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: Homomorphim, 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.

Writing Assignments
   6-10 Assignments Various Dates, 4 will be returned for rewriting 100 Pts.

Total Grade Point Base 700 Pts.

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.