**MATH 301: LINEAR ALGEBRA II (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course unit is to equip learners with the application of the techniques of linear algebra in [analytic geometry](http://en.wikipedia.org/wiki/Analytic_geometry), [engineering](http://en.wikipedia.org/wiki/Engineering), [physics](http://en.wikipedia.org/wiki/Physics), [natural sciences](http://en.wikipedia.org/wiki/Natural_science), [computer science](http://en.wikipedia.org/wiki/Computer_science), and economics .The students will also use the application of concepts of linear algebra in the solution of linear systems of [differential equations](http://en.wikipedia.org/wiki/Differential_equations).

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

Explain the properties of the determinant in relation to other notions such as eigenvalues and trace

Apply the eigenvalues and eigenvectors concepts in diagonalization and maximization

Diagonalize a matrix and determine orthonormal bases using Gram-Schmidt process

Solve problems in Quadratic and Hermitian forms for a given linear transformation

Develop the ability to use matrices in solving modern problems in Mathematics and associated disciplines.

**Course Content**

Determinants. Minimal polynomials.Eigenvalues and eigenvectors. Canonical forms. Linear functionals.Bilinear and quadratic forms.Orthogonal matrices and operators .Complex inner product spaces.

**References**

Lay, David C.,(2005) *Linear Algebra and Its Applications* (3rd ed.), Addison Wesley

Poole, David,(2006) *Linear Algebra: A Modern Introduction* (2nd ed.),

Larson,RonandDavidC.Famvo.(2008) *ElementaryLinearAgebra*,6thedition,PennsylvaniaStateUniversity

G Hamilton(1989) *Linear Algebra: An Introduction.* Cambridge University Press

S. Lipschutz(1974) *Linear Algebra.* (Schaum’s Outline Series), McGraw-Hill, New.York,

L. Smith(1984) *Linear Algebra.* Springer-Verlag, New York

G. Strang (1988) *Linear Algebra.* (3rd ed., Harcourt, Brace, Jovanovich, San Diego

David C. Lay, Steven R. Lay, and Judi J. McDonald *Linear Algebra and Its Applications* (2022)

**MATH 305: ALGEBRA I [CF 3.0, 45 HRS]**

**COURSE PURPOSE**

The purpose of this course unit is to enhances mathematical maturity, provides tools for problem-solving across various domains, and deepens understanding of abstract structures and symmetries in mathematics and beyond. It is foundational for many advanced mathematical topics and has far-reaching applications in science and technology

**EXPECTED LEARNING OUTCOMES**

By the end of the course the learner should be able to:

Define and evaluate different types of groups

Describe a subgroup, normal subgroup as used in group theory.

Review permutation groups as a generalization other types of groups.

Classify shapes and spaces, leading to insights in topology and geometry

Analyze symmetry operations and patterns, which are crucial in fields like crystallography, geometry, and physics.

Apply group theory in algorithm design and analysis understanding the complexity of algorithms and designing efficient algorithms for various problems.

**COURSE CONTENT**

Group theory introduction, subgroups and normal subgroups; cyclic groups; permutation groups; factor(quotient) groups; Sylow’s theorems for groups.

**REFERENCES**

S. Singh and Qazi Zameeruddin : ” *Modern Algebra* ” Vikas Publishing House ( 1972).

V. K. Khanna & S. K .Bhambri : ” *A Course in Abstract Algebra* ” Vikas Publishing House (2004)

H. A. Nielsen. ” *Elementary Commutative Algebra* ”Department of Mathematical Sciences-University of Aarhus(2005).

P. Garrett : ”Abstract Algebra-Lectures and Worked Examples for a Graduate Course ” (2005).

Michael Artin :Algebra(2th ed): Pearsons 2005

**MATH 405: ALGEBRA II (45/0 C.F.3.0)**

**COURSE PURPOSE**

The purpose of this course is to provide concrete algebraic knowledge which can be applied in ring theory, coding theory and quantum cryptography.

**EXPECTED LEARNING OUTCOMES**

By the end of the course, the learner should be able to:

Demonstrate a thorough understanding of the basic definitions and properties of rings, including subrings, ideals, homomorphisms, and quotient rings.

Perform computations involving rings, such as determining sums, products, and powers of elements, as well as solving equations within rings.

Apply ring theory concepts to other areas of mathematics, such as algebraic geometry, number theory, and cryptography.

Enhance their problem-solving skills by tackling theoretical and computational problems related to rings, including proving theorems and constructing examples.

Critically evaluate theorems and their proofs in abstract algebra, particularly in the context of ring theory, and develop the ability to construct rigorous mathematical arguments.

Apply the relevance of ring theory in various real-world applications, such as coding theory, signal processing, and error correction.

**COURSE CONTENT**

Rings and sub rings: Integral domains, ideals, principal ideals, principal ideal domains quotient rings; polynomial rings; Euclidean rings; fields, basic properties of polynomial over fields divisibility of polynomials .highest common factors and lcm, the Euclidean algorithm.

**REFERENCES**

Singh and Qazi Zameeruddin (1972). *Modern Algebra* ” Vikas Publishing House .

Khanna and S. K. Bhambri (2004). *A Course in Abstract Algebra* ” Vikas Publishing House (2004).

Nielsen. F. (2005). ” *Elementary Commutative Algebra* ”Department of Mathematical Sciences-University of Aarhus.

Garrett P. (2005). Abstract Algebra-Lectures and Worked Examples for a Graduate Course.

Bhattacharya, P. B., Jain, S. K., & Nagpaul, S. R. (2000). Basic abstract algebra (2nd ed.). Cambridge University Press.

Dummit, D. S., & Foote, R. M. (2004). Abstract algebra (3rd ed.). John Wiley & Sons.

Fraleigh, J. B. (2003). A first course in abstract algebra (7th ed.). Pearson Education.

**MATH 403: MEASURE THEORY (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course unit is to establishes a rigorous framework for understanding size, integration, probability, and functional spaces, with applications spanning diverse areas of mathematics especially in the foundations of the [Lebesgue integral](http://en.wikipedia.org/wiki/Lebesgue_integral), in [Andrey Kolmogorov](http://en.wikipedia.org/wiki/Andrey_Kolmogorov)'s [Axiomatisation](http://en.wikipedia.org/wiki/Axiomatisation) of [Probability Theory](http://en.wikipedia.org/wiki/Probability_theory) and [Ergodic Theory](http://en.wikipedia.org/wiki/Ergodic_theory).

**Expected Learning Outcomes**

By the end of the lesson, the learner should be able to:

* Define a Lebesque and Outer Lebesque measures.
* Apply Lebesgue integration techniques to compute integrals of various functions and understand the relationship between Lebesgue and Riemann integration.
* Master advanced topics such as convergence theorems (e.g., Monotone Convergence Theorem, Dominated Convergence Theorem, Fatous Lemma)
* Apply measure-theoretic tools to problems in analysis, including harmonic analysis, functional analysis, and partial differential equations.
* Development of critical thinking skills through analyzing and interpreting measure-theoretic results and their implications.

**Course Content**

Lebesgue measure of the real line. Outer lebesgue measure, Measurable function, Integral, Monotone convergence theorem. Fatou'sLemma. Lebesgue Dominate convergence theorem. Relation between Riemaman and Lebesgue integral.

**References**

R. G. Bartle, (1995). The elements of integration and Lebesgue measure, Wiley.

Stein, E. M. and Shakarchi, R. (2005). *Real Analysis - measure theory, integration and Hilbert spaces*, Princeton University Press.

Royden, H. L., (1998). *Real Analysis*, Third Edition, Macmillan Publishing Company .

Rudin, W., (1987). *Real and Complex Analysis*, Third Edition, McGraw-Hill Book Company.

Halmos, P. R., (1950). *Measure Theory*, D. Van Nostrand Company Inc., Princeton, N.J.

Kingman and Taylor, (1996). Introduction to measure and probability, Cambridge University Press.