussion, board work, short quizzes, selected homework, writing assignments, examinations and other optional activities deemed appropriate by the instructor. Class grades will be assigned according to the following rubric:

## Curricular Content

### Chapter 0 – Background

- a. Sets, Maps & Functions

Concepts: One-to-one, Onto, Image, Invertible

- b. Equivalence Relations & Partitions

Concepts: Reflexive, Symmetric, Transitive

- c. Properties of Integers

Principles: Well-Ordering Axiom, Mathematical Induction, Binomial Theorem, Division

Algorithm, Euclidean Algorithm, Fundamental Theorem of Arithmetic, Modular Arithmetic

Concepts: Greatest Common Divisor, Least Common Multiple, Linear Combination

- d. Complex Numbers  
Concepts: Real Part, Imaginary Part, Modulus, Conjugate,
- e. Matrices  
Concepts: Matrix, Matrix Sum, Matrix Product, Invertible, Determinant

## Chapter 1 – Groups

- a. Examples and Basic Concepts  
Concepts: Operation, Group Axioms, Abelian, Group Tables, Order  
Principles: Basic Group Properties
- b. Subgroups  
Concepts: Subgroup, Cyclic Subgroup, Center
- c. Cyclic Groups  
Concepts: Cyclic, Generator, Finite Order, Subgroup Lattice
- d. Permutations  
Concepts: Permutation, Permutation Group (Symmetric Group of Degree  $n$ )  $S_n$ , Length, Cycle, Alternating Group of Degree  $n$

## Chapter 2 – Homomorphisms

- a. Cosets and Lagrange's Theorem  
Concepts: Cosets, Index  
Principles: Lagrange's Theorem
- b. Homomorphisms  
Concepts: Homomorphism, Isomorphism  
Principles: Basic Group Homomorphism Properties
- c. Normal Subgroups  
Concepts: Normal Subgroup
- d. Quotient Groups  
Concepts: Quotient Group  
Principles: First Isomorphism Theorem, Cauchy's Theorem for Abelian Groups
- e. Automorphisms  
Concepts: Automorphism, Inner Automorphism

## Chapter 3 – Direct Products and Abelian Groups

- a. Examples and Definitions  
Concepts: Direct Product
- b. Computing Orders
- c. Direct Sums  
Concepts: Direct Sum
- d. Fundamental Theorem of Finite Abelian Groups  
Concepts: Decomposable, Square-free  
Principles: Fundamental Theorem of Finite Abelian Groups

## Chapter 4 – Group Actions

- a. Group Actions and Cayley's Theorem  
Concepts: Group Action,  
Principles: Cayley's Theorem
- b. Stabilizers and Orbits under a Group Action  
Concepts: Stabilizer, Orbit
- c. Burnside's Theorem and Applications  
Concepts: Fixed  
Principles: Burnside's Theorem
  
- d. Conjugacy Classes and the Class Equation  
Concepts: Conjugate, Conjugacy Class  
Principles: Class Equation
- e. Conjugacy in  $S_n$  and Simplicity of  $A_5$   
Concepts: Simple

## Chapter 14 – Symmetries

- a. Linear Transformations  
Concepts: Linear Transformation, Eigenvector, Eigenvalue, Transpose, Dot Product, Length, Distance, Orthogonal Group
- b. Isometries  
Concepts: Rigid Motion, Isometry, Translations, Rotations, Reflections
- c. Symmetry Groups  
Concepts: Group of Symmetries  
Principles: Fixed Point Theorem
- d. Platonic Solids  
Concepts: Regular Polyhedron, Platonic Solid, Dual

## Chapter 6 – Rings

- a. Examples and Basic Concepts  
Concepts: Ring, Commutative Ring, Ring with Unity, Subring
- b. Integral Domains  
Concepts: Zero Divisor, Cancellation Laws, Integral Domain
- c. Fields  
Concepts: Unit, Field, Subfield, Division Ring, Characteristic  
Principles: Scarecrow's Theorem

## Chapter 7 – Ring Homomorphisms

- a. Definitions and Basic Principles  
Concepts: Ring Homomorphism, Kernel, Ring Isomorphism, Isomorphic

- b. Ideals  
 Concepts: Ideal, Principal Ideal  
 Principles: First Isomorphism Theorem for Rings

Chapter 8 – Ring of Polynomials

- a. Basic Concepts and Notation  
 Concepts: Indeterminate, Polynomial, Value, Argument, Zero, Degree, Leading Coefficient, Rational Function
- b. Division Algorithm in  $F[x]$   
 Concepts: Quotient, Remainder, Divisor, Multiple, Factoring, Common Divisor, Relatively Prime  
 Principles: Division Algorithm, Euclidean Algorithm
- c. More Applications of the Division Algorithm  
 Concepts: Multiplicity,  $n$ th Roots of Unity  
 Principles: Factor Theorem, Remainder Theorem
- d. Irreducible Polynomials  
 Concepts: Primitive Polynomial  
 Principles: Unique Factorization Theorem, Rational Roots Theorem

Grading

Examinations:

Mid-Term Exams	(September 24, Oct 15, Nov 12)	300 Pts.
Final Exam	(December 15, 1:30-4:30 pm)	200 Pts.

Home Work

6-10 Assignments, Various Dates	100 Pts.
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Writing Assignments

6-10 Assignments Various Dates, 4 will be returned for rewriting	100 Pts.
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Total Grade Point Base	700 Pts.
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Scale

A...100% - 90%    B...89% - 80%    C...79% - 70%    D...69% - 60%    F...59% - 0%

Critical Dates

September 13	Last Day to Drop on MyTech (Without Penalty)
October 11-12	Fall Break
October 25	Mid-Semester Grades Due
November 1	Last Day to Drop on MyTech (With Penalty)
November 24-25	Thanksgiving Break
December 2-8	Period of No Exams

## Notices

### Academic Integrity (Extracted from [OP 34.12](#))

It is the aim of the faculty of Texas Tech University to foster a spirit of complete honesty and high standard of integrity. The attempt of students to present as their own any work not honestly performed is regarded by the faculty and administration as a most serious offense and renders the offenders liable to serious consequences, possibly suspension.

“Scholastic dishonesty” includes, but it not limited to, cheating, plagiarism, collusion, falsifying academic records, misrepresenting facts, and any act designed to give unfair academic advantage to the student (such as, but not limited to, submission of essentially the same written assignment for two courses without the prior permission of the instructor) or the attempt to commit such an act.

### Observance of Religious Holiday (Extracted from [OP 34.19](#))

A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence.

### Accommodation for Students with Disabilities

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor’s office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office in 335 West Hall or 806-742-2405.