**University of Management and Technology**

**Course Outline**

**Course code: MTH 605 Course title: Advanced Abstract Algebra**

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| Program | MS-MA |
| Credit Hours | 3 |
| Duration | One Semester |
| Prerequisites | Before diving into Modern Algebra, it is essential to have a solid understanding of basic algebra, including topics such as sets, functions, and elementary number theory. Knowledge of linear algebra is also beneficial |
| Resource Person | Dr. Agha Kashif, Dr. Zohaib Zahid, Dr. Sohail Zafar |
| Counseling Timing  (Room# ) |  |
| Contact | [sohail.zafar@umt.edu.pk](mailto:sohail.zafar@umt.edu.pk) , [kashif.khan@umt.edu.pk](mailto:kashif.khan@umt.edu.pk), [zohaib.zahid@umt.edu.pk](mailto:zohaib.zahid@umt.edu.pk), |

**Chairman/Director signature………………………………….**

**Dean’s signature…………………………… Date………………………………………….**

**Course Description:**

This course introduces students to abstract algebraic structures such as groups, rings, fields, and modules.

**Learning Objective:**

1. **Understanding Abstract Structures:** Modern Algebra introduces students to abstract algebraic structures such as groups, rings, fields, and modules. The course aims to help students understand the properties and relationships between these structures.
2. **Developing Problem-Solving Skills:** Modern algebra involves proving theorems and solving problems using abstract concepts. The course aims to develop students' ability to think abstractly and solve problems using algebraic techniques.
3. **Understanding Algebraic Structures in Mathematics:** Many mathematical structures, such as groups and rings, are fundamental in various branches of mathematics. The course aims to provide students with a solid foundation in these structures, which can be applied in other areas of mathematics.
4. **Preparing for Advanced Mathematics:** Modern Algebra is a prerequisite for many advanced mathematics courses, such as algebraic geometry, number theory, and representation theory. The course aims to prepare students for these advanced courses by providing them with a strong understanding of algebraic structures.
5. **Understanding Applications in Other Fields:** Algebraic structures have applications in various fields, including computer science, cryptography, and physics. The course aims to help students understand these applications and how abstract algebra can be used to solve real-world problems.

**Learning Methodology**

Modern Algebra is a highly theoretical subject, so it is crucial to develop problem-solving skills. Work on a variety of exercises, including proofs, computations, and applications. Start with easier problems and gradually move on to more challenging ones.

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in a semester.

**Marks Evaluation Marks in percentage**

Quizzes (3-4): 10

Assignments (3-4) 10

Mid Term (1) 25

Attendance & Class Participation 00

Term Project (1) 10

Presentations (1) 05

Final exam (1) 40

Total 100

**Recommended Text Books:**

1. D. S. Dummit and R. M. Foote, Abstract Algebra, 3rd Edition, Addison-Wesley Publishing Company, 2004.

**Reference Books:**

1. [Joseph Gallia](http://www.amazon.com/s/ref=dp_byline_sr_book_1?ie=UTF8&text=Joseph+Gallian&search-alias=books&field-author=Joseph+Gallian&sort=relevancerank)n, Contemporary Abstract Algebra 8th Edition,  2013.
2. David M. Burton, A First Course In Rings And Ideals
3. I.N. Herstein, Topics in Algebra, Xerox Publishing Company, 1964.
4. P. M. Cohn, Algebra, John Wiley and Sons, London, 1974.
5. M.F. Atiyah, I.G. Macdonald, Introduction to Commutative Algebra, Addison-Wesley.

**Calendar of Course contents to be covered during semester**

**Course code: MTH 605 Course title: Advanced Abstract Algebra**

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| --- | --- | --- |
| **Week** | **Course Contents** | **Reference Chapter(s)** |
| 1 | Groups, subgroups, cyclic groups  The lattice of subgroups of a group | Chapter 1 |
| 2 | Cosets, Quotient groups, Lagrange’s Theorem, permutation groups, Cayley's theorem | Chapter 2 and 3 |
| 3 | Normal Subgroups, Quotient Group. Homomorphisms and Isomorphism Theorems | Chapter 3 |
| 4 | Group Actions and Permutation representation  Automorphisms  Sylow's theorems for finite groups, p-groups, | Chapter 4 |
| 5 | Rings, Subrings, | Chapter 7 |
| 6 | Ideals, examples, Operations with ideals. | Chapter 7 |
| 7 | The ideal generated by a set. Maximal and Prime Ideals. | Chapter 7 |
| 8 | Midterm exam |  |
| 9 | Quotient rings. Ring homomorphism. The isomorphism theorems & applications. | Chapter 7 |

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| 10 | Finitely generated ideals. Rings of fractions.  The Chinese Remainder theorem  Euclidean domains. The Euclidean algorithm | Chapter 8 |
| 11 | Principal ideal domains. Unique factorization domains, | Chapter 8 |
| 12 | Polynomial Rings, Irreducibility criteria for polynomials.  Polynomial rings in several variables and Grobner Basis | Chapter 9 |
| 13 | Modules: Definition of Modules, Quotient Modules, | Chapter 9 |
| 14 | Module Homomorphism, Module Isomorphism theorems (applications), Generation of Modules, | Chapter 10 |
| 15,16 | Direct Product of Modules, Free Modules, Exact Sequences of Modules, Projective and Injective Modules. | Chapter 10 |