DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus
For
M.Sc. (HONS) MATHEMATICS
(Program ID-37)

1st TO 4th SEMESTER
Examinations 2014–2015 Session Onwards

Syllabi Applicable For Admissions in 2014

DAV UNIVERSITY, JALANDHAR

Scheme of Courses M.Sc.

M.Sc. (HONS) MATHEMATICS

Semester 1

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	MTH501	Real Analysis	4	0	0	4	25	25	25	25	100
2	MTH502	Algebra-I	4	0	0	4	25	25	25	25	100
3	MTH503	Linear Algebra	4	0	0	4	25	25	25	25	100
4	MTH505	Differential Equations	4	0	0	4	25	25	25	25	100
5	MTH508	Classical Mechanics and Calculus Of Variation	4	0	0	4	25	25	25	25	100
6	CSA551	Computer Fundamentals and office Automation	4	0	0	3	25	25	25	25	75
7	CSA553	Computer Fundamentals and office Automation LAB	0	0	2	1	-	-	-	-	25
			23			**24**					**600**

A: Continuous Assessment: Based on Objective Type & Subjective Type Test
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

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Scheme of Courses M.Sc.

M.Sc. (HONS) MATHEMATICS

Semester 2

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	MTH 504	Complex Analysis	4	0	0	4	25	25	25	25	100
2	MTH 506	Theory of Measure and Integration	4	0	0	4	25	25	25	25	100
3	MTH 507	Algebra-II	4	0	0	4	25	25	25	25	100
4	MTH 509	Differential Geometry	4	0	0	4	25	25	25	25	100
5	MTH 510	Number Theory	4	0	0	4	25	25	25	25	100
6	MTH 511	Computational Techniques	4	0	0	3	25	25	25	25	75
7	MTH 512	Computational Techniques Laboratory	0	0	2	1	-	-	-	-	25
			23			**24**					**600**

A: Continuous Assessment: Based on Objective Type & Subjective Type Test
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

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Scheme of Courses M.Sc.

M.Sc. (HONS) MATHEMATICS

Semester 3

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	MTH 601	Topology	4	0	0	4	25	25	25	25	100
2	MTH 602	Probability and Statistics	4	0	0	4	25	25	25	25	100
3	MTH 603	Mathematical Methods	4	0	0	4	25	25	25	25	100
4	MTH 604	Operations Research-I	4	0	0	4	25	25	25	25	100
5	**Elective/Optional Courses** (Choose any **Two** courses)										
6	MTH 605	Fluid Mechanics-I	4	0	0	4	25	25	25	25	100
7	MTH 606	Discrete Mathematics	4	0	0	4	25	25	25	25	100
8	MTH 607	Finite Element Analysis	4	0	0	4	25	25	25	25	100
9	MTH 608	Fuzzy Sets and Fuzzy Logic	4	0	0	4	25	25	25	25	100
10	MTH 609	Advance Complex Analysis	4	0	0	4	25	25	25	25	100
11	MTH 610	Advance theory of Partial Differential Equations and Sobolev spaces	4	0	0	4	25	25	25	25	100
			24			**24**					**600**

A: Continuous Assessment: Based on Objective Type & Subjective Type Test
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

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Scheme of Courses M.Sc.

M.Sc. (HONS) MATHEMATICS

Semester 4

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	MTH 611	Functional Analysis	4	0	0	4	25	25	25	25	100
2	MTH 612	Differential Geometry of Manifolds	4	0	0	4	25	25	25	25	100
3	MTH 613	Operations Research-II	4	0	0	4	25	25	25	25	100
4	MTH 614	PROJECT	0	0	0	8	-	-	-	-	200
	Elective/Optional Courses (Choose any **ONE** course)										
5	MTH 615	Advanced Numerical Analysis	4	0	0	4	25	25	25	25	100
6	MTH 616	Wavelet Analysis	4	0	0	4	25	25	25	25	100
7	MTH 617	Fluid Mechanics-II	4	0	0	4	25	25	25	25	100
8	MTH 618	Special Functions	4	0	0	4	25	25	25	25	100
9	MTH 619	Algebraic Topology	4	0	0	4	25	25	25	25	100
			16			**24**					**600**

A: Continuous Assessment: Based on Objective Type & Subjective Type Test
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

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Instruction for candidates (Theory Paper)

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.
- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.
- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.
- The books indicated as text-book(s) are suggestive However, any other book may be followed.

* Wherever specific instructions are required these are given at the starting of that particular subject/paper

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Instruction for candidates (Practical Paper)

- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test**.**

Course Title: Real Analysis-I
Paper Code: MTH 501

L	T	P	Credits	Marks
4	0	0	4	100

Objective:

The aim of this course is to make the students learn fundamental concepts of metric spaces, The Riemann-Stieltjes integral as a generalization of Riemann Integral, the calculus of several variables and basic theorem.

UNIT-I **14 Hours**

Basic Topology: Finite, countable and uncountable sets, metric spaces, compact sets, perfect sets, connected sets.
Sequences and series: Convergent sequences, sub sequences, Cauchy sequences(in metric spaces), completion of a metric space, absolute convergence, addition and multiplication of series, rearrangements of series of real and complex numbers.

UNIT-II **14 Hours**

Continuity: Limits of functions (in metric spaces), continuous functions, continuity and compactness, continuity and connectedness, monotonic functions.
The Riemann-Stieltjes integral: Definition and existence of the Riemann-Stieltjes integral, properties of the integral, integration of vector-valued functions, rectifiable curves.

UNIT-III **14 Hours**

Sequences and series of functions: Problem of interchange of limit processes for sequences of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, equicontinuous families of functions, Stone Weierstrass Theorem.

UNIT-IV **14 Hours**

Differentiation: Differentiation of vector-valued functions.
Functions of several variables: The space of linear transformations on R^n to R^m as a metric space. Differentiation of a vector-valued function of several variables. The Inverse function theorem. The implicit function theorem Jacobians, extremum problems with constarints, Lagrange's multiplier method, Differentiation of integrals, Partitions of Unity, Differential forms, Stoke's Theorem.

Reference Books:

1. Rudin, W. *Principles of Mathematical Analysis, 3rd Edition*. New Delhi: McGraw-Hill Inc., 1976.
2. Royden, H. L. *Real Analysis, 3rd Edition.* New Delhi: Macmillan Publishing Company.
3. Apostol, Tom. *Mathematical Analysis –A modern approach to Advanced Calculus*. New Delhi: Narosa Publishing House, 1957.
4. Titchmarsh, E.C. *The Theory of functions, 2nd Edition,* U.K. Oxford University Press 1961.

Course Title: Algebra-I
Paper Code: MTH 502

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
This course provides the foundation required for more advanced studies in Algebra. The aim is also to develop necessary prerequisites for Math MTH 507.

UNIT-I **14 Hours**
Review of basic property of Groups, Dihedral groups, Symmetric groups and their congruency classes, Simple groups and their examples. Simplicity of A_n ($n \geq 5$), Normal and Subnormal Series, Derived Series, Composition Series, Solvable Groups, Zassenhaus Lemma and Jordan-Holder Theorem

UNIT-II **15 Hours**
Sylow's Theorems and their applications, Direct Products, Finite Abelian Groups, Invariants of a finite abelian groups. Groups of order p^2, pq. Fundamental Theorem on Finite Abelian Groups.

UNIT-III **13 Hours**
Review of Rings, Zero Divisors, Nilpotent Elements and idempotents, Matrices, Ring of endomorphisms, Ideals, Maximal and prime ideals, Nilpotent and nil ideals, Zorn's Lemma.

UNIT-IV **15 Hours**
Polynomial rings in many variables, Factorization of polynomials in one variable over a field. Unique factorization domains. Gauss Lemma, Eisenstein's Irreducibility Criterion, Unique Factorization in R[x], where R is a Unique Factorization Domain. Euclidean and Principal ideal domains.

Reference Books:

1. Herstein, I. N. *Topics in Algebra, 2nd Edition*, New Delhi: Vikas Publishing House, 1976.
2. Bhattacharya, P.B., Jain S.K. and Nagpal, S.R. *Basic Abstract Algebra, 2nd Edition.* U. K.: Cambridge University Press, 2002.
3. Singh, Surjeet and Zameeruddin, Q. *Modern Algebra, 7th Edition*. New Delhi: Vikas Publishing House, 1993.
4. Luthar, I.S. and Passi. I.B.S. *Algebra Vol. 2, Rings*, New Delhi: Narosa Publishing House, 1999.
5. Gallian, J. A. *Contemporary Abstract Algebra, 4th Edition,* New Delhi: Narosa Publishing House, 1998

DAV UNIVERSITY, JALANDHAR

Course Title: Linear Algebra
Paper Code: MTH 503

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines. The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

UNIT-I **14 Hours**
Vector Spaces, Subspaces, Linear dependence, Basis and Dimensions, Algebra of Linear Transformation, Algebra of Matrices, Elementary matrices, Row rank, Column rank and their equality, System of Linear Equations

UNIT-II **14 Hours**
Eigen values and Eigenvectors, Characteristic and minimal polynomials, companion matrix, Cayley Hamilton Theorem, Matrix representation of Linear Transformation, Change of Basis, Canonical forms, Diagonal forms, triangular forms, Rational and , Canonical Jordan Forms

UNIT-III **14 Hours**
Eigen spaces and similarity, Linear functional, Dual Spaces and dual basis, the double dual, Inner Product Spaces, Norms and Distances, Orthonormal basis, The Gram-Schmidt Orthogonalization, Orthogonal complements.

UNIT-IV **14 Hours**
The Adjoint of a Linear operator on an inner product space, Normal and self-Adjoint Operators, Unitary and Normal Operators, Spectral Theorem, Bilinear and Quadratic forms.

Reference Books:

1. Lipschutz, S. and Lipson, M. *Linear Algebra, 3rd Edition*, New Delhi: Tata McGraw-Hill, 2011.
2. Hoffman, K. and Kunze, R. *Linear algebra, 2nd Edition*, New Delhi: Prentice Hall, 1971.
3. Axler, S. *Linear Algebra Done Right, 2nd Edition*, New York: Springer Verlag, 2004.
4. Lang, S. *Undergraduate Texts in Mathematics, 3rd Edition*, New York: Springer-Verlag, 2004

DAV UNIVERSITY, JALANDHAR

Course Title: Classical Mechanics and Calculus Of Variations
Paper Code: MTH 508

L	T	P	Credits	Marks
4	0	0	4	100

Objectives:
The objective of this paper is to introduce the concept of variation of a functional and variational techniques. The Calculus of variation helps a lot to understand the Lagrangian and Hamiltonian equations for dynamical systems. Vibrational principles and their applications are introduced at large.

UNIT-I **15 HOURS**
Velocity and acceleration of a particle along a curve, Radial & Transverse components (plane motion). Relative velocity and acceleration. Kinematics of a rigid body rotating about a fixed point. Vector angular velocity, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations. Composition of angular velocities. Moving axes.

UNIT-II **13 HOURS**
Newton's laws of motion, work, energy and power. Conservative forces, potential energy. Impulsive forces, rectilinear particle motion: Uniform accelerated motion, Resisted motion, Simple harmonic motion, Damped and forced vibrations, Projectile motion under gravity, constrained particle motion, angular momentum of a particle.

UNIT-III **14 HOURS**
The cycloid and its dynamical properties. Motion of a particle under a central force, Use of reciprocal polar coordinates, pedal- coordinates and equations. Kepler's laws of planetary motion and Newton's Law of gravitation.

UNIT-IV **15 HOURS**
Extrema of Functionals: The variation of a functional and its properties - Euler's equation - Field of externals - sufficient conditions for the Extremum of a Functional conditional Extremum Moving boundary problems, Brachistochrone problem, Extension of the vibrational method. Hamilton's Principle, Principle of Least action. Distinctions between Hamilton's Principle and the Principle of Least Action, Approximate solution of boundary value problems:-Rayleigh-Ritz Method, Galerkin's method Kantorovich and Treffiz method. Isoperimetric problems. Geodesics.

Reference Books:

1. Jackson, J. D. *Classical Electrodynamics*, New York: John Wiley and Sons, 1999.
2. Goldstein, H., *Classical Mechanics*, 2nd *Edition*, New Delhi: Narosa Publication, 2000.
3. Chorlton, F. *A Text Book of Dynamics*, New Delhi: CBS Publishers, 1985.
4. Fox, C. *An Introduction to the Calculus of Variation*, New York: Dover Publications York, 1987

DAV UNIVERSITY, JALANDHAR

L	T	P	Credits	Marks
4	0	0	4	100

Course Title: Differential Equation
Paper Code: MTH 505

Objective:

The objective of this course is to equip the students with knowledge of some advanced concepts related to differential equations and to understand some basic approach to mathematical oriented differential equation.

UNIT A **15 HOURS**

Review of fundamental of Ordinary differential equations. Applications of differential equations. Initial value problem and boundary value problem, mth order equation as a first order system. Concept of existence and uniqueness for the solution of the equation $\frac{dy}{dx} = f(x, y)$ with examples. A theorem on convergence of solution of a family of initial value problem. The method of successive approximation, general properties of solution of linear differential equation of order ***n*,** Ad joint and self-ad joint equations. Total differential equations. Simultaneous differential equations.

UNIT B **15 HOURS**

Sturm Liouville's boundary value problems, Sturm comparison and separation theorems. Eigen value problem and Sturm-Liouville problem, Stability of linear and non-linear systems, nonlinear conservative systems, Liapunov's direct method

UNIT C **15 HOURS**

First Order linear and quasi Partial differential equations, method of Lagrange's, Integral surface through a given curve, Surface orthogonal to given system of surfaces. Nonlinear Partial differential equations of first order, Cauchy's characteristic method and Jacobi's method.

UNIT D **15 HOURS**

Partial differential equations of the 2^{nd} order. Linear Partial differential equations with constant coefficients. Second order Partial differential equations with variable coefficients and their classification. Non-linear Partial differential equations of second order, Monge's method. Solution of linear hyperbolic equation, Solution of Laplace, Wave and diffusion equations by method of separation of variables. Dirichlet and Neumann problems, Green functions for elliptic, parabolic and hyperbolic equations.

References Books

1. George, F Simmons, *Differential equations with applications and historical notes*, New Delhi: Tata McGraw Hill, 1974.).
2. Ross S. L., *Differential Equation*s, New Delhi: John Wiley and Sons (2004).

3. Sneddon I. N., *Elements of Partial Differential Equations*, New Delhi: Tata McGraw Hill (1957).
4. Piaggio H. T. H., *Differential Equations*,New Delhi: CBS Publisher (2004).
5. Raisinghania, M.D. *Advanced Differential Equations*, New Delhi: S.Chand & Company Ltd. 2001

Course Title: Theory of Measure and Integration
Paper Code: MTH 506

L	T	P	Credits	Marks
4	0	0	4	100

Objective:

The objective of this course is to study measure in an abstract setting after having studied Lebesgue measure on real line. The general L^p spaces are also studied.

UNIT-I **14 Hours**

Lebesgue Measure: Introduction, Lebesgue outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebsegue measurability, Non-measurable sets. Littlewood's three principles.

UNIT-II **14 Hours**

Lebesgue Integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of a non-negative function, The general integral, Convergence and measures.

UNIT-III **14 Hours**

Differentiation and Integration: Differentiation of monotone functions, Functions of bounded variation, differentiation of an integral The Four derivatives, Lebsegue Differentiation Theorem. Absolute continuity. Convex Functions.

UNIT-IV **14 Hours**

The L^P-spaces, Minkowski and Holder inequalities, Convergence and Completeness of L^P spaces, Approximations in L^P spaces, Bounded linear functional on the L^P spaces.

Reference Books:

1. Rudin, W. *Principles of Mathematical Analysis 3rd Edition,* New Delhi: McGraw-Hill Inc. 1976.
2. Royden, H. L. *Real Analysis 3rd Edition*. New Delhi: Macmillan Publishing Company.

Course Title: Algebra-II
Paper Code: MTH 507

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
This course is a basic course in Algebra for students who wish to pursue research work in Algebra. Contents have been designed in accordance with the UGC syllabi in mind.

UNIT-I **14 Hours**
Canonical forms-Similarity of linear transformations. Invariant subspaces. Reduction to triangular form. Nilpotent transformations. Index of nil potency. Invariants of nilpotent transformations. The primary decomposition theorem. Jorden blocks and Jorden forms.

UNIT-II **14 Hours**
Fields, Examples, Algebraic and Transcendental elements. The degree of a field extension. Adjunction of roots. Splitting fields. Finite fields. Algebraically closed fields, Separable and purely inseparable extensions. Perfect fields.

UNIT-III **14 Hours**
Primitive elements, Lagrange's theorem on primitive elements. Normal extensions, Galois extensions. The fundamental theorem of Galois Theory.

UNIT-IV **14 Hours**
Modules and module homomorphism, sub module and quotient module, operation on sub modules, direct sum and product, finitely generated modules, exact sequences.

Reference Books:

1. Artin, M. *Algebra*, New Delhi: Prentice Hall of India Pvt. Ltd., 1994.
2. Luthar, I. S. and Passi, I. B. S. *Algebra Vol.4, Field Theory*, New Delhi: Narosa Publishing House, 2004.
3. Ian, Stewart. *Galois Theory* 3rd *Edition*, Capman & Hall, 2003.
4. Atiyah, M.F. and MacDonald, I.G. *Introduction to Commutative Algebra*, Levant Books, Indian Edition, 2007.

DAV UNIVERSITY, JALANDHAR

Course Title: Complex Analysis
Paper Code: MTH 504

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The objective of the course is to provide foundation for other related branches of Mathematics. Most of the topics covered are widely applicable in Applied Mathematics and Engineering.

UNIT-I **14 Hours**
Function of Complex variables, continuity and differentiability, Analytic functions, Conjugate function, Harmonic function, Cauchy Riemann equations (Cartesian and Polar form). Construction of analytic functions.

UNIT-II **14 Hours**
Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form. Cauchy's inequality. Poisson's integral formula, Morera's theorem. Liouville's theorem, conformal transformation, bilinear transformation, critical points, fixed points, Cross ratio problems.

UNIT-III **14 Hours**
Power series, Taylor's theorem, Laurent's theorem, Maximum modulus theorem (Principle), Schwarz's Lemma, poles and zero's of meromorphic functions, Argumenta principle, and Fundamental theorem of Algebra and Rouche's theorem.

UNIT-IV **14 Hours**
Zeros, Singularities, Residue at a pole and at infinity. Cauchy's Residue theorem, Jordan's lemma. Integration round Unit Circle. Evaluation of Integrals and integrations of many valued functions.

Reference Books:

1. Copson, E.T. *Theory of functions of complex variables*, U.K. Oxford University Press, 1970.
2. Ahlfors, L.V. *Complex Analysis 2nd Edition*, New Delhi: McGraw- Hill, 1966.
3. Narayan, Shanti and Mittal, P.K. *Theory of functions of a Complex variable*, New Delhi: Sultan Chand, 2007.
4. Conway, J.B. *Functions of one complex variable*, New York: Springer Verlang, 1978

Course Title: Differential Geometry
Paper Code: MTH- 509

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
To introduce students to Differential Geometry. Surfaces; the shape operator; principal, Gaussian and mean curvatures; minimal surfaces; geodesics.

Unit –I **14 HOURS**
Tangent, Principal normal, Curvature, Binormal, Torsion, Serret Frenet formulae, Locus of center of curvature, Spherical curvature, Locus of center of spherical curvature. Theorem: Curve determined by its intrinsic equations, Helices, Involutes & Evolutes.

Unit – II **14 HOURS**
Surfaces, Tangent plane, Normal, Curvilinear co-ordinates First order magnitudes, Directions on a surface, The normal, second order magnitudes, Derivatives of n, Curvature of normal section. Meunier's theorem, Principal directions and curvatures, first and second curvatures, Euler's theorem. Surface of revolution.

Unit – III **14 HOURS**
Conjugate directions, Asymptotic lines, Curvature and torsion of Asymptotic lines, Gauss's formulae, Gauss characteristic equation, Mainardi – Codazzi relations, Derivalives of angle

Unit – IV **14 HOURS**
Introduction to Geodesics, Canonical Geodesic Equation, Normal property of Geodesic, Equations of geodesics, Surface of revolution, Torsion of Geodesic, Bonnet's theorem, vector curvature, Geodesic curvature.

Reference Books:
1. Weatherburn, C.E. *Differential Geometry of Three Dimension*, New Delhi: Khosla Publishing House 2003.
2. Willmore, T.J. *Introduction to Differential Geometry*, Dover Publication Inc. 2012.
3. Do Carmo, Manifredo P. *Riemannian Geometry*, Birkhauser 2011.
4. Berger, M. *A Panoramic View of Riemannian Geometry*, Springer 2003.

Course Title: Number Theory
Paper Code: MTH-510

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The objectives of this course is to teach the fundamentals of different branches of Number Theory, namely, Geometry of Numbers and Analytic Number Theory.

UNIT-I **14 Hours**
Divisibility of Integers, Greatest common divisor, Euclidean algorithm. The Fundamental theorem of Arithmetic, Congruences, Residue classes and reduced residue classes.

UNIT-II **14 Hours**
Chinese remainder theorem, Fermat's little theorem, Wilson's theorem, Euler's theorem. Arithmetic functions $\sigma(n)$, $d(n)$, $\tau(n)$, $\mu(n)$, Order of an integer modulo *n*, primitive roots for primes, composite numbers having primitive roots, theory of indices.

UNIT-III **14 Hours**
Quadratic residues, Legendre symbol, Euler's criterion, Gauss's lemma, Quadratic reciprocity law, Jacobi symbol. Perfect numbers, Characterization of even perfect numbers, Elementary results on the distribution of primes, Twin primes, Mersenne primes and Fermat numbers.

UNIT-IV **14 Hours**
Representation of an integer as a sum of two and four squares. Diophantine equations $ax + by = c$, $x^2+y^2=z^2$, $x^4+y^4=z^4$. Farey sequences, continued Fractions.

Reference Books:

1. David, M. Burton *Elementary* Number Theory, 7th Edition New Delhi: Tata McGraw-Hill 2012.
2. Niven, I., Zuckeman, S. and Montgomery, H.L. *Introduction to Number Theory*, Wiley Eastern 1991.
3. Apostal, T.N. *Introduction to Analytic Number Theory*, Springer Verlag 1976.
4. Hardy, G.H. and Wright, E. M. *An Introduction to the Theory of Number*, U.K.:Oxford Univ. Press 2008..

Course Title: Computational Techniques
Paper Code: MTH 511

L	T	P	Credits	Marks
4	0	0	3	75

Objective:

The objective of this course is to teach the basics of computer and computer programming so that one can develop the computer program in C their own. For the purpose of learning programming skill, some Numerical methods which are extremely useful in scientific research are included. For practising the programmes of the numerical method, the course of practical has also been included in this paper. The contents of the curriculum have been designed keeping in view the UGC guidelines.

UNIT-I **14 Hours**

Ms Excel: Introduction, Functions and Formulae, Graphics and Data base. Programming in C: Historical development of C, Character set, Constants Variables, Keywords, Operators, Hierarchy of arithmetic operations, if and if –else statements, logical and computational Operators, Switch structure while structure , do-while and For-Loops, Nested Loops, Break and Continue statements,

UNIT-II **14 Hours**

Arrays, functions ,Print functions, Function Declaration and Function Prototype, Return Statement, Local and Global Variables, Passing Arrays as Parameter, Recursion and Library Function, Files in C, Introduction to pointers , Simple Programs.

UNIT-III **14 Hours**

Approximate numbers, Significant figures, rounding off numbers. Error Absolute, Relative and percentage.

Operators: Forward, Backward and Shift (Definitions and some relations among them).

Non-Linear Equations: Bisection, Regula-Falsi, Secant, Newton-Raphson, General Iteration Methods and their convergence, Methods for multiple roots, Newton-Raphson and General iteration, Methods for System of Non-Linear Equations

UNIT-IV **13 Hours**

Lagrange's interpolation, Newton Interpolation, Finite Difference Operators, Piecewise and Spline Interpolation. Numerical differentiation, Numerical integration: General formulae, Trapezoidal rule, Simpson's 1/3 and 3/8 rule.

Solution of Ordinary Differential Equations: Taylor's Series , Picard method of Successive approximation , Euler's Method, Modified Euler's Method , Runge Kutta Method 2^{nd} and 4^{th} order.

Reference Books:

1. Shastry, S. S. *Introductory Methods of Numerical Analysis*, PHI Learning Pvt. Ltd., 2005.
2. Xavier, C. *C Language and Numerical Methods*, New Age Int. Ltd., 2007.
3. Gerald, C.F. and Wheatley, P.O. *Applied Numerical Analysis, 7th Edition*, Pearson Education Asia. 2003

Course Title: Computational Techniques Laboratory
Paper Code: MTH 512

L	T	P	Credits	Marks
0	0	2	1	25

Writing Programs in C for the Problems based on the methods studied in theory paper and to run the Program on PC

- WAP on Numerical Integration.
- WAP on Trapezoidal and Simpson's rule
- WAP on on Gaussian Quadrature.
- WAP on Taylor Series method.
- WAP on Picard method.
- WAP on Runge-Kutta Methods
- WAP on Finite Difference Methods
- WAP on Predictor-Corrector Methods
- WAP on Approximations of Functions

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Course Title: Topology
Paper Code: MTH 601

L	T	P	Credits	Marks
4	0	0	4	100

Objective:

The course is an introductory course on point-set topology so as to enable the reader to understand further deeper topics in topology like Differential/Algebraic Topologies etc.

UNIT-I **14 HOURS**

Countable and uncountable sets, infinite sets and Axiom of choice, Cardinal numbers and their arithmetic. Schroeder-Bernstein Theorem, Cantor's theorem and the continuum hypothesis, Zorn's Lemma, Well-ordering theorem.

UNIT-II **14 HOURS**

Topological Spaces, **Examples of topological spaces:** the product topology, the metric topology, the quotient topology. Bases for a topology, the order topology, the product topology on X ×Y, the subspace topology. Open sets, closed sets and limit points, closures, interiors, continuous functions, homeomorphisms.

UNIT-III **14 HOURS**

Sequence, Connected spaces, connected subspaces of the real line, components and local connectedness. **Connectedness and Compactness:** Connected spaces, Connected subspaces of the real line, Components and local connectedness, Compact spaces, Compact space of the real line, limit point compactness, Heine-Borel Theorem, Local -compactness.

UNIT-IV **14 HOURS**

Separation Axioms: The Countability Axioms, The Separation Axioms, Hausdorff spaces, Regularity, Complete Regularity, Normal Spaces, Normality, Urysohn Lemma, Tychonoff embedding and Urysohn Metrization Theorem, Tietze Extension Theorem.
Tychnoff Theorem, One-point Compacti-fication.

Reference Books:

1. James, R. Munkers. *Topology*, Delhi: Prentice Hall of India, 2002.
2. James, Dugundji. *Topology*, USA: William C Brown Pub, 1990.
3. Kelley, J. L. *General Topology*,Van Nostrand: Springer 1975.
4. Bourbaki, N. *General Topology*, New York: Springer, 1989.
5. Simmons, G. F. *Introduction to Topology and Modern Analysis*, Tokyo: McGraw Hill, 1963.
6. Thron, W. J. *Topological structures* Holt, Canada: Rinehart and Winston, 1966.
7. Copson, E.T. *Metric Spaces*, New York: Cambridge University Press, 1963.
8. Willord, S. *General Topology*, Philippines: Addison Wesley Publishing Company, 1970.
9. Joshi, K. D. *Introduction to General Topology*, New Delhi: New Age International, 1983.

Course Title: Probability and Statistics
Paper Code: MTH 602

L	T	P	Credits	Marks
4	0	0	4	100

Objectives:
The course is designed to equip the students with various probability distributions and to develop greater skills and understanding of Sampling and estimation.

UNIT-I **15 Hours**
Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Discrete distributions: uniform, binomial, Poisson, geometric and negative binomial distributions and their properties. Continuous distributions: uniform, normal and exponential distributions and their properties.

UNIT-II **14 Hours**
Sampling Theory: Types of Sampling, errors in sampling, Parameter and Statistic, Tests of Significance: Null Hypothesis, Alternative Hypothesis, One-tailed, Two-tailed tests. Sampling Attributes: Tests of Significance for single proportion and difference of proportions. Sampling of Variables.

UNIT-III **14 Hours**
Sampling Distributions: Chi-Square Distribution, Moment generating function of Chi-Square and its applications. Student's't' distribution. ***F*** and ***Z*** distributions.

UNIT-IV **14 Hours**
Estimation Theory: Characteristics of Estimators, Efficient estimator, Most Efficient estimator, Minimum variance unbiased estimators. Methods of estimation.

Reference Books:

1. Gupta, S. C., and Kapoor, V. K. *Fundamentals of Mathematical Statistics*, New Delhi: Sultan Chand & Sons, 2002.
2. Baisnab, and Jas, M. *Element of Probability and Statistics*, New Delhi: Tata McGraw Hill, 2001.
3. Meyer, P. L. *Introductory Probability and Statistical Applications*, Philippines: Addison-Wesley Publishing Company, 1970.
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Course Title: Mathematical Methods
Paper Code: MTH 603

L	T	P	Credits	Marks
4	0	0	4	100

Objective:

To acquaint the students with the application of Laplace and Fourier Transform to Solve the Differential Equations.

UNIT-I **14 Hours**

Laplace Transform: Definition, existence and basic properties of the Laplace transform, Inverse Laplace transform, Convolution theorem, Laplace Transform solution of linear differential equation and simultaneous linear differential equation with constant coefficients, Complex inversion formula.

UNIT-II **15 Hours**

Fourier Transform: Definition, existence and basic properties, Inversion formula of Fourier transform Convolution theorem, Parseval's relation. Fourier transform of derivatives and integrals, Fourier sine and cosine transform, Inverse Fourier transform, Solution of linear ordinary differential equations and partial differential equations.

UNIT-III **14 Hours**

Volterra Equations: Integral equations and algebraic system of linear equations. Volterra equation L_2 Kernels and functions. Volterra equations of first and second kind. Volterra integral equation and linear differential equation.

UNIT-IV **13 Hours**

Fredholm Equations: Solution by the method of successive approximations. Solution of Fredholm integral equation for degenerate kernel; Examples, Faltung type(closed cycle type) integral equation, Singular integral equation; Solution of Abel's integral equation Neumann's series. Fredholm's equation with Pincherte-Goursat Kernel's.

Reference Books:

1. Kanwal, R. P. *Linear Integral Equations*, Boston: Birkhauser Boslon, 1996.
2. Pinckus, A, and Zafrany, S. *Fourier Series and Integral Transform*, New York: Cambridge University Press, 1997.
3. Mikhlin, S. G. *Integral equations and their applications to certain problems in Mechanics, Mathematical Physics and Technology*, Oxford: Pergamon Press, 1964.

Course Title: Operational Research-I
Paper Code: MTH 604

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The objective of this course is to acquaint the students with the concept of convex sets, their properties and various separation theorems so as to tackle with problems of optimization of functions of several variables over polyhedron and their duals. The results, methods and techniques contained in this paper are very well suited to the realistic problems in almost every area

UNIT-I **14 Hours**
Operations Research and its Scope. Necessity of Operations Research in industry Mathematical formulation of linear programming problem Linear Programming and examples, Convex Sets, Hyper plane, Open and Closed half-spaces, Feasible, Basic Feasible and Optimal Solutions, Extreme Point & graphical methods. Simple method, Charnes-M method, two phase method, Determination of Optimal solutions, unrestricted variables.

UNIT-II **14 Hours**
Duality theory, Dual linear Programming Problems, fundamental properties of dual Problems, Complementary slackness, unbounded solution in Primal. Dual Simplex Algorithm, Sensitivity analysis. Integer Programming- Branch and Bound Technique.

UNIT-III **14 Hours**
The General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, linear programming formulation, solution of transportation problem, test for optimality, degeneracy, transportation algorithm(MODI method), time minimization transportation problem. Assignment Problems: Mathematical formulation of assignment problem, the assignment method, typical assignment problem, the traveling salesman problem.

UNIT-IV **14 Hours**
Game Theory: Two-person zero sum games, maximin-minimax principle, games without saddle points (Mixed strategies), graphical solution of $2 \times n$ and $m \times 2$ games, dominance property, arithmetic method of $n \times n$ games, general solution of $m \times n$ rectangular games.

Reference Books:

1. Taha, H. A. *Operations Research - An Introduction*, New York: Macmillan Publishing Company Inc., 2006.
2. Swarup, K., Gupta, P. K., and Mohan, Man: *Operations Research*, New Delhi: Sultan Chand & Sons, 2001.
3. Bazaraa, M. S., and Shetty, C. M. *Nonlinear Programming, Theory & Algorithms*, New York: Wiley, 2004.
4. Sinha, S. M. *Mathematical Programming, Theory and Methods*, Delhi: Elsevier, 2006.
5. Mangasarian, O. L. *Nonlinear Programming*, Delhi: TATA McGraw Hill Company Ltd., 1969.
6. Hadley, G. *Linear Programming*, New Delhi: Narosa Publishing House, 1987.
7. Kambo, N. S. *Mathematical Programming Techniques*, New Delhi: Affiliated East-West Press Pvt. Ltd., 1984, Revised Edition, Reprint 2005.

Course Title: Fluid Mechanics-I
Paper Code: MTH 605

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The objective of this course is to introduce to the fundamentals of the study of fluid motion and to the analytical approach to the study of fluid mechanics problems.

UNIT-I **15 Hours**
Real fluids and ideal fluids, velocity of fluid at a point, streamlines, path lines, streak lines, velocity potential, vorticity vector, local and particle rate of change, equation of continuity, irrigational and rotational motion, acceleration of fluid, conditions at rigid boundary.

UNIT-II **14 Hours**
Euler's equation of motion, Bernoulli's equation, their applications, Potential theorems, axially symmetric flows, impulsive motion, Kelvin's Theorem of circulation, equation of vorticity.

UNIT-III **13 Hours**
Some three dimensional flows: sources, sinks and doublets, images in rigid planes, images in solid sphere, Stoke's stream function.

UNIT-IV **13 Hours**
Two dimensional flows: complex velocity potential, Milne Thomson Circle Theorem and applications, Theorem of Blasius, vortex rows, Karman Vortex Street.

Reference Books:

1. Charlton, F. *Text Book of Fluid Dynamics*, Delhi: CBS Publishers, Indian Edition, 2004.
2. Landau, and Lipschitz, E. N. *Fluid Mechanics*, London: Pergamon Press Ltd., 1987.
3. Batchelor, G. K. *An Introduction to Fluid Mechanics*, New York: Cambridge University Press, 1967.
4. Kundu, and Cohen. *Fluid Mechanics*, Delhi: Harcourt (India) Pvt.Ltd., 2003.

Course Title: DISCRETE MATHEMATICS
Paper Code: MTH-606

L	T	P	Credits	Marks
4	0	0	4	100

Objectives:
The objective of this course is to acquaint the students with the concepts in Discrete Mathematics. It includes the topics like Logics, Graph Theory, Trees and Boolean algebra.

UNIT-I **13 HOURS**
Basic logical operations, conditional and bi-conditional statements, tautologies, contradiction, Quantifiers, prepositional calculus. Recursively Defined Sequences. Solving Recurrence Relations. The Characteristic Polynomial. Solving Recurrence Relations: Generating Functions. Basics of Counting and the Pigeon-hole Principle.

UNIT-II **14 HOURS**
Language and Grammars: Computability and Formal Languages. Ordered sets, languages. Phrase structure grammars. Types of grammars and languages. **Finite state machines**-equivalent machines. Finite state machines as language recognizers. **Analysis of algorithm**-Time complexity. Complexity of problems.

UNIT-III **15 HOURS**
Graphs and Planar Graphs: Basic Terminology, Special types of Graphs. The Handshaking Theorem, Paths and Circuits Shortest paths. Connectivity of Graphs. Isomorphism of Graphs. Homeomorphic Graphs. Eulerianand Hamiltonian Graphs. Planar and Non Planar Graphs. Euler's formula. Graph Coloring. Adjacency and Incidence Matrices. Travelling Salesman Problem.

UNIT-IV **14 HOURS**
Trees: Basic Terminology. Binary Trees. Tree Traversing: Preorder, Postorder and Inorder Traversals. Minimum Spanning Trees, Prim's and Kruskal's Alogrithm. **Boolean AIgebras**: Boolean Functions, Logic Gates, Lattices and Algebraic Structures.

Reference Books:

1. Rosen, K. H. *Discrete Mathematics and its Applications*, Delhi: McGraw Hill, 2007.
2. Joshi , K. D. *Foundation of Discrete Mathematics*, Delhi: J. Wiley & Son's, 1989
3. Malik, D. S., and Sen, M. K. *Discrete Mathematical Structures Theory and Applications*, Thomson/Course Technology, 2004.
4. Liu, C. L. *Elements of Discrete Mathematics***,** Delhi: McGraw Hill, 1986.

DAV UNIVERSITY, JALANDHAR

Course Title: Finite Element Analysis
Paper Code: MTH 607

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The aim of this course is to make the students learn fundamental concepts of finite elements so as to enable the students to understand further topics related to solution of differential equations. Finite element analysis is a helpful tool to solve a variety of problems of science and engineering related to fluid flows, structures etc.

UNIT I **13 HOURS**
General theory of finite element methods, Difference between finite element and finite difference, Review of some integral formulae, Concept of discretization, Convergence requirements, Different coordinates, One dimensional finite elements, shape functions, stiffness matrix, connectivity, boundary conditions, equilibrium equation, FEM procedure.

UNIT II **15 HOURS**
Generalization of the finite element concepts-weighted residual and variationalApproaches (Ritz method, Galerkin method, collocation method etc.) Numerical integration, Interpolation formulas and shape functions, Axis symmetric formulations, solving one-dimensional problems.

UNIT III **13 HOURS**
Two dimensional finite element methods, Element types: triangular, rectangular, quadrilateral, sector, curved, isoperimetric elements and numerical integration, two dimensional boundary value problems, connectivity and nodal coordinates, theory of elasticity, variational functions, triangular elements and area coordinates, transformations, cylindrical coordinates.

UNIT IV **15 HOURS**
Three dimensional finite elements, higher order finite elements, element continuity, plate finite elements, Application of finite element methods to elasticity problems and heat transfer problems, Computer procedures for Finite element analysis.

Reference Books:

1. Braess, D., Schumaker and Larry L. *Finite Elements: Theory, Fast Solvers, and Applications in Solid Mechanics*, New York: Cambridge University Press, 2001.
2. Desai C. S. *Introductory Finite Element Method*, Boca Raton: CRC Press, 2001.
3. Smith, G. D. *Numerical solution of Partial Differential Equations*, Oxford: Clarendon Press, 1986.
4. Bradie, B. *A friendly introduction to Numerical Analysis*, Delhi: Pearson, 2005.
5. Reddy, J. N. *An introduction to Finite Element Methods*, Delhi: McGraw-Hill Higher Education, 2005.

Course Title: Fuzzy Sets and Fuzzy Logic
Paper Code: MTH 608

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The objective of this course is to acquaint the students with the concept of fuzzy logics.

UNIT-I **15 HOURS**
Fuzz Sets-Basic definitions. α-level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference. T-norms and t-conorms. The Extensions Principle- The Zadeh's extension principle. Image and inverse image of fuzzy sets. Fuzzy Numbers. Elements of fuzzy arithmetic.

UNIT-II **14 HOURS**
Fuzzy Relations and Fuzzy Graphs-Fuzzy, relations on fuzzy sets. Composition of fuzzy relations. Min-Max composition and its properties. Fuzzy Equivalence relations. Fuzzy compatibility relations. Fuzzy relation equations. Fuzzy graph. Similarity relations.

UNIT-III **13 HOURS**
Possibility Theory-Fuzzy measures. Evidence theory. Necessity measures. Possibility measures. Possibility distribution. Possibility theory and fuzzy sets.

UNIT-IV **14 HOURS**
Fuzzy logic- An overview of classical logic, Multivalued logics. Fuzzy propositions. Fuzzy Quantifiers. Linguistic variables and hedges. Inference from conditional fuzzy propositions, the compositional rule of inference.

Reference Books:

1. Zimmermann, H. J. *Fuzzy set theory and its Applications,* New Delhi: Allied Publishers Ltd., 1991.
2. Klir G. J., and Yuan, B. *Fuzzy sets and fuzzy logic*, New Delhi: Prentice-Hall of India, 1995.

DAV UNIVERSITY, JALANDHAR

Course Title: Advanced Complex Analysis
Paper Code: MTH-609

L	T	P	Credits	Marks
4	0	0	4	100

Objectives:
This course is designed to enable the readers to understand further deeper topics of Complex Analysis and will provide basic topics needed for students to pursue research in pure Mathematics.

Unit –I **15 HOURS**

Harmonic function: Definition, Relation between a harmonic function and an analytic function, Examples, Harmonic Conjugate of a harmonic function, Poisson's Integral formula, Mean Value Property, The maximum & minimum principles for harmonic functions, Diritchlet Problem for a disc and uniqueness of its solution, Characterization of harmonic functions by Mean Value Property.

Unit –II **14 HOURS**

Analytic continuation: Direct Analytic continuation, Analytic continuations along arcs, Homotopic curves, The Monodromy theorem, Analytic continuation via reflection. Harneck's principle. Open mapping theorem, normal families, The Riemann Mapping Theorem, Picard's theorem.

Unit –III **15 HOURS**

Weierstrass Elliptic functions: Periodic functions, Simply periodic functions, fundamental period, Jacobi's first and second question, Doubly periodic functions, Elliptic functions, Pair of Primitive Periods, Congruent points, First and Second Liouville's Theorem, Relation between zeros and poles of an elliptic function, Definition of Weierstrass elliptic function (z) and their properties, The differential equation satisfied by (z) [i.e., the relation between (z) and (z)], Integral formula for (z),Addition theorem and Duplication formula for (z).

Unit –IV **13 Hours**

Weierstrass Zeta function: Weierstrass Zeta function and their properties, Quasi periodicity of (z), Weierstrass sigma function (z) and their properties, Quasiperiodicity of (z), associated sigma functions.

Reference Books:

1. Conway, J. B. *Functions of one Complex variable*, USA: Springer-Verlag, International, 1978.
2. Ahlfors, L.V. *Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable*, Delhi: McGraw-Hill Higher Education, 1979.
3. Lang S.**,** Complex Analysis, New York: Springer, 2003.
4. Walter R. *Real and Complex Analysis*, New Delhi: McGraw- Hill Book Co., 1986.
5. Ponnusamy, S. *Foundations of Complex Analysis*, New Delhi: Narosa Publication House, 1995.

DAV UNIVERSITY, JALANDHAR

Course Title: Advance Theory of Partial Differential Equations and Sobolev Spaces
Paper Code: MTH 610

L	T	P	Credits	Marks
4	0	0	4	100

Objectives:
The objective of this course is to equip the students with knowledge of some basic as well as advanced concepts related to partial differential equations and to understand some basic approach to mathematical oriented PDEs.

UNIT-I **15 HOURS**
Distribution-Test Functions and Distributions, Examples, Operations on Distributions, Supports and Singular Supports, Convolution, Fundamental Solutions, Fourier Transform, Schwartz space, Tempered Distributions.
Sobolev spaces-Basic properties, Approximation by smooth functions, Extension theorems, Compactness theorems, Dual spaces, Functional order spaces, Trace spaces, Trace theory, Inclusion theorem.

UNIT-II **14 HOURS**
Weak solutions of Elliptic Boundary Value Problems-Variational problems, Weak formulation of Elliptic PDE, Regularity, Galerkin Method, Maximum principles, Eigenvalue problems, Introduction to finite element methods.
Evolution Equations- Unbounded linear operators, C_0 – Semigroups, Hille-Yosida theorem, Contraction Semigroup on Hilbert Spaces, Heat equation, Wave equation, Schrodinger equation, Inhomogeneous equations.

UNIT-III **13 HOURS**
Calculus of Variations-Euler-Lagrange Equation, Second variation, Existence of Minimizers(Coactivity, Lower Semi-continuity, Convexity), Regularity, Constraints(Nonlinear Eigenvalue problems, Variational Inequalities, Harmonic maps, Incompressibility), Critical points(Mountain Pass theorem and Applications to Elliptic PDE).

UNIT-IV **14 HOURS**
Nonvariational Methods-Monotonicity Methods, Fixed Point Theorems, Sub and Super solutions, Geometric properties of solutions(Radial Symmetry) Nonexistence of solutions, Gradient Flows. Hamilton-Jacobi Equations-Viscosity solutions, Uniqueness, Control theory, Dynamic programming. System of Conservation Laws-Integral Solutions, Travelling waves, hyperbolic systems, Riemann's problem, System of two conservation laws, Entropy criteria.

Reference Books:

1. Kesavan, S. *Topics in Functional Analysis and Application.,* New Delhi: Wiley-Eastern, New International, 1999.
2. Evans, L. C. *Partial Differential Equations. Graduate Studies in Mathematics*, Providence: AMS, 1998

DAV UNIVERSITY, JALANDHAR

Course Title: Functional Analysis
Paper Code: MTH 611

L	T	P	Credits	Marks
4	0	0	4	100

Objective:

The objective of this course is to introduce basic concepts, methods of Functional Analysis and its Applications. It is a first level course in Functional Analysis.

UNIT-I **10 HOURS**

Metric Spaces: Metric spaces with examples, Holder inequality and Minkowski inequality, Open set, Closed set, Neighbourhood, Various concepts in a metric space, Separable metric space with examples, Convergence, Cauchy sequence, Completeness, Examples of Complete and Incomplete metric spaces, Completion of Metric spaces.

UNIT-II **14 HOURS**

Normed / Banach Spaces: Vector spaces with examples, Normed Spaces with examples, Banach Spaces & Schauder Basis, Finite Dimensional Normed Spaces and Subspaces, Compactness of Metric/Normed spaces, Linear Operators- definition and examples, Bounded linear operators in a Normed Space, Bounded linear Functionals in a Normed space, Concept of Algebraic Dual and Reflexive space, Dual Basis and Algebraic Reflexive Space, Dual spaces with examples.

UNIT-III **14 HOURS**

Inner-Product Space & Hilbert Space: Inner Product and Hilbert space, Further properties of Inner product spaces, Projection Theorem, Orthonormal Sets and Sequences, Total Orthonormal Sets and Sequences, Separable Hilbert Spaces, Representation of functionals on a Hilbert Spaces (Riesz's Lemma and Representation), Hilbert Adjoint Operator, Self Adjoint, Unitary & normal Operators.

UNIT-IV **12 HOURS**

Fundamental Theorems for Normed & Banach Spaces: Partially Ordered Set and Zorn's Lemma, Hahn Banach Theorem for Real Vector Spaces, Hahn Banach Theorem for Complex Vector Spaces and Normed Spaces, Baire's Category and Uniform Boundedness Theorems, Open Mapping Theorem, Closed Graph Theorem, Adjoint Operator, Strong and Weak Convergence, Convergence of Sequence of Operators and Functionals, Banach Fixed Point Theorem

Reference Books:

1. Kreyzig, E., *Introductory Functional Analysis with Applications*, Jaohn Willey and Sons, New York, 1989.
2. Limaye, B. V. *Functional Analysis,* New Age International (P) Ltd, New Delhi, 1996.
3. Siddiqui, A. H. *Functional Analysis with Applications*, Tata-McGraw Hill, New Delhi,1987.
4. Walter, W. *Functional Analysis,* Tata-McGraw Hill Pub. Co.
5. Nair, M. T., *Functional Analysis-A First Course*, Prentice- Hall of India Private Limited, New Delhi, 2008.
6. Maddox, I.J., *Elements of Functional Analysis*, Cambridge University Press.

Course Title: Differential Geometry of Manifolds
Paper Code: MTH 612

L	T	P	Credits	Marks
4	0	0	4	100

Objective:

This course is designed to enable the readers to understand advanced topics of Topology and will provide basic topics needed for students to pursue research in pure Mathematics.

UNIT-I **14 Hours**

Topological groups, Lie groups and lie algebras. Product of two Lie-groups, One parameter subgroups and exponential maps. Examples of Lie groups, Homomorphism and Isomorphism, Lie transformation groups, General Linear groups.

UNIT-II **14 Hours**

Principal fibre bundle, Linear frame bundle, Associated fibre bundle, Vector bundle, Tangent bundle, Induced bundle, Bundle homomorphism.

UNIT-III **14 Hours**

Sub-manifolds, induced connection and second fundamental form. Normals, Gauss formulae, Weingarten equations, Lines of curvature, Generalized Gauss and Mainardi–Codazzi equations.

UNIT-IV **14 Hours**

Almost Complex manifolds, Nijenhuis tensor, Contravariant and covariant almost analytic vector fields, F-connection.

Reference Books:

1. Sinha, B. B. *An Introduction to Modem Differential Geometry*, New Delhi: Kalyani Publishers, 1982.
2. Yano, K., and Kon, M. *Structure of Manifolds*, Chennai: World. Scientific Publishing Co. Pvt. Ltd., 1984.
3. Matsushima, Y. *Differentiable Manifolds*, Dekker, 1972.

Course Title: Operational Research-II
Paper Code: MTH 613

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
To acquaint the students with the concepts of convex and non-convex functions, their properties, various optimality results, techniques to solve nonlinear optimization problems and their duals over convex and non-convex domains.

UNIT-I **15 HOURS**

Queuing Theory: Introduction, Queuing System, elements of queuing system, distributions of Arrivals, inter arrivals, departure service times and waiting times. Classification of queuing models, Queuing Models**:** (M/M/1): (∞/FIFO), (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process, (M/M/C): (∞/FIFO), (M/M/C) (N/FIFO).

UNIT-II **14 HOURS**

Inventory Control: The inventory decisions, costs associated with inventories, factors affecting Inventory control, Significance of Inventory control, economic order quantity (EOQ), and Deterministic inventory problems with-out shortage and with shortages, EOQ problems with Price breaks, Multi item deterministic problems. Processing of n jobs through two machines, The Algorithm, Processing of n jobs through m machines, Processing of two jobs through m machines.

UNIT-III **13 HOURS**

Network Analysis-Shortest Path Problem, Minimum Spanning Tree Problem, Maximum Flow Problem, Minimum Cost Flow Problem, Network Simplex Method, Project scheduling by PERT/CPM: Introduction, Basic differences between PERT and CPM, Steps of PERT/CPM Techniques, PERT/CPM network Components and Precedence Relationships, Critical Path analysis, Probability in PERT analysis, Project Crashing, Time cost Trade-off procedure, Updating of the Project, Resource Allocation.

UNIT-IV **14 HOURS**

Non Linear Programming –One and Multi Variable Unconstrained Optimization, Kuhn-Tucker Conditions for Constrained Optimization, Quadratic Programming ,Separable Programming Convex programming. Non Convex Programming.

Reference Books:

1. Taha, H. A. *Operations Research - An Introduction* (8th edition), New York: Macmillan Publishing Co. 2006.
2. Gupta, Swarup, and Manmohan. *Operations Research.* New Delhi: Sultan Chand & Sons.
3. Hadly, G. *Non-Linear and Dynamic Programming.* New Delhi: Addision Wesley, Reading Mass. 1967.
4. Hadly, G. *Linear Programming*. New Delhi: Narosa Publishing House. 1963.
5. Rao, S. S. *Optimization theory and Applications* (4th edition). New Delhi: Wiley Eastern Ltd. 2009.

Course Title: Advanced Numerical Analysis
Paper Code: MTH 615

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to do programming in MATLAB and understand the basic concepts in Numerical Analysis of differential equations.

UNIT-I **15 HOURS**
Finite difference approximation to partial derivatives, parabolic equations: An explicit method, Crank Nicolson Implicit method, solution of implicit equations by Gauss Elimination, derivative Boundary conditions, local truncation error, Convergence and stability, Multi-dimensional search without using derivatives, the Method of Rosen brock, Cyclic coordinate method, Method of Hooke and Jeeves and their convergence.

UNIT-II **14 HOURS**
Hyperbolic equations: Implicit difference methods for wave equation solution of advection equation by finite difference method and Maccormack method, stability analysis, Lax, Wendroff explicit method on rectangular mesh for 1st order equations, Iterative methods for elliptic equations.

UNIT-III **14 HOURS**
Numerical Differentiation, Trapezoidal and Simpson's one third, Simpson's three eight rule for Numerical integration, adaptive Integration, Boole, Weddle rule, Double integration.
Multidimensional search using derivatives, Steepest Descent algorithm and its convergence analysis, Newton's method and modified Newton's method. Methods using conjugate directions: the method of Davidon-Fletcher- Powell (DFP) method, the Broyden-Fletcher-Goldfarb-Shanno (BFGS) method

UNIT-IV **14 HOURS**
Constrained optimization: Indirect methods, the concept of penalty functions, exterior penalty function method (EPF), exact absolute value and augmented Lagrangian Penalty methods and their convergence analysis. Direct methods, successive linear programming approximation (SLP), successive quadratic programming approximation (SQP), gradient project method of Rosen, generalized reduced gradient method (GRG), convex simplex algorithm of Zangwill

Reference Books:

1. Smith, G. D. *Numerical solution of Partial Differential Equations: Finite Difference Methods, third edition.* New York, NY: Oxford University Press, 1985.
2. Bradie, B. *A friendly introduction to Numerical Analysis.* Delhi: Pearson Education, 2007.
3. Reddy, J.N. *An Introduction to Finite Element Methods.* Delhi: McGraw-Hill, 2000.
4. Bazaraa, M.S., Sherali, H.D. and Shetty, C.M. *Nonlinear Programming Theory and Algorithms.* Delhi: John Wiley and Sons, 2004.

Course Title: Wavelets Analysis
Paper Code: MTH 616

L	T	P	Credits	Marks
4	0	0	4	100

Objectives:
The course is an introductory course on Wavelets so as to enable the students to understand further topics related to solution of differential equations. Wavelets are a helpful tool to solve a variety of problems of science and engineering such as image processing, cloud computing etc.

UNIT I **15 HOURS**
Preliminaries, Different ways of constructing wavelets-Orthonormal bases generated by a single function, the Balian-Low theorem. Smooth projection on $L^2(R)$. Local sine and cosine bases and the construction of some wavelets. The unitary folding operators and the smooth projections. Multiresolution analysis and construction of wavelets. Construction of compactly supported wavelets and estimates for its smoothness. Band limited wavelets.

UNIT II **15 HOURS**
Orthonormality. Completeness. Characterization of Lemare-Meyer wavelets and some other Characterizations. Franklin wavelets and spline wavelets on the real line. Orthonormal bases of piecewise linear continuous functions for $L^2(T)$. Orthonormal bases of periodic splines. Periodization of wavelets defined on the real line.

UNIT III **14 HOURS**
Characterization in the theory of wavelets- The basic equations and some of its applications. Characterizations of MRA Wavelets, low pass filters and scaling functions. Non-existence of smooth wavelets in $H^2(R)$. Frames-The reconstruction formula and the Balian-Low theorem for frames. Frames from translation and dilation. Smooth frames for $H^2(R)$.

UNIT IV **13 HOURS**
Discrete transforms and algorithms-The discrete and fast Fourier transforms. The discrete and fast cosine transforms. The discrete version of the local sine and cosine bases. Decomposition and reconstruction algorithms for wavelets.

Reference Books:

1. Goswami, J.C. and Chan A.K. *Fundamentals of wavelets: Theory, Algorithms and Applications.* New York: Wiley, 1999.
2. Chui, C.K. *An Introduction to wavelets.* San Diego: Academic Press, 1992.
Hackbusch, W. *Multigrid Methods and Applications*. Berlin: Springer-Verlag, 1985.

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DAV UNIVERSITY, JALANDHAR

Course Title: Fluid Mechanics-II
Paper Code: MTH 617

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
This course is designed to make the students learn to develop mathematical models of fluid dynamical systems and use mathematical techniques to find solutions to these models.

UNIT-I **13 HOURS**
Stress components, Stress and strain terror, coefficient of viscosity and Laminar flow, plane Poiseuille flows and Couette flow.

UNIT-II **13 HOURS**
Flow through tubes of uniform cross section in the form of circle, Ellipse, equilateral triangle, annulus, under constant pressure gradient.

UNIT-III **15 HOURS**
Diffusion of vorticity. Energy dissipation due to viscosity, steady flow past a fixed sphere, dimensional analysis, Reynolds numbers, Prandtl's boundary layer. Boundary layer equation in two dimensions, Karman integral equation.

UNIT-IV **14 HOURS**
Elements of wave motion, waves in fluids, Surface gravity waves, standing waves, group velocity, energy of propagations, path of particles, waves at interface of two liquids.

Reference Books:

1. Charlton, F. *Text Book of Fluid Dynamics*. New Delhi: CBS Publishers, Indian Edition, 2004.
2. Landau, L.D. and Lipschitz, E.M. *Fluid Mechanics*. London: Pergamon Press, 2nd edition, Vol. 6, 1985.
3. Batchelor, G. K. *An Introduction to Fluid Mechanics*. Cambridge: Cambridge University Press, 1967.
4. Kundu, P.K. and Cohen I.M. *Fluid Mechanics*. Delhi: Indian Reprint, Published by Harcourt (India) Pvt. Ltd., 2003.

DAV UNIVERSITY, JALANDHAR

Course Title: Special functions
Paper Code: MTH 618

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The objective of this course is to introduce the special function as a solution of specific differential equations.

UNIT-I **14 HOURS**
Legendre polynomial it's generating function; Rodrigue's formula, recurrence relations and differential equations satisfied by it; its orthogonality, expansion of a function in a series of Legendre Polynomials.

UNIT-II **12 HOURS**
Adjoint equation of n-the order: Lagrange's identity, solution of equation from the solution of its adjoint equation, self-adjoint equation, Green's function.

UNIT-III **15 HOURS**
Hypergoemetric and Generalized Hypergeometric functions: Function 2F1 (a,b;c;z) A simple integral form evaluation of 2F1 (a,b;c;z) Contiguous function relations, Hyper geometrical differential equation and its solutions, F (a,b;c;z) as function of its parameters, Elementary series manipulations, Simple transformation, Relations between functions of z and 1 –z

UNIT-IV **14 HOURS**
Series Solution : Ordinary point and singularity of a second order linear differential equation in the complex plane; Fuch's theorem, solution about an ordinary point, solution of Hermite equation as an example; Regular singularity, Frobenius' method – solution about a regular singularity, solutions of hypergeometric, Legendre, Laguerre and Bessel's equation as examples.

Reference Books:

1. Rainville, E.D. *Special Functions.* New York: The Macmillan co., 1971.
2. Lebdev, N.N. *Special Functions and Their Applications*. New Jersey: Prentice Hall, Englewood Cliffs, 1995.
3. Saran, N. Sharma, S.D. and Trivedi, T.N. *Special Functions with Application*. Meerut: Pragati Prakashan, 7th Edition, 2000.
4. Srivastava, H.M. Gupta, K.C. and Goyal, S.P. *The H-functions of One and Two Variables with Applications*. New Delhi: South Asian Publication, 1982.

DAV UNIVERSITY, JALANDHAR

Course Title: Algebraic Topology
Paper Code: MTH 619

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
The objective of this course is to introduce the

UNIT-I **14 HOURS**
The Fundamental group: Homotopy of paths, Homotopy classes, The Fundamental group, change of base point, Topological invariance, covering spaces, The Fundamental group of the circle.

UNIT-II **12 HOURS**
Retractions and fixed points, No Retraction Theorem, The Fundamental theorem of Algebra, The Borsuk - Ulam theorem, The Bisection theorem, Deformation Retracts and Homotopy type, Homotopy invariance.

UNIT-III **15 HOURS**
Direct sums of Abelian Groups, Free products of groups, uniqueness of free products, least normal subgroup, free groups, generators and relations, The Seifert-Van Kampen theorem, also classical version, The Fundamental group of a wedge of circles.

UNIT-IV **14 HOURS**
Classification of covering spaces: Equivalence of covering spaces, The general lifting lemma, the universal covering space, covering transformation, existence of covering spaces.

Reference Books:

1. Munkres, James R. *Topology*. New Jersey: Prentice Hall, Upper Saddle River, 2000.
2. Dieck, T. T. *Algebraic Topology*. London: European Mathematical Society, 2008.
3. Hatcher, A.E. *Algebraic Topology.* Cambridge: Cambridge University Press, 2002

Course Title: Mathematics for Chemists
Paper Code: MTH-560

L	T	P	Credits	Marks
4	0	0	4	100

Objective: To provide the understanding and use of mathematical techniques for various chemistry concepts.

UNIT-A **15 HOURS**

Matrices, Operations on Matrices, Determinants, Properties of determinants, Singular and non-singular matrices, Adjoint and Inverse of a matrix, Rank of Matrix, The solution of linear equations Basic idea of linear transformation, orthogonal matrices and orthogonal transformations, Symmetry operations, The Eigen value problem, Properties of the Eigen vectors, Matrix Diagonalization

UNIT-B **14 HOURS**

Limit and continuity, Differentiation from first principle, Differentiation by rule, Implicit functions, Logarithmic differentiation, successive differentiation Stationary points, Linear and angular motion. Integral as anti derivative. Integration by substitution, by partial fractions and by parts. The method of partial fractions, parametric differentiation of integrals Definite integral and its properties. Areas of bounded regions Reduction formulas, rational integrands. Static properties of matter.

UNIT-C **13 HOURS**

Basic concepts, Scalar product, Vector product, Vector differentiation, Arc length. Line, Surface and Volume integrals. The gradient, divergence and curl. The Del operator. Green's, Gauss' and Stokes' theorems (statements only)

UNIT-D **14 HOURS**

Permutation and Combination: Idea of Factorial notation for natural numbers, Fundamental principle of counting, basic concept of Permutation, Basic concept of Combination
Probability and probability theorems**:** introduction to probability, addition theorem of probability, multiplication theorem of probability.

Reference Books:

1. Grewal, B. S., *Higher Engineering Mathematics*. New Delhi: Khanna Publishers, 2007.
2. Kreyszig, Erwin, *Advanced Engineering Mathematics*. New Delhi: Wiley Eastern Ltd., 2003.
3. Dence, Joseph B., *Mathematical Techniques in Chemistry*. New Delhi: Wiley, 1975.
4. Narayan, Shanti and Mittal, P. K., *A Text Book of Matrices.* New Delhi: S. Chand & Co. Ltd., 2002.

Course Title: Numerical Analysis
Paper Code: MTH 551

L	T	P	Credits	Marks
4	1	0	4	100

Objective:
The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to do programming in MATLAB and understand the basic concepts in Numerical Analysis of differential equations.

UNIT-A **15 HOURS**
Approximate numbers, Significant figures, rounding off numbers. Error Absolute, Relative and percentage.
Algebraic and transcendental equations: Review of some concepts, Solution of algebraic and transcendental equations: Bisection method, Regula Falsi, Newton Raphson, Lin Barstow's, convergence.
Systems of simultaneous Equations: Crammer's rule, Gauss elimination, Gauss Jordon method, Matrix inversion method, Iterative methods: Jacobi method and Gauss-Seidel method, partition method, Eigenvalues and Eigen vectors: Cayley Hamilton theorem, Power method for finding largest Eigen value.

UNIT –B **13 HOURS**
Finite Difference Methods: Forward, Backward, Central differences, Newton's forward, backward and divided difference formulae, Gauss, Stirling, Bessel central difference formulae.

UNIT –C **14 HOURS**
Numerical Differentiation and Numerical Integration: Numerical Differentiation, Trapezoidal and Simpson's one third, Simpson's three eight rule for numerical integration, adaptive integration, Taylor's series method, Euler, modified Euler method, Runge-Kutta methods, Boole, weddle rule, Double integration.

UNIT –D **14 HOURS**
Ordinary and Partial Differential Equations: Solution of second and higher order differential equations, boundary value problems, Solution of partial differential equations: Laplace, Heat, Wave equation.

Reference Books:

1. Atkinson, K.E. *An Introduction to Numerical Analysis*. New Delhi: Wiley, 1989.
2. Eriksson, K., Estep, D., Hansbo, P. and Johnson, C. *Computational Differential Equations.* Cambridge: Cambridge Univ. Press, 1996.
3. Golub, G.H. and Ortega, J.M. *Scientific Computing and Differential Equations: An Introduction to Numerical Methods*. London: Academic Press, 1992.
4. Conte, S.D. and Boor, C.D. *Elementary Numerical Analysis, An Algorithmic Approach***.** New Delhi: Tata McGraw Hill, 1981.
5. Jain, M.K. *Numerical Analysis for Scientists and Engineers*. New Delhi: S.B.W. Publishers, 1971

Course Title: Computer Fundamentals and Office Automation
Course Code: CSA551
Course Duration: 45 Hours

L	T	P	Credits	Marks
4	0	0	3	75

Course Objective: The objective of this course is to develop understanding of different software and hardware systems available in industry among the participants and to build up the experience of computer usage in business organizations with specific reference to commercial data processing systems.

UNIT – A **11 Hours**

Computer Fundamentals and Number System

- Block Structure of a Computer
- Characteristics of Computers
- Generations of Computers, Uses of Computers
- Classification of Computers
- Input-Output Devices, Memory and Mass Storage Devices
- Bit, Byte, Binary, Decimal, Hexadecimal, and Octal Systems, Conversion from One System to the other

UNIT – B **11 Hours**

Computer Software , Network & Communication

- Application and system software
- Programming languages and their classification
- Assemblers, compilers and interpreters, Process of software development
- Operating systems: functions of operating systems
- Network topologies
- Network communication devices, Physical communication media
- Network protocol (TCP/ IP)
- Internet and its applications: e-mail, TELNET, FTP, World Wide Web, Internet chatting

UNIT – C **12 Hours**

Word Processing and Spreadsheets

- Editing and Formatting a Document, Text Formatting, Paragraph Formatting, Headers and Footers
- FIND command & REPLACE command, Checking Spelling and Grammar; On-line Spelling and Grammar correction using Auto correct, Auto Text, Using Thesaurus, Using Clip Gallery
- Inserting Graphics From files, Working with Tables - Entering Text in the Table, Creating Table, Changing Format of Text of cells, Changing Column width and Row height, Formatting Table Border
- Using Mail Merge - Mail Merge Procedure, Printing a document
- Basic Operations - Arithmetic operators, Comparison operators, Text operator & (ampersand) Reference operator
- Modifying the worksheet layout - Changing Width of Column,

Changing Height of Row, Deleting Rows/Columns/Cells, Moving and copying contents of cell, Alignment of text in the cell

- Working with functions - Date and time function, Statistical function, Financial function, Mathematical and Trigonometric functions, Lookup and Reference Functions, Data Base functions, Text function, Logical functions
- Printing the workbook - Setting up Print Area, Setting up Margins, Defining Header and Footer, Controlling Gridlines
- Introduction to CHARTS - Formatting Charts

UNIT – D 11 Hours

Presentations and DBMS

- Creating a presentation slide, Design Templates and Blank presentations, Power Point standard toolbar buttons
- Changing Font, Font Size and Bold; Moving the frame and inserting clip art; Different slide layouts; Formatting the Slide Design; Work with the Slide Master; Saving the presentation
- The Auto Content Wizard; Using Existing Slides; Using the different views of a slide, Adding Transitions and Animation, Running Slide Show
- Adding and Deleting Records
- Creating, Saving , Editing, Joining Tables in Queries
- Creating and Using Forms
- Creating and Printing Reports

Reference Books:

1. Kumar, K., and Rajkumar, R. *Computer Applications in Business*, New Delhi: Tata McGraw Hill
2. Kogent Learning Solutions Inc, Office 2010 in Simple Steps, DreamTech Press
3. Goel, A. *Computer Fundamentals*, New Delhi: Pearson. 2010.
4. Silberschatz and Korth, A. *Database System Concepts*, New York: McGraw-Hill. 2013.
5. Simpson A., and Robinson, C. *Mastering Access 2000*, New Delhi: Sybex. 1999.
6. Taxali, R. K. *P C Software Made Simple*, New Delhi: Tata McGraw-Hill.

DAV UNIVERSITY, JALANDHAR

Course Title: Computer Fundamentals and Office Automation Laboratory
Course Code: CSA553

L	T	P	Credits	Marks
0	0	2	1	25

- The laboratory will comprise of using commands and tools available in MS Word, PowerPoint, and Excel.
- Assignments based on the applications of above mentioned software packages.