MA-415: ALGEBRAIC SYSTEMS AND CODING THEORY (3 Credits)

An introduction to the use of abstract methods in mathematics, using algebraic systems that play an important role in many applications of mathematics.

Abelian groups, Commutative rings with identity, fields, Ideals, Polynonial rings, Principal Ideal domains, arithmetic of integers mod n and finite fields. Vector spaces over arbitraty fields, Examples of Algebra of Polynomial rings over an arbitrary field, subspaces, bass, linear transformations. Eigenvalues, eigenvectors, eigenspaces, Characteristies, Polynomial, Minimal Polynomial, Linear Transformation as a matrix operator, geometric and algebraic multiplicity and diagonalisation. Groups: subgroups, cosets, Lagrange's theorem, homomorphisms.

Applications to coding theory will be chosen from: linear codes, encoding and decoding, the dual code, the parity check matrix, syndrome decoding, Hamming codes, perfect codes, cyclic codes, BCH codes.

COURSE OBJECTIVES:

- To gain proficiency in dealing with abstract concepts, with emphasis on clear explanations of such concepts to others.
- To understand the concept of a field and to recognize fields, including finite and infinite fields.
- To understand the basic group theoretical concepts such as subgroup, coset and homomorphism, and their elementary properties.
- To understand the basic concepts of a vector space over and field, subspaces, bases for a vector space and to be able to recognase these entities in given examples.
- To understand what a linear transformation is, the properties of a linear transformation, and the relationship of the matrix of a linear transformation to a given basis.
- To be able to calculate eigenvalues and eigenvectors of a linear transformation, and to use these to diagonalise a matrix.
- To apply the algebraic concepts that are studied to the theory of error correcting codes.
- To use the internet and the library to research some areas of the course.

SOME REFERENCES

Any book labeled "Abstract Algebra" or "An Introduction to Abstract Algebra". Call numbers are AQ 162 and QA266. In addition.

John B Fraleigh
A First Course in Abstract Algebra, 5th edition, Addison-Wesley, 1994, AQ266.F7.

Richard Laatsch
An Introduction to Abstract Algebra, McGraw-Hill, 1968, QA266..L3

Max D Larsen
Introduction to Modern Algebraic Concepts, Addison-Wesley, 1969, QA266.L.36

F.J. Budden
The Fascination of Groups, Cambridge University Press, 1972, QA 171. B83.

Joel G Broida and S Gill Williamson
A comprehensive Introduction to Linear Algebra, Addison-Wesley, 1989, AQ 184. B75 1989.

Hill, Raymond, 1942
A first course in coding theory, Oxford [Oxford shire]: Clarendon Press; New York: Oxford University Press, 1986, QA268.H55 1986.

McEliece, Robert J
The theory of information and coding, Cambridge, U.K; New York: Cambridge University Press, 2002, Q360.M25 2002.

Roman, Steven
Introduction to coding and information theory, New York: Springer, c1997 QA268. R66, 1997

Assmus, E.F
Designs and their codes, Cambridge: Cambridge University Press, 1992, QA268. A88, 1992

Hamming R. W. (Richard Wesley), 1915-
Coding and information theory / Richard W. Hamming, Englewood Cliffs N.J: Prentice-hall, c1986, QA268. H35 1986.

Some electronic references are:

Numbers, Groups and Codes, J.F Humphreys & M. Y. Prest.
http://www-math.cudenver.edu/-wcherowi/courses/m5410/m5410cd1.htm1
http://www.mdstud.chalmers.se/-md7sharo/coding/main/node2.htm1
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http://www.ping.be/-ping1339/vect.htm
http://distance-ed.math.tamu.edu/Math640/chapter3/nodel.html
http://www.ping.be/math/mathindex.htm
http://www.maths.nottingham.ac.uk/personal/jff/G12VSP/