Ordinance No. :- V-141-B-5

(Approved in Academic Council meeting held on 11.03.2026
Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus
of

M.Sc. Mathematics

TWO – YEAR POST GRADUATE
PROGRAM
(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand

SUBHARTI UNIVERSITY

Meerut

Effective from 2025-2026

Head
Deptt. of Mathematics
Faculty of Science
S.V.S.U., Meerut

M.Sc. Mathematics Programme Details:

Programme Objectives (POs):

The M.Sc. Mathematics programme's main objectives are

- To inculcate and develop mathematical aptitude and the ability to think abstractly in the student.
- To develop computational abilities and programming skills.
- To develop in the student the ability to read, follow and appreciate mathematical text.
- Train students to communicate mathematical ideas in a lucid and effective manner.
- To train students to apply their theoretical knowledge to solve problems.
- To encourage the use of relevant software such as MATLAB and MATHEMATICA.

Programme Outcomes (POs): On successful completion of the M.Sc. Mathematics programme a student wil:l

PO-1 Have a strong foundation in core areas of Mathematics, both pure and applied.

PO-2 Be able to apply mathematical skills and logical reasoning for problem solving.

PO-3Communicate mathematical ideas effectively, in writing as well as orally.

PO-4 Have sound knowledge of mathematical modeling, programming and computational techniques as required for employment in industry.

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT								
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE								
Department of Mathematics								
M.Sc. Program offered by Department of Mathematics (Session 2025-26 onwards)								
		I	**II**	**Internship after II Sem**	**III**	**IV**	**Total**
1	Core Course	20	20	**4**	8	4	52
2	Elective (DEC)	-	-		12	8	20
3	PC/Dissertation/Project Work	4	4		4	12	24
4	SEMINAR/VAC/OEC/EEC/CHM	2 (SEMINAR)	2 (CHM)		2 (OEC)	2 (EEC)	8
	Total	26	26		26	26	108

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Department of Mathematics

Course Name -M.Sc. Mathematics

Batch:2025-26								**SEM:I**						
S. No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**External Assessment**	**Total**	**Remark**
				L	**T**	**P**								
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/PPT /Assignment (10)**	**Mid Sem Test (15)**	**TOTAL**	**End Sem Exam (70)**		
1	COURSE COURSE-1	MSMT-101	Advanced Algebra	4	0	0	4	5	10	15	30	70	100	
2	COURSE COURSE-2	MSMT-102	Real Analysis	4	0	0	4	5	10	15	30	70	100	
3	COURSE COURSE-3	MSMT-103	Differential Equations	4	0	0	4	5	10	15	30	70	100	
4	COURSE COURSE-4	MSMT-104	Mathematical Methods	4	0	0	4	5	10	15	30	70	100	
5	COURSE COURSE-5	MSMT-105	Calculus of Variations	4	0	0	4	5	10	15	30	70	100	
6	PRACTICAL COURSE-1	MSMT-106P	Computational Mathematics Lab I	0	0	8	4	5	10	15	30	70	100	
7	SEMINAR	MSMT-107S	Seminar	0	0	4	2	4	4	7	15	35	50	
TOTAL CREDITS / ASSESSMENT							**26**	34	64	97	195	455	**650**	

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Department of Mathematics

Course Name -Mathematics

Batch:2025-26							**SEM:II**							
S. No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**External Assessment**	**Total**	**Remark**
				L	**T**	**P**								
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/PPT /Assignment (10)**	**Mid Sem Test (15)**	**TOTAL**	**End Sem Exam (70)**		
1	COURSE COURSE-6	MSMT -201	Metric Spaces	4	0	0	4	5	10	15	30	70	100	
2	COURSE COURSE-7	MSMT -202	Complex Analysis	4	0	0	4	5	10	15	30	70	100	
3	COURSE COURSE-8	MSMT -203	Mathematical Statistics	4	0	0	4	5	10	15	30	70	100	
4	COURSE COURSE-9	MSMT -204	Operations Research	4	0	0	4	5	10	15	30	70	100	
5	COURSE COURSE-10	MSMT -205	Mechanics	4	0	0	4	5	10	15	30	70	100	
6	PRACTICAL COURSE-2	MSMT -206P	Computational Mathematics Lab II	0	0	8	4	5	10	15	30	70	100	
7	CHM	CHM		0	0	0	2	4	4	7	15	35	50	
TOTAL CREDITS / ASSESSMENT							**26**	34	64	97	195	455	**650**	

1. AN INTERNSHIP COURSE OF 4 CREDITSOF 4-6 WEEKS DURATION DURING SUMMER VACATION AFTER IIND SEMSTER TO BE COPLETED BY EVERY STUDENTS. INTERNSHIP CAN BE SITHER FOR ENHANCING THE EMPLOYAILITY OR AN DEVELOPING THE RESEACH APTITUDE.

2. THE POST GRADUATE DIPLOMA IN Mathematics WILL BE AWARDED HERE AFTER THE SUBMISSION OF INTERNSHIP COURSES OF 04 CREDITS

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I YEAR, I SEMESTER

Course Name: **ADVANCED ALGEBRA**	Credits**: 04**	
Course Code: **MSMT-101**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The course will develop an in-depth understanding of one of the most important branch of the abstract algebra with applications. Classification of all finite Abelian groups (up to isomorphism) can be done. The basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers used in finite fields. The fundamental algebraic structures and has an extensive theory dealing mainly with field extensions which arise in the study of roots of polynomials.

Unit-I

Normal subgroups, Quotient groups, Simple groups, Homomorphisms, Isomorphisms and Automorphisms, Cayley's theorem, Factor's theorem, Cauchy's theorem, Second Fundamental theorem.

Unit-II

Normal & Composition chains, Jordon Holder's Theorem, Solvable groups, Permutation groups, Alternating groups, Simplicity of A_n (n>=5), Galois theorem, Conjugacy, Class equations, Sylow's theorems, Direct products, Finite abelian groups, Fundamental theorem on finite abelian groups, Decomposable groups.

Unit-III

Rings, Ideals, Prime and maximal ideals, Homomorphism, Quotient- rings, Integral domains, Imbedding of rings, Field, Prime fields, Wilson's theorem, Zorn's lemma, Zrulls theorem, Field of quotients of an Integral domain, Euclidean domains, The ring of Gussian integers, Principal ideal domains, Unique factorization theorem, Fermat's theorem.

Unit-IV

Polynomial rings over rings and fields, Division algorithm, Gauss lemma, Eisenstein's irreduciblity criterion, Primitive polynomials, Cyclotomic polynomials, Unique factorization in R[x] where R is a Unique factorization Domain.

Unit-V

Field extensions, Algebraic and transcendental extensions, Normal extensions, Construction by Ruler and Compass, Finite fields, Structure of finite fields, Subfields of finite fields.

Courses Learning Outcomes: On completion of this course, the student will be able to:

CO1. Automorphisms for constructing new groups from the given group.

CO2. External direct product $Z_2 \otimes Z_2$ applies to data security and electric circuits.

CO3. Group actions, Sylow theorems and their applications to check nonsimplicity

CO4. Appreciate the significance of unique factorization in rings and integral domains.

CO5**.** identify and construct examples of fields, distinguish between algebraic and transcendental extensions, characterize normal extensions in terms of splitting fields and prove the existence of algebraic closure of a field.

CO6. characterize perfect fields using separable extensions, construct examples of automorphism group of a field and Galois extensions as well as prove Artin's theorem and the fundamental theorem of Galois theory.

Reference books:

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[1] Dummit, David S., & Foote, Richard M. (2016). Abstract Algebra (3rd ed.). Student Edition. Wiley India.
[2] Gallian, Joseph. A. (2013). Contemporary Abstract Algebra (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
[3] Herstein, I. N. (2006). Topics in Algebra (2nd ed.). Wiley Student Edition. India.
[4] Hoffman, Kenneth, & Kunze, Ray Alden (1978). Linear Algebra (2nd ed.). Prentice-Hall of India Pvt. Limited. Delhi. Pearson Education India Reprint, 2015.

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I YEAR, I SEMESTER

Course Name: **REAL ANALYSIS**	Credits**: 04**	
Course Code: **MSMT-102**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: Real Analysis is a major course in mathematics, traditionally viewed as a difficult subject. It is important that this characteristic is not as something distasteful, but provides an exciting opportunity to expand mental horizons. A great deal of the course is intended to immerse the student into the world of formal/abstract mathematics in which formal proofs and definitions are used in abundance.

Unit I

Definition and existence of Reimann -Stieltjes integral. Properties of the integral, Integration and differentiation, the fundamental theorem of calculus, Integration of vector-valued functions.

Unit II

Sequences and series of functions. Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Uniform convergence and continuity, Uniform convergence and Riemann-Stieltjes integration, Uniform convergence and differentiation, Weierstrass approximation theorem.

Unit III

Power series, algebra of power series, Uniqueness theorem for power series. Abel’s and Tauber’s theorems.

Unit IV

Functions of several variables, Linear transformation, Derivatives in an open subset of Rn, Chain rule, Partial derivatives, Interchange of the order of differentiation, Derivatives of higher orders, Taylor’s theorem.

Unit V

Inverse function theorem and Implicit function theorem (without proof), Jacobians, Extremum problems with constraints, Lagrange’s multiplier method, Differentiation of integrals.

Course Learning Outcomes: This course will enable the students to learn:

CO1. The conceptual variations when advancing in calculus from one variable to multivariable discussions.

CO2. Applications of multi variable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

CO3. To understand the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables.

CO4. Geometric applications of Higher derivations in more than two dimensions.

Reference books:

[1] M. Giaquinta and G. Modica, Mathematical Analysis: An Introduction to Functions of Several Variables, Birkhäuser, 2009.

[2] J.R. Munkres, Analysis on Manifolds, CRC Press, Taylor & Francis, 2018.

[3] W. Rudin, Principles of Mathematical Analysis, 3rd Edition, Mc Graw Hill, 1986.

[4] M. Spivak, Calculus on Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus, Taylor & Francis, 2018.

I YEAR, I SEMESTER

Course Name: **DIFFERENTIAL EQUATIONS**	Credits**: 04**	
Course Code: **MSMT-103**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives:

The theory of differential equations" is an important branch of Mathematics. The subject may be considered to occupy a central position from which different lines of development extend in many directions. The objective of this course is to study the solutions of first order ODE's, linear second order ODE's. This course is devoted to learning basic scientific computing for solving differential equations.

Unit I

Ordinary Differential Equations: Qualitative properties of solution: Oscillation, Wronskian, Sturm separation and comparison theorems.

Unit II

Ordinary points, Regular singular points, Frobenius series solution.

Unit III

Gauss hyper geometric equation, the point at infinity, Gamma functions, Hermite polynomials

Unit IV

Partial Differential Equations: Origin of first order partial differential equations, Linear equations of the first order, Integral surfaces passing through a given curve, Surface orthogonal to a given system of surface, Non-linear partial differential equations of the first order, Charpits method, Special type of first order equations, Jacobi method. Origin of second order partial differential equation, Linear partial differential equations with constant coefficients, Equations with variable coefficients.

Unit V

Problems of Laplace, wave and diffusion equations by the method of separation of variables, Reduction of second order partial differential equation into its canonical form. Non-linear equation of second order.

Course Learning Outcomes: After studying this course the student will be able to

CO1. Know about existence, uniqueness and continuity of solutions of first order ODE's, properties of zeros of solutions of linear second order ODE's, Liouville systems.

CO2. Be well equipped to undertake any advanced course on ordinary as well as partial differential equations.

CO3. Understand the key ideas, concepts and definitions of the computational algorithms, origins of errors, convergence theorems.

CO4. decide the best numerical method to apply to solve a given differential equation and quantify the error in the numerical (approximate) solution.

Reference books:

[1] K.E. Atkinson, W. Han and D.E. Stewart, Numerical Solution of Ordinary Differential Equations, John Wiley & Sons, 2009.

[2] J.C. Butcher, Numerical Methods for Ordinary Differential Equations, Third Edition, John Wiley & Sons, 2016.

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[3] E.A. Coddington, An Introduction to Ordinary Differential Equations, Dover Publications, 2012.
[4] T. Myint-U, Ordinary Differential Equations, Elsevier, North-Holland, 1978.
[5] S.L. Ross, Differential Equations, Second Edition, John Wiley & Sons, India, 2007.

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I YEAR, I SEMESTER

Course Name: **MATHEMATICAL METHODS**	Credits**: 04**	
Course Code: **MSMT-104**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The course covers two important areas. The objectives of the course are to teach students new techniques namely Fourier series methods and Integral equations methods for solving ordinary and partial differential equations involving initial and boundary value conditions. After completing the course the students will be able to understand the terminology, scope, main results, and applications of Fourier analysis and integral equations to solve problems in mathematics, science, and engineering.

Unit I

Inner products of functions. Orthogonal set of functions. Fourier series and their properties. Bessels inequality and a property of fourier constants. Parseval's equation, Convergence of Fourier series, Fourier theorem, Uniform convergence of Fourier series.

Unit II

Differentiation of Fourier series, Integration of Fourier series, Solutions of ordinary boundary value problems in Fourier series. A slab with faces at prescribed temperature. A Dirichlet problem (in Cartesian coordinates only), a string with prescribed initial velocity, an elastic bar. Applications of Fourier series in Sturm Lioville problems

Unit III

Definitions of integral equations and their classification, Relation between integral and differential equations, Fredholm integral equations of second kind with separable kernels, Reduction to a system of algebraic equations.

Unit IV

Eigen values and eigen functions, iterated kernels, iterative scheme for solving Fredholm integral equation of second kind (Neumann series), Resolvent kernel, Application of iterative scheme to Volterra's integral equation of second kind.

Unit V

Hilbert Schmidt theory, symmetric kernels, Orthonormal systems of functions. Fundamental properties of Eigen values and Eigen functions for symmetric kernels. Solution of integral equations by using Hilbert Schmidt theory**.**

Course Learning Outcomes: After studying this course the student will be able to

CO1. derive a Fourier series of a given periodic function by evaluating Fourier coefficients.

CO2. Drive integral equations and their solutions.

CO3. compute solutions to Volterra integral equations by method of resolvent kernel, method of successive approximations, system of Volterra integral equations and integro-differential equation.

CO4. determine the solutions of Fredholm integral equations and derivation of Hilbert Schmidt theorem.

Suggested Readings:

[1] J. W. Brown, R.V. Churchill, Fourier Series and Boundary Value Problems, McGraw Hill Education, New Delhi

[2] R. P. Kanwal, Linear Integral Equation, Theory and Technique, Academic Press New York 1971.

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[3] V. Lovitt, Linear Integral Equation, Wiley Inter science New York.
[4] F. B. Hildebrand, Method of Applied Mathematics, PHI, India

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I YEAR, I SEMESTER

Course Name: **Calculus of variations**	Credits**: 04**	
Course Code: **MSMT-105**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objective: This course contains extrema of functional, the Brachistochrone problem, Euler's equation, variational derivative and invariance of Euler's equations. It plays an important role for solving various engineering sciences problems.

Course Contents:

Unit 1: Introduction, problem of brachistochrone, problem of geodesics, isoperimetric problem,Variation and its properties, functions and functionals, Comparison between the notion of extrema of a function and a functional.

Unit 2: Variational problems with the fixed boundaries, Euler's equation, the fundamental lemmaa of the calculus of variations, examples, Functionals in the form of integrals, special cases contaning only some of the variables, examples, Functionals involving more than one dependent variables and their first derivatives, the system of Euler's equations, Functionals depending on the higher derivatives of the dependent variables, Euler- Poisson equation, examples, Functionals containing several independent variables, Ostrogradsky equation, examples, Variational problems in parametric form, applications to differential equations, examples, Variational problems with moving boundaries, pencil of extremals, Transversality condition, examples

Unit 3: Moving boundary problems with more than one dependent variables, transversality condition in a more general case, examples, Extremals with corners, refraction of extremals, examples, One- sided variations, conditions for one sided variations,

Unit 4: Field of extremals, central field of extremals, Jacobi's condition, The Weierstrass function, a weak extremum, a strong extremum, The Legendre condition, examples, Transforming the Euler equations to the canonical form, Variational problems involving conditional extremum, examples, constraints involving several variables and their derivatives, Isoperimetric problems, examples.

Course Learning Outcomes: After studying this course the student will be able to

CO1. To understand the formulation of variational problems,

CO2. To understand variational problems with moving boundaries, pencil of extremals, Transversality condition with their applications.

CO3. To understand the Jacobi`s condition for externals of central field.

CO4. To understand the variation of a functional and its properties, extremum of functional, necessary condition for an extremum.

Reference books:

[1] Curant, R. and D. Hilbert: Methods of Mathematical Physics, Vol I. Interscience Press, 1953.

[2] Elsgolc, L.E.: Calculus of Variations, Pergamon Press Ltd., 1962.

[3]Weinstock, Robert: Calculus of Variations with Applications to Physics and Engineering, Dover, 1974.

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I YEAR, I SEMESTER

Course Name: **Computational Mathematics Lab-I**	Credits**: 04**	
Course Code: **MSMT-106P**	Hours (Total): **60**	**L+T+P (0+0+4)**

Course objective: To inculcate and develop mathematical aptitude and the ability to think abstractly in the student.

- To develop computational abilities and programming skills.
- To develop in the student the ability to read, follow and appreciate mathematical text.
- Train students to communicate mathematical ideas in a lucid and effective manner.
- To train students to apply their theoretical knowledge to solve problems.
- To encourage the use of relevant software such as MATLAB and MATHEMATICA.

The student is expected to familiarize with popular software's for numerical computation. Real life problems requiring knowledge of numerical algorithms for linear and nonlinear algebraic equations, Eigen value problems/ writing computer program in a programming language. To this end software's like MATLAB & MATHEMATICA can be adopted with following course outline.

1. Matrix operations, vector and Matrix Computation and its applications.
2. 2-D Graphics and 3-D Graphics - general purpose graphics functions, colour maps and colour controls.
3. Analytical solution of calculus
   - 3.1 Analytical solution to limit problems
   - 3.2 Analytical solution to derivative problems
   - 3.3 Analytical solution to integral problems
4. Computation of series solution and evaluation
5. Non-Linear equations and numerical optimization problems
6. Constrained optimization problems

Course learning outcome: By the end of this course, the student will be able to Have a strong foundation in core areas of Mathematics, both pure and applied.

CO1: Be able to apply mathematical skills and logical reasoning for problem solving.

CO2: Communicate mathematical ideas effectively, in writing as well as orally.

CO3: Have sound knowledge of mathematical modeling, programming and computational techniques as required for employment in industry.

References books:

[1] MATLAB Manuals and Handbooks

[2] Duane Hanselman, Bruce Little Field "Mastering MATLAB 7" , Pearson Education India

[3] MATLAB - High performance numeric computation and visualization software: User's Guide.

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[4] MATHEMATICA - Stephen Wolfram, Cambridge
[5] http://www.eng-tips.com/threadminder.cfm?pid=575
[6] http://www.matlabtutorials.com/mathforum/
[7] http://www.mathworks.in/matlabcentral/
[8] http://www.cfd-online.com/Forums/tags/matlab.html
[9] http://diydrones.com/forum/topic/listForTag?tag=Matlab.

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I YEAR, II SEMESTER 2025

Course Name: **COMPLEX ANALYSIS**	Credits**: 04**	
Course Code: **MSMT-201**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: This course aims to introduce the basic ideas of analysis for complex functions in complex variables with visualization through relevant practical's. Particular emphasis has been laid on Cauchy's theorems, series expansions and calculation of residues.

Course Contents:

Unit I

Complex integration. Cauchy-Goursat Theorem. Cauchy's integral formula. Higher order derivatives. Morera's Theorem. Cauchy's inequality and Liouville's theorem The fundamental theorem of algebra. Taylor's theorem. Maximum modulus principle. Schwarz lemma.

Unit II

Bilinear transformations, their properties and classifications. Definitions and examples of conformal mappings Meromorphic functions. The argument principle. Rouche's theorem. Inverse function theorem.(Statement only).

Unit III

Laurent's series. Isolated singularities. Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functionswith special reference to arg z, log z and za .

Unit IV

Weierstrass' factorization theorem. Gamma function and its properties. Riemann zeta function. Riemann's functional equation. Runge's theorem. Mittag-Leffler's theorem. Analytic continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation.

Unit V

Canonical products. Jensen's formula. Poisson-Jensen formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.

Course Learning Outcomes: After studying this course the student will be able to

CO1. understand analytic function as a mapping on the plane, Mobius transformation and branch of logarithm.

CO2. understand Cauchy's theorems and integral formulas on open subsets of the plane.

CO3. understand how to count the number of zeros of analytic function giving rise to open mapping theorem and Goursat theorem as a converse of Cauchy's theorem.

CO4. know about the kind of singularities of meromorphic functions which helps in residue theory and contour integrations.

CO5. handle integration of meromorphic function with zeros and poles leading to the argument principle and Rouche's theorem.

CO6. know different versions of the maximum principle as well as the Schwarz's lemma representing analytic function on a disk as fractional mappings.

Reference books:

1. Shanti Narain , Function of Complex Variable, S Chand, 2005

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2. S Ponnusamy, Functions of Complex Analysis, Narosa, 2005
3. Brown & Churchill, Complex variable and applications, 2013
4. L.V. Ahlfors, Complex Analysis, Mc Graw Hill Co., Indian Edition, 2017.
5. J.B. Conway, Functions of One Complex Variable, Second Edition, Narosa, New Delhi, 1996

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I YEAR, II SEMESTER 2025

Course Name: **Numerical Analysis**	Credits**: 04**	
Course Code: **MSMT-202**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations. Also, the use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem solving skills.

Unit I

Errors in computation- Floating point representation of numbers, Significant digits, Rounding and chopping a number and error due to these absolute and relative errors, Computation of errors using differentials, Errors in evaluation of some standard functions, Truncation error. Linear equations-Gauss elimination method, LU Decomposition method, Gauss–Jordan method, Tridiagonal system, Inversion of matrix, Gauss-Jacobi method, Gauss- Seidal method.

Unit II

Nonlinear equations-Iterative method, Bisection method, Method of false position, its convergence, Secant method, Newton-Raphson method, Convergence of Newton-Raphson method for simple and multiple roots,

Unit III

Interpolation-Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, Stirling's and Bessel formulae, Lagrange's method, Divided differences and Newton's divided difference formula.

Unit IV

Numerical differentiation and integration-Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula, Integration- Methodology of numerical integration, Rectangular rule, Trapezoidal rule,Simpson's1/3rd and 3/8th rules, Gauss-Legendre quadrature formula.

Unit V

Ordinary differential equations- Initial and boundary value problems, Solutions of Initial Value Problems, Picard's method, Taylor's method, Single and multistep methods, Euler's and Modified Euler's method, Runge-Kutta second order method and statement of fourth order, Milne's method, Adams-Bashforth method.

Course Learning Outcomes: The course will enable the students to learn the following:

1. Some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.

2. Interpolation techniques to compute the values for a tabulated function at points not in the table.

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3. Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.
4. Find the consequences of finite precision and the inherent limits of numerical methods.
5. Appropriate numerical methods to solve algebraic and transcendental equations.
6. How to solve first order initial value problems of ODE's numerically using Euler methods.

Reference:

1. Bradie, Brian. (2006). *A Friendly Introduction to Numerical Analysis*. Pearson Education, India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.
2. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). *Numerical Methods for Scientific and Engineering Computation*. (6th ed.). New Age International Publisher, India, 2016.

3. Gerald, C. F., & Wheatley, P. O. (2008). *Applied Numerical Analysis* (7th ed.). Pearson Education. India.
4. Jain, M. K., Iyengar, S. R. K., & Jain R. K. (2012). Numerical Methods for Scientific and Engineering Computation (6th ed.). New Age International Publishers. Delhi.

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I YEAR, II SEMESTER

Course Name: **MATHEMATICAL STATISTICS**	Credits**: 04**	
Course Code: **MSMT-203**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The main objective of this course are to introduce the Mathematical Statistics and its application.

Course Contents:

Unit I

Probability: Set theoretic approach, Baye's theorem, Geometric probability, Random experiments, Sample spaces, Random variables, Distribution functions, Joint probability distribution function, Conditional distribution function, Transformation of one and two dimensional Random variables, Mathematical expectation : Covariance, Variance of variables, Chebysheff's inequality.

Unit II

Moment generating function, Cumulant generating function and cumulants, Applications and why they are used, Discrete distributions: Geometric, Binomial, Poisson and uniform distributions, Continuous distributions: Normal, Exponential, Gamma, Chi-square ,t , F, Beta , and uniform on an interval.

Unit III

Central limit theorem and applications (1) for a sequence of independent, identically distributed random variables (2) to establish normal approximations to other distributions, and to calculate probabilities, Statistical inference and sampling distribution.

Unit IV

Correlation and regression: Partial and multiple correlations, Correlation coefficients, rank correlation, Regression lines and its properties.

Unit V

Test of significance: (1) Null and alternative hypotheses, Simple and composite hypotheses, Errors, Test statistic. (2) Large sample tests for proportion and mean, Small sample test based on t, F and Chi-square statistics.

Course Learning Outcomes: After studying this course the student will be able to:

CO1: To understand the basic knowledge of probability and Mathematical Expectation with their applications.

CO2: To understand the Discrete and Continuous distributions with their applications.

CO3: To apply Central limit theorem for distributions to calculate probability.

CO4: To understand Correlation and regression and their properties.

CO5: To understand test of significance for large sample tests for proportion and mean, Small sample test based on t, F and Chi-square statistics.

Reference books:

[1] Chambers, J. (2008). Software for Data Analysis: Programming with R, Springer.
Crawley,
[2] M.J. (2017). The R Book, John Wiley & Sons. Eckhouse, R.H. and Morris, L.R. (1975).
[3] Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.

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Matloff, N. (2011).
[4] The Art of R Programming, No Starch Press, Inc. Eckhouse, R.H. and Morris, L.R. (1975).
[5] Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.
Great Harvey (2019): Excel 2019 all in one, John Wiley &b Sons.

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I YEAR, II SEMESTER

Course Name: **OPERATIONS RESEARCH**	Credits**: 04**	
Course Code: **MSMT-204**	Hours (Total): **60**	**L+T+P (4+0+0**

Course Objectives: The main aim of this course is to present different methods of solving optimization problems in the areas of linear programming, inventory and queuing theory, In addition to theoretical treatments, there will be some introduction to numerical methods for optimization problems**.**

Course Contents:

Unit I

Operations research and its scope, Necessity of operations research in industry. Linear programming problems. Convex sets, Simplex method, Theory of simplex method. Duality theory and sensitivity analysis. Dual simplex method.

Unit II

Transportation and Assignment problems of linear programming. Sequencing theory and Travelling salesperson's problem.

Unit III

Replacement: Replacement of items that deteriorate. Problems of choosing between two machines, Replacement of items that fail completely, Problems in mortality and staffing. Inventory problems, Simple deterministic and stochastic models of inventory control.

Unit IV

Network analysis: Shortest-path problem, Minimum spanning tree problem, Maximum flow problem, Minimum cost flow problem, Network simplex method. Project planning and control with PERT/CPM.

Unit V

Queuing theory: Steady state solution of Markovian queuing models: M/M/1, M/M/1 with limited waiting space. Game theory: Two person zero-sum games, Games with mixed strategies, Graphical solutions, Solutions by linear programming.

Course Learning Outcomes: After studying this course the student will be able to:

CO1: The student will be able to solve various problems based on convex sets and linear programming. After successful completion of this paper will enable.

CO2: The students to apply the basic concepts of transportation problems and its related problems to apply in further concepts and application of operations research.

CO3: To understand project planning and control with PERT/CPM and their applications.

CO4. The students understand the use of game theory in daily life and solutions by linear programming.

RECOMMENDED BOOK

[1] H.A. Taha: Operation Research- An introduction, Macmillan Publishing Co. Inc., NY

REFERENCES

1- Kanti Swarup, PK Gupta and Man Mohan, Operations Research, S Chand and sons, New Delhi.

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2- S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi.
3- G. Hadley, Linear Programming, Narosa Publishing House, 1995.
4- F.S. Hillier and G.J. Lieberman, Introduction to Operations Research (Sixth Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995.

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I YEAR, II SEMESTER

Course Name: **Mechanics**	Credits**: 04**	
Course Code: **MSMT-205**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The objective of the course is to develop the ability to determine the Lagrangian and Hamiltonian of mechanical systems and use these functions to obtain the corresponding equations of motions as well as identify any conserved quantities associated with the system.

Course Contents:

Unit I

Generalized coordinates, Holonomic and non-holonomic systems. Scleronomic and rheonomic systems, Constraints, Generalized potential, Lagrange's equations of motion of second kind, Energy equation for conservative field.Derivation of Lagrange's equations from D' Alembert's principle, Simple applications of the Lagrangian formulation.

Unit II

Hamilton's variables, Hamiltonian, Hamilton canonical equations, Derivation of Hamilton's equations of motion by variational principle, Simple applications of Hamilton's equations of motion, Cyclic coordinates and conservation theorems, Routh's equations of motion., The principle of least action. Derivation of Lagrange's equations from Hamilton's principle, Derivation of Hamilton's principle from D' Alembert's principle.

Unit III

Fundamental lemma of calculus of variations, Some techniques of calculus of variations, Euler's equation for functions of one dependent variable and its generalization to (i) "n" dependent variables (ii) higher order derivatives, Motivating problems of calculus of variation – Shortest distance, Minimum surface of revolution, Brachistochrone problem, Isoperimetric problem, Geodesic, Conditional extremum under geometric constraints and under integral constraints.

Unit IV

Canonical transformation, Poisson brackets, Equations of motion in Poisson brackets form, Poisson's theorem, Jacobi-Poisson theorem, Lagrange's brackets. Invariance of Poisson and Lagrange's brackets with respect to canonical transformations, Relation between Poisson and Lagrange's brackets.

Unit V

Hamilton Jacobi theory: Hamilton Jacobi equation, Jacobi theorem. Method of separation of variables in Hamilton Jacobi equation and its simple applications.

Course Learning Outcomes: After studying this course the student will be able to:

CO1. Apply fundamental conservation principles to analyze mechanical systems.

CO2. Introduce advanced theoretical techniques including variational principles and Hamilton Jacobi theory and develop the capability to apply these techniques to analyze elementary mechanical systems.

CO3. These entire courses are important in engineering and industrial applications for solving boundary value problem.

CO4. The student, after completing the course can go for higher problems in mechanic such as

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hydrodynamics, this will be helpful in getting employment in industry.

CO5. To understand method of separation of variables in Hamilton Jacobi equation and its simple applications.

RECOMMENDED BOOK

1. H. Goldstein, Classical Mechanics **(**2ND Edition**),** Narosa Publishing House, New-Delhi, 2001.

REFFERENCE BOOKS

1. A. S. Ramsey, Dynamics Part-II, The English Language Book Society and Cambridge University Press, 1972.

2. F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers Moscow, 1975

3. I. M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice Hall.

4. Narayan Chandra Rana & Pramod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991**.**

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Course Name: **Computational Mathematics Lab-II**	Credits**: 04**	
Course Code: **MSMT-206P**	Hours (Total): **60**	**L+T+P (0+0+4)**

Course Objective: The goal of the course is to increase knowledge and requisite skills of participants on the use of Excel and SPSS and to enable them make the most of this powerful software package while allowing them to work independently on their own data and provide a solid foundation for advanced data analysis work. Knowledge & Skills for efficiency and productivity in development

The student is expected to familiarize with popular software's for Basic Statistics and Analysis. Statistical Analysis for Discrete and Big Databases, Sample problems, Statistical testing etc. should be attempted. The objective of such a laboratory is to equip students to model and simulate systems using Statistical languages/programming languages. To this end software's like EXCEL, SPSS, R, SAS can be adopted with following course outline.

1. Problems based on t – test.
2. Problems based on F-test.
3. Problems based on Chi-square test.
4. Problems based on calculation of power curve.
5. Problems based on large sample tests.
6. Graphs using SPSS software or tools.
7. Parametric test: Test for Normality
8. t-test for paired means
9. t-test for difference between means.

COURSE OUTCOMES: At the end of the course, participants should be able to:

CO1: To be able to perform a wide range of data management tasks in Excel and SPSS application and understand the basic workings of SPSS, and perform basic statistical analyses.

CO2: To perform database management tasks, descriptive statistics and graphics, and basic inferential statistics for comparisons and correlations.

CO3: To perform data checking and create simple tables and charts.ϖ To perform advanced analysis in Excel and SPSS

Reference:

[1] Hinton, P., McMurray, I., & Brownlow, C. (2014). *SPSS explained*. Routledge.

[2] Huizingh, E. (2007). *Applied statistics with SPSS*. Sage.

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[3]Gardener, M. (2017). *Statistics for ecologists using R and Excel: Data collection, exploration, analysis and presentation*. Pelagic Publishing Ltd.
[4] Bluman, A. G. (2009). *Elementary statistics: A step by step approach*. New York;: McGraw-Hill Higher Education.
[5] Students may be asked to perform practical problems assigned to them by using MS-Excel/any Statistical software.

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Mathematics														
Course Name -Mathematics														
Batch:2025-26							**SEM:III**							
S. No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**External Assessment**	**Total**	**Remark**
				L	**T**	**P**								
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**TOTAL**	**End Sem Exam (70)**		
1	COURSE COURSE-11	MS MT-301	Topology	4	0	0	4	5	10	15	30	70	100	
2	COURSE COURSE-12	MS MT-302	Measure and integration	4	0	0	4	5	10	15	30	70	100	
3	DISCIPLINE ELECTIVE COURSE -1	MS MT-303 A	DEC-1'	4	0	0	4	5	10	15	30	70	100	
4	DISCIPLINE ELECTIVE COURSE -2	MS MT-303 B	DEC-2'	4	0	0	4	5	10	15	30	70	100	
5	DISCIPLINE ELECTIVE COURSE -3	MS MT-303 C	DEC-3'	4	0	0	4	5	10	15	30	70	100	

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6	PRACTICAL COURSE-3	MSMT-304P	Computational mathematics lab III	0	0	8	4	5	10	15	30	70	100	
7	OEC		To Be selcted from the Bucket of Courses	0	0	0	2	4	4	7	15	35	50	
TOTAL CREDITS / ASSESSMENT							**26**	34	64	97	195	455	**650**	

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Mathematics														
Course Name -Mathematics														
Batch:2025-26							**SEM:IV**							
S. No .	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**External Assessment**	**Total**	**Remark**
				L	**T**	**P**								
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**TOTAL**	**End Sem Exam (70)**		
1	DISCIPLINE ELECTIVE COURSE -4	MSMT-401A/ B/C	DEC-4'	4	0	0	4	5	10	15	30	70	100	
3	DISCIPLINE ELECTIVE COURSE -5	MSMT-402A/ B/C	DEC-5'	4	0	0	4	5	10	15	30	70	100	
4	DISCIPLINE ELECTIVE COURSE -6	MSMT-403A/ B/C	DEC-6'	4	0	0	4	5	10	15	30	70	100	
5	DISSERTATION	MSMT-404D		6	0	12	12	20	30	50	100	200	300	
7	EEC		To Be selcted from the Bucket of Courses	0	0	0	2	4	4	7	15	35	50	
TOTAL CREDITS / ASSESSMENT							26	39	64	102	205	445	650	

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OR

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Mathematics														
Course Name - Mathematics														
Batch:2025-26							**SEM:IV**							
S. *N*o .	**Course Type**	**Cours e Code**	**Cour se Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**Exter nal Assess ment**	**Tota l**	**Rem ark**
				L	**T**	**P**								
THEORY and PRACTICAL SUBJECTS								**CLASS PARTIC IPATIO N**	**Quiz/PP T/Assign ment (10)**	**Mid Sem Test**	**TO TAL**	**End Sem Exam**		
1	DISSERT ATION	MSMT -404D		12	0	24	24	40	60	100	200	400	600	
3	EEC		To Be selcte d from the Buck et of Cours es	0	0	0	2	4	4	7	15	35	50	
TOTAL CREDITS / ASSESSMENT							26	44	64	107	215	435	650	

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II YEAR, III SEMESTER

Course Name: **TOPOLOGY**	Credits**: 04**	
Course Code: **MSMT-301**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course objective: To introduce basic concepts of point set topology, derived concepts, basis and subbasis for a topology and order topology. Further, to study continuity, homeomorphisms, open and closed maps, product and box topologies and introduce notions of connectedness, path connectedness, local connectedness, local path connectedness, convergence, nets, countability axioms and compactness of spaces.

Unit I

Definition and examples of topological space, Closed sets, Closure, Dense subset, Neighborhoods, interior, exterior, boundary and accumulation points, Derived sets, Bases and sub-bases. Subspaces, product spaces and relative topology.

Unit II

Continuous functions, homeomorphisms, the pasting lemma, Connected and disconnected sets, connectedness on the real line, components, locally connected spaces.

Unit III

Countability axioms – First and second countable spaces, Lindelof's theorems, Separable spaces, second countability and separability.

Unit IV

Separation axioms – T_0, T_1, T_2, T_3, T_4, their characterizations and basic properties. Urysohn's lemma and Teitze extension theorem, Statement of Urysohn's metrization theorem.

Unit V

Compactness – Continuous functions and compact sets, basic properties of compactness, compactness and finite intersection property, sequentially and countably compact sets, local compactness and one point compactification. Statements of Tychonoff's Product theorem and Stone-cech compactification theorem.

Course learning outcome: On successful completion of the course the student would be able to

1. To determine interior, closure, boundary, limit points of subsets and bases and subbasis of topological spaces.
2. To check whether a collection of subsets is a basis for a given topological spaces or not, and determine the topology generated by a given basis.
3. To identify the continuous maps between two spaces and maps from a space into product space and determine common topological property of given two spaces.
4. To determine the connectedness and path connectedness of the product of a arbitrary family of spaces.
5. To find Hausdorff spaces using the concept of net in topological spaces and learn about 1st and 2nd countable spaces, separable and Lindelof spaces.

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6. To learn Bolzano-Weierstrass property of a space and prove Tychonoff theorem.

Reference:

[1] G. E. Bredon, Topology and Geometry, Springer-Verlag, 2005.
[2] J. Dugundji, Topology, Allyn and Bacon, 1970.
[3] J.L. Kelley, General Topology, Springer-Verlag, 2005.
[4] J. R. Munkres, Topology, second edition, Pearson Education, 2003.
[5] T. B. Singh, Elements of Topology, CRC Press, 2013.
[6] S. Willard, General Topology, Dover Publications, Inc. N.Y., 2004.

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II YEAR, III SEMESTER

Course Name: **MEASURE AND INTEGRATION**	Credits**: 04**	
Course Code: **MSMT-302**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course objectives: Measure and Integration generalises the notion of integration. The main objective is to familiarize with the Lebesgue outer measure; Measurable sets; Measurable functions, Integration, Convergence of sequences of functions and their integrals, Functions of bounded variation, The Lp-spaces.

Unit I

Countable and uncountable sets, Infinite sets and the Axiom of Choice, Cardinal numbers and its arithmetic, Schroeder-Burstein theorem, Cantor's theorem and continuum hypothesis, Zorn's Lemma, Well-ordering theorem, Decimal, Binary and Ternary Expansion, Cantor's Ternary set.

Unit II

Algebra's of sets, Lebesgue outer measure, Measure of open and closed sets, Borel sets, Measurable sets, Regularity, A non-measurable sets.

Unit III

Measurable functions, Algebra of measurable functions, Step functions, Characteristic functions, Borel and Lebesgue measurability, Little wood's three principles, Convergence almost everywhere and convergence in measure, Egoroff's and Reisz- Fisher Theorems.

Unit IV

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

Unit V

Functions of Bounded Variation, Lebesgue Differentiation Theorem, Differentiation of Monotone Functions, Differentiation of an Integral, Absolute Continuity. The Lp-Space, Convex function, Jensen's Holder's and Minkowsky's inequality, Completeness of Lp-space.

Course learning outcome: On successful completion of the course the student would

1. Be able to verify whether a given subset of R or a real valued function is measurable.
2. Be able to understand the requirement and the concept of the Lebesgue integral (a generalization of the Reimann integration) along its properties.
3. Be able to demonstrate understanding of the statement and proofs of the fundamental integral convergence theorems, and their applications.
4. Be able to introduce the concepts of functions of bounded variations and the absolute continuity of functions with their relations.
5. Be able to extend the concept of outer measure in an abstract space and integration with respect to a measure.
6. Be able to learn and apply Holder and Minkowski inequalities in Lp-spaces, completeness of L_p-spaces and convergence in measures.

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Reference:

[1] G. de Barra, Measure and Integration. New Age International (P) Ltd., New Delhi, 2006.
[2] M. Capinski and E. Kopp, Measure, Integral and Probability, SpringerVerlag, 2003.
[3] E. Hewitt and K. Stromberg, Real and Abstract Analysis, Springer, Berlin, 1988.
[4] H.L. Royden and P.M. Fitzpatrick, Real Analysis, 4th Edition, Prentice Hall, 2010.

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II YEAR, III SEMESTER
Elective Course (Any one out of the three papers)

Course Name: **Optimization Techniques**	Credits**: 04**	
Course Code: **MSMT-303A**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: One of the objective of the course is to develop the conjugate duality theory and deal with some numerical techniques to solve a nonlinear problem. Further, the course aims to study dynamic programming approach to solve different types of problems and to study optimal control problems.

Course Contents :

Unit I: Extended real valued functions, Proper convex functions, Subgradients, Directional derivatives

Unit II: Conjugate functions, Dual convex programs, Optimality conditions and Lagrange multipliers, Duality and optimality for standard convex programs, Gradient descent method, Gradient projection method.

Unit III: Newton's method, Conjugate gradient method, Dynamic programming, Bellman's principle of optimality, Allocation problem, Stage coach problem.

Unit IV: Optimal control problem and formulations, Variational approach to the fixed-time free endpoint problem, Pontryagin's maximum principle, Dynamic programming and Hamilton–Jacobi–Bellman equation.

Course Learning Outcomes: After studying this course the student will be able to

CO1. have studied notions of sub-gradients and directional derivative for nondifferentiable functions.

CO2. understand the use of conjugate functions to develop the theory of conjugate duality.

CO3. know numerical methods like gradient descent method, gradient projection method, Newton's method and conjugate gradient method.

CO4. deal with dynamic programming approach to solve some problems including stage coach problem, allocation problem and linear programming problem.

CO5. know both classical and modern approaches in the study of optimal control problems.

Reference books:

[1] Mordecai Avriel, Nonlinear Programming: Analysis & Methods, Dover Publications, New York, 2003.

[2] Osman Gler, Foundations of Optimization, Springer 2010.

[3] Frederick S. Hillier and Gerald J. Lieberman, Introduction to Operations Research, McGraw-Hill, 2010.

[4] Daniel Liberzon, Calculus of Variations and Optimal Control Theory: A Concise Introduction, Princeton University Press, 2012.

[5] Jan Brinkhuis and Vladimir Tikhomirov, Optimization : Insights and Applications, Princeton University Press, 2005.

[6] Kenneth Lange, Optimization, Springer 2013.

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Course Name: **Advanced Graph Theory**	Credits**: 04**	
Course Code: **MSMT-303B**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: This course aims at introducing the concepts of graph theory. The course discusses some important applications of graph theory in real life situations .

Course Contents :

Unit 1: Graphs: Vertices of graphs, Walks and connectedness, Degrees, Operations on graphs, Blocks, Cut-points, bridges and blocks, Block graphs and cutpoint graphs

Unit 2: Trees: Elementary properties of trees, Centers and Centroids, Block-cut point trees, Independent cycles and cocycles

Unit 3: Connectivity and Traversability: Connectivity and line connectivity, Menger's theorems, Eulerian graph, Hamiltonian graphs

Unit 4: Planarity and Coloring: Planar graphs, outer planar graphs, Kuratowski's theorem, dual graphs, chromatic number, five color theorem

Course Learning Outcomes: On completion of this course, the student will be able to:

CO1: model problems using different types of basic graphs like trees, bipartite graphs and planar graphs.

CO2: understand and identify special graphs like Euler graphs and Hamiltonian graphs.

CO3: have increased ability to understand various forms of connectedness in a graph

CO4: appreciate different graph-coloring problems and their solutions.

CO5: to model simple problems from real life as graph-coloring problems.

Text book(s).

[1] F. Harary, Graph theory, Narosa Publishing House, New Delhi, 1988.

Reference books.

[1] R. Balakrishnan and K. Renganathan, A textbook of Graph theory, Springer, 2000

[2] Bela Bollobas, Modern Graph Theory Springer, 2002

[3] G. Chartrand, L. Lesniak, Graphs & digraphs. Fourth edition. Chapman & Hall/CRC, 2005.

[4] Robin J. Wilson, Introduction to Graph Theory (4th Edition), Addison Wesley, 1996

Course Name: **PROGRAMMING IN C**	Credits**: 04**	
Course Code: **MSMT-303C**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The course is designed to provide complete knowledge of C language. Students will be able to develop logics which will help them to create programs, applications in C. Also by learning the basic programming constructs they can easily switch over to any other language in future

Course Contents:

Unit 1: Computer system introduction, Characteristics and classification of computers, CPU, ALU, Control unit, data & instruction flow, primary, secondary and cache memories, RAM, ROM, PROM, EPROM, Programming language classifications.

Unit 2: C fundamentals. Constants, Variables and Data types

Unit 3: Operators and expression, formatted input and output. Decision makings,

Unit 4: Branching and Looping. Arrays. User defined functions.

Unit 5: Structures. Pointers. File handling. Programming based on above.

Course Learning Outcomes: After studying this course the student will be able to

CO1: Understand the basic terminology used in computer programming

CO2: Write, compile and debug programs in C language.

CO3: Use different data types in a computer program.

CO4: Design programs involving decision structures, loops and functions

CO5: Evaluate the usability of File and preprocessors of c Programming terminology.

Reference books:

1. SamanthaD, Classic Data Structures, Prentice-Hall of India, 2001.

2. Heilman G I,. Data Structures, Algorithms and Object-Oriented Programming, Tata McGraw-l lill. 2002.

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II YEAR, III SEMESTER
Elective Course (Any one out of the three papers)

Course Name: **DIFFERENTIAL GEOMETRY**	Credits**: 04**	
Course Code: **MSMT-304A**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The primary objective of this course is to understand the notion of level sets, surfaces as solutions of equations, geometry of orientable surfaces, vector fields, Gauss map, geodesics, Weingarten maps, line integrals, parametrization of surfaces, areas, volumes and Gauss- Bonnet theorem.

Course Content:

Unit I

Theory of space curves, arc length, tangent and normals, Curvature and torsion of curve given as the intersection of two surfaces, Involute and Evolute.

Unit II

Metric: The first and second fundamental form, Weingarton equation, Orthogonal trajectories, Mensuier theorem, Gaussian curvature, Euler’s theorem, Dupin’s theorem, Rodrigue’s theorem, Dupin’s indicatrix.

Unit III

Envelopes, Edge of regression, Ruled surface. Developable surface, Monge’s theorem, Conjugate directions.

Unit IV

Asymptotic lines, the fundamental equations of surface theory, Gauss’s formulae, Gauss characteristics equations, Mainardi Codazzi equations, Weingarton equations, Bonnet’s theorem on parallel surface.

Unit V

Geodesics, Clairaut’s theorem, Gauss Bonnet theorem, conformal mapping and Geodesic mappings, Tissot’s theorem, Dini’s theorem.

Course Learning Outcomes: After studying this course the student will be able to

CO1. understand the concepts of graphs, level sets as solutions of smooth real valued functions vector fields and tangent space.

CO2. comfortably familiar with orientation, Gauss map, geodesic and parallel transport on oriented surfaces.

CO3. learn about linear self-adjoint Weingarten map and curvature of a plane curve with applications in geometry and physics.

CO4. know line integrals, be able to deal with differential forms and calculate arc length and curvature of surfaces.

CO5. deal with parametrization and be familiar with well-known surfaces as equations in multiple variables, able to find area and volumes.

CO6. study surfaces with boundary and be able to solve various problems and the Gauss- Bonnet theorem.

Suggested Readings:

[1] W. Kühnel, Differential Geometry, Curves-Surfaces-Manifolds, Third Edition, American Mathematical Society, 2013.

[2] A. Mishchenko and A. Formentko, A Course of Differential Geometry and Topology, Mir Publishers Moscow, 1988.

[3] A. Pressley, Elementary Differential Geometry, Springer, India, 2004.

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Course Name: **DISCRETE MATHEMATICS**	Credits**: 04**	
Course Code: **MSMT-304B**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: This course aims at introducing the concepts of lattices, Boolean algebras, switching circuits and graph theory. The course discusses some important applications of Boolean algebra and graph theory in real life situations through switching circuits and shortest path algorithms.

Course Contents:

Unit 1: Formal Logic- Statements, Symbolic Representation of statements, duality, Tautologies and contradictions. Quantifiers, Predicates and Validity of arguments. Propositional Logic. Languages and Grammars, Finite State Machines and their transition table diagrams.

Unit 2: Lattices: Lattices as partially ordered sets, their properties, duality, Lattices as algebraic systems, Sub lattices, Direct products, Bounded Lattices, Complete Lattices, Complemented Lattices and Distributive lattices. Cover of an elements, atoms, join and meet irreducible elements.

Unit 3: Boolean Algebras: Boolean Algebras as lattices. Various Boolean Identities. The Switching Algebra example. Sub algebras, Direct products and Homeomorphisms. Boolean forms and their Equivalence. Min-term Boolean forms, Sum of product Canonical forms. Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map method.

Unit 4: Definition of (undirected) graph, Walk, Path, Circuit, Cycles, Degree of a vertex, Connected graphs, Complete and Bipartite graphs, Planar graphs, Euler's formula for connected Planar graphs, Kuratowski's Theorem (Statement only) and its uses. Colouring of graphs, Five colour theorem and statement of Four colour theorem.

Unit 5: Trees , Cut-sets, Spanning Trees, Fundamentals Cut-sets and minimum Spanning Trees, Prim's and Kruskal's algorithms, Connectivity, Matrix Representation of graphs, Directed Graphs, Indegree and outdegree of a vertex.

Course Learning outcomes: After the course, the student will be able to understand the concepts of:

CO1: Lattices and their types;
CO2: Boolean algebra, switching circuits and their applications;
CO3: Graphs, their types and its applications in study of shortest path algorithms.

References:

1. Davey, B. A., & Priestley, H. A. (2002). *Introduction to lattices and order* (2nd ed.). Cambridge University press, Cambridge
2. Goodaire, Edgar G., & Parmenter, Michael M. (2011). *Discrete Mathematics with graph theory* (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.

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3. Lidl, Rudolf & Pilz, Gunter. (2004). *Applied Abstract Algebra* (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.

4. Rosen, Kenneth H. (2012). *Discrete Mathematics and its applications, with combinatorics and graph theor*y. (7th ed.). McGraw Hill Education. Indian Reprint.

Course Name: **DATA STRUCTURES**	Credits**: 04**	
Course Code: **MSMT-304C**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: This course aims to impart the basic concepts of data structures, algorithms and step by step approach in solving problems with the help of fundamental data structures

Course Contents:

Unit-I Basic data Structures: Primitive Data Types, Abstract Data Types, Arrays - Static and Dynamic, Matrix, Linked Lists - Single, Doubly-linked, Circular; Stacks and Queues using arrays and linked lists.

Unit-II Trees: Binary Tree, Binary Search Tree, Height Balanced Trees: AVL/RB Tree, 2-3Trees, B and B+ Trees, Splay Trees, Heaps, Priority Queues, Mergeable heaps, Tries, Prefix and Suffix Trees, Skip Lists.

Unit-III Sets: Sets, Multisets, Maps, Hash Tables, Dictionaries.

Unit-IV Graphs: Representation of Graphs, Searching in Graphs – BFS and its applications, DFS and its applications.

Course Learning Outcome: On completion of this course, the student will be able to:

CO1: develop programs using basic data structures: sets, lists, stacks, queues, trees, graphs and advanced data structures like balanced trees and skip lists.

CO2: understand the behaviour and application of advanced data structures like Tries, Prefix- and Suffix-trees.

CO3: identify best suited data structure for the problem at hand.

CO4: identify the programming constructs to optimize the performance of the data structure in different scenarios.

Reference books:

1. Goodrich, M., Tamassia, R. and Mount D, Data Structures and Algorithms in C++/Java, 2nd Edition, 2016, Wiley.

2. Elliot B. Koffman, Paul A.T. Wolfgang, Objects, Abstraction, Data Structures and Design Using C++/Java, 1st Edition, 2005, Wiley Global Education.

3. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, 3rd Edition, 2010, Prentice-Hall of India Learning Pvt. Ltd.

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II YEAR, III SEMESTER

Elective Course (Any one out of the three papers)

Course Name: **NUMBER THEORY**	Credits**: 04**	
Course Code: **MSMT-305A**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The main objective of the course is to provide an introduction to elementary and contemporary number theory. It will include many examples of intermediate and advanced techniques, methods of proofs, and rigorous analytic thinking used in upper level mathematics. Also, another objective is to make the students familiar with simple number theoretic techniques, to be used in data security.

Course Contents:

Unit I

The Division Algorithm, the gcd, The Euclidean Algorithm, Diophantine equation ax + by = c. The fundamental theorem of arithmetic. The Sieve of Eratosthenes. The Goldbach conjecture.

Unit II

Theory of Congruences – Basic properties of Consequence, Linear Congruences, Chinese remainder theorem, Fermat's Theorem, Wilson's Theorem. Statement of Prime number theorem. Some primality testing.

Unit III

Number-Theoretic Functions – The functions T and Sigma. The mobius inversion formula, The Greatest integer function, Euler's Phi function – Euler Theorem, Properties of the Phi-function, Applications to Cryptography.

Unit IV

The order of an integer modulo n, Primitive roots for primes, The theory of indices, Euler's criterion, Legendre's symbol and its properties, Quadratic reciprocity, Quadratic congruences with composite moduli.

Unit V

Perfect Numbers, Representation of integers as sum of two squares and sum of more than two squares.

Course Learning Outcomes: This course will enable the students to learn:

1. Some of the open problems related to prime numbers, viz., Goldbach conjecture etc.
2. About number theoretic functions and modular arithmetic.
3. Public crypto systems, in particular, RSA.

References:

1. Burton, David M. (2007). *Elementary Number Theory* (7th ed.). Tata Mc-Graw Hill Edition, Indian Reprint.

2. Jones, G. A., &Jones, J. Mary. (2005). *Elementary Number Theo*ry. Undergraduate Mathematics Series (SUMS). First Indian Print.

Additional Reading:

1. Neville Robinns. (2007). *Beginning Number Theory* (2nd ed.). Narosa Publishing House Pvt. Limited, Delhi.

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Course Name: **Mathematical Modeling**	Credits**: 04**	
Course Code: **MSMT-305B**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: This course provides introduction of mathematical modeling and analysis in biological sciences. It is designed for students in both applied mathematics and bio-medical / biological sciences.

Course Contents:

Unit 1: Overview of mathematical modeling and types of mathematical models, Introduction to population dynamics, solution methods of linear difference equations and discrete time model.

Unit 2: Linear system theory, stability analysis, role of eigen values & vectors and phase diagrams.

Unit 3: Single-species population model, Allee effect, Predator-Prey model, Lotka-Volterra model and SIR model.

Unit 4: Introduction to models in chemical-kinetics, Hopf bifurcation, Poincare-Bendixson theory and index theory.

Course Learning outcomes: By the end of the course, students will be able to:
CO1: to handle freely the concepts using in mathematical modeling;
CO2: to analyze a simple physical phenomena in order to create a mathematical model;
CO3: to interpret numerical results given by program in order to predict the behavior of the system in various models;
CO4: to understand the mechanism of mathematical modeling in chemical engineering.

References:

1. Nicola Bellomo, Elena De Angelis, and Marcello Delitala (2007) - Lecture Notes on Mathematical Modelling in Applied Sciences .

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Course Name: **Partial Differential Equations**	Credits**: 04**	
Course Code: **MSMT-305C**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The aim of this course is to introduce various numerical methods especially finite difference schemes for the solution of partial differential equations along with analyzing them for consistency, stability and convergence.

Course Contents:
Unit I: Finite difference methods for 2D and 3D elliptic boundary value problems (BVPs) of second approximations, Finite difference approximations to Poisson's equation in cylindrical and spherical polar coordinates, Solution of large system of algebraic equations Seidel and SOR),–corresponding to discrete problems and iterative methods (Jacobi, Gauss Alternating direction methods.

Unit II: Different 2- and 3-level explicit and implicit finite difference approximations to heat conduction equation with Dirichlet and Neumann boundary conditions, Stability analysis, compatibility, consistency and convergence of the difference methods, ADI methods for 2- & 3-D parabolic equations, Finite difference approximations to heat equation in polar coordinates.

Unit III: Methods of characteristics for evolution problem of hyperbolic type, explicit and implicit difference schemes for first order hyperbolic equations in 1D and 2D dimension and their stability and consistency analysis, System of equations for first order hyperbolic equations.

Unit IV: Finite element methods for second order elliptic BVPs, Finite element equations, Variational problems, Triangular and rectangular finite elements, Standard examples of finite elements, Finite element methods for parabolic initial and boundary value problems.

Course Learning Outcomes: After studying this course the student will be able to
CO1. use discretization methods for solution of PDEs using finite difference schemes.
CO2. analyze the consistency, stability and convergence of a given numerical scheme.
CO3. apply various iterative techniques for solving system of algebraic equations.
CO4. know the basics of finite element methods for the numerical solution of PDEs.
CO5. construct computer programme using some mathematical software to test and implement numerical schemes studied in the course.

Suggested Readings:
[1] A.J. Davies, The Finite Element Method: An Introduction with Partial Differential Equations, Second Edition, Oxford University Press, 2011.
[2] C. Johnson, Numerical Solution of Partial Differential Equations by the Finite Element Methods, Dover Publications, 2009.
[3] K.W. Morton and D.F. Mayers, Numerical Solution of Partial Differential Equations, Second Edition, Cambridge University Press, 2011.
[4] J.C. Strikwerda, Finite Difference Schemes & Partial Differential Equations, Second Edition, SIAM,

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2004.
[5] J.W. Thomas, Numerical Partial Differential Equations: Finite Difference Methods, Springer, 2013.
[6] J.W. Thomas, Numerical Partial Differential Equations: Conservation Laws and Elliptic Equations, Springer-Verlag, Berlin, 1999.

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II YEAR, III SEMESTER

Course Name: **Computational Mathematics Lab-III**	Credits**: 04**	
Course Code: **MSMT-306P**	Hours (Total): **60**	**L+T+P (0+0+4)**

The student is expected to familiarize with popular software's for numerical computation and optimization. Numerical algorithms for linear and nonlinear algebraic equations, Eigen value problems, Finite difference methods. Differentiation; Integration Ordinary differential equations etc. should be attempted. The objective of such a laboratory is to equip students to model and simulate systems using optimization modeling languages/programming languages. To this end software's like MATLAB & MATHEMATICA can be adopted with following course outline.

1. Numerical integration.
2. Nonlinear Equations and Optimization techniques.
3. Differential equations.
4. Sparse Matrices - Iterative methods for sparse linear equations, Eigen values of sparse matrices, Game of life.
5. Linear Programming, Integer Programming and Quadratic Programming – Modeling and Simulation Techniques.

References

1. MATLAB - High performance numeric computation and visualization software: User's Guide.
2. MATHEMATICA - Stephen Wolfram, Cambridge.

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II YEAR, IV SEMESTER
Elective Course (Any one out of the three papers)

Course Name: **FUNCTIONAL ANALYSIS**	Credits**: 04**	
Course Code: **MSMT-401A**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: To familiarize with the basic tools of Functional Analysis involving normed spaces, Banach spaces and Hilbert spaces, their properties dependent on the dimension and the bounded linear operators from one space to another.

Course Contents:

Unit I

Normed linear spaces, Banach spaces, Examples and counter examples, Quotient space of normed linear spaces and its completeness. Equivalent norms,

Unit II

Reisz Lemma, Basic properties of finite dimensional normed linear spaces, Bounded linear transformations and normed linear spaces of bounded linear transformations, Uniform boundedness theorem and some of its applications.

Unit III

Dual spaces, weak convergence, open mapping and closed graph theorems, Hahn Banch theorem for real and complex linear spaces.

Unit IV

Inner product spaces, Hilbert spaces – Orthonormal sects, Bessel's inequality, complete orthonormal sets and Perseval's identity.

Unit V

Structure of Hilbert spaces, Projection theorem, Riesz representation theorem, Adjoint of an operator on Hilbert space, Self adjoint operators, Normal and Unitary operators. Projections.

Course Learning Outcomes: After studying this course the student will be able to

CO1. verify the requirements of a norm, completeness with respect to a norm, relation between compactness and dimension of a space, check boundedness of a linear operator and relate to continuity, convergence of operators by using a suitable norm, compute the dual spaces.

CO2. distinguish between Banach spaces and Hilbert spaces, decompose a Hilbert space in terms of orthogonal complements, check totality of orthonormal sets and sequences, represent a bounded linear functional in terms of inner product, classify operators into self-adjoint, unitary and normal operators.

CO3. extend a linear functional under suitable conditions, compute adjoint of operators, check reflexivity of a space, ability to apply uniform boundedness theorem, open mapping theorem and closed graph theorem, check the convergence of operators and functional and weak and strong convergence of sequences.

CO4. compute the spectrum of operators and classify the set into subclasses, show the spectrum to be nonempty, give expansion of resolvent operator.

Suggested Readings:

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[1] G. Bachman and L. Narici, Functional Analysis, Dover Publications, 2000.
[2] R. Bhatia, Notes on Functional Analysis, Hindustan Book Agency, India, 2009.
[3] E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, India, 2006.
[4] M. Schechter, Principles of Functional Analysis, Second Edition, American Mathematical Society, 2001.

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Course Name: **Advanced Group Theory**	Credits**: 04**	
Course Code: **MSMT-401B**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The course aims to introduce the learner to the concepts of normal series, composition series and Zessenhaus lemma. A study of solvable groups, nilpotent group and fitting and Frattini subgroup will be conducted and the students will be introduced to free group, presentation of a group and properties of a free group.

Course Contents:

Unit I: Normal series, composition series, Zessenhaus lemma, Schreier's refinement theorem, JordanHolder theorem.

Unit II: Solvable groups, derived series, supersolvable groups, minimal normal subgroup, Hall's theorem, Hall subgroup, p-complements, central series, Schur's theorem.

Unit III: Nilpotent groups, Fitting subgroup, Jacobi identity, Three subgroup lemma, Frattini subgroup, Burnside basis theorem. Indecomposable groups, Fitting's lemma, KrullSchmidt theorem, Semidirect product.

Unit IV: Free group, Generators and relations of a group, Rank of free group, Projective and injective property of a free group, Free semigroup and representation of a quotient semigroup.

Course Learning Outcomes: After doing this course student will be able to

CO1. prove Schreier's refinement theorem and Jordan -Holder theorem and also to prove fundamental theorem of arithmetic using Jordan -Holder theorem

CO2. prove Hall's theorem, Schur's theorem and Burnside basis theorem.

CO3. identify indecomposable spaces and to prove Krull -Schmidt theorem.

CO4. determine distinct presentations of a group.

Suggested Readings:

[1] T.W. Hungerford, Algebra, Springer-Verlag, 1981.
[2] D.J.S. Robinson, A Course in the Theory of Groups, Springer-Verlag, 1996.
[3] J.S. Rose, A Course on Group Theory, Dover Publications, 2012.
[4] J.J. Rotman, An Introduction to the Theory of Groups, Springer, 1995.
[5] M. Suzuki, Group Theory-I, Springer, 2014.

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Course Name: **Bio-Mathematics**	Credits**: 04**	
Course Code: **MSMT-401C**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The focus of the course is on scientific study of normal functions in living systems. The emphasis is on exposure to nonlinear differential equations with examples such as heartbeat, chemical reactions and nerve impulse transmission. The basic concepts of the probability to understand molecular evolution and genetics have also been applied.

Course Contents:

Unit 1: Modeling Biological Phenomenon

Population growth, Administration of drugs, differential equations, Heartbeat, Nerve impulse prey models.
Cell division, Systems of linear ordinary transmission, Chemical reactions, Predator-

Unit 2: Mathematics of Heart Physiology and Nerve Impulse Transmission

Stability and oscillations**:** Epidemics, The phase plane and the Jacobian matrix, Local stability, Stability, Limit cycles, Forced oscillations; Mathematics of Heart Physiology**:** The local model, The Threshold effect, The phase plane analysis and the heartbeat model, A model of the cardiac pacemaker; Mathematics of Nerve Impulse Transmission**:** Excitability and repetitive firing, Travelling waves.

Unit 3: Bifurcation and Chaos

Bifurcation, Bifurcation of a limit cycle, Discrete bifurcation and period-doubling, Chaos, Stability of limit cycles, The Poincaré plane.

Unit 4: Modeling Molecular Evolution and Genetics

Modelling Molecular Evolution**:** Matrix models of base substitutions for DNA sequences, The Jukes-Cantor model, The Kimura models, Phylogenetic distances; Constructing Phylogenetic Trees**:** Phylogenetic trees, Unweighted pair-group method with arithmetic means (UPGMA), Neighbor joining method; Genetics**:** Mendelian genetics, Probability distributions in genetics.

Course Learning outcomes: Apropos conclusion of the course will empower the student to:

1. Learn the development, analysis and interpretation of bio mathematical models.
2. Reinforce the skills in mathematical modeling.
3. Appreciate the theory of bifurcation and chaos.
4. Learn to apply the basic concepts of probability to molecular evolution and genetics.

References:

1. Allman, Elizabeth S., & Rhodes, John A. (2004). *Mathematical Models in Biology*: *An Introduction*. Cambridge University Press.

2. Jones, D. S., Plank, M. J., & Sleeman, B. D. (2009). *Differential Equations and Mathematical Biology* (2nd ed.). CRC Press, Taylor & Francis Group, LLC.

Additional Readings:

1. Murray, J. D. (2002). *An Introduction to Mathematical Biology* (3rd ed.). Springer.
2. Myint-U, Tyn (1977). *Ordinary Differential Equation*. Elsevier North-Holland, Inc.
3. Simmons, George F., & Krantz, Steven G. (2015). *Differential Equations*. McGraw-Hill Education. Indian Reprint.
4. Strogatz, Steven H. (2009). *Nonlinear Dynamics and Chaos* (2nd ed.). Perseus Book Publishing. LLC. Sarat Publication, Kolkata, India.

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II YEAR, IV SEMESTER

Elective Course (Any one out of the three papers) 2025

Course Name: **FUZZY SETS AND ITS APPLICATIONS**	Credits**: 04**	
Course Code: **MSMT-402A**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The basic aim of the course is to study various fuzzy sets especially t norms and fuzzy equations. Further to find out relations among fuzzy sets and possibility theory along with fuzzy linear programming.

Course Contents:

Unit I

Basic definitions, á -level sets, comparison with classical (crisp) sets, Types of fuzzy sets, extension principle.

Unit II

Fuzzy complement, t-norms, t-conorms, combination of operations, aggregation operations. Fuzzy numbers, linguistic variables, arithmetic operations on intervals, arithmetic operations on fuzzy numbers, lattice of fuzzy numbers, fuzzy equations.

Unit III

Crisp versus fuzzy relation, projections and cylindric extensions, binary fuzzy relations, binary relations on a single set, fuzzy equivalence relations, fuzzy compatibility and fuzzy ordering relations.

Fuzzy measures, evidence theory, possibility theory, fuzzy sets and possibility theory.

Unit IV

An overview of classical logic, multivalued logic, fuzzy propositions, fuzzy quantifiers, linguistic hedges, Inference from conditional fuzzy propositions, Inference from conditional and qualified propositions.

Information and uncertainty, non-specificity of crisp and fuzzy sets, fuzziness of fuzzy sets.

Unit V

Individual, multiperson, multicriteria decision making, fuzzy ranking method, fuzzy linear programming. Methods of defuzzyfication.

Course Learning Outcomes: After studying this course the student will be able to

CO1. use fuzzy sets for evidence theory.

CO2. apply Fuzzy measures techniques for possibility theory.

CO3. know the basics of fuzzy propositions for different Inferences.

CO4. construct fuzzy linear programming, Methods of defuzzyfication schemes studied in the course.

Suggested Readings:

[1] Fuzzy Logic: Intelligence, Control, and Information" by J Yen and R Langari.

[2] Fuzzy Set theory and its Applications" by H J Zimmermann.

[3 Fuzzy Sets And Applications" by Sudhir K.

[4] Fuzzy Set Theory Fuzzy Logic and their Applications" by Bhargava A K.

[5] Introduction to Fuzzy Logic using MATLAB" by S N Sivanandam and S Sumathi.

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Course Name: **MATHEMATICAL CRYPTOGRAPHY**	Credits**: 04**	
Course Code: **MSMT-402B**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: This course helps the students to develop skills and knowledge of standard concepts in cryptography and demonstrates how cryptography plays an important role in the present digital world by knowing encryption.

Course Contents:

Unit-I

Classical cryptography: Encryption schemes, Symmetric key encryption, Feistel ciphers, NDS, DES, Multiple encryptions, Modes of operation, Applications to authentication and identification.

Unit-II

Some Mathematical Tools: Algorithm, complexity, Modular arithmetic, Quadratic residues, Primality testing, Factoring and square roots, Discrete logarithm.

Unit-III

Public key Cryptography: Public key cryptosystems and their applications, RSA algorithm and its security, Key management, Diffie-Hellman key exchange.

Unit-IV

Elliptic curve cryptography, ID based public key cryptosystems.

Unit-V

Introductory concepts of Signcryption and Certificate less public key cryptosystems.

Course Learning Outcomes: After studying this course the student will be able to

CO1. have been introduced to the concept of secure communication and fundamentals of cryptography.

CO2. know classical ciphers such as Vigenere Cipher and Hill Cipher.

CO3. have insight into DES and AES.

CO4. be familiar with secure random bit generator and linear feedback shift register sequences.

CO5. know ofRSA, attacks on RSA, Diffie−Hellman key exchange and ElGamal, public key cryptosystem.

Suggested Readings:

[1] Stallings, William (2017). *Cryptography and Network Security, Principles and Practice* (7th ed.). Pearson Education Limited. England.

[2] Trappe, Wade & Washington, Lawrence C. (2006). *Introduction to Cryptography with Coding Theory* (2nd ed.). Pearson Education International.

[3] Stinson, Douglas R. (2005). *Cryptography Theory and Practice* (3rd ed.). CRC Press.

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Course Name: **Algebraic Coding Theory**	Credits**: 04**	
Course Code: **MSMT-402C**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: This course provides an introduction to algebraic coding theory, particularly linear codes. Bounds on the parameters have been discussed and cyclic codes have been explored. Some well-known codes such as BCH and Reed Muller codes have been described.

Course Contents:

Unit I

The Communication Channel**.** The coding problem. Types of codes. Error – Detecting and Error – Correcting Codes. Linear Codes. The Hemming Metric. Description of Linear Block Codes by Matrices.

Unit II

Dual Codes. Standard Array Syndrome. Step by Step Decoding Modular Representation. Error – Correction Capabilities of linear codes. Bounds of Minimum Distance for Block Codes. Plotkin Bound. Hamming sphere packing Bound. Bounds for Burst – Error Detecting and Correcting Codes.

Unit III

Important linear Block – Codes. Hamming Codes. Golay Codes. Perfect Codes. Quasi – perfect Codes. Reed – Muller Codes. Codes derived by Hadamard Matrices. Product Codes. Concatenated Codes.

Unit IV

A double-error correcting decimal Code and an introduction to BCH Codes, BCH bounds. Cyclic Codes. Matrix representation of Cyclic Codes.

Unit V

Hamming and Golay Codes as Cyclic Codes. Error detection with Cyclic codes. MDS Codes.

Course Learning Outcomes: After studying this course the student will be able to

CO1. get an insight into matrix representation of a code as well as encoding and decoding.

CO2. understand Hamming codes, MDS codes and Reed−Muller codes.

CO3. learn about cyclic codes and their generator polynomial.

Suggested Readings:

[1]S. Ling and C. Xing, Coding Theory: A First Course, Cambridge University Press, 2004

[2]R. Hill, A First Course in Coding Theory, Oxford University Press, 1986.

[3]W.C. Huffman and V. Pless, Fundamentals of Error Correcting Codes, Cambridge University Press, 2010.

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II YEAR, IV SEMESTER

Elective Course (Any one out of the three papers) 2025

Course Name: **FLUID DYNAMICS**	Credits**: 04**	
Course Code: **MSMT-403A**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: To prepare a foundation for advanced study of fluid motion in dimensions of compressible fluid, magnetohydrodynamics and boundary layer theory. Develop concept, models and techniques which enable to solve the problems and help in research in these broad areas.

Course Contents:

Unit I

Concept of fluid and its physical properties, Continuum hypothesis, Kinematics of fluids-Methods of describing fluid motion, Translation, Rotation and deformation of fluid elements, Stream Lines, Path lines and Streak lines, concepts of Vorticity.

Unit II

General theory of stress and rate of strain in a real fluid –Symmetry of stress tensor, Principal axes and Principle values of stress tensor, Constitutive equation for Newtonian fluid. Conservation laws- Conservation of mass, Conservation of momentum, Conservation of energy.

Unit III

One and two dimensional inviscid incompressible flow-Equation of continuity and motion using stream tube, Circulation, Velocity potential, Irrotational flow, Some theorems about rotational and irrotational flows – Stoke’s theorem, Kelvin’s minimum energy theorem, Gauss theorem, Kelvin’s circulation theorem.

Unit IV

Vortex motion and its elementary properties, Integration of equations of motion - Bernoulli’s equation, Stream function in two dimensional motion, Complex variable technique, flow past a circular cylinder, Blasius theorem, Milne’s circle theorem, Sources, Sinks and Doublets. Dynamical similarity, Buckingham’s pie theorem, Non-dimensional numbers and their physical significance

Unit V

Incompressible viscous fluid flows- Steady flow between two parallel plates (non-porous and porous) - Plane couette flow, Plane poiseuille flow, Generalized plane couette flow, Steady flow of two immiscible fluids between two rigid parallel plates, Steady flow through tube of uniform circular cross section, Steady flow through annulus under constant pressure gradient.

Course Learning Outcomes: After studying this course the student will be able to

CO1. know about the basics of first and second law of thermodynamics, internal energy, specific heats and concept of entropy, different form of energy equations and dimensional analysis.

CO2. know about compressibility in real fluids, the elements of wave motion, sound wave, shock wave, their formation, properties and elementary analysis.

CO3. understand the interaction between hydrodynamic process and electromagnetic phenomena in term of Maxwell electromagnetic field equation.

CO4. formulate the basic equations of motion in inviscid and viscous conducting fluid flow and be familiar

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with the Alfven's wave and magneto-hydrodynamic wave.

CO5. know the concepts of boundary layer, boundary layer equations and their solutions with different concept and measurement of boundary layer thickness.

Suggested Readings:

[1] F. Chorlton, Text Book of Fluid Dynamics, CBS Publisher, 2005.

[2] A. Jeffrey, Magnetohydrodynamics, Oliver & Boyd, 1966.

[3] H. Schlichting, K. Gersten, Boundary Layer Theory, 8th Edition, Springer, 2003.

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Course Name: **MATHEMATICAL PROGRAMMING**	Credits**: 04**	
Course Code: **MSMT-403B**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The objective of this course is to study optimality conditions, Lagrangian duality and numerical methods of mathematical programming problems with nonlinear objective and nonlinear constraints.

Course Contents:

Unit I

Convex sets, convex functions, pseudo-convex functions, quasi-convex, explicit quasi-convex, quasi-monotonic functions and their properties from the point of view of mathematical programming. Kuhn-Tucker conditions of optimality.

Unit II

Theory of revised simplex algorithm. Duality theory of linear programming. Sensitivity analysis.

Unit III

Parametric linear programming. Integer programming and linear goal programming.

Unit IV

Quadratic programming: (i) Wolfe's algorithm (ii) Beale's algorithm (iii) Theil and Vande-Panne algorithm.

Unit V

Duality theory of quadratic and convex programming, separable programming, sequential unconstrained minimization.

Course Learning Outcomes: After studying this course the student will be able to

CO1. derive first and second order optimality conditions for a nonlinear programming problem and consider convex functions for deriving sufficient optimality conditions.

CO2. understand duality theory in terms of Lagrangian function and investigate saddle point theory.

CO3. understand numerical methods like Wolfe's method, convex simplex method and penalty function methods for solving different types of nonlinear programming problems.

Suggested Readings:

[1] M.S. Bazaraa, H.D. Sherali and C.M. Shetty, Nonlinear Programming: Theory and Algorithms, John Wiley & Sons, 2013.

[2] O. Güler, Foundations of Optimization, Springer 2010.

[3] D.G. Luenberger and Y. Ye, Linear and Nonlinear Programming, Springer, 2008.

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Course Name: **Database Management System**	Credits**: 04**	
Course Code: **MSMT-403C**	Hours (Total): **60**	**L+T+P (4+0+0)**

Course Objectives: The basic aim of the course is to study various database, Inverted and Multilist files and different types of trees. Also to get through languages like SQL and Relational Database Design.

Course Contents:

Unit I

File Organization: the constitution of a file, Operations on files, Primary key Retrieval, Sequential files, index sequential files: implicit index, limit indexing multilevel, indexing schemes, Structure of index sequential file, VSAM direct files, hashing techniques, Extended hashing.

Secondary Key Retrieval: Inverted and Multilist files.

Indexing Using Tree Structures: Tree schemes, operation, capacity, B-Tree, B+- trees.

Unit II

Data base Management System: What is DBMS? Three **-** level architecture of DBMS.

Relation Data Model: Relational Database**:** Attributes and domains, Tuples, Relations and their schemes, Relation representation, Keys, Relational operations, Integrity Rules

Relational Algebra: Basic Operations, Additional Relation algebraic operations, Some Relational Algebra Queries.

Unit III

Structural Query Language (SQL): Data definition, Data manipulation, Condition Specification, Arithmetic and aggregate operators, SQL join, Set Manipulation, categorization, updates.

Unit IV

Relational Database Design: Functional dependencies. First, second, third and BCNF normal Forms, Data integrity and recovery.

Unit V

Concurrency and security Management: Security of database. Serializability. Locking Schemes. Time stamp based order.

Course Learning Outcomes: After studying this course the student will be able to

CO1: describe the architecture of a web application.

CO2: describe the issues in query optimization.

CO3: develop a web-based database application incorporating security issues.

Suggested Readings:

1. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008.
2. R. Elmsasri,S. Navathe Fundamentals of Database Systems, Pearson Education, Fifth Edition, 2007
3. MySQL : Reference Manual
4. A. Silberschatz, H. Korth and S. Sudarshan, Database System Concepts (6th ed.), McGraw Hill, 2010.

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Course Name: **DISSERTATION**	Credits**: 12**	
Course Code: **MSMT-404D**	Hours (Total): **144**	**L+T+P (120+0+24)**

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