Course Title: **Advanced Functional Analysis**
Course Code: **MTH-521**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The course combines ideals and methods from different areas of mathematics. It is designed especially for students who want to choose operator algebras as their speciality, but the content of the course also be useful to students interested in other branches of analysis.

THEORY:

Topological vector spaces, separation properties, linear mappings, meterizations, boundedness and continuity, semi norms and local convexity, quotient spaces, fundamental theorem of functional analysis, Zorn's lemma, Hahn-Banach theorem, Banach-Steinhaus theorem, open mapping theorem, closed graph theorem, convexity, Weal topologies, vector valued integration, homomorphism functions, duality, adjoints compact operators, bounded operators on the Hilbert Spaces, bounded linear operators, the spectral theory, Positive operators and square roots, The group of invertible operators, B^* algebras, a characterization of B^* algebras.

RECOMMENDED BOOKS:

1. E . Kreyzig,. 2001. Introductory Functional Analysis with Applications. 1st Edition John Wiley.
2. H. Brezis. 2011. Functional Analysis. Sobolev Spaces and Partial Differential Equations. 1st Edition Springer.
3. W . Ruden . 2001. Functional Analysis.1st Edition. McGraw-Hill.
4. Y . Eidelman,. V. Milman. 2004. Functional Analysis An Introduction. 1st Edition Americal Mathematical Society.

Course Title: **Convex Analysis**

Course Code: **MTH-522**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim is to develop the core analytical and algorithmic issues of continuous optimization. duality. and saddle point theory using a handful of unifying principles that can be easily visualized and readily understood.

THEORY:

Convex functions on the real line. continuity and differentiability of convex functions. characterizations. differences of convex functions. conjugate convex functions. convex sets and affine sets. convex functions on a normed linear space. continuity of convex functions on normed linear space. differentiable convex function on normed linear space. support of convex functions. differentiability of convex function on normed linear space. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. A. W. Roberts, D. E. Varberg. 2001. Convex Functions. 1st Edition. Academic Press. New York.

2. J. M. Borwien, A. S. Lewis. 2010. Convex Analysis and Nonlinear Optimization: Theory and Examples. (CMS Books in Mathematics). Edition. Springer.

3. C. P. Niculescu, L. E. Person. 2006. Convex Functions and Their Applications. 1st Edition. Springer -Verlag. New York.

4. R. T. Rockefeller. 2001. Convex Analysis. Princeton University Press. Princeton. N.J.

Course Title: **Inequalities Involving Convex Functions**

Course Code: **MTH-523**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas of Inequalities Involving Convex Functions and indicate Convex functions play an important role in many branches of mathematics. as well as other areas of science and engineering. In this course. we will discuss the definition of convex. look at convex shapes and convex functions. and learn how to identify them through rules and examples.

THEORY:

Jensen's and related inequalities. some general inequalities involving convex functions. Hadamard's inequalities. inequalities of Hadamard type I. inequalities of Hadamard type II. some inequalities involving concave functions. miscellaneous inequalities. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. B. G. Pachpatte. 2005. Mathematical Inequalities. North-Holland Mathematical Library. Vol. 67. Elsevier.
2. D. S. Mitrinovic. J. Pecaric, A. M. Fink. 2000. Classical and New Inequalities in Analysis. Kluwer Academic Publishers. Netherlands.
3. J. Pecaric. F. Proschan, Y. C. Tong. 2002. Convex Functions. Partial Orderings and Statistical Applications. Vol. 187 of Mathematics in Science and Engineering. Academic Press Boston Mass. USA.
4. R. Bhatia. 2002. Matrix Analysis. Springer-Verlag. New York.

Course Title:	**Integral Equations**
Course Code:	**MTH-524**
Credit Hours:	**3(3-0)**

AIMS AND OBJECTIVES:

In mathematics, an integral equation is an equation in which an unknown function appears under an integral sign. There is a close connection between differential and integral equations, and some problems may be formulated either way. See, for example, Green's function, Fredholm theory, and Maxwell's equations.

THEORY:

Linear integral equations of the first kind. Linear integral equations of the second kind. Relationship between differential equation and Volterra integral equation. Newmann series. Fredholm Integral equation of the second kind with separable Kernels. Eigenvalues and eigenvectors. Iterated functions. Quadrature methods. Least square methods. Homogeneous integral equations of the second kind. Fredholm integral equations of the second kind. Fredholm integral equations of the first kind. Abel’s integral equations. Hilbert Schmidt theory of integral equations with symmetric Kernels. Regularization and filtering techniques. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. C. T. H.Baker.2000. Integral Equations. Clarendon Press.
2. F. Smithies. 2000. Integral Equations. Cambridge University Press.
3. W. Squire. 2000. Integration for Engineers and Scientists. American Elsevier. New
4. A. M. Wazwaz. 2000. A First Course in Integral Equations. World Scientific Pub.
5. W. V. Lovitt. 2005 Linear Integral Equations (Dover Publication). New York.

Course Title: **Variational Inequalities and its Applications**

Course Code: **MTH-525**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas of Variational Inequalities and they are shown to be extremely useful across a wide variety of subjects, ranging from linear programming to free boundary problems in partial differential equations. Exciting new areas like finance and phase transformations along with more historical ones like contact problems have begun to rely on variational inequalities, making this book a necessity once again.

THEORY:

Basic concepts, existence and uniqueness results. Fixed-points formulation, Wiener-Hopf equations, equivalence between variational inequalities and Wiener-Hopf equations, iterative methods, auxiliary principle techniques, dynamical systems, sensitivity analysis, convergence analysis, numerical solutions of obstacle problems, variational inclusions, resolvent equations, applications , equilibrium problems. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. A. Baiocchi, A. Capelo. 2000. Variational and Quasi-Variational Inequalities. John Wiley and Sons. New York.
2. D. Kinderlehrer, G. Stampacchia. 2000. An Introduction to Variational Inequalities and their Applications. SIAM Publications. Phildelphia.
3. M. A. Noor. 2009. Principles of Variational Inequalities. Lap-Lambert Academic Publishing AG & Co. Saarbrucken.
4. A.S. Kravchuk, P. J. Neittaanmaki. 2007. Variational and Quasi-Variational Inequalities in Mechanics. Springer. Dordrecht.

Course Title: **Operator Theory**

Course Code: **MTH-526**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

In mathematics, operator theory is the study of linear operators on function spaces, beginning with differential operators and integral operators. The operators may be presented abstractly by their characteristics, such as bounded linear operators or closed operators, and consideration may be given to nonlinear operators.

THEORY:

Spectral Theory of Linear operators in Normal spaces: Spectral theory in finite dimensional normed spaces. Basic concepts. Spectral properties of bounded liner operators. Further properties of resolvent and spectrum. Use of complex analysis in spectral theory. Basic algebras. Further properties of Banach algebra. Compact linear Operators on Normed Spaces and their Spectrum: Compact linear operators on normed spaces. Further properties of compact linear operators. Special properties of compact liner operators on normed spaces.

Spectral Theory of Bounded Self-Adjoint Operators linear operators: Spectral properties. Operations of bounded self adjoint linear operators. Positive operators. Square roots of positive operators. Projection operators. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. C. L. DeVito. 2000. Functional Analysis and Linear Operator Theory. Addison Wesley Publishing Co.
2. E. Kreyszig. 2000. Introductory Functional Analysis with Applications. John Wiley.
3. E. B. Davis. 2000. Spectral Theory and Differential Operators. Cambridge University Press.
4. L. Nachbin. 2000. Introduction to Functional Analysis: Branch Spaces and Differential Calculus (Marcel Dekker. Inc).

Course Title: **Commutative Algebra**
Course Code: **MTH-531**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

This course will give the student a solid grounding in commutative algebra which is used in computational algebra.

THEORY:

Rings and ideals, quotient rings, prime, maximal, radical, Nil-radicals, Jacobson radicals, domains, UFDs, and related theorems. Modules, types of modules. Regular sequences, some functors applied on exact sequences and their behavior. Chain conditions, spectrum and Max-spectrum of rings Nakayama Lemma and system of generators. Rings and modules of fractions and behavior of classes of ideals in ring of fractions. Noetherianess and Artinianess of rings, Hilbert Basis Theorem. Primary decomposition, Filtration of ideals and modules, associated graded rings. Krull-dimensions. Krull intersection theorem. Hilbert function. System of parameters and injective dimension and add equivalent definitions of Krull-dimension. Free resolutions associated to modules. Depth of modules, Cohen-Macaulay Rings. Regular local rings

RECOMMENDED BOOKS:

1. D. S . Dummit , R . M . Foote . 2004. Abstract Algebra.3rd Edition. John Wiley & Sons.
2. E . Kunz . 2012. Introduction to Commutative Algebra and Algebraic Geometry. 1st Edition . Birkhauser.
3. G . Kemper . 2010. A Course in Commutative Algebra. 1st Edition.Springer.
4. R . Y. Sharp. 2000. Steps in Commutative Algebra. 2nd Edition . Cambridge University Press.

Course Title: **Representation Theory of Symmetric Groups**
Course Code: **MTH-532**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The representation theory of symmetric groups is a special case of representation theory of finite groups. One main aim is to construct and to parameterize the simple modules of the symmetric groups over an arbitrary field.

THEORY:

Matrix representation of groups, examples for cyclic groups, symmetric groups, permutation groups, permutation and regular representations, equivalence of representations, irreducible representations, reducible and completely reducible representations, Mashke's theorem, groups characters, permutation and regular character, examples, condition of irreducibility and equivalence in terms of characters, number of irreducible characters equal to number of classes of conjugate elements, character tables, Schur's lemma and relations, orthogonality relations, construction of representations, direct product of representations, induced representations and characters, lifting of representations

RECOMMENDED BOOKS:

1. A. Kleshchev. 2005. Linear and Projective Representations of Symmetric Groups. 1st Edition Cambridge University Press.
2. B. E .Sagan. 2001. The Symmetric Group Representations. Combinatorial Algorithms and Symmetric Functions. 2nd Edition. Springer.
3. G. D. James, M. Liebeck. 2001. Representation of characters and groups.1st Edition Cambridge University Press.
4. G. D . James. 2009. Representation Theory of Symmetric Groups.1st Edition Cambridge University Press.

Course Title: **Lie algebra**
Course Code: **MTH-533**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

This is an introductory graduate course in Lie algebras. The course will start with basic concepts in Lie algebras such as subalgebras, ideals, homomorphisms, and derivations. Then we will discuss various properties of solvable, nilpotent, and semi-simple Lie algebras. At the end of the course, students will have a basic understanding of Lie algebras that will allow them to continue their study of this important area of Mathematics if they so desire.

THEORY:

Definition and examples of Lie algebras, ideals and quotients, simple solvable and nilpotent Lie algebras, radical of Lie algebra, semi-simple Lie algebra, Engel's forms criterion for semi-simplicity, product of Lie algebras, classification of Lie algebras up to dimension 4, application of Lie algebras

RECOMMENDED BOOKS:

1. B. C. Hall. 2003. Lie Groups. Lie Algebrasand Representations An Elementary Introduction. 1st Edition. Springer-Verlag.
2. K. Edmann, W .Mark. 2006. Introduction to Lie Algebras. 1st Edition. Springer.
3. R. Gilmore. 2012. Lie Groups. Lie Algebras and Some of their Applications. 1st Edition. Dover Publication.
4. W. Rossmann. 2002. Lie Groups An Introduction Trough Linear Groups. 1st Edition. Oxford University Press Inc.

Course Title: **Advanced Graph Theory**
Course Code: **MTH-534**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

After completion, the students will be able to use combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in graph theory.

THEORY:

Basics of Graphs: Graphs Models, Connected graphs, Multigraphs, Digraphs, Degrees, Regular and Irregular graphs, Isomorphic Graphs: Graphs and Groups, Trees: Bridges, Trees, The minimum spanning tree, Connectivity: Cut-Vertices, Blocks,
Eulerian Graphs, Hamiltonian graphs, Digraphs: Strong digraphs, Tournaments, Mathching: Marriage and Menger's Theorem, Planar Graphs, Coloring: The four color problem. Flows: Flows in networks. Labeling

RECOMMENDED BOOKS:

1. B. Bollobas. 2002. Modern Graph theory.1st Edition. Springer Verlag. New York.
2. J. L. Gross, J. Yellen. 2005. Graph Theory and I ts Applications.1st Edition. Chapman and Hall.
3. R. Balakrishnan, K. Ranganathan. 2012. A Textbook of Graph Theory. 2nd Edition. Springer.
4. R. Diestel. 2012. Graph Theory. 4th Electronic Edition. Springer.

Course Title: **Advanced Group Theory and its Applications**
Course Code: **MTH-535**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

This is advance course on group theory. The learning out come of this subject are to learn Sylow P-theorems, Fundamental theorem of finitely generated groups, free groups and solvable groups.

THEORY:

Review: Dihedral groups, Quaternion group, Quotient groups, P-groups, Isomorphism theorems, Automorphisms

Direct products and normal products of groups, Holomorphic of a group, Finitely generated abelian groups, Group action on a set, orbits and transitive actions, Stabilizers , The orbit stabilizer theorem, Characteristic and fully invariant subgroups, symmetric and alternating groups, generators of symmetric and alternating groups, Simple groups, simplicity of An, n≥5, series in groups. Zassenhau's Lemma, normal series and their refinements, composition series, principal or chief series, Nilpotent and Solvable groups

RECOMMENDED BOOKS:

1. D. S. Dummit, R. M. Foote, 2004. Abstract Algebra. 3rd Edition. John Wiley & Son.
2. J. Gallian, 2013. Contemporary Abstract Algebra. 8th Edition. Brooks/Cole Cengage Learning.
3. N. Carter, 2009. Visual Group Theory. American Association of America Inc.
4. P. M. Cohn, 2000. Classic Algebra. 1stEdition. London . John Wiley & Sons Inc.

Course Title: **Theory of Semi-groups**
Course Code: **MTH-536**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to familiarize students with the elementary notions of semigroup theory. Abstract ideas will be illustrated by applying them to semigroups such as $\mathcal{T}_{X,}$ $M_n(\mathbb{R})$ and the bicyclic semigroup B. The will move on to study Green's relations and how these may be used to develop structure theorems for semigroups.

THEORY:

Semi-groups, monoids, ideals, homomorphisms and congruences, the essential difference between semi-groups and previously studied algebraic structure, Green's relations, regular D-Classes, Green's theorem that any II-Class containing an idempotent is a subgroup, completely 0-simple semi-groups, Rees' theorem, regular and inverse semi-groups

RECOMMENDED BOOKS:

1. A. Nagy, 2001. Special Classes of Semigroups. 1st Edition. Kluwer Academic Publishers.
2. J. N. Mordeson, D. S. Malik, N. Kuroki, 2003. Fuzzy Semigroups. 1st Edition. Springer.
3. T. W. Hungerford, 2012. Abstract Algebra. An Introduction, Brooks/Cole 1st Edition. Cengage Learning.
4. U. Kaljulaid, 2006. Semigroups and Automata. 1stEdition. Selecta IOS Press.

Course Title: **Computational Algebra**
Course Code: **MTH-537**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To study monomial ideals and related concepts using computer algebra systems so that students can do research in this field.

THEORY:

Monomial ideals: Operations on ideals. Module Theory: Graded modules. Operations on submodules. Direct Sum and direct product. Finitely generated modules. Primary decomposition and associated prime ideals. Integral Closure of monomial ideals. Simplicial Complex. Grobner bases: Dickson's Lemma. Hilbert basis theorem. Division algorithm. Buchberger's criterion. Edge ideals. Dimension Theory: Hilbert function and Hilbert Series. Graded free resolution. The Koszul Complex. Depth. Cohen-Macaulay modules. Introduction to Singular.

RECOMMENDED BOOKS:

1. E. Miller, B. Strumfels. 2006. Combinatorial Commutative Algebra. 1st Edition. Springer.
2. G. M. Gruel, G. Pfister, H. Schonemann, 2001. A Computer Algebra System for Polynomial Computations. 1st Edition. Centre for Computer Algebra, University of Kaiserslautern.
3. J. Herzog, T. Hibi, 2010. Monomial Ideals. 1st Edition. Springer.
4. R. H. Villaraeal, 2000. Monomial Algebras. 1st Edition. Marcel Dekker Inc. New York.

Course Title: **Homological Algebra**

Course Code: **MTH-538**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

Homological algebra is the branch of mathematics that studies homology in a general algebraic setting. It is a relatively young discipline, whose origins can be traced to investigations in combinatorial topology (a precursor to algebraic topology) and abstract algebra (theory of modules and syzygies).

THEORY:

Chain complexes, Snake theorem, resolution, projective, injective and flat modules, Ext and Tor. derived functors, dimension (Projective, Global) of rings, bi-complexes, Kunneth theorems, and spectral sequences. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. J. Rotman. 2008 An Introduction to Homological Algebra. 2nd Edition. Springer.
2. C. A. Weibei. 2000 An Introduction to Homological Algebra. Cambridge University Press.
3. P. J. Hilton, U. Stammbach. 2000. A Course in Homological Algebra. Springer-Verlag.
4. L. R. Vermani. 2003. An Elementary Approach to Homological Algebra. Chapmann & Hall/CRC.

Course Title: **Field Extensions & Galois Theory**

Course Code: **MTH-539**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas of Field Extensions & Galois Theory and in modern mathematics, the theory of fields (or field theory) plays an essential role in number theory and algebraic geometry.

THEORY:

Extension of a field. Degree of an extension. Finite extensions. Algebraic and transcendental elements, Algebraic extension. Roots of a polynomial. Splitting extension. Automorphisms of a field. Fixed field of a group of homomorphisms. Normal extensions. Galois extensions. Fixed field of a group. Galois group of a polynomial. The fundamental theorem of Galois Theory. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. I. N. Herstein. 2000. Topics in Algebra. 2nd Edition. Lexington Xerox College Publishing.
2. E. Artin. 2000. Galois Theory. 2nd Edition. Notre Dame Univ. Indiana.
3. I. Stewart. 2000. Galois Theory. 2nd Edition. Chapman and Hall.
4. W. Ledermann. 2000. Introduction to Group Theory (Oliver and Boyd).

Course Title: **Advanced Partial Differential Equations**
Course Code: **MTH-541**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The course aims at developing understanding about fundamental concepts of PDEs theory, identification and classification of their different types, how they arise in applications, and analytical methods for solving them. Special emphasis would be on wave, heat and Laplace equations.

THEORY:

Cauchy's problem for linear second order equations in n-independent variables, Cauchy Kowalewski theorem, characteristics surfaces, adjoint operations, bi-characteristics, spherical and cylindrical waves, heat equation, wave equation, Laplace equation, maximum-minimum principle, integral transform.

RECOMMENDED BOOKS:

1. C. R. Chester. 2000. Techniques in Partial Differential Equations. 1st Edition. McGraw-Hill .
2. J. D. Logan . 2015. Applied Partial Differential Equations. 3rd Edition. Springer.
3. L. Debnath , T. Mynit-U. 2006. Linear Partial Differential Equations for Scientists and Engineers. 4th Edition. Birkhaser.
4. L. C . Evans. 2010. Partial Differential Equations. 2nd Edition American. Mathematical Society.

Course Title: **Numerical Solution of Ordinary Differential Equations**
Course Code: **MTH-542**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To introduce and give an understanding of numerical methods for the solution of ordinary differential equations, their derivation, analysis and applicability.

THEORY:

Theory and implementation of numerical methods for initial and boundary value problems in ordinary differential equations, one-step, linear multi-step, Runge-Kutta and extrapolation methods; convergence, stability, error estimates and practical implementation, study and analysis of shooting, finite difference and projection methods for boundary value problems for ordinary differential equations.

RECOMMENDED BOOKS:

1. A . Iserles. 2011. A First Course in Numerical Analysis of Differential Equations. 2nd Edition Cambridge University Press.
2. D . F. Griffiths, D. J. Higham. 2010. Numerical Methods for Ordinary Differential Equations Initial Value Problem. 1st Edition. Springer.
3. J. C . Butcher . 2010. Numerical Methods for Ordinary Differential Equations. 2nd Edition. John Wiley & Sons Ltd.
4. K . Atkinson. E. W. Han , D. E .Stewart .2009. Numerical Solution of Ordinary Differential Equations. 1st Edition. John Wiley & Sons.

Course Title: **Numerical Solutions of Partial Differential Equations**
Course Code: **MTH-543**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

This course will introduce fundamental methods for approximating the solution of PDEs that are widely used in a various fields of science and engineering. These include both discretization methods that reduce infinite-dimensional PDEs to finite-dimensional systems of equations that may be solved on a computer, and also solution methods that efficiently solve the discretized equations.

THEORY:

Classification of PDEs into elliptic, parabolic and hyperbolic types, initial and boundary conditions, finite difference approximation methods (explicit and implicit), matrix and Von-Neumann methods for stability analysis for different schemes, convergence, method of characteristics for quasi-linear equations, finite element methods, Rayleigh-Ritz and Galerkin methods.

RECOMMENDED BOOKS:

1. G. D. Smith. 2001. Numerical solution of partial differential equations. 3rd Edition. Oxford University Press.
2. G. Sewell. 2005. The Numerical Solution of Ordinary and Partial Differential Equations. 2nd Edition. John Wiley & Sons. Inc.
3. K. W. Morton, D. F. Mayers. 2005. Numerical Solution of Partial Differential Equations. 2nd Edition. Cambridge University Press.
4. L. Lapidus, D. F. Pinder. 2011. Numerical Solution of Partial Differential Equations in Science and Engineering. 1st Edition. John Wiley & Sons. Inc.

Course Title: **Perturbation Methods**

Course Code: **MTH-544**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aims of the course are to give a clear and systematic account of modern perturbation theory and to show how it can be applied to differential equations. Perturbation methods underlie numerous applications of physical applied mathematics: including boundary layers in viscous flow. celestial mechanics. optics. shock waves. reaction-diffusion equations. and nonlinear oscillations.

THEORY:

Introduction to perturbation expansion. singular and regular perturbation. boundary layers. harmonic approximations. Beats phenomena. method of averages. perturbation and ordinary differential equation. perturbation and partial differential equation. heat conduction with slow radiation. non-linear Klein-Gordon equation. perturbation for eigen - value problems. integrals. the method of stationary phase. asymptotic analysis of telegraph equations. the method of steepest descent. correlation functions. Wiener-Hopf method. homotopy perturbation method. homotopy analysis method. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. A. H. Nafeh. 2000. Perturbation Methods. 1st Edition. John Wiley & Sons.
2. A. H. Nafeh. 2001. Problems in Perturbation. 1st Edition. John Wiley & Sons.
3. A. W. Bush. 2001. Perturbation Methods for Engineers and Scientists. 1st Edition. John Wiley & Sons.
4. C. M. Bender, S. A. Orszag. 2001. Advanced Mathematical Methods for Scientists and Engineers. 1st Edition. McGraw-Hill. Inc.
5. S. Liao. 2003. Beyond Perturbation. 1st Edition. Chapman & Hall/CRC.

Course Title: **Theory of Interpolation Spaces**

Course Code: **MTH-545**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas of Interpolation Spaces and interpolation space is a space which lies "in between" two other Banach spaces. The main applications are in Sobolev spaces, where spaces of functions that have a noninteger number of derivatives are interpolated from the spaces of functions with integer number of derivatives.

THEORY:

Compatible couples, the sum and intersection spaces, intermediate spaces, interpolation spaces, K-functional, K-interpolation spaces, interpolation of LP-spaces, non-increasing rearrangement elements, formula for the K-functional for the couple ($L1$, $L\infty$), Lorentz spaces as

interpolation spaces. Marcinkiewiz interpolation theorem, Holmstedt's formula, the classical reiteration theorem, slowly varying function, Holmstedt's type formulae, the generalized reiteration theorems, reiteration in limiting cases. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. C. Bennett & R. Sharpley. 2000. Interpolation of operators. Academic Press. New York.
2. J. Berg & J. Lofstrom 2000. Interpolation Spaces. An Introduction. Springer-Verlag. New York.
3. J. A. Brudnyi & N. J. Krigliak 2000. Interpolation Spaces and Interpolation Function. North-Holland. Amsterdam.
4. L. Tarter 2007. An Introduction to Sobolev Spaces and Interpolation Spaces. Springer Verlag. Berlin .

Course Title: Fixed Point Theory
Course Code: MTH-551
Credit Hours: 3(3-0)

AIMS AND OBJECTIVES:

To learn fixed point theory as an interesting application of metric spaces, to understand the applications of this theory to numerical analysis, ordinary differential equations and integral equations and linear algebra.

THEORY:

What is fixed point theory? The Banach contraction principle, geometry of Banach spaces, elements of non-expensive mapping theory, minimal invariant sets, uniformly Lipschitzian, periodic, rotative maps etc, compact sets in Banach spaces, Schuder's theorem, equivalence of Brouwer's and Shuder's theorems, some applications, some more fixed point methods

RECOMMENDED BOOKS:

1. J. Dugundji. A. Granas. 2003. Fixed Point Theory. 1st Edition. Springer.
2. K.. Goebel . 2002. Concise Course on Fixed Point Theorems. 1st Edition. Yokohama Publishers Japan.
3. K. A. M. Khamsi. 2001. An Introduction to Metric Spaces and Fixed Point Theory. 1st Edition. John Wiley & Sons. Inc.
4. M. P. R. Agarwal, M. O'Regan. 2004. Fixed Point Theory and Applications. 1st Edition. Cambridge University Press.

Course Title: **Geometric Function Theory**
Course Code: **MTH-552**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of this course is to acquire the distortion theorems, special classes of univalent functions, Lowner's theory, generalization of the area theorem, Gunsky inequalities.

THEORY:

Area theorem, growth, distortion theorems, coefficient estimates for univalent functions, special classes of univalent functions, Lowner's theory and its applications, Bieberbach conjecture, de Branges theorem, generalization of the area theorem, Grunsky inequalities, exponentiation of the Grunsky inequalities, logarithmic coefficients, subordination and sharpened form of Schwarz lemma

RECOMMENDED BOOKS:

1. D. Shoikhet. 2001. Semigroups in Geometrical Function Theory. 1st Edition. Kluwer Academic Publishers.
2. I. Graham, G. Kohr. 2003. Geometric Function Theory in One and Higher Dimensions. 1st Edition. Marcel Dekker. New York.
3. L. V. Ahlfors. 2010. Conformal Invariants. Topics in Geometric Function Theory. 1st Edition. AMS Chelsea Publishing.
4. S. G. Krantz. 2007. Geometric Function Theory Explorations in Complex Analysis. 1st Edition. Springer.

Course Title: **Advanced Number Theory**

Course Code: **MTH-553**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

Number theory is a vast and fascinating field of mathematics, sometimes called "higher arithmetic," consisting of the study of the properties of whole numbers. Primes and prime factorization are especially important in number theory, as are a number of functions such as the divisor function, Riemann zeta function, and totient function.

THEORY:

A spectacular development (Proof of Fermat's Last Theorem for n=3, 4). Gauss's Quadratic reciprocity law. The Jacobi symbol and applications of Gaussian integers. The ring Z[ ], Finite fields. Primitive polynomials. Irreducibility. Gauss lemma and Eisenstein criterion of irreducibility. Number fields and integral dependence. Integers in number fields. Cyclotomic polynomials and fields Class groups. Discriminants. Some results from geometry of numbers. Dirichlet's theorem. Splitting of rational primes. The group of units and Norm-Euclidean number fields. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. P. Harry, G. D. Harold. 2000. The Theory of Algebraic Numbers (The Mathematical Association of America.
2. G. H. Hardy, E. M. Wright. 2000 . An Introduction to the Theory of Numbers. Oxford University Press.
3. A. M. Daniel. 2000. Number Fields. Springer-Verlag.
4. B. N. Melvyn. 2000. Methods in Number Theory. Springer-Verlag.
5. E. Grosswald. 2000. Topics From The Theory of Numbers.The Macmillan Company. Narosa.

Course Title: **Fuzzy Algebra**

Course Code: **MTH-554**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The main aim of this paper is to discuss the basic ideas and concepts of fuzzy algebra.

THEORY:

Introduction, The Concept of Fuzziness Examples, Mathematical Modeling, Operations of fuzzy sets, Fuzziness as uncertainty. Algebra of Fuzzy Sets: Boolean Algebra and lattices, Equivalence relations and partitions, Composing mappings, Alpha-cuts, Images of alpha-level sets, Operations on fuzzy sets. Fuzzy Relations: Definition and examples, Binary Fuzzy relations Operations on Fuzzy relations, fuzzy partitions. Fuzzy Semigroups: fuzzy ideals of semigroups, Fuzzy quasi-ideals, Fuzzy bi-ideals of Semigroups, Characterization of different classes of semigroups by the properties of their fuzzy ideals fuzzy quasi-ideals and fuzzy bi-ideals. Fuzzy Rings: Fuzzy ideals of rings, Prime, semiprime fuzzy ideals, Characterization of rings using the properties of fuzzy ideals

RECOMMENDED BOOKS:

1. Hung T. Nguyen and A First course in Fuzzy Logic, Chapman and Hall/CRC Elbert A. Walker 1999.

2. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, Prentice-Hall of India, 2006.

3. John N. Mordeson and Fuzzy Commutative algebra, World Scientific, 1998.D.S. Malik,

4. John N. Mordeson, Fuzzy Semigroups, Springer-Verlage, 2003. D.S. Malik and Nobuki Kuroki

Course Title: **Advanced Numerical Analysis**
Course Code: **MTH-561**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

This course is designed to teach the students about numerical methods and their theoretical bases. The course aims at inculcating in the students the skill to apply various techniques in numerical analysis , understand and do calculations about error that can occur in numerical methods.

THEORY:

Numerical solutions of nonlinear equations: bisection, regula falsi, Newton-Raphson, fixed point methods, some higher order methods for the solution of non linear equations and their convergences, solution of system of linear equations: Gauss elimination method, Jacobi and Gauss-Seidel methods and their convergences, relaxation, SOR, SUR, eigenvalues and eigenfunctions, system of nonlinear equations, interpolations, Lagrange interpolating polynomials, Hermite polynomial, cubic spline, numerical integration, solution of differential equations: Euler's method, Runge-Kutta method, Adam Bashforth method, system of differential equations, Milne methods(Algorithms with computer programming)

RECOMMENDED BOOKS:

1. C. F. Gerald. 2003. Applied Numerical Analysis. 1st Edition. Pearson.
2. P. Linz, R .W. Exploring. 2003. Numerical Methods. 1st Edition. Jones and Bartlett Publishers. Barb House. Barb news London W6 7PA. UK.
3. R. L . Burden, D. J . Faires. 2015. Numerical Analysis . 10th Edition. Brooks/Cole.
4. W. Gautschi. 2012. Numerical Analysis. 2nd Edition . Springer.

Course Title: **Approximation Theory**
Course Code: **MTH-562**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To systematic study of the different approximation methods, numerical evaluation of the approximations and the error involved.

THEORY:

Introduction and revision of function norms, Weierstrass theorem for polynomial approximation, Chebyshev polynomials, best Euclidean (L_2) polynomial approximation, rational approximation, Padé approximants, Weierstrass approximation theorem, interpolation, interpolation by polynomials, Neville's algorithm, Newton's interpolation formula, the error in the polynomial interpolation, Hermite interpolation, the Hermite cubic form, least square approximation, Lagrange interpolations, interpolation by rational functions, trigonometric interpolation, interpolation based surfaces, tensor product based patches, interpolation based patches: Lagrange interpolation, Hermite interpolation, fast Fourier transform, the Z – transform

RECOMMENDED BOOKS:

1. E. W. Cheney, W. Light, 2009. A Course in Approximation Theory. 1st Edition. American Mathematical Society.

2. H. N. Mhaskar, D. V. Pai, 2000. Fundamentals of Approximation Theory. 1st Edition, Narosa Publishing House New Delhi.

3. J. H. Mathews, K. K. Fink, 2004. Numerical Methods Using MATLAB. 3rd Edition. Pearson Education, Inc., Publishing as Prentice Hall.

4. L. N. Trefethen, 2013. Approximation Theory and Approximation Practice. 1st Edition. Oxford University. Oxford.

Course Title: **Theory of Majorization**
Course Code: **MTH-563**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas of Majorization. In mathematics, Majorization is a preorder on vectors of real numbers. Majorization is a partial ordering and precisely defines the vague notion that the components of a vector are "less spread out" or "more nearly equal" than the components of another vector. Functions that preserve the ordering of majorization are said to be Schur-convex or Schur-concave.

THEORY:

Motivation and basic definitions, majorization as a partial ordering, order-preserving functions, partial orderings induced by convex cones, partial orderings, generated by groups of transformations, majorization for vectors of unequal length, majorization for infinite sequences, majorization for matrices, Lorenz ordering, majorization and dilations, convex Majorization. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. A. W. Marshall, I. Olkin, B. Arnold. Inequalities. 2011. Theory of Majorization and Its Applications. 2nd Edition. Springer.
2. R. Bhatia. 2000. Matrix Analysis. Springer-Verlag. New York.
3. J. Pecaric, F. Proschan , Y. C. Tong.2000. Convex Functions. Partial Orderings and Statistical Applications. Vol. 187 of Mathematics in Science and Engineering. Academic Press. Boston Mass. USA.
4. D. S. Mitrinovic, J. Pecaric, A. M. Fink. 2000. Classical and New Inequalities in Analysis. Kluwer Academic Publishers. Netherlands.

Course Title: **Linear Groups & Group Representations**

Course Code: **MTH-564**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

In the mathematical field of representation theory, group representations describe abstract groups in terms of linear transformations of vector spaces; in particular, they can be used to represent group elements as matrices so that the group operation can be represented by matrix multiplication. They are also important in physics because, for example, they describe how the symmetry group of a physical system affects the solutions of equations describing that system.

THEORY:

Direct Products. Classification of Finite Abelian Groups. Semidirect Products. Extensions. Central and Cyclic Extensions. General Linear Groups. Special and Projective Linear Groups. Tvansvections. Generators of Linear Groups. Exceptional Isomorphism. Simple Linear Groups. Classification of Groups with at most 31 elements. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. G. James, M. Lieback. 2001 Representations and Characters of Groups (Cambridge University Press).
2. H. S. M. Coxeter, W. J. Moser. 2000. Generators and Relations for Discrete Groups (Springer Verlag)
3. J. J. Rotman. 2000. An Introduction to The Theory of Group (Allyn and Bacon).
4. W. Lederman. 2000. Introduction to Group Character (Cambridge University Press).
5. J. L. Alperin , R.B. Bell. 2000. Groups and Representations (Springer).
6. J. F. Humphreys. 2004. A Course in Group Theory (Oxford University Press).

Course Title: **Theoretical Physics (Plasma Physics)**
Course Code: **MTH-581**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of this course is to give students a solid grounding in fundamental plasma physics. The course is designed to appeal to graduate students in astrophysics and physics.

THEORY:

Occurrence of plasmas in nature, definition of plasma, concept of temperature , Debye shielding, plasmas parameters, criteria for plasmas, and applications

Single particle motion: Uniform and non-uniform electrostatic **E** and magnetic **B** fields, time -varying **E** and **B** fields and their description for plasmas

Waves in plasmas**:** Introduction to plasma oscillations, electron plasma waves, ion waves, plasma approximation, electrostatic electron oscillations perpendicular to **B**, the lower hybrid Frequency, the upper hybrid frequency, electromagnetic waves with $\mathbf{B_0=0}$, electromagnetic waves perpendicular to $\mathbf{B_0}$ cut-offs and resonances, electromagnetic waves parallel to B_0, Alfeven waves, magneto sonic waves,

Introduction to controlled fusion, fusion reactions (P^{p} CNO Cycles controlled nuclear fusion, D^{D} D Reactor fusion related to the future.

Equilibrium and stability: Stream instability, the gravitational instability.

RECOMMENDED BOOKS:

1. A. Piel. 2010. Plasma Physics. An Introduction to Labortory. Space and Fusion Plasmas. 1st Edition. Springer.
2. J. A. Bittoncourt. 2004. Fundamentals of Plasma Physics. 3rd Edition. Springer Verlag
3. P. M . Bellan. 2008. Fundamentals of Plasma Physics. 1st Edition. Cambridge University Press.
4. W. M. Stacey. 2005. Fusion Plasma Physics.1st Edition. Wiley-VCH.

Course Title: **Advanced Fluid Dynamics**
Course Code: **MTH-582**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to introduce some of the most current research subjects in the field of fluid dynamics and to present them for research in this area.

THEORY:

Exact solutions of the Navier Stokes equations, approximate solutions for low Reynolds numbers, approximate solutions for high Reynolds numbers, incompressible boundary layer theory, laminar and turbulent boundary layer theory, flow separation, compressible laminar and turbulent boundary layers

RECOMMENDED BOOKS:

1. G. Currie, 2012. Fundamental Mechanics and Fluids. 1st Edition. CRC Press.

2. H. Schlichting, 2000. Boundary Layer Theory. 1st Edition. Springer.

3. J. H. Spurk, N. Aksel, 2008. Fluid Mechanics. 2nd Edition. Springer.

4. R. K. Bansal, 2005. A Textbook of Fluid Mechanics. 1st Edition. Laxmi Publications (P) LTD. New Delhi.

Course Title: **Acoustics**
Course Code: **MTH-583**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To introduce the participants to fundamental acoustic concepts and to give the necessary background for more specialized courses in acoustic.

THEORY:

Fundamental of vibrations, Energy of vibration, Damped and free oscillations Transient response of an oscillator vibrations of springs, membranes and plates, forced vibrations. Normal modes, acoustic waves equation and its solution, equation of state, Cout-Euler equations, linearized wave equation, speed of sound in fluid, energy density, acoustic intensity, specific acoustic impedance, spherical waves, transmission, transmission from one fluid to another (Normal incidence) reflection at a surface of solid (Normal and oblique incidence). Absorption and attenuation of sound waves in fluids, pipes cavities waves guides; under water acoustics.

RECOMMENDED BOOKS:

1. L. E. Kinsler, A. R. Frey, A. B. Coppens, J. V. Sanders, 2000. Fundamentals of Acoustics. 4th Edition. John Wiley & Son.
2. L. L. Beranek, T. J. Mellow, 2012. Acoustics: Sound Fields and Transducers. 1st Edition. Elsevier Inc..
3. M. P. Morse, 2005. Vibration and Sound. 1st Edition. McGraw Hill Book Company.
4. U. Inguard, 2008. Acoustics. 1st Edition . Infinity Science Press LLC.

Course Title: **Heat Transfer**
Course Code: **MTH-584**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas Heat Transfer and indicate their applications in fields such as Fluid Mechanics and Viscous Fluid.

THEORY:

The importance of heat transfer. the fundamental laws of conductions. the fundamental laws of convection. the fundamental laws of radiation. material properties of importance in heat transfer. steady state heat conduction in one dimension. the critical thickness of pipe insulation. heat conduction in two or more independent variables. numerical methods for heat conduction. the fundamental principles of viscous. steady state conduction in rectangular plates. transient conduction in the infinite slab. fluid motion and boundary layer motion. examples of analytic solutions to problems of forced convection. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. A. Bejan, A. D. Kraus. 2003. Heat Transfer Handbook. 1st Edition. Willy Interscience.

2. A. J. Chapman. 2001. Heat Transfer. Fourth Edition. Prentice Hall .

3. D. R. Pitts, L. E. Sisson. 2001. Schaum's Outlines of Heat Transfer. 1st Edition. Mc-Graw Hill.

4. J. H. Lienhardt IV, J. H. Lienhardt V. 2003 . A Heat Transfer Textbook. 1st Edition. Philogeston Press.

Course Title: **Viscous fluid flow**

Course Code: **MTH-585**

Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas of viscous flow and indicate their applications in fields such as Fluid Mechanics and Viscous Fluid.

THEORY:

Some examples of viscous flow phenomena. properties of fluids. boundary conditions. equation of continuity. the Navier-Stokes' equations. the energy equation; boundary conditions. orthogonal coordinate system. dimensionless parameters. velocity considerations. two dimensional considerations and the stream functions. Coutte flows. Poissillee flow. unsteady duct flows. similarity solutions. some exact analytic solution from the paper. introduction to laminar boundary layers equations. similarity solutions. two dimensional solutions. thermal boundary layer. Some exposure will also be given from the recent literature appearing in the journals.

RECOMMENDED BOOKS:

1. F. M. White. 2006.Viscous Fluid Flow. 1st Edition. McGraw-Hill .

2. G. K. Batchelor. 2001. An Introduction to Fluid Dynamics. 1st Edition. Cambridge University Press .

3. H. Ockendon. 2001. Viscous flow. 1st Edition. Cambridge University Press .

4. P. K. Kundu. 2001. Fluid Mechanics. 1st Edition. Academic Press .

Course Title: **Integral Transforms**
Course Code: **MTH-586**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

The aim of the course is to describe the ideas of Fourier and Laplace Transforms and indicate their applications in fields such as differential equations.

THEORY:

Introduction. their appearance in ODEs and PDEs. the Laplace transforms the Fourier transform. the Hankel transform. the Mellin transform. their properties like linearity. scaling. differential formulas and their applications to solutions of boundary and initial value problems.

RECOMMENDED BOOKS:

1. B. Davies. 2002. Integral Transforms and Their Applications. 3rd Edition. Springer-Verlag.
2. J. W. Miles. 2008. Integral Transforms in Applied Mathematics. 1st Edition. Cambridge University Press.
3. L. Debnath, D. Bhatta. 2014. Integral Transforms and Their Applications. 3nd Edition. Chapman & Hall/CRC.
4. M. Y. Antimirov, A. A. Kolyshkin, R. Vaillancourt. 2007. Applied Integral Transforms. 1st Edition. American Mathematical Society.

Annexure "A"

COMPULSORY MATHEMATICS
COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

Course Title:	**Mathematics I**
Course Code:	**MTH-100**
Credit Hours:	**3(3-0)**

AIMS AND OBJECTIVES:

To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

THEORY:

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.
Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.
Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.
Sequences and Series: Arithmetic progression, geometric progression, harmonic progression. Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.
Trigonometry: Fundamentals of trigonometry, trigonometric identities.

RECOMMENDED BOOKS:

1. J. E .Kaufmann, College Algebra and Trigonometry, PWS-Kent Company, Boston
2. M. P. Dolciani, W.Wooton, E. F.Beckenback, S. Sharron. Algebra 2 and Trigonometry, Houghton & Mifflin, Latest Edition
3. W. E. Swokowski, Fundamentals of Algebra and Trigonometry. PWS-Kent Company, Boston.

Course Title: **Mathematics II**
Course Code: **MTH-101**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

THEORY:

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.
Limits and Continuity: Limit of a function, left-hand and right-hand limits, continuity, continuous functions.
Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.
Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

RECOMMENDED BOOKS:

1. B. G. Thomas. A. R. Finney. Calculus. Addison-Wesley, Reading, Ma, USA. Latest Edition.
2. H. B. Anton, I. Davis.Calculus: A New Horizon. John Wiley. Latest Edition.
3. J. Stewart, Calculus. Brooks/Cole. Latest Edition.
4. W. Swokowski. Calculus and Analytic Geometry. PWS-Kent Company. Boston. Latest Edition.

Course Title: **Calculus and Analytic Geometry**
Course Code: **MTH-103**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To prepare the students, not majoring in mathematics, with the essential tools of calculus and geometry to apply the concepts and the techniques in their respective disciplines.

THEORY:

Complex Numbers, DeMoivre's Theorem and its Applications, Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Limit and Continuity, Differentiation of Functions. Derivative as Slope of Tangent to a Curve and as Rate of Change, Application to Tangent and Normal, Linearization, Maxima/Minima and Point of Inflexion, Taylor and Maclaurin Expansions and their convergence; Integral as Anti-derivative, Indefinite Integration of Simple Functions. Methods of Integration: Integration by Substitution, by Parts, and by Partial Fractions, Definite Integral as Limit of a Sum, Application to Area, Arc Length, Volume and Surface of Revolution.

RECOMMENDED BOOKS:

1. G. B. Thomas, A. R. Finney Calculus,Addison-Wesley, Reading,Ma,USA. Latest Edition.
2. H.B .Anton, I.Davis. Calculus:A New Horizon, John Wiley, Latest Edition.
3. J.Stewart.Calculus, Brooks/Cole. Latest Edition.
4. W.Swokowskie .Calculus and Analytic Geometry , PWS-KentCompany, Boston, Latest Edition.

Course Title: **Mathematics III**
Course Code: **MTH-202**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

THEORY:

Geometry in Two Dimensions: Cartesian-coordinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.
Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation

RECOMMENDED BOOKS:

1. J. E. Kaufmann, College Algebra and Trigonometry, PWS-Kent Company, Boston, Latest Edition.
2. S. Abraham, Analytic Geometry, Scott, Freshman and Company, Latest Edition.
3. W. E. Swokowski, Fundamentals of Algebra and Trigonometry, PWS-Kent Company, Boston, Latest Edition.

Course Title: **Multivariable Calculus**
Course Code: **MTH-201**
Credit Hours: **3(3-0)**

AIMS AND OBJECTIVES:

To prepare the students, not majoring in mathematics, with the essential tools of calculus and geometry to apply the concepts and the techniques in their respective disciplines.

THEORY:

Functions of Several Variables and Partial Differentiation. Multiple Integrals, Line and Surface Integrals. Green's and Stoke's Theorem. Fourier Series: periodic functions, Functions of any period P-2L, Even & odd functions, Half Range expansions, Fourier Transform; Laplace Transform, Z-Transform.

RECOMMENDED BOOKS:

1. A. Kaseberg. 2004. Intermediate Algebra, Thomson Brooks/COLE.
2. C.H. Edward and E.D Penney, Calculus and Analytics Geometry, Prentice Hall, Inc.
3. E. W. Swokowski, Calculus with Analytic Geometry,PWS Publishers, Boston, Massachusetts.
    A. Jr Frank, Elliott Mendelson, Calculus, Schaum's outlines series, 4th Edition.
4. H. Anton, I. Bevens, S. Davis. 2005. Calculus, 8th Edition, John Wiley &Sons, Inc.
5. Hughes-Hallett, Gleason, McCallum, et al. 2002.Single and Multivariable Calculus. Edition 3rd John Wiley & Sons, Inc. A. Jr.
6. J. Stewart. Multivariable Calculus. Latest Edition. Cengage Learning Publishers.
7. Thomas. 2005. Calculus. 11th Edition. Addison Wesley Publishing Company.