MAHARAJA SUHEL DEV UNIVERSITY, AZAMGARH

Choice Based Credit System (C.B.C.S.)

4 YEARS UG (HONS.) PROGRAMME/4 YEARS UG (HONS. WITH RESEARCH) PROGRAMME AND P.G. PROGRAMME

COURSE STRUCTURE AND SYLLABUS

Effective from 2024-25

MATHEMATICS

(Convenor)

16/10/24

MAHARAJA SUHEL DEV UNIVERSITY, AZAMGARH

Syllabus

Semester Courses of 4 YEARS UG (HONS.) PROGRAMME/4 YEARS UG (HONS. WITH RESEARCH) PROGRAMME AND P.G. PROGRAMME(M.A./M.Sc. in Mathematics) Based on CBCS

Course Objectives and Outcomes:

1. To develop deep understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.

2. To provide advanced knowledge of topics in pure mathematics particularly in Algebra, Analysis and Mechanics empowering the students to proceed with the area at higher level.

3. To develop understanding of applied mathematics and motivating the students to use mathematical techniques as a tool in the study of other scientific domains.

4. To encourage students for research studies in Mathematics and related fields.

5. To provide students a wide variety of employment options as they can adopt research as a career or take up teaching jobs or can get employment in banking or can go for any other profession.

6. To inculcate problem solving skills, thinking and creativity through presentations, Assignment and project work

7. To help students in their preparation (personal counseling, books) for competitive Exams e.g. NET, GATE, etc.

8. To enable the students being life-long learners who are able to independently expand their mathematical expertise when needed.

4 YEARS UG (HONS.) /4 YEARS UG (HONS. WITH RESEARCH)/ M.A./M.Sc.(MATHEMATICS)
(Effective from session 2024-2025)

The fourth year of UG(Hons.)/UG(Hons with Research)degree consist of two Semesters in a year and M.A. / M.Sc. (Mathematics) Course consists of four Semester(02 Semesters in each year). The examinations will be held in the months of December and April respectively. Each semester examination will consist of Theory Papers, Practical and Research Project of that semester. Each paper will be of three hours' duration and of 4 credit (maximum marks 75), and the Practical Examination will be of two hours(Maximum Marks 100). There will be 25% internal evaluation in each paper based on:

1. Attendance	5 Marks
2. Sessional Test	10 Marks
3. Assignment	10 Marks

Format of the Question Paper:

There will be Section-A of one compulsory question consisting of 10 parts of very short answer type question. Each part will have to be answered in about 50 words. Section-B consist eight short answer type questions. Attempt any five questions from section-B. Each question will have to be answered in about 200 words. Each question will have to be answered in about 200 words. Section-C consist four long answer type questions. Attempt any two questions from section-C. Each question will have to be answered in about 500 words.

M.A./M.Sc. Mathematics

Year	Semester	Subject/ Courses	Course Code	Paper Title	Theory / Practical	Credits
4 Year UG Degree (Hons.)/ P.G. FIRST semester	VII	Major/ compulsory	B030701T	Abstract Algebra-I	Theoretical	4
			B030702T	Real Analysis	Theoretical	4
			B030703T	Topology	Theoretical	4
			B030704T	Complex Analysis	Theoretical	4
			Optional	**Choose any one of the following**		
			B030705T	(A) Differential Equations	Theoretical	4
			B030706T	(B) Special Functions	Theoretical	4
4 Year UG Degree (Hons.)/ P.G. SECOND semester	VIII	Major/ compulsory	B030801T	Abstract Algebra-II	Theoretical	4
			B030802T	Functional Analysis	Theoretical	4
			B030803T	Advanced Discrete Mathematics	Theoretical	4
			Optional	**Choose any one of the following**		
			B030804T	(A)Integral Equation and boundary value problem	Theoretical	4
			B030805T	(B) General relativity and Cosmology	Theoretical	4
			B030806P	Problem Solving through Python	Practical	- 4
P.G. THIRD semester	IX	Major/ compulsory	B030901T	Measure and Integration	Theoretical	4
			B030902T	Partial Differential Equations	Theoretical	4
			B030903T	Classical Mechanics	Theoretical	4
			Optional	**Choose any one of the following**		
			B030904T	(A)Operations Research	Theoretical	4
			B030905T	(B) Algebraic Topology	Theoretical	4
		Research Project	B030906R	Research Project	Project	4
P.G. FOURTH semester	X	Major/ compulsory	B031001T	Fluid Dynamics	Theoretical	4
			Optional	**Choose any one of the following**		
			B031002T	(A) Advanced Complex Analysis	Theoretical	4
			B031003T	(B) Algebraic Number theory	Theoretical	4
			Optional	**Choose any one of the following**		
			B031004T	(A) Advanced Functional Analysis	Theoretical	4
			B031005T	(B)Fuzzy sets and their applications	Theoretical	4
			Optional	**Choose any one of the following**		

			B031006T	(A)Differential Geometry of Manifolds	Theoretical	4
			B031007T	(B)Mathematical Modeling	Theoretical	4
		Research Project	B031008R	Research Project	Project	4

4 Year UG Degree (Hons. with research)

Year	Semester	Subject/ Courses	Course Code	Paper Title	Theory / Practical	Credits
4 Year UG Degree (Hons. with research)	VII	Major/ compulsory	B030701T	Abstract Algebra-I	Theoretical	4
			B030702T	Real Analysis	Theoretical	4
			B030703T	Topology	Theoretical	4
			B030704T	Complex Analysis	Theoretical	4
			B030705R	Research Project		4
4 Year UG Degree (Hons. with research)	VIII	Major/ compulsory	B030801T	Abstract Algebra-II	Theoretical	4
			B030802T	Functional Analysis	Theoretical	4
			B030803T	Advanced Discrete Mathematics	Theoretical	4
			B030804P	Problem Solving through Python	Practical	4
			B030805R	Research Project		4

16/10/24

16.10.2024

U.G. (4th Year) /
M.A. / M.Sc. I (First Semester) Mathematics
Paper I

Course Code: B030701T **Abstract Algebra-I**

M.M.: 75 Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Symmetric groups, Dihedral groups, Matrix groups. Normal and Subnormal series. Zassenhaus' lemma, Schreier's refinement theorem. Composition Series. Jordan-Holder theorem. Chain condition.	15
II	Commutator subgroup and commutator series of a group, Solvable groups, Lower and upper central series, Nilpotent group.	15
III	Field theory-Extension fields. Algebraic and transcendental extensions. Splitting fields, Separable and inseparable extensions. Normal extensions Perfect fields.	15
IV	Primitive elements. Finite fields. Algebraically closed fields. Automorphism of extensions. Galois extensions, Fundamental theorem of Galois theory. Insolvability of the general equation of degree 5 by radicals,	15

References:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattachrya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, Indian Edition, 1997.
3. M.Artin. Algebra, Prentice-Hall of India, 1991.
4. N. Jacobson, Basic Algebra, Vols. I & IIi, W.H. Freeman, 1980.
5. S. Lang, Algebra, Addison-Wesley, 1991.
6. Ramji Lal, Algebra, Vols. I & II, Shail Publications, Allahabad, 2002.

U.G. (4^{th} Year) /

M.A./ M. Sc. I (First Semester) Mathematics

Paper –II

Course Code: B030702T **Real Analysis**

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Countable and uncountable sets. Infinite sets and the Axiom of Choice, Cardinal numbers and its arithmetic. Schoeder-Bemstem theorem. Cantor's theorem and the continuum hypothesis. Zorn's lemma. Well-ordering theorem, Definition and existence of Riemann Sieltjes integral. Conditions for R-S integrability. Properties of the R-S integral.	**15**
II	Rearrangements of terms of a series, Riemann's theorem Sequences and series of function, pointwise and uniform convergence. Cauchy criterion for uniform, convergence, Mn test, Welerstrass M-test, Dini theorem, Abel's and Dirichlet's tests for uniform convergence,	**15**
III	Uniform convergence and continuity, Uniform convergence and Riemannn-Stieltjies integration, Uniform convergence and differentiation.Weiesrtrass approximation theorem, Power series, Radius of convergence, Uniqueness theorem for power series, Able's and Tauber's theorems.	**15**
IV	Functions of Several Variable, linear transformation, Derivative of functions in an open subset of R^n into R^m as a linear transformation, Chain rule, Directional derivatives and differentiability, Inverse function theorem and implicit function theorem.	**15**

References:

1. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., New Delhi.
2. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
3. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Kogakusha, 1976.
4. E. Hewitt and K. Stromberg, Real and Abstract Analysis, Berlin, Springer, 1969.
5. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar, Inc., New York, 1975.
6. T.P. Natanson. Theory of Functions of Real Variable, Vol. I, Frederick Unger Publishing Co. 1961.

U.G. (4^{th} Year) /

M.A./ M. Sc. I (First Semester) Mathematics

Paper-III

Course Code: B030703T **Topology**

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Definition and examples of topological spaces, Closed sets. Closure, Dense subsets. Neighborhoods. Interior, exterior and boundary. Accumulation points and derived sets and bases, sub-bases. Subspaces and relative topology, Product topology, Quotient topology.	15
II	Continuous functions and homeomorphism First and Second Countable spaces. Lindelof's theorems. Separable space second. Countability and Separability. Separation axioms T0, T1, T2, T3, T4 ; their Characterizations and basic properties. Urysohn's lemma. Tietze extension theorem	15
III	Compactness, Continuous functions and compact sets, Basic properties of compactness. Compactness and finite intersection property. Sequentially and countably compact sets.	15
IV	Locally compact spaces, Tychonoff's theorem one point compactification. Stone-check compactification. Connectedness spaces. Connectedness on the real line. Components. Locally connected spaces.	15

References:

1. James R. Munkers, Topology, A First Course, Prentice-Hall of India Pvt. Ltd. New Delhi. 200.
2. George F. Simmons, Introduction to Topology and Modern Analysis, MeGraw Hill Book Company, 1963.
3. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. 1983.
4. J. Hocking and G. Young, Topology, Addison-Wesley, Reading, 1981.
5. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.

U.G. (4^{th} Year) /
M.A./ M.Sc. I (First Semester) Mathematics
Paper-IV

Course Code: B030704T **Complex Analysis**

M.M.: 75 Duration: -3.00 hours

Unit	Topics	No. of Lectures
I	An Integration and differentiation of power series, Absolute and uniform convergence of power series. Linear transformations, the transformation $w = 1/z$, Möbius transformations and its geometric properties, Conformal mapping and conformal representation	15
II	Branch point, branch cut, branches of a multi-valued function, analyticity of the branches of $Log\ z$, z^a. Singularities and their classification, Weierstrass-Casorati's theorem.	15
III	Zeros of analytic function, Argument principal, Rouche's theorem Jordan's lemma, Jordon's theorem, Integration of many-valued function, A Quadrant or a sector of a circle as the contour, Rectangular contour	15
IV	Uniqueness of analytic continuation along a curve. Power series method of analytic continuation. Schwarz Reflection principle. Monodromy theorem and its consequences, Gamma function and its properties. Riemann Zeta function. Reimann's functional equation.	15

References:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
3. L.V. Ahlfors, Complex Analysis, MC Graw Hill, 1979.
4. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
5. Walter Rudin, Real and Complex Analysis, McGraw Hill Book Co., 1968.
6. E. Hille, Analytic Function Theory, Hindustan Book Agency, Delhi, 1994.

U.G. (4th Year) /

M.A. / M.Sc. I (First Semester) Mathematics

Optional

M.A./ M.Sc. I (First Semester) Mathematics

Paper-V(A)

Course Code: B030705T **Differential Equations**

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Existence and uniqueness of solutions of ordinary differential equation of first order. Picard's Method. Existence theorem in complex plane. Existence of uniqueness theorem for ordinary differential equation of higher order. The Lipschitz's case Existence of solutions. Boundary Value Problems for Differential Equations.	**15**
II	The self-adjoint second order linear equation, Linear independence and Wronskians, General solution covering all solutions for homogeneous and non-homogeneous linear system Abel's formula, Power series solution , Frobenius generalized power series method, Regular and logarithmic solutions near regular singular points, Hypergeometric function	**20**
III	Sturm comparison and separation theorem, Sturm-Lioville's systems, Eigen value and Eigen functions, Poincare-Bendixson theorem, Green function, Construction of Green function.	**15**
IV	Ascoli- Arzela Theorem, Picad – Lindelof theorem, Peano's existence theorem, Gronwall's inequality.	**10**

References:

1. Walter G. Kelley and Allan C. Peterson, Difference Equations: Introduction with applications, Academic Press 2nd Edition.
2. Pundir and Pundir, Difference Equations, Pragati Prakashan, 1st edition, 2006.
3. Calvin Ahlbrandt an Allan C. Peterson, Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Ricati Equations, Kluwer, Boston, 1996.
4. H. Levy and F. lessman, Finite Difference Equations, Dovel Publications.

U.G. (4th Year) /

M.A./ M. Sc. I (First Semester) Mathematics

Paper-V (B)

Course Code: B030706T

Special Functions

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	The Gamma Functions: Analytic Character, Euler's limit formula, Duplication formula. Eulerian integral of the first kind, Euler's Constant, Canonical product, Asymptotic expansions, Watson's lemma, Asymptotic expansion of $\Gamma(z)$ and its range of validity, Asymptotic behavior of $\lvert\Gamma(x+iy)\rvert$.	15
II	The Hyper geometric Functions, Hyper geometric Differential Equation and its solutions characterized by the regular singular points of this differential equation, Euler's Integral Representation of $F(a, b, c; z)$, ${}_2F_1$ as a function of the parameters, Contiguous function relations, Simple transformations,Relation between function of (z) and $(1\text{-}z)$ quadratic transformations, Differential properties.	15
III	The confluent Hyper geometric Functions ${}_1F_1$, The confluent Hyper geometric equation, Basic properties of ${}_1F_1$, Whittaker's function, Whittaker's Differential equation and its solutions. . Generalized Hyper geometric series: The function pFq, Differential equation satisfied by pFq, Integral Representation of pFq with unit argument, Kummer's first and second theorem, The Barnes type Integral Representation.	15
IV	Bessel Functions; Bessel's differential equation and its series solutions, recurrence formulae for $J(z)$, generating functions for $J(z)$. Hankel functions, Connection between the Bessel and Hankel functions, Hermite Polynomials, Asymptotic expansion of the Bessel's functions.	15

References:

1. E. T. Copson An introduction to the theory of function of a complex variable. Oxford University Press 1974.
2. Rainville, E.D.: Special Function.
3. Saran, N. S. D. Sharma & Trivedi T. N.: Special Functions, Pragati Prakashan, Meerut.
4. M. S. Khan, Special Functions and their Applications, Ayushman Publications House, New Delhi.
5. Dr. G. S. Sao, Special Functions, Published by: Shree shiksha Sahitya prakashan, Meerut.

U.G. (4th Year) /

M.A. / M.Sc. I (Second Semester) Mathematics

Paper -I

Course Code: B030801T **Abstract Algebra-II**

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Modules, Submodules, Quotient modules. Homomorphism and Isomorphism theorems. Cyclic modules, Simple modules. Semi-simple modules. Schuler's lemma Free modules	**15**
II	Noetheiran and artinan modules and rings. Hilbert basis theorem. Wedderburn-Artin theorem. Uniform modules, primary modules and Noether Lasker theorem.	**15**
III	Canonical forms, Similarity of linear transformation, Invarient subspaces, Reduction to triangular forms.	**15**
IV	Nilpotent transformations, Index of nilpotency, Invariants of nilpotent transformation, The primary decomposition theorem. Jordan blocks and Jordan form.	**15**

References:

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattachrya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, Indian Edition, 1997.
3. M. Artin. Algebra, Prentice-Hall of India, 1991.
4. N. Jacobson, Basic Algebra, Vols. I & II, W.H. Freeman, 1980.
5. S. Lang, Algebra, Addison-Wesley, 1991.

U.G. (4th Year) /

M.A./ M.Sc. II (Second Semester) Mathematics

Paper –II

Course Code: B030802T **Functional Analysis**

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Normed and Banach speces- Definitions and elementry properties. Some complete normed and Banach spaces. Quotient spaces. Completion of normed spaces.	**15**
II	Bounded linear operators- definitions, examples and basic properties. Spaces of bounded linear operators. Equivalent norms. Finite dimensional normed spaces and copmactness Open mapping theorem and its consequences. Closed graph theorem and its consequences. Uniform boundedness principal. The Banach-Steimhaus Theorem.	**15**
III	Bounded linear functionals- definitions, examples and basic properties. The form of some dual spaces. Hahn-Banch theorem and its consequences Embedding and reflexivity of normed spaces. Adjoint of bounded linear operators. Weak conversions and weak* conversions	**15**
IV	Hibert spaces. Orthogonal complements and projection theorem. Orhtonormal sets. Functional and operators on Hilbert spaces-bouded linear functionals. Hilbert-adjoint operators. Self-adjoint operators. Normed operators. Unitary operators. Orthogonal projection operators	**15**

References:

1. K.K. Jha, Functional Analysis, Students Friends. 1986.
2. A.H. Siddiqi, Functional Analysis with applications. Tata Mc Graw Hill Publishing Company Ltd, New Delhi.
3. Walter Rudin, Functional Analysis, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi 1973.
4. P.K. Jain, O.P. Ahuja and Khalil Ahmad, Functional analysis, New Age International (P) Ltd., Lucknow.

U.G. (4th Year) /

M.A./ M. Sc. I (Second Semester) Mathematics

Paper-III

Course Code: B030803T **Advanced Discrete Mathematics**

M.M.: 75 Duration: -3.00 hours

Unit	Topics	No. of Lectures
I	Lattice Theory; Lattices as partially ordered sets. Their properties. Lattices as Algebraic systems. Sublattices. Direct product and Homomorphisms. Some Special Lattices e.g., Complete, Complemented and Distributive Lattices.	**15**
II	Boolem Algebras- Boolean Algebras as Lattices. Various Boolean indentities. The switching Algebra example. Subalgebras, Direct Product and Homomorphisms, Joinrreducible elements, Atoms and Minterms. Boolean Forms and their Equivalence. Minter Boolean Forms. Sum of products. Cannonical Forms. Minimization of Boolean Functions, Application of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaughj Map method.	**15**
III	Graph Theory- Definition of (undirected) Graphs, Paths, Circuits, Cycles & Subgraphs, Induced Subgraphs. Degree of vertex. Connectivity. Complete & Complete Bipartite Graphs. Planar Graphs and their properties. Euler's Formula for connected Planar Graphs. Eulerian graph, Hamiltonian graphs.	**15**
IV	Trees: Spanning Trees. Cut-sets, Fundamental Cut-sets, and Cycles. Minimal Spanning Trees and Kruskal's Algorithm. Directed Tress. Search Trees. Tree Traversals. Kuratowski's Theorem (statement only) and its use. Matrix representation of Graph.	**15**

References:

1. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hill Book Co.
2. S. Wiitala, Discrete Mathematics- A Unfired Approach, McGraw-Hill Book Co.
3. J.L. Gersting, Mathematical Structures of Computer Science. Computer Science Press, New York.

U.G. (4^{th} Year) /

M.A. / M.Sc. I (Second Semester) Mathematics

Optional

M.A./ M. Sc. I (Second Semester) Mathematics
Paper-IV (A)

Course Code: B030804T **Integral Equation and Boundary Value Problems**
M.M.: 75
Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Integral Equations: Integral transform, Abel Integral Equations, Poisson Integral Equations, Linear and Non linear Integral Equations. Solution of Integral Equations kind. Leibnitz's rule, General Integral Equations Fredholms and Volterra integral equations of first, second and third kind.	15
II	Convert a multiple integral into single ordinary integral equations, Conversion of differential equation to integral equations. Solving of Fredholm and Volterra integral equations of second kinds by the method of successive substitutions; successive approximations iterative, Neumann series and basic existence theorem.	15
III	Classification of integral equations of Volterra and Fredholm types; Conversion of initial and boundary value problem into integral equation; Conversion of integral equation into differential equation (When it is possible);	15
IV	Volterra and Fredholm integral operators and their iterated kernels; Resolvent kernels and Neumann series method for solution of integral equations.	15

References:

1. R.P. Kanwai, Linear Integral Equation: Theory and Techniques. Academic Press, New Youk, 1971
2. S.G. Mikhin, Linear Integral Equation. Hindustan Book Agency, 1960.
3. I.N. Sneddon. Mixed Boundary Value Problem in Potential Theory. North HOLLAND, 1966.
4. Pundir and Pundir, Integral equations and Boundary Value Problems; A Pragati Prakashan, Meerat
5. Dr. M. D. Raisinghania, Integral equations and Boundary Value Problems, S Chand &Company Pvt. Ltd., New Delhi
6. I. Stakgold, Boundary Value Problems of mathematical physics,Vol. I and II, Macmillan, 1969.

U.G. (4th Year) /
M.A./ M. Sc. I (Second Semester) Mathematics
Paper-IV(B)

Course Code: B030805T **General Relativity and Cosmology**
M.M.: 75
Duration: -3.00 hours

Unit	Topics	No. of Lectures
I	General Relativity- Transformation of coordinates. Tensors. Algebra of Tensors. Symetric and skew symmetric Tensors. Contraction of tensors and quotient law. Reimannian metric, Parallel transport, Christoffel Symbols. Covariant derivatves. Intrinsic derivatives and geodesics, Reiemann Christoffel curvature tensor and its symmetry properties. Bianchi identities and Einstein tensor.	15
II	Review of the special theory of relativity and the Newtonian Theory of gravitation. Principle of equivalence and general covariance, geodesic principle. Newotonian approximation. Schwarzchild external solution and its isotropic form. Planetary orbits and analogues of Kepler's laws in general relativity.	15
III	Energy- momentum tensor of a perfect fluid. Schwarzchild internal solution. Boundary conditions. Energy momentum tensor of an electromagnetic filed. Eistein-Maxwell equations. Reissner-Nordstrom solution. Cosmology- Mach's principal. Einstein modified field equations with cosmological term. Static Cosmological models of Einstein and De-Sitter, their derivation, properties and comparison with the actual universe	15
IV	Hubble's law. Cosmological principle's Wey'Is postulate. Derivation of Robertson-Walker metric. Hubble and deceleration parameters. Redshift. Redsshift versus distance relation. Anuglar size versus redshift relation and source counts in Robertson- Walker space-time.	15

References:

1. C.E. Weatherburn An Introduction to Riemannian Geometry and the tensor Calculus, Cambridge University Press, 1950.
2. J.V. Narlikar, General Relativity and Cosmology, The Machmillann Company of India Ltd. 1978.
3. B.F. Shutz, A first course in genral relativity, Combridge University Press, 1990.
4. A.S. Eddington, The Mathematical Theory of Relativity, Cambridge University Press, 1965.
5. S. Weinberg, Gravitation and Cosmology: Principle and applications of the general theory of relativity, John Wiley & Sons, Inc. 1972.
6. J.V. Narlikar, Introduction to Cosmology, Cambridge University

U.G. (4^{th} Year) /
M.A./ M. Sc. I (Second Semester) Mathematics

M.M.: 100 **Practical** Duration:-2.00 hours

Course Code: B030806P / B030804P (For U.G. Hons. with Research)

Problem Solving through Python. (Practical)

	Overview of Programming: Structure of a PythonProgram, Elements of Python, IDEs for python, Python Interpreter, Using Python as calculator, Python shell,Indentation. **Introduction to Python:** Atoms, Identifiers and keywords,Literals, Strings, Operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment, Operator, Ternary operator, Bit wise operator, Increment orDecrement operator). **Creating Python Programs:** Input and OutputStatements, Control statements (Looping- while Loop, for Loop, Loop Control, Conditional Statement- if...else,Difference between break, continue and pass). **Structures**: Numbers, Strings, Lists, Tuples, Dictionary, Date & Time, Modules, Defining Functions, Exit function, default arguments. File handling in python.	
	Practical / Lab work to be performed in Computer Lab. List of the practicals to be done using R/Python/Mathematical /MATLAB /Maple /Scilab/Maxima etc. **Section: A (Simple programs)** 1. Write a menu driven program to convert the given temperature from Fahrenheit to Celsius and vice versa depending upon user's choice. 2. Write a menu-driven program, using user-defined functions to find the area of rectangle, square, circle and triangle by accepting suitable input parameters from user. 3. WAP to display the first n terms of Fibonacci series. 4. WAP to find factorial of the given number. 5. WAP to find sum of the following series for n terms: $1 - 2/2! + 3/3!$ ----- 6. WAP to calculate the sum and product of two compatible matrices. **Section: B (Visual Python)** All the programs should be written using user defined functions, wherever possible. 1. Write a menu-driven program to create mathematical 3D objects I. curve II. sphere III. cone IV. arrow V. ring VI. Cylinder. 2. WAP to read n integers and display them as a histogram. 3. WAP to display sine, cosine, polynomial and exponential curves. 4. WAP to plot a graph of people with pulse rate p vs. height h.	

The values of p and h are to be entered by the user.

5. WAP to calculate the mass m in a chemical reaction. The mass m (in gms) disintegrates according to the formula m=60/(t+2), where t is the time in hours. Sketch a graph for t vs. m, where t>=0.
6. A population of 1000 bacteria is introduced into a nutrient medium. The population p grows as follows:

   P(t) = (15000(1+t))/(15+ *e)*

   where the time t is measured in hours. WAP to determine the size of the population at given time t and plot a graph for P vs t for the specified time interval.

Suggested Readings:

1. P. K. Sinha & Priti Sinha , "Computer Fundamentals", BPB Publications, 2007.
2. Dr. Anita Goel, Computer Fundamentals, Pearson Education, 2010.
3. T. Budd, Exploring Python, TMH, 1st Ed, 2011
4. Python Tutorial/Documentation www.python.or 2010
5. Allen Downey, Jeffrey Elkner, Chris Meyers , How to think like a computerscientist : learning with Python , Freely available online.2012
6. Rober Sedgewick, K Wayne -Introduction to Programming in Python: Aninterdisciplinary Approach" Pearson India

Suggested Readings:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised andupdated for Python 3.2, Network Theory Ltd., 2011.
3. Charles Dierbach, "Introduction to Computer Science using Python: A ComputationalProblem-Solving Focus, Wiley India Edition, 2013.
4. John V Guttag, "Introduction to Computation and Programming Using Python'', Revisedand expanded Edition, MIT Press , 2013
5. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning,2012.

M.A./ M. Sc. II (Third Semester) Mathematics

Paper-I

Course Code: B030901T

Measure and Integration

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Lebesgue outer measure. Measureable sets. Regularity. Measureable functions. Borel and Lebesuge measurability. Non-measurable sets.	**15**
II	Integration of Non-negative functions. The General integral, Integration of Series. Reimann and Lebesgue integrals. The Four derivatives. Functions of Bounded variation. Lebesuge Differentiation Theorem. Differentiation and Integration.	**15**
III	Measures and outer measures. Extension of measure. Uniquenss of Extension. Completion of a measure. Measure spaces. Integration with respect to a measure.	**15**
IV	The Lp-spaces. Convex functions. Jensen's inequality. Holder and Mindowski inequalities.	**15**

References:

1. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 2000.
2. J.H. Williamson, Lebesgue Integration, Holt Rinehart and Winston, Inc. New York, 1962.
3. P.R. Halmos, Meausure Theory, Van Nostrand, Princeton, 1950.
4. Inder P. Rana, An Introduction to Measure and Integration, Narosa Publishing House, New Delhi, 1997.
5. G. de Barra, measure Theory and Integration, Wiley Eastern Ltd., 1981.

M.A./ M. Sc. II (Third Semester) Mathematics

Paper-II

Course Code: B030902T **Partial Differential Equations**

M.M.: 75

Duration: -3.00 hours

Unit	Topics	No. of Lectures
I	Non-linear Partial Differential Equation, Classification of partial differential equation, Canonical form of partial differential equation, Integral surface, Cauchy Characteristic equation. Some important non-linear partial differential equation. Calculus of Variation-Variational problem with moving boundaries.	15
II	Heat Equation- Fundamental Solution. Mean Value Formula. Properties of Solutions Energy Methods. Hopf –Lax Formula.	15
III	Wave Equation. Mean value Method, Solution of Wave equation with initial values, Energy methods. Hopf-Cole Transformation D'Alembert's solution of an infinite vibrating string problem.	15
IV	Laplace's equation- Fundamental solution. Mean Value Formula Properties of Harmonic Functions. Green's Function. Energy Methods.	15

References:

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19, AMS, 1998.
2. I.N. Sendon, Elements of Partial Differential Equations, McGraw Hill Book Co., 1988.
3. P. Prasad and R. Ravindran, Partial Differential Equations.

M.A./ M. Sc. II (Third Semester) Mathematics

Paper-III

Course Code: B030903T **Classical Mechanics**

M.M.: 75 Duration: -3.00 hours

Unit	Topics	No. of Lectures
I	Rigid body as a system of particles, the concept of angular velocity, the general equation of motion of a rigid body, The inertia tensor, Principal axes, Kinetic energy and angular momentum of a rigid body in terms of inertia consants. Moving frame of reference, Eulerian angles, Euler dynamical and geometrical equations of motion.	15
II	Generalized coordianates. Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Lagrange's equations for a holonomic system, Energy equation for conservative fields. Lagrange equations for impulsive motion. Hamilton's variables. Hamilton canonical equations. Cyclic coordinates Routh's equations, Poisson's Bracket. Poisson's Identity.	15
III	Motivating Problems of calculus of variations. Shortest distance. Minimum surface of revolution. Brachistochrone problem, Phase space and Hamilton's variational principle, Principle of least action. Theory of small oscillations, Lagrange's method.	15
IV	Canonical transformation, Lagrange Brackets, Condition of canonical character of a transformation Poisson brackets. Poisson brackets under canonical transformation. Hamilton-Jacobi (Outline only) equation. Jacobi theorem.	15

References:

1. H. Goldstein, Classical Mechanics, Narosa Publishing house, New Delhi.
2. Chorlton, F., Textbook of Dynamics. John Wiley & Sons
3. A.S. Ramsey, Dynamics Part II, The English Language Book Society and Cambridge University Press, 1972.
4. F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
5. Narayan Chandra Rana & Promod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1911.

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Optional

M.A./ M. Sc. II (Third Semester) Mathematics
Paper-IV(A)

Course Code: B030904T **Operations Research**

M.M.: 75

Duration: -3.00 hours

Unit	Topics	No. of Lectures
I	Operations Research and its Scope, Methodology of OR, Necessity of Operations Research in Industry. Linear Programming- Simplex Method. Revised Simplex Method. Duality. Dual Simplex Method and Sensitivity Analysis.	**15**
II	Parametric Linear Programming. Upper Bound Technique. Interior Point Algorithm. Linear Goal Programming.Nonlinear Programming- One and Multi-Variable Unconstrained Optimization. Kuhn-Tucker. Conditions for constrained Optimization. Quadract Programming	**15**
III	Inventory MODELS: EOQ MODELS, Lead time,EOQ without shortages. EOQ with shortages. Dynamic Programming: Bellman's Optimality principle. Applications. Job sequencing: n jobs-2 machines, n jobs-K machines, 2 jobs-n machines.	**15**
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-CMP.	**15**

References:

1. H.A. Taha, Operations Research- Ann Introduction, Macmillan Publishing Co. Inc., New York.
2. N.S. Kambo, Mathematical Programming Techniques, Affiliated East- West Press Pvt. Ltd. New Delhi, Madras.
3. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd. New Delhi.
4. Prem Kumar Gupta and D.S. Hira, Operations Research- An Introductions. S. Chand & Co. Ltd., New Delhi.
5. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, McGraw Hill International Edition, Industrial Engineering Series, 1995.

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Paper-IV(B)

Course Code: B030905T **Algebraic Topology**

M.M.: 100

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Fundamental group functo, homotopoy of maps between topological spaces, homotopy equivalence, contractible and simply connected spaces, fundamental groups of S^1, and $S^2 \times S^1$ ect.	15
II	Calculation of fundamental group of S^n, n>1 using Van Kampen's theorem, fundamental groups of a topological group, Brouwer's fixed point theorem, fundamental theorem of algebra, vector fields on planer sets, Frobenius theorem for 3x3 matrics.	15
III	Covering spaces, unique path lifting theorem, covering homotopy theorems, group of covering transformations, criterion of lifting of maps in terms of fundamental groups, universal covering, its existence, special cases of manifolds and topological groups.	15
IV	Sigular homology, reduced homology, Eilengerg Steenrod axioms of homology (no proof for homotopy invariance axion, excision axiom and exact sequence axiom) and their application, relation between group and first homology.	15

References:

1. James R. Munkres, Topology- A first Course, Prentice Hall of India Pvt. Ltd., New Delhi 1978.
2. Marwin J. Greenberg and J.R. Harper, Algebraic Topology-A first Course, Addison- Wesley Publishing Co., 1981.
3. W.S. Massey, Algebraic Topology- An Introduction, Harcourt, Brace and World Inc. 1967, SV., 1977.

M.A./ M. Sc. II (Fourth Semester) Mathematics
Paper-I

Course Code: B031001T **Fluid Mechanics**

M.M.: 75 Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Kinematics- Lagrangian and Eulerian methods. Equations of continuity. Boundary surfaces. Stream lines. Path lines and streak lines. Velocity potential. Irrotaional and rotational motions. Vortex lines.	10
II	Equations of Motion- Lagrange's and Euler's equations of motion. Bernoulli's theorem. Equations of motion by flux method. Equations referred to moving axex. Implulsive actons. Stream function. Irrotaional motion in two-dimensions. Complex velocity potential. Sources, sinks, doublets and their images. Conformal mapping. Miline- Thomson circle theorem.	20
III	Two-dimensional irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid. Kinetic energy of liquid. Theorem of Balsius. Motion of a sphere through a liquid at rest at infinity. Liquid streaming past a fixed sphere. Equation of motions of a sphere. Stoke's stream function.	20
IV	Vortex motion and its elementary properties. Kelvin's proof of permances. Motions due to circular and rectilinear votices. Wave motion in a gas. Speed of Sound.	10

References:

1. W.H. Besaint and A.S. Ramsey, A Treatise on Hydromechanics Part Ii, CBS Publisher, Delhi, 1988.
2. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.
3. F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers, Delhi, 1985.

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Optional

M.A./ M. Sc. II (Fourth Semester) Mathematics
Paper-II(A)

Course Code: B031002T **Advanced Complex Analysis**
M.M.: 75
Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	The space of continuous function, Space of analytic function, Analytic function and their inverses. Entire function, Order of integral function, Weierstrass factorization theorem. Runge's theorem. Mittag-Leffler's theorem.	15
II	Univalent functions, Harmonic function, Basic properties of harmonic functions, Subharmonic and Superharmonic functions, Harmonic functions on a disk. Haranck's inequality and theorem. Dirichlet problem.	15
III	Canonical product. Jensen's formula. Poisson-Jensen formula. Maximun and minimum modulus of an entire function. Handamard's three circles theorem. Exponent of Convergence. Hadamard's factorization theorem, Hurwitz's theorem,	15
IV	The range of an analytic function, Poisson Kernal, Poisson integral formula, Poisson integral theorem, Borel's theorem, Bloch's theorem. The Great Picard theorem. Schottky's theorem. Montel-Caratheodory theorem.	15

References:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
3. L.V. Ahlfors, Complex Analysis, MC Graw Hill, 1979.
4. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
5. Walter Rudin, Real and Complex Analysis, McGraw Hill Book Co., 1968.
6. E. Hille, Analytic Function Theory, Hindustan Book Agency, Delhi, 1994.

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Paper-II(B)

Course Code: B031003T **Algebraic Number theory**

M.M.: 100

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Algebraic number fields and their rings of integers; calcilations for quadratic and cubic cases.	15
II	Localization, Galois extensions, Dedekind rings, discrete valuation rings, completion, unramified and ramiified extensions,	15
III	different discriminant, cyclotomic fields, roots of unity. Class group and the finiteness of the class number.	15
IV	Dirichlet unit theorem, Pell's equation. Dedekind and Riem, ann zeta functions, analytic class number formula.	15

References:

1. S. Lang Algebraic Number theory, GTM Vol. 110, Springer-Verlage, 1994.
2. J.P. Serre, Local fields, GTM Vol. 67, Springer-Verlag, 1979.
3. J. Esmonde, and M. Ram Murty, Problems in Algebraic Number Theory, GTM Vol. 190, Soringer-Verlag, 199.

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Paper-III (A)

Course Code: B031004T **Advanced Functional Analysis**

M.M.: 75

Duration: -3.00 hours

Unit	Topics	No. of Lectures
I	Topological properties of convex set, Compact set Topological vector space and general properties, Product space and quotient space, Bounded and totally bounded sets, Orthogonal projection, Orthogonal complements, Projection theorem, Projection of convex set.	**15**
II	Locally convex spaces and general properties, Subspaces, Product spaces and Quotient spaces, Convex and compact set in locally convex spaces, Weak compactness, Separation theorem in locally convex spaces. Geometric Consequences of the Hahn-Banach Theorem.	**15**
III	Continuous linear operator, Open operator and closed operator, Space of operator, Properties of the space of continuous linear operator, Dual vector spaces definition and properties. Vector measures, Radon-Nikodym property and geometric equivalent.	**15**
IV	Spectra theory of continuous linear operator- Eigenvalues and eigenvectors, Resolvent operators, Spectral properties of bounded linear operators, Compact linear operator on normed spaces, Spectral theory of compact linear operator.	**15**

References:

1. K.K. Jha, Functional Analysis, Students Friends. 1986.
2. A.H. Siddiqi, Functional Analysis with applications. Jata Mc Graw Hill Publishing Company Ltd, New Delhi.
3. Walter Rudin, Functional Analysis, Jata Mc Graw Hill Publishing Co. Ltd., New Delhi 1973.
4. Q. H. Ansari Topics in nonlinear Analysis and Optimization, Word Education Delhi, 2012

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Paper-III(B)

Course Code: B031005T **Fuzzy sets and their applications**

M.M.: 100

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Fuzzy Sets-Basic definitions, level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets.	**15**
II	Cartesian products. Algebraic products. Bounded sum and differences. T-norms and t-conorms.	**15**
III	The Extension Principle- The Zadeh's extension principal. Image and iverse image of fuzzy sets. Fuzzy numbers. Elements of fuzzy arithmetic.	**15**
IV	Fuzzy relations and Fuzzy Graphs- Fuzzy relations on fuzzy sets. Composition of fuzzy relations. Min-Max composition and its properites. Fuzzy equvalence relations. Fuzzy compatibility relations. Fuzzy relations.	**15**

References:

1. Rimple Pundir and Sudhir Kumar Pundir, Fuzzy sets and their applications , Pragati Prakashan, Meerut.
2. Chander Mohan, An Introduction to Fuzzy Set Theory and Fuzzy Logic, Second Ed., Viva Books Origonals, 2020.
3. D.S. Hooda and Vikas Rich, Fuzzy Information Measures with Applications, Narosa Publishing House, Edition-1, 2015.
4. H. J. Zimmermann, Fuzzy Set Theory and its Applications, 4th Edition, Kluwer Acodemic Pubishers, Boston, London, 2020.

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Paper-IV (A)

Course Code: B031006T **Differential Geometry of Manifolds**

M.M.: 75 Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Definition and examples of differentiable manifolds. Tangent spaces. Jacobian map. One parameter group of transformations. Lie derivatives. Immersions and imbedding. Distributions. Exterior algebra. Exterior derivative.	15
II	Topological groups. Lie groups and lie algebras. Product of two liegroups. One parameter subgroups and exponential maps. Emaples of liegroups Homomorphism and isomorphism.	15
III	Lie transformation groups. General linear groups. Principal fibre bindle. Linear frame bundle, Associated fibre bindle. Vector bundle. Tangent bundle. Induced bundle. Bundle homomorphisms.	15
IV	Riemannian mainifolds. Riemannian connection, Curvature tensor. Sectional Curvature. Schur'stheorem. Geodesics in a Riemannian manifold. Projective curvature tensor. Conformal curvature tensor.	15

References:

1. R.S. Mishra, A course in tensors with applications to Riemannian Geometry, Pothishala (Pvt) Ltd., 1965.
2. R.S. Mishra, Structures on a differentiable manifold and their applications, Chandrama Prakshan, Allahabad 1984.
3. B.B. Sinha, An Introduction to modern Differential Geometry, kalyani Publishers, New Delhi, 1982.
4. K. Yano and M. Kon Structure of Manifolds, World Scientific Publishing Co. Ltd. 1984.

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Paper-IV(B)

Course Code: B031007T **Mathematical Modeling**

M.M.: 75

Duration:-3.00 hours

Unit	Topics	No. of Lectures
I	Simple situations requiring mathematical modeling, techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models, Some simple illustrations.	**15**
II	Mathematical modeling through differential equations, linear growth and decay models, Non linear growth and decay models, Mathematical modeling in dynamics through ordinary differential equations of first order.	**15**
III	Mathematical models through difference equations, some simple models, Mathematical modeling through difference equations in economic, finance and population dynamic.	**15**
IV	Mathematical modeling through linear programming, Linear programming models in Transportation and assignment.	**15**

References:

1. J. N. Kapur, Mathematical Modeling, Wiley Eastern.
2. D. N. Burghes, Mathematical Modeling in the Social Management and Life Science, Ellie Herwood and John Wiley.
3. F. Charlton, Ordinary Differential and Difference Equations, Van Nostrand.