湖北工業大學
HUBEI UNIVERSITY OF TECHNOLOGY

Course Title	Applied Algebra and Coding Theory
Course Code	MATH 3804
Semester	Fall 2027
Course Length	8 Weeks, 60 Contact Hours
Credits	4
Instructor	TBA
Office	TBA
Email	TBA
Prerequisite(s)	MATH 2151 Linear Algebra I MATH 2711 Introduction to Abstract Mathematics
Antirequisite	MATH 3802 Applied Algebra and Coding Theory (4 Weeks)

Course Description:

This course introduces fundamental algebraic structures and explores their applications in modern mathematics and information technologies. The course develops students' understanding of groups, rings, fields, and finite algebraic systems, with emphasis on structures that arise in computational and practical settings. Topics include finite field arithmetic, polynomial methods over finite systems, algebraic approaches to error detection and correction, and selected applications in coding and secure communication. Through theoretical development and problem-solving exercises, students learn how abstract algebraic concepts provide systematic methods for analyzing discrete mathematical structures.

Course Goals:

Students who successfully complete this course will demonstrate competency in the following general education core goals:

- **Critical Thinking Skills** – Students will engage in analytical thinking, demonstrating the ability to critically evaluate, synthesize, and apply knowledge to complex problems, and construct well-reasoned solutions and arguments.
- **Independent Research and Inquiry** – Students will conduct independent research, utilizing academic resources to explore relevant topics, formulating research questions, analyzing data, and presenting findings in a coherent, scholarly manner.
- **Problem-Solving and Application** – Students will apply theoretical concepts and methodologies learned in the course to real-world problems, demonstrating the ability to develop practical solutions informed by academic inquiry.
- **Global and Cultural Awareness** – Students will gain awareness of the global and cultural contexts relevant to the course, appreciating diverse perspectives

and considering the implications of their studies in a broader, international context.

Student Learning Outcomes:

Upon completion of this course, students will be able to:

- Demonstrate a working understanding of groups, rings, fields, and their homomorphisms, with an emphasis on finite algebraic structures;
- Construct and classify finite fields of various orders, and perform arithmetic operations within these fields;
- Define, construct, and analyse linear codes, including the computation of generator and parity-check matrices, as well as encoding and decoding procedures;
- Apply the theory of Hamming codes to detect and correct transmission errors, and evaluate their efficiency and limitations;
- Explain the structure of cyclic codes and their connection to polynomials over finite fields, including the use of generator polynomials;
- Describe and implement BCH codes, demonstrating their error-correction capabilities and decoding algorithms.

Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:

Primary Textbook: Darel W. Hardy, Fred Richman, Carol L. Walker (2009). *Applied Algebra: Codes, Ciphers and Discrete Algorithms (2nd ed.).* CRC Press / Chapman & Hall.

Secondary Reference: W. Keith Nicholson (2012). *Introduction to Abstract Algebra (4th ed.).* Wiley.

Course Requirements:

Homework Assignments (20%)

Regular homework assignments are designed to reinforce fundamental concepts and problem-solving techniques. Students complete exercises involving modular arithmetic, algebraic structures, coding methods, and cryptographic algorithms.

Application Project (15%)

Students complete a small-scale application project involving an algebraic method introduced in the course. Students will select or be assigned a topic related to finite fields, coding theory, cryptographic algorithms, or algebraic computation. The project deliverables include a project proposal, a written technical report, supporting computational materials (such as code, calculations, or demonstrations), and an oral presentation summarizing the mathematical concepts, methods, and results.

Midterm Examination (25%)

The midterm examination evaluates students' understanding of the first half of the course, including integer arithmetic, modular systems, cryptographic foundations, and algebraic coding principles.

Final Examination (40%)

The final examination assesses comprehensive understanding of algebraic methods developed throughout the semester, including finite fields, BCH codes, advanced coding techniques, and cryptographic applications.

Assessments: Activity	**Percent Contribution**
Homework Assignments	20%
Application Project	15%
Midterm Examination	25%
Final Examination	40%

Grading:

Final grades will be based on the sum of all possible course points as noted above.

Grade	**Percentage of available points**
A	94-100
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73
D	64-69
D-	60-63
F	0-59

Course Schedule:
The schedule of activities is subject to change at the reasonable discretion of the instructor. Minor changes will be announced in class, major ones provided in writing.

MATH 3804 Schedule		
Lecture	Topic	Readings
L1	Introduction to applied algebra and mathematical algorithms	*Hardy* Ch.1
L2	Integers, divisibility, induction and algorithmic thinking	*Hardy* Ch.1; *Nicholson* Ch.1
L3	Modular arithmetic and computation modulo n	*Hardy* Ch.3; *Nicholson* 1.3
L4	Greatest common divisors and Euclidean algorithms	*Hardy* Ch.3
L5	Extended Euclidean algorithm and applications *Homework 1 Due*	*Hardy* Ch.3
L6	Classical cryptography and cipher systems	*Hardy* Ch.4
L7	Public key cryptography foundations	*Hardy* Ch.7-8
L8	RSA cryptosystem and digital signatures	*Hardy* Ch.8
L9	Error detection principles and Hamming distance *Homework 2 Due*	*Hardy* Ch.5
L10	Hamming codes and decoding methods	*Hardy* Ch.5
L11	Linear codes and algebraic coding concepts	*Hardy* Ch.5; *Nicholson* 2.11
L12	Groups and algebraic structures supporting coding theory	*Nicholson* Ch.2

L13	Rings, polynomial structures, and algebraic operations *Project Proposal Due*	*Nicholson* Ch.3-4
---	**Midterm Examination**	Covers L1-12
L14	Fields and finite field concepts *Homework 3 Due*	*Nicholson* 6.4
L15	Construction of finite fields GF(p) and polynomial fields	*Hardy* Ch.9
L16	Extensions of finite fields GF(p^n)	*Hardy* Ch.9
L17	BCH codes and algebraic decoding *Homework 4 Due*	*Hardy* Ch.10; *Nicholson* 6.7
L18	Reed-Solomon codes and advanced error correction	*Hardy* Ch.10
L19	AES and finite-field based encryption	*Hardy* Ch.11
L20	Polynomial algorithms and interpolation methods	*Hardy* Ch.12
L21	Applications of finite fields in communication systems	*Hardy* Ch.9-10
L22	Advanced cryptographic applications *Homework 5 Due*	*Hardy* Ch.8,11
L23	Computational implementation and project presentation *Project Report & Presentation Due*	Selected chapters
L24	Comprehensive review of algebraic methods	All chapters
L25	Final examination review	All chapters
---	**Final Examination**	Covers L1-25

Accommodation Statement:

Academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as he/she is not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow.

Academic Integrity Statement

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in coursework may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records.

Other Items:

Attendance and Expectations

All students are required to attend every class, except in cases of illness, serious family concerns, or other major problems. We expect that students will arrive on time, be prepared to listen and participate as appropriate, and stay for the duration of a meeting rather than drift in or out casually. In short, we anticipate that students will show professors and fellow students maximum consideration by minimizing the

disturbances that cause interruptions in the learning process. This means that punctuality is a must, that cellular phones be turned off, and that courtesy is the guiding principle in all exchanges among students and faculty. You will be responsible for the materials and ideas presented in the lecture.

Assignment Due Dates
All written assignments must be turned in at the time specified. Late assignments will not be accepted unless prior information has been obtained from the instructor. If you believe you have extenuating circumstances, please contact the instructor as soon as possible.

Make-Up Work
The instructor will not provide students with class information or make-up assignments/quizzes/exams missed due to an unexcused absence. Absences will be excused and assignments/quizzes/exams may be made up only with written documentation of an authorized absence. Every effort should be made to avoid scheduling appointments during class. An excused student is responsible for requesting any missed information from the instructor and setting up any necessary appointments outside of class.

Access, Special Needs, and Disabilities
Please notify the instructor at the start of the semester if you have any documented disabilities, a medical issue, or any special circumstances that require attention, and the school will be happy to assist.