**University of Management and Technology**

**Course Outline**

Course code: MTH734……………….... Course title: **Algebraic Coding Theory**

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| Program | MS/MPhil Mathematics |
| Credit Hours | 3 |
| Duration | Semester |
| Prerequisites | Linear Algebra, Group Theory, Rings and Fields |
| Resource Person | Muhammad Asif |
| Counseling Timing  (Room# ) |  |
| Contact | muhammadasif@skt.umt.edu.pk |

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

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

**Learning Objective and Outcomes:**

The objective of Algebraic Coding theory is to develop systems and methods that allow to detect/correct errors caused when information is transmitted through noisy channels.

After completing this course, the students should be able to:

1. Understand Block Codes and Maximum Likelihood Decoding.
2. Apply mathematical structures on channel coding.
3. Understand Decoding Tables, Hamming Weight and Distance and Error Correction and Detection.
4. Understand Generator Matrix, Parity-Check Matrix and Error-Correcting Capability of a Linear Code.
5. Design an error detecting and correcting system for semiconductor memory system to meet given system specification.
6. Understand Binary Cyclic Codes, encoding with (n-k)-Stage Shift Register and Syndrome Calculations and Error Detection.

7. Design an error detecting and correcting system for magnetic storage device to meet given system specification.

8. Understand Error detecting and correcting for Cyclic Codes.

9. Understand BCH Codes and RS codes the encoding and decoding techniques.

10. Understand the difference between simplex, hamming and reed muller codes.

11. Able to utilize BCH Codes in Data Security, Watermarking, Channel Coding, Steganography,

DNA sequences.

**Learning Methodology:**

Quizzes, Assignments, presentations, sessional and final exams are utilized to learn this course. MATLAB software is used for implementation of encoding and decoding scheme.

**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 15

Assignments 10

Mid Term 30

Attendance & Class Participation 0

Term Project 0

Presentations 5

Final exam 40

Total 100

**Recommended Text Books:**

**1. “**Channel coding for Telecommunications by Martin Bossert”

**2**. “ Topics in Applied Abstract Algebra by S.R Nagpaul and S.K Jain”

**Reference Books:**

1. “ Algebraic coding theory by Elwyn Berlekamp”

2. “ Topics in Applied Abstract Algebra by S.R Nagpaul and S.K Jain”

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

**Course code:** MTH734**…...... Course title: Algebraic Coding Theory**

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| **Week** | **Course Contents** | **Reference Chapter(s)** |
| 1 | * Group * Rings and Field * Vector Space * Prime Field * Galois Field |  |
| 2 | * Galois Ring * Galois extension field * Irreducible polynomials * Primitive polynomial |  |
| 3 | * Introduction to Coding Theory * Block Codes and Maximum Likelihood Decoding |  |
| 4 | * Decoding principle * Hamming Weight and Distance * Error Correction vs Detection |  |
| 5 | * Linear Codes * Generator Matrix * Parity-Check Matrix * Hamming Codes |  |
| 6 | * Error-Correcting Capability of a Linear Code * The Standard Array and Syndrome Decoding of a Linear Code |  |
| 7 | * Definition of Cyclic Codes * Encoding of Cyclic Codes * Syndrome Calculations and Error Detection |  |
| 8 | * A General Decoder for Cyclic Codes * Shortening and extension of Cyclic Codes |  |
| 9 | * Definition of Primitive BCH Codes * Cyclotomic Cosets * Encoding of BCH Codes using Cyclotomic Cosets |  |

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| 10 | * Decoding of the BCH Codes over Galois Field * Barlekamp Massey Algorithm |  |
| 11 | * Nonbinary BCH Codes and Reed-Solomon Codes * Cyclic Codes over Ring, Maximal Cyclic Subgroup |  |
| 12 | * Encoding of BCH codes over Galois Ring * Reed-Solomon Codes over Galois ring, |  |
| 13 | * Shortened BCH codes over Ring * Relationship between Codes over Galois Ring and Galois Field |  |
| 14 | * Reed Muller Codes * Simplex Codes * Relationship between Simplex and Reed Muller Codes * Relation between Hamming and Reed Muller Codes |  |
| 15 | Applications of BCH Codes   * BCH Codes and Telecommunications * BCH Codes and Watermarking * BCH Codes and Steganography * BCH Codes and Data Security * BCH Codes and DNA Sequence |  |