THIRD SEMESTER SYLLABUS

M. Sc. MATHEMATICS

APPLICABLE TO BATCHES

2024 - 2026

2025 - 2027

2026 - 2028

BABA GHULAM SHAH BADSHAH UNIVERSITY RAJOURI, J&K, INDIA

THIRD SEMESTER

COURSE CODE	COURSE TITLE	NO. OF CREDITS	DISTRIBUTION OF MARKS		
CORE COURSES					
MM - 301	Topology	4	40	60	100
MM - 302	Advanced Topics in Complex Analysis	4	40	60	100
MM - 303	Theory of Operators	4	40	60	100
CHOICE BASED OPEN ELECTIVE COURSES					
Elective - 01 (Choose any one of the following four courses)					
MM - 304	Theory of Fields	4	40	60	100
MM - 305	Advanced Topics in Measure Theory	4	40	60	100
MM - 306	Numerical Methods for ODE & PDE	4	40	60	100
MM - 307	Differential Geometry				
Elective - 02 (Choose any one of the following four courses)					
MM - 308	Theory of Integral Equations	2	20	30	50
MM - 309	Mathematical Programming	2	20	30	50
MM - 310	Bio Mathematics	2	20	30	50
MM - 311	Soft Computing				
Elective - 03 (Choose any one of the following four courses)					
MM - 312	Fourier Analysis	2	20	30	50
MM - 313	Financial Mathematics	2	20	30	50
MM - 314	Graph Theory	2	20	30	50
MM - 315	Number Theory				
CORE COURSES					
MM - 316	Introduction to Communication Skills	2	20	30	50
MM - 317	Introduction to LATEX (Lab. Course)	2	25	25	50
	TOTAL	24	245	355	600

SEMESTER - III

Course Title	Topology	Maximum Marks	100
Course Code	MM - 301	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …..................		The aim of this course is to introduce the students the core methods of topology.
UNIT 01	Topological spaces (TS)	Definition and examples - metric topology, Sierpinski space, radial plane, finite complement topology; open sets; nhood of a point; metrizable space; Basis / subbasis for a Topology - iff conditions for a collection to be Basis / subbasis, topology generated by a Basis / subbasis, equivalent basis, Sorgenfrey line, the Moore plane, the slotted line; Local basis at a point; First & IInd countable spaces (SCS); Closed sets; closure and interior of a set; dense & no - where dense sets; separable TS and their relation with SCS.
UNIT 02	Convergence, Continuity and Subspace Topology	Hausdorff space; Convergent sequence & its Connection with closure of a set; Continuous functions & their charecterizations in terms of open / closed sets, closure, basis / subbasis; Relation b / w continuity and convergence; Open / closed maps; Homeomorphism - its characterizations in terms of open & closed maps, homeomorphism b/w all open / closed intervals; Topological property - metriziablity; Subspace topology; Connection of an open / closed sets of a subspace and closure / interior of a subset of a subspace with the full space; Heriditary topological property - Hausdorff, Ist & IInd countability, metrizability, separability; Effect of restriction & extension of domain / codomain on continuity - Pasting Lemma.
UNIT 03	Product & Quotient Spaces	Cartesian product of a family of sets; Product topology (PT) - basis and subbasis of PT; Relation b / w basis of PT and basis of topologies of factor spaces; Continuity & openness of projections; PT as the weakest topology making projections continuous; Relation of PT on product of sub - spaces of all the factor spaces of a product space with the subspace topology of the product space; Charecterization of continuity of a function with range as a product space; Closure of product of sets; Product of Hausdorff spaces, separable spaces, first countable spaces & second countable spaces. Quotient space, decomposition space & Identification space.
UNIT 04	Connected Spaces	Connected space (CS) - sepearated sets, connectedness of R, continuous image of a CS, Intermediate value theorem, Connectedness of closure of a set and intersection of CSs, closedness of components of a CS, Product of CSs, the concept of simple chain, fixed point property of [0, 1] and cut points of a CS; Pathwise connected space (PWCS) and its conncetion with CS; locally pathwise connected space(LPWCS) - LPWCS plus CS implies PWCS, path components; Locally connected space(LCS) - its relation with LPWCS, Product of LCSs & Openness of components of a LCS; Totally disconnected spaces (TDSs) - product of TDSs, 0 - dimensional spaces.

UNIT 05	Compact Topological Spaces	Compact sets in a topological space - relation with closed sets, continuous image of a compact set, functions with domain as a compct set and co- domain as a Hausdorff space, compactness in terms of the open covers consisting of sets from a fixed basis / subbasis (Alexander subbase theorem), Tychnoff theroem, charecterization of Compact sets interms of closed sets with with FIP; Spaces with BWP, Countably compact spaces and sequentially compact spaces and their relationship with each other and with compactness; Locally compact spaces (LCS) - relation with compact spaces, various charecterizations of a space to be a LCS, continuous image of a LCS; closed subsets of a LCS and product of LCSs.

COURSE OUCOMES

On successful completion of this course, we expect that a student

1	Should be able to explain the concepts of open sets, closed sets, interior of a set, closure of a set ; basis & sub - basis of a topological space.
2	Should be able to explain the first countable, second countable, separable spaces and relation b/w them.
3	Should be able to explain convergence of sequences in a topological space and their inadequacy.
4	Should be able to explain continuous functions and their various charecterizations in a topological space.
5	Should be able to explain the concept of subspace topology and structrue of open, closed sets, closure and interior of a set in a subspace.
6	Should be able to explain the concept of product topology, its basis, subbasis, projection map etc.
7	Should be able to explain the concept of quotient spaces.
8	Should be able to explain the concept of connected space, Locally connected space, path - wise connected space, Locally path - wise connected space, relations between them and theior continuous images.
9	should be able to explain the concept of components in a topological space and their various properties.
10	should be able to explain the concept of components and their various properties.
11	Should be able to explain the concept of Compact and locally compact topological spaces and their various properties.
12	Should be able to explain the relation ships b/w spaces with BWP, countably CS, sequentially CS and compact spaces.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Patty, C.W. (2010),** Foundations of Topology, second Edition, Jones and Barlet.

REFERENCE BOOKS

1. **Adams, C. and Franzosa, R. (2009),** Introduction to Topology – Pure and Applied, **Pearson.**

2. **Munkers, J.R. ,(2000),** Topology, 2nd Edition, **PHI.**

3. **Searcoid, M. O., (2007),** Metric Spaces, **Springer.**

4. **Willard, S., (1976),** General Topology **(1970), Dover Publications New York.**

SEMESTER - III

Course Title	Advanced Topics in Complex Analysis	Maximum Marks	100
Course Code	MM-302	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …...................		The aim of this course is to learn the advance topics of complex analysis.
UNIT 01	Hormonic Functions - I	Definition of a hormonic function [HF] - Re(f) and Im(f) of an Analytic function [AF], HF as real part of an AF; Bounded HFs on C; Mean Value property [MVP] for HFs; HF which are constant in the nhood of a point in a domain; Maximum Principle for HFs; Borel – Carath´eodory theorem; Poisson Integral Formula for hormonic functions - complex Poission integral; Schwarz's Theorem.
UNIT 02	Hormonic Functions - II	Harnack's Inequality - Liouville theroem ; Hormonicity of continuous functions with MVP; Harnack's Principle; Properties of AFs with positive real part; Subhormonic function [SHF]; Sub MVP for SHF; Composition of a SHF and an increasing convex function; Maximum principle for SHFs; Functions hormonic in Annulii; Charecterization of twice continuously differentiable SHFs in terms of non - negative Laplacian; Reflection principle for HFs.
UNIT 03	Normal Families & Schlicht Functions	Uniformly bounded family [UBF] & locally uniformally bounded family [LUBF]; Family of nth derivatives of members of a LUBF of AFs; Equicontinuous family [ECF] - realtion b/w ECF & LUBF of AFs; Normal family [NF] ; Montel's Theorem; Definition of a Schlicht class [S] & the class Tau [T]; Area theorem; Bieberbach Conjecture (Proof for n=2); Koebe one quarter theorem.
UNIT 04	Infinite product of complex numbers and Meromorphic functions	Infinite product (IP) of complex numbers - relation b/w convergence Pi[1+an] & Pi[1-an] with the convergence of Summatiom[an] and Summatiom[Log(1+an)], absolute convergence of an IP & its relation with convergence of the IP; Infinite product (IP) of Analytic functions - M-test; Weierstrass's Product Theorem; Entire functions having same zeros with the same multiplicities; Expansion of an entire or meromorphic function; Meromorphic function as quotient of entire functions; Mittag-Leffler's Theorem.
UNIT 05	Jenson's formula & Entire functions of finite order	Blashhke factor and its properties; Jenson's formula and its applications to the distribution of zeros of an AF on unit disc; Blaschke product - expansion of an AF on unit disc in terms of Blaschke product of its zeros; Pharegman - Lindelof theorem; Hadamard three circle theorem; Entire function of finite order (EFOFO) - convergence of series involving zeros and order of an EFOFO,Weirstrass canonical factorization of an entire function of finite order.

COURSE OUTCOMES

On successful completion of this course, we expect that a student is able to explain

1. Hormonic function & its connection with an analytic function along with its Mean Value property & som eimportant results like Maximum Principle, Borel – Carath´eodory theorem & Poisson Integral Formula.
2. Harnack's Inequality, hormonicity of continuous functions with MVP, the concept of subhormonic function with proprties and some related results.
3. Uniformly bounded family, locally uniformally bounded family, equicontinuous family, normal family and relation b/w them.
4. Schlicht & class Tau class of functions, Area theorem, Bieberbach Conjecture & Koebe one quarter theorem.
5. Infinite product (IP) of complex numbers, its convergence, absolute convergence and elementary properties.
6. Infinite product of Analytic functions, M-test, Weierstrass's Product Theorem & Mittag-Leffler's Theorem.
7. Blashhke factor and its properties and Jenson's formula with its applications to the distribution of zeros of an AF on unit disc and expansion of an analytic function on unit disc in terms of Blaschke product of its zeros
8. Some important results Pharegman - Lindelof and Hadamard three circle theorem.
9. Entire function of finite order and related results with Weirstrass canonical factorization.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1 **Ponnusamy, S. & Silverman, H. (2006),** Complex Analysis with Applications, **2nd edition, Birkhauser.**

2 **Greene, R. E. & Krantz, S.G.(2006),** Function Theory of One Complex Variable, **American Mathematical Society, Graduate Studies in Mathematics, Third edition, Volume 40.**

REFERENCE BOOKS

1 **Holland,A. S. B., (1973), Introduction to the Theory of Entire Functions, Academic Press**

2 **C Ahlofrs, L. R., (1996),** Complex Analysis, **McGraw Hill.**

3 **Rudin, W., (1987),** Real and Complex Analysis, **3rd edition, McGraw Hill International Edition.**

SEMESTER - III

Course Title	Theory of Operators	Maximum Marks	100
Course Code	MM-303	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives ………………..		The aim of this course is to study various operators on Hilbert spaces, compact operators on normed spaces and their basic spectral properties.
UNIT 01	Hilbert - Adjoint, self adjoint, Unitary & Normal operators on Hilbert spaces	Definition, examples & basic properties of Hilbert - Adjoint operators; closed range theorem; self adjoint operators (SAO) - characterization in terms of (Tx,x), completeness of the space of SAOs, norm in terms of numerical radius; unitary operators - basic properties and charecterization in terms of isometery and surjectivity; normal operators - basic properties and charecterization in terms of norms of Tx and T*x.
UNIT 02	Compact Linear Operators (CLOs) b/w normed spaces & Hilbert spaces	Definition, examples and various charecterizations of CLOs; compact integral opearor; product of a BLO and CLO; completeness of space of all CLOs; CLO as a limit of a squence of finite rank operators; strong convergence of image of a weakly convergent sequence under a CLO; separability of range of a CLO; compactness of adjoint b/w normed spaces. Relation b/w compactness of T & T*; Hilbert Schmidt operator and its connection with compactness.
UNIT 03	Invertible operators & spectral theory of BLOs in Banach spaces	Invertible BLO; Nuemann series for the inverse of I-T; the set of all invertible operators in B(X, Y); bounded below operator (BBO); closedness of range of a BBO; charecterizing invertibility in terms of bounded below property; spectrum and resolvant of a BLO on a normed space; closedness & boundness of spectrum of a BLO on a Banach space; non - emptiness of the spectrum of a BLO on a Banach space; spectral mapping theorem; spectral radius formula.
UNIT 04	Spectral properties of Compact linear operators	Countability of spectrum of A CLO; finite dimension of null space of T- aI; closedness of range of T- aI; increasing (decreasing) sequence of null (range) spaces of products of T-aI and their equality after some stage; relation between non zero spectral values and eigen values for a CLO on a Bancah space; normed space as a direct sum of null and range spaces;
UNIT 05	Spectrum of a SAO, Positive operators and Projections	Charecterization of resolvent of a SAO in terms of bounded below property; realness of spectrum; supremum and infimum of numerical range as spectrum bounds and spectral values; emptiness of residual spectrum; positive operators; product of two positive operators; monotone sequence of operators; existence and uniqueness of square root of a positive operator; projection operators - definition, sum, product and difference of projections.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1. should be able to explain adjoint of an operator, self adjoint operator; unitary operator, normal operator and their various charecterizations.
2. should be able to explain the closed range theorem, completeness of the space of all self adjoint operators.
3. should be able to explain compact operators, its various examples and charecterizations.
4. should be able to explain the compactness of adjoint of CLO, compactness of product of a CLO and a BLO and Hilbert - Schmidt operator.
5. should be able to explain invertible operators, their charecterization in terms of bounded below property.
6. should be able to explain the concept of spectrum of a bounded linear operator(BLO), its various properties such as compactness and non emptiness and spectral mapping theorem.
7. should be able to explain the cardinality of spectrum and relation between spectral values and eigen values of a CLO.
8. should be able to explain the finite dimensional property of null space of T-aI and closedness of range space of T-aI.
9. should be able to explain the basic spectral properties of a self adjoint BLOs such as realness of the spectrum, spectrum bounds and their relationship with norm of the operator and emptiness of residual spectrum.
10. should be able to explain the concept and properties of positive operator, square root of a positive operator, projection operators and their properties such as sum, difference and product.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Kreyszig, E., (2005),** Introductory Functional Analysis with Applications, 1st edition, **Wiley Student edition.**

REFERENCE BOOKS

1. **Conway, J. B., (2000),** A Course in Operator Theory, 2nd edition, **American Mathematical Society.**

2. **Douglas, R. G., (2008),** Banach Algebra Techniques in Operator Theory, 2nd edition, **Springer.**

SEMESTER - III

Course Title	Theory of Fields	Maximum Marks	100
Course Code	MM-304	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …...................		The aim of this course to study the advance topics algebra in field theory.
UNIT 01	Finite and algebraic extension	Definition and examples of field; extension fields; finite extension; transitivity of finite extension property; algebraic element; necessary and sufficient condition for an element to be algebraic in terms of dimension of the smallest field; subfield of algebraic elements; algebraic extension and transitivity of algebraic extension property; algebraic number; transcendence of e.
UNIT 02	Roots of polynomials and construction with straight edge and compass	Roots of a polynomial over field; remainder theorem; number of a roots a polynomial in an extension field; existence of an extension of F of an irreducible polynomial over F; splitting field; uniqueness of splitting field; constructible real numbers and their properties; impossibility of trisecting 60^0, duplicating cube and constructing a regular septagon by straight edge and compass; derivative of a polynomial; simple extension; relation between simple extension and characteristic of a field.
UNIT 03	Galois theory	Automorphism of a field; fixed field of a group; the group G(K,F); the inequality O(G(K,F) ≤ [K:F]; field of symmetric rational function and its properties; normal extension and its relation with splitting field, Galois group of a polynomial; fundamental theorem of Galois theory.
UNIT 04	Solvability by radicals and Galois group over the rationals	Solvable group; commutator subgroups; relation between solvability and commutator subgroups; homomorphic image of a solvable group; non-solvability of S_n (n≥5); relation between solvability by radicals of a polynomial and solvability of the Galois group; non-solvability of polynomial of degree ≥ 5; Galois group; simple extension based on above topics.
UNIT 05	Finite fields	Number of elements in a finite field; finite fields having same number of elements; existence of finite fields; group of non-zero elements of a field; roots of an irreducible polynomials over finite fields; nature of roots; relation between splitting field of two irreducible polynomials of same elements.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1 Explain the concept of finite extensions, algebraic elements, algebraic numbers and transcendence of e.

2 Explain the concept of roots of polynomial over field, remainder theorem, irreducible polynomials, splitting filed, constructible real numbers and their properties.

3 Explain the relation between simple extension and characteristic of a field.

4 Explain the concept of automorphism of a fields, fixed field of a group and normal extension.

5 Explain the concept of fundamental theorem of galois theory, galois group of a polynomial.

6 Explain the concept of solvable group, commutator sub group, relation between solvability and commutator subgroup.

7 Explain the concept of radicals, radicals of a polynomial and solvability of polynomial of degree ≥ 5.

8 Explain the concept of finite field, existence of a finite field and roots of irreducible polynomials over finite fields.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Herstein, I. N., (2004), Topics in Algebra, 2nd edition, Wiley Student Edition.**

REFERENCE BOOKS

1. **Lidl, R. and PilzG. , (2004),** Applied Abstract Algebra, 2nd edition, **Springer.**

2. **Gallian, J. A. (1998),** Contemporary Abstract algebra**, Fourth edition, Narosa.**

3. **Artin, M., (2010),** Algebra**, 2nd edition, Springer.**

SEMESTER - III

Course Title	Advanced Topics in Measure Theory	Maximum Marks	100
Course Code	MM-305	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives		The aim of this course to expose the students to the advanced topics in measure theory.
UNIT 01	Signed Measure	Signed Measures-Signed measure space, Decomposition of signed measures,integration on a signed measure space; Absolute continuity of a measure- The Radon Nikodym derivative, Absolute continuity of a signed measure relative to a positive measure; properties of Radon-Nikodym derivative
UNIT 02	Bounded linear Functionals on the L^p spaces	Bounded linear functionals arising from integration; Approximation by simple functions; converse of Holder's inequality; Riesz Representation theorem on L^p spaces.
UNIT 03	Integration on locally compact Hausdorff Space	Continuous functions on a locally compact hausdroff space, Urysohn's lemma; Borel and random measures; positive linear functional on Cc(X), Riesz Markoff Theorem; Approximation by continuous functions; signed measures; Dual space of Cc(X).
UNIT 04	Measure and Integration on the Euclidean space-I	Lebesgue measure the Euclidean space-lebesgue outer measure on Euclidean space, regularity properties of lebesgue measure space on R^n,lebesgue measure space on R^n as the completion of a product measure space; Translation of the lebesgue integral on R^n.
UNIT 05	Measure and Integration on the Euclidean space-II	Differentiation on the Euclidean space-Lebesgue differentation theorem, Differentiation of a set functions w.r.t lebesgue measure, Differentiation of the indefinite; Change of Variable of integration on the Euclidean space-Change of variable of Integration by Differentiable Transformations.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1 explain the concept, examples and properties of signed measure space.

2 explain the concept of absolute continuity of a measure.

3 explain the concept of L^p spaces and bounded linear functional on it.

4 explain the concept continuous function on locally compact Hausdorff space.

5 explain the concept of derivatives of measure.

6 explain the concept of Integartion on the Euclidean space.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Yeh, J., (2000),** Lectures on Real Analysis, **World Scientific.**

REFERENCE BOOKS

1. **Rudin, W.,(1987),** Real and Complex Analysis**, 3rd Edition, Tata Mcgraw-Hill Edition.**

2. **Bauer, H. (2001),** Measure and Integration Theory**, Walter de Gruyter**

3. **Axler, S. (2024), Measure, Integration & Real Analysis, Springer.**

SEMESTER - III

Course Title	Numerical Methods for ODE & PDE	Maximum Marks	100
Course Code	MM-306	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …....................		The objective of this course is to introduce students to numerical methods for solving ordinary and partial differential equation and their computer implementation.
UNIT 01	Numerical solutions of ordinary differential equations-I	Euler's method; Heun's method; Taylor's series method; Runge-Kutta methods; Adam- Bash forth- Moulton method; Milne-Simpson method; Hamming method.
UNIT 02	Numerical solutions of ordinary differential equations-II	Shooting method; finite difference methods; collocation method; BVPs; basic existence theorem for BVPs (statement only); numerical solutions of systems and higher order differential equations.
UNIT 03	Partial Differential equation of first order	Introduction; Formation of Partial Differential equation, Solution of Partial Differential equation of first order, Lagrange Linear Equation of the type Pp +Qq = R Partial Differential equation non linear in p & q, Charpit's Method, Cauchy problem for first order.
UNIT 04	Partial Differential equation of 2nd order	Classification of second order Partial Differential equation, Laplace equation solution by the method of separation of variable, Dirichlet problem for a rectangular, Neumann problem for a rectangular solution of Laplace equation in Cylindrical & spherical coordinates.
UNIT 05	Heat & Wave equation	Heat equation solution by the method of separation of variables, Solution of heat equation in Cylindrical & spherical coordinates Wave equation solution by the method of separation of variables, solution of wave equation in spherical coordinates.

COURSE OUTCOMES

After studying this course a student should be able to

1 explain the methods of obtaining numerical solutions of differential equations by using different numerical methods such as, Euler's method, Heun's method, Taylors series method, Runge Kutta methods, Adam Bashforth method, Adam Moulton method, Milne simpson method, Hamming method etc.

2 explain the concept and existence of solutions of a BVPs.

3 explain the methods of obtaining numerical solutions of BVPs by using different numerical methods such as, shooting method, Finite difference method etc. and their error analysis.

4 explain the method of formation of a partial differential equations and the methods of finding solutions of linear and non – linear(such as Charpit's method) of partial differential equations.

5 explain various classes of second order Partial Differential equations.

6 explain Cauchy problem. $\geq 5.$

7 explain the methods of solutions of Heat and wave equations by the method of separation of variables

8 explain the methods of solutions of Heat and wave equations in Cylindrical and spherical coordinates.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Kharab, A. and Guenther, R. B., (2006),** An Introduction to Numerical Methods: A MATLAB Approach**, Chapman and Hall/CRC.**

2. **Rao, K. Sankara (2013),** Introduction to Partial Differential equation**, PHI Learning Private limited.**

3. **Sneddon, I.N.(1957),** Elements of Partial Differential equation**, Mcgran Hill Book Company.**

REFERENCE BOOKS

1. **John, H. M. and Kurtis, D. F., (2007),** Numerical Methods using Matlab, **4th edition, Prentice Hall of India Pvt. Limited, New Delhi.**

2. **Burden, R. L. and Faires, J. D.,(2009),** Numerical Analysis, **7th edition, CENAGE Learning India (Pvt) Ltd.**

3. **Evans, G., Blackledge, J. M. and Yardley, P. ,(2000),** Numerical Methods for Partial Differential Equations, **Springer.**

SEMESTER - III

Course Title	Differential Geometry	Maximum Marks	100
Course Code	MM-307	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …...................		The aim of this course to study geometry in Euclidean space with the help of calculus.
UNIT 01	Differential calculus in $\mathbb{R}^n$	Differential calculus in ; Diffeomorphism; tangent space of ;vector fields on ; natural frame field; dual vector space; gradient vector field; directional derivative; curve of class C^k.
UNIT 02	Differential forms and manifolds	Integral curve; local flow; derivative map; covariant derivative; cotangent space and differentials forms on ; Lie bracket; charts and atlases; differential manifolds.
UNIT 03	Topology on manifolds	Induced topology on manifolds; functions and maps; some special functions of class; para-compact manifolds; pullback functions; tangent vectors and tangent space; tangent bundle; pullback vector fields.
UNIT 04	Tensors-I	Multi-linear functions and tensors; tensor product; tensor fields; tensors on finite dimensional vector spaces; tensors of type (p,q); connections; torsion tensor; curvature tensor.
UNIT 05	Tensors-II	Contraction; Concepts of symmetric and alternating tensors and basic properties; Bianchi and Ricci identities; concept of geodesics; concept of Riemannian manifold.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1 explain the concepts of diffeomorphism, tangent space and vector fields on fields onR^n, natural frame field, gradient vector field, and

2 explain the concepts of integral curve, local flow, derivative map, cotangent space and differentials forms on R^n, Lie bracket, charts atlases.

3 explain the concepts of differential manifolds, induced topology on manifolds and para-compact manifolds.

4 explain the concepts of pullback functions, tangent vectors and tangent space, tangent bundle and pullback vector fields.

5 explain the concept of tensor, tensor product, tensor field, torsion tensor; curvature tensor and tensors of type (p, q).

6 explain the properties of tensors on finite dimensional vector spaces.

7 explain the concept of symmetric and alternating tensors and their basic properties

8 explain the Bianchi and Ricci identities and the concept of geodesics and Riemannian manifold.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. Amur, K. S., Shetty, D. J. and Bagewadi, C. S.,(2010),An Introduction to Differential Geometry, Narosa Publishing house.

REFERENCE BOOKS

1. De, U. C. and Shaikh,A. A.,(2009), Differential Geometry of Manifolds, Narosa Pub. House.
2. Neill, B. O., (1966),Elementary Differential Geometry, Academic Press, New York.
3. Thorpe, J. A., (1979),Elementary Topics in Differential Geometry, Undergraduate Text in Mathematics, Springer Verlag.
4. Somasundaram, D., (2010), Differential Geometry: A First Course, Narosa Pub. House.

SEMESTER - III

Course Title	Theory of Integral Equations	Maximum Marks	50
Course Code	MM-308	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	3 HOURS

Objectives ….................... The objective of this course is to introduce students the fundamentals of Integral Equations and their Applications.

UNIT 01	Classification of integral equation	Definition and classification of integral equations; regularity conditions; special kind of kernels; integral equation with separable kernels; reduction to a system of algebraic equation; Fredholm alternate; an approximate method.
UNIT 02	Method of successive approximations	Introduction; iterative scheme; Volterra integral equation; some results about the resolvent kernel; classical Fredholm theory; the method of solution of Fredholm ; Fredholm's first theorem.
UNIT 03	Applications to ordinary differential equation	Initial value problems; boundary value problems; Dirac- delta function; Green's function approach; Green's function for nth order ordinary differential equations.

COURSE OUTCOMES

On successful completion of this course, we expect that a student is able to explain

1 The concept and classification of integral equations and kernels.

2 Method to solve the volterra integral equation and fredhlom integral equations by different techniques.

3 Applications of integral equations to initial value and boundary value problems.

4 The concept of dirac- delta and green's function.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1 **Kanwal, R. P., (1997),** Linear Integral Equations (Theory and Technique)**, 2nd edition, Academic Press Birkhauser.**

REFERENCE BOOKS

1 **Porter, D., and Stirling, D. S. G., (1990),** Integral Equations a Practical Treatment from Spectral Theory to Applications**, Cambridge University Press.**

2 **M.L. Krasnov(1971),** Problems and Exercises Integral Equations, **Mir Publication Moscow.**

SEMESTER - III

Course Title	Mathematical Programming	Maximum Marks	50
Course Code	MM - 309	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	2 HOURS

Objectives …....................	The objective of this course is to study various types of Programming and their applications to real world problems.
UNIT 01 Linear programming	Definition of operation research; simplex method; degenerate solution ; basic feasible solution; reduction of a feasible solution to a basic feasible solution; two phase method; big-M method; inverting a matrix using simplex method; applications of simplex method; duality in linear programming; duality and simplex method; dual simplex method.
UNIT 02 Integer programming	Shooting method; finite difference methods; collocation method; BVPs; basic existence theorem for BVPs (statement only); numerical solutions of systems and higher Introduction; fractional cut method; applications of integer programming; transportation problem-general transportation problem; duality in transportation problem; loops in transportation; stepping stone solution method; LP formulation of the transportation problem
UNIT 03 Dynamic programming	Introduction; Bellman's principle of optimality; characteristics of dynamic programming; applications of dynamic programming; finding solutions of linear programming problems by dynamic programming.

COURSE OUTCOMES

After studying this course we expect a student have understood

1 the concept of linear programming, feasible solution, basic feasible solution and reduction of feasible solution to a basic feasible solution.

2 how to find feasible solution of linear programming problem by different methods such as simplex method, dual simplex method, two phase method and Big-M method

3 the concept of Integer programming and its applications

4 the concept of transportation problem and related ideas such as duality and loops and the stepping stone solution method

5 the Bellman's principle of optimality.

6 the characteristics of dynamic programming with applications.

7 finding solutions of linear programming problems by dynamic programming.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. Sharma, S. D., (2006), Operation Research, KedarNath Ram Nath and co.

REFERENCE BOOKS

1. Hamady, T., (1995), Operation Research, Mac Milan Co

2. Kanti S., Gupta, P. K. and Manmohan, (2008), Operation Research, 4thedition,S.Chandand Co

SEMESTER - III

Course Title	Bio-Mathematics	Maximum Marks	50
Course Code	MM-310	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	2 HOURS

Objectives …...................		The objective of this course is to study the Mathematical modeling in biology.
UNIT 01	Continuous population models for single species	Growth and decay models in Biology; population in natural and laboratory environments; intoxicants and nutrients; stability analysis interacting population with predation; basic models and their solutions; compartmental model.
UNIT 02	Deterministic compartmental models	deterministic models with and without removal; general deterministic models with removal and immigration; control of an epidemic; stochastic epidemic model without removal.
UNIT 03	Models for interacting population	Models in genetics; basic models for inheritance; further discussion of basic model for inheritance of genetic characteristics; models for genetic improvement; selection and mutation; models for genetic inbreeding.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1. Have a deep knowledge of basic models such as growth and decay models, compartmental models, epidemic models, deterministic and stochastic epidemic models
2. Have a deep knowledge of Models in genetics such as inheritance model, genetic improvement model, genetic inbreeding models etc.
3. Explain the concepts of Pharmaco-kinetics, bio-diffusion, trans-capillary exchange, oxygenation and de-oxygenating of blood, cardio vascular flow patterns and temperature regulation in human subjects.
4. The concepts of Curve fitting and biological modeling.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. Cullen, M.R., (1985), Linear Models in Biology (Pharmacy), E. Horwood, University of California.

2 Murray, J. D.,(2003), Mathematical Biology, 3rd edition, Springer

REFERENCE BOOKS

1. Allman, E. S. And Rhodes, J. A., (2004), An Introduction Mathematical Models in Biology, Cambridge University press.

2. Rubinow, S. I., (1997), Introduction to Mathematical Biology, John Willey and Sons Publication

SEMESTER - III

Course Title	Intoduction to Soft Computing	Maximum Marks	50
Course Code	MM-311	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	2 HOURS

Objectives …..................		The aim of this course is to equip students with some fundamental understanding of how soft computing techniques can be applied to solve complex, real-world problems where conventional approaches may not work well.
UNIT 01	Soft Computing and Fuzzy Logic	Introduction to Soft Computing - Definition and Characteristics of Soft Computing, Comparison of Hard and Soft Computing, Importance and Applications of Soft Computing; Fuzzy Logic - Introduction to Fuzzy Logic and Fuzzy Sets,Fuzzy Membership Functions, Fuzzy Inference System (FIS), Applications of Fuzzy Logic in Decision Making.
UNIT 02	Neural Networks & Evolutionary Algorithms	Neural Networks - Introduction to Neural Networks, Structure of Artificial Neurons, Learning Algorithms such as Supervised and Unsupervised Learning, Applications in Pattern Recognition and Classification; Evolutionary Algorithms - Introduction to Evolutionary Computation, Genetic Algorithms (Concepts and Operators - Selection, Crossover, Mutation), Fitness Functions and Evolutionary Process, Applications in Optimization Problems.
UNIT 03	Hybrid Systems & Case Studies	Hybrid Systems - Introduction to Hybrid Soft Computing Systems (e.g., Neuro-Fuzzy Systems), Benefits of Hybrid Systems, Real-World Examples; Case Studies and Applications - Real-World Applications of Soft Computing in Engineering, Business, and Medicine, Problem Solving Using Soft Computing Techniques.

COURSE OUTCOMES

By the end of this course, students will be able to:

1 Understand the basic concepts of soft computing and how they differ from traditional hard computing.

2 Explore various soft computing techniques, including fuzzy logic, neural networks, and evolutionary algorithms.

3 Apply soft computing methods to solve problems involving uncertainty, ambiguity, and approximation.

4 Implement simple soft computing algorithms for real-world applications.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 06 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 06 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 08 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Jang, J. S. R., Sun, C. T. and Mizutani, E.(1997),** Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, **Prentice Hall.**

REFERENCE BOOKS

1. **Rajasekaran. S. and Pai, G. A. V.(2013)** Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, **PHI.**

2. **Ross, T. J., (2004),** Fuzzy Logic with Engineering Applications, **Second Edition, John Wiley and Sons.**

SEMESTER - III

Course Title	Fourier Analysis	Maximum Marks	50
Course Code	MM- 312	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	2 HOURS

Objectives …..................		The main objective of this course is to introduce students various techniques of Fourier Analysis.
UNIT 01	Fourier series	Fourier series, Fourier sine and cosine series, Riemann- Lebesgue and Cantor- Lebesgue lemma, Dirichlet and Fourier kernels, convergence of Fourier series – Dini's test, Lipschitz condition, Riemann localization principle, Drichlet's point-wise convergence theorem, Relation between a convergent trigonometric series and Fourier series, Gibbs phenomenon
UNIT 02	Fourier series & Fourier Transform	Term wise differentiation and integration of Fourier series, Lebesgue point-wise convergence theorem(statement only), Fourier transform of L^1 (R) functions and its basis properties, convolution theorem, Fejer- Lebesgue inversion theorem (statement only), inversion formula when f^ L ^1 (R) and when f is of BV, the Fourier map an its properties.
UNIT 03	Fourier transform	Fourier transform of derivates and integrals, Parseval's identities, Fourier transform of L^2 (R) functions, Plancherel's theorem, Shannon sampling theorem, applications of FT to ODEs and integral equations; The discrete Fourier transform(DFT) and fast Fourier transform.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1. Fourier series and its convergence issues including its relation with a convergent trigonometric and Drichlet's point-wise convergence theorem.
2. Riemann - Lebesgue and Cantor- Lebesgue lemmas and Riemann localization principle.
3. term wise differentiation and integration of Fourier series and Lebesgue point-wise convergence theorem.
4. The concept of Fourier transform of L^1 (R) functions with its basic properties and some connected results such convolution theorem, Fejer- Lebesgue inversion theorem, inversion formula, Parseval's identities.
5. The concept of Fourier transform of L^2 (R) functions with its basic and connected results such as Plancherel's theorem, Shannon sampling theorem.
6. Applications of FT to ODEs and integral equations.
7. The concept of Discrete and Fast Fourier transforms.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. Bachman. G, Narici. L, Beckenstein. E (2010), Fourier and Wavelet Analysis, Springer

REFERENCE BOOKS

1. Kreyszig, E., (2010),Advance Engineering Mathematics, 10thEdition, Wiley India Private limited.

2. Pinsky, M. A., (1994), Partial Differential Equations and Boundary-Value Problems with Applications, 3rd Edition, McGraw Hill.

SEMESTER - III

Course Title	Financial Mathematics	Maximum Marks	50
Course Code	MM - 313	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	2 HOURS

Objectives …....................		The objective of this course is to study applications of Mathematical methods to the world of finance.
UNIT 01	Option Theory	Introduction to options and markets; European and American options; asset price random walks; a simple model for asset prices; It ^'s lemma; elimination of randomness. o
UNIT 02	Black-Scholes model-I	Arbitrage; option values; payoffs and strategies; put-call parity formula; the Black-Scholes analysis; the Black-Scholes equation; boundary and final conditions for European options; the Black-Scholes formulae for European options; hedging in practice; implied volatility.
UNIT 03	Black-Scholes model-II	The Black-Scholes formulae; similarity solutions; derivation of Black-Scholes formulae; binary options; risk neutrality; variations on Black-Scholes model – option on dividend-paying assets; time dependent parameters in the Black- Scholes equation.

COURSE OUTCOMES

On successful completion of this course, we expect that a student have understood

1 The concepts of options and markets

2 the European and American Options, asset price random walk and It ^'s lemma.

o

3 the concept of Arbitrage, the put call parity formula and binary options.

4 the Black-Scholes formulae and their derivation.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Wilmott,P., Howison, S. and Dewynne, J., (1995),** The Mathematics of Financial Derivatives-A student Introduction, **Cambridge University Press.**

REFERENCE BOOKS

1. **Duffie, D., (2001),** Dynamic Asset Pricing Theory, **3rd edition, Princeton.**

2. **Hull,J., (1993),Options,** Futures and other Derivative Securities,**2nd edition, Prentice-Hall.**

3. **Siddiqi, A. H., Manchanda, P. and Kocvara, M., (2007)** An Iterative two Step Algorithm for American Option Pricing, **IMA Journal of Mathematics Applied to Business and Industry.**

SEMESTER - III

Course Title	Graph Theory	Maximum Marks	50
Course Code	MM - 314	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	2 HOURS

Objectives …...................

UNIT 01	Graphs, Paths and Circuits	The concept of a graph - Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, and Null Graph; Paths & Circuits - Isomorphism, Subgraphs, Walks, Paths, and Circuits, Connected Graphs, Disconnected Graphs, and Components, Euler Graphs, Operations On Graphs, Hamiltonian Paths and Circuits, The Traveling Salesman Problem
UNIT 02	Trees, fundamental circuits & . Cutsets	Trees - Properties of Trees, Pendant Vertices , Distance and Centers in a Tree, Rooted and Binary Trees, On Counting Trees, Spanning Trees; Fundamental Circuits - Finding All Spanning Trees of a Graph; . Cut-sets and cut-vertices - Properties of a Cut-Set, All Cut-Sets in a Graph, Fundamental Circuits and Cut-Sets, Connectivity and Separability, 1-Isomorphism & 2-Isomorphism
UNIT 03	Planar graphs, Vector spaces of a graph & Coloring of a Graph	Planar graphs - Kuratowski's Two Graphs, Different Representations of a Planar Graph, Detection of Planarity; Vector spaces of a graph - Basis Vectors of a Graph, Circuit and Cut-Set Subspaces, Matrix representation of graphs - Incidence Matrix, Submatrices of A(G), Circuit Matrix, 4 Fundamental Circuit Matrix , Cut-Set Matrix, Path Matrix, Adjacency Matrix; Coloring - Chromatic Number, Chromatic Partitioning, Chromatic Polynomial, The Four Color Problem

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1 is able to explain the concept of a Graph and related ideas,

2 is able to explain the ideas of Paths and Circuits and related results.

3 is able to explain the idea of a Tree, its Properties and Spanning Trees;

4 is able to explain the idea of Fundamental Circuits and related terminology and results.

5 is able to explain all Spanning Trees of a Graph.

6 has understood the idea of Cut-sets, cut-vertices and related properties.

7 has understood the idea of Planar graphs, its different representations and detection of planarity.

8 has understood Vector space of a graph with related properties.

9 the idea of graph coloring and related results and terminology.

10 the idea of Matrix representation of graphs.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Deo, N., (2007),** Graph Theory with Applications to Engineering and Computer Science**, Prentice Hall of India Pvt. Ltd. New Delhi.**

REFERENCE BOOKS

1. **Gary, C. and Ping, Z.,(2005),** Introduction to graph theory**, McGraw Hill.**
2. **Wallis,W.D., (2006),** A Beginner's Guide to Graph Theory, **IInd Edition, Springer.**
3. **West,D. B., (2005),** Introduction to Graph Theory**, 2nd edition, Prentice Hall of India Pvt. Ltd. New Delhi.**

SEMESTER - III

Course Title	Number Theory	Maximum Marks	50
Course Code	MM-315	University Examination	30
Credits	4	Sessional Assessment	20
		Duration of Exam.	3 HOURS

Objectives …................... The aim of this course to familiarize the students with numbers and their properties.

UNIT 01	Arithmetic Functions	Greatest integer function; arithmetic functions; multiplicative arithmetic functions(elementary ones); Mobius inversion formula; convolution of arithmetic functions; group properties of arithmetic functions; recurrence functions; fibonacci numbers and their elementary properties.
UNIT 02	Diophantine equations	Diophantine equations – solutions of $ax + by = c$, $x^2 + y^2 = z^2$, $x^4 + y^4 = z^2$;properties of Pythagorean triplets; sums of two , four and five squares; assorted examples of diophantine equations.
UNIT 03	Continued fractions	Simple continued fractions; finite and infinite continued fractions; uniqueness; representation of rational and irrational numbers as simple continued fractions; rational approximation to irrational numbers; Hurwitz theorem; basic facts of periodic continued fractions and their illustrations (without proofs); Pell's equation.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1 explain the concept and properties of arithmetic functions and Fibonacci numbers.

2 explain Mobius inversion formulae, Diophantine equations, Pythagorean triplets and Fermat's last theorem.

3 explain the simple continued fractions, finite and infinite continued fractions, rational and irrational numbers as simple continued fractions.

4 Explain the Hurwitz theorem, periodic continued fractions and Pell's equation.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1 **Niven,I., Zuckerman,H. S. and Montegomery, H. L., (2003),** An Introduction to the Theory of Numbers, 6th edition, **John Wiley and sons, Inc., New York**

2 **Burton,D. M., (2002),Elementary Number Theory, 4th edition, Universal Book Stall,New Delhi.**

REFERENCE BOOKS

1 **Dickson,L. E., (1971),History of the Theory of Numbers , Vol. II, Diophantine Analysis, Chelsea Publishing Company, New York.**

2 **Hardy,G. H. and Wright, E. M., (1998),** An Introduction to the Theory of Numbers, 6th edition, **The English Language Society and Oxford University Press.**

3 **Niven, I., Zuckerman, H. S. , (1993),** An Introduction to the Theory of Numbers, 3rd edition, **Wiley Eastern Ltd., New Delhi.**

SEMESTER - III

Course Title	Introduction to Communication Skills	Maximum Marks	50
Course Code	MM - 316	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	3 HOURS

Objectives …...................		To equip students with essential communication techniques, enhancing their ability to express ideas clearly, listen actively, and interact effectively in personal, professional, and social contexts.
UNIT 01	Verbal & Non - verbal communication	Definition of Communication and its importance; Types of Communication; The Communication Process - Sender, message, medium, receiver, and feedback loop; Barriers to Communication - hysical, psychological, cultural, and language barriers; Elements of Effective Speaking - Clarity, tone, and articulation; Building Vocabulary; Public Speaking Basics; Story telling and Persuasion; Body Language - Understanding gestures, posture, and facial expressions; Eye Contact; Tone of Voice; Space and Proximity.
UNIT 02	Listening Skills, Written Communication and Miscellaneous communication skills	Listening Skills - Active Listening, Empathy in Listening, Questioning Techniques, Constructive criticism and affirmations; Written Communication - Clarity and Precision; Email Etiquette; Formal vs. informal communication in professional settings; Structuring Written Content; Editing and Proofreading, Communication in various Contexts - Interpersonal Communication; Team Communication; Techniques for addressing and resolving misunderstandings; Cross-Cultural Communication; Digital Communication - Online Etiquette, Social Media Communication, Virtual Meetings, Best practices for remote communication.
UNIT 03	Communication Challenges and Solutions & Development of Confidence in Communication	Communication Challenges and Solutions - Dealing with Miscommunication, Handling Difficult Conversations, Managing Emotions in Communication; Developing Confidence in Communication - Overcoming Communication Anxiety, Self-Awareness and Self-Expression, Building Assertiveness; Action Plan for Continuous Improvement - Setting Personal Communication Goals, Continuous Practice, Self-Evaluation and Feedback.

COURSE OUTCOMES

On successful completion of this course, we expect that a student is able to

1	Communicate more clearly and confidently in various contexts
2	Actively listen and provide constructive feedback.
3	Navigate communication barriers and adapt to different audiences.
4	Engage in written, verbal, and non-verbal communication effectively.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Hanh, T. N. (2014),** The Art of Communicating, **HarperOne; Reprint edition.**

2. **Pease, P and Pease, A (2006),** Definitive Book of Body Languag , **RHUS; Illustrated edition.**

3. **Kuhnke, E.,(2012),** Communication Skills For Dummies, **CBS Publishers and Distributors PVT. LTD.**

REFERENCE BOOKS

1. **Lesikar, R. V. and Pettir, Jr., (2004),** Business Communication Theory and Applications, **6th edition, A. I. T. B. S, New Delhi.**

2. **Thakar, P. K., Desai, S.D. and Purani, J. J., (1998),** Developing English Skills, **Oxford University Press.**

SEMESTER - III

Course Title	Introduction to LATEX (Lab. Course)	Maximum Marks	50
Course Code	MM-317	University Examination	25
Credits	2	Sessional Assessment	25
		Duration of Exam.	2 HOURS

Objectives .... The objectives of this course is to expose the students to introductory knoweldge on LATEX.

* Each student is required to maintain a practical record book.
* Two practical tests, one Internal and one External, are to be conducted.
* Each practical test will be of 25 marks.
* The student has to pass both internal and external practical tests separately scoring a minimum of 10 marks in each test

Overview of LaTeX and its uses; Setting Up LaTeX- Installing LaTeX, Installing and using LaTeX editors & knowing online LaTeX tools; Document Structure - Creating a simple document, Basic sections , Adding titles, authors, and dates; Text Formatting - Basic text formatting (bold, italic, underline, font sizes), Paragraphs, line spacing, indentation Special characters (e.g., %, &, $, _, #), Handling different languages and character sets; Mathematical Typesetting - Inline math mode, Display math mode, Common math symbols and equations (fractions, square roots, exponents), Aligning equations using align or eqnarray environments; Lists and Tables - Creating ordered and unordered lists (itemize, enumerate), Creating simple tables with tabular Formatting tables (borders, spacing, alignment); Inserting Graphics and Figures - ncluding images with \includegraphics Adjusting image size, placement, and captions (figure environment) Creating and labeling figures; Referencing and Citations - Cross-referencing sections, equations, figures, and tables (\label, \ref, \cite) Using bibliography and citation styles (BibTeX, \bibliography).

COURSE OUCOMES

On successful completion of this course, we expect that a student have understood

1 Overview of LaTeX and its uses.

2 Setting Up LaTeX- Installing LaTeX, Installing and using LaTeX editors & knowing online LaTeX tools.

3 Document Structure - Creating a simple document, Basic sections , Adding titles, authors, and dates.

4 Text Formatting - Basic text formatting (bold, italic, underline, font sizes), Paragraphs, line spacing, indentation Special characters (e.g., %, &, $, _, #), Handling different languages and character sets.

5 Mathematical Typesetting - Inline math mode, Display math mode, Common math symbols and equations (fractions, square roots, exponents), Aligning equations using align or eqnarray environments.

6 Lists and Tables - Creating ordered and unordered lists (itemize, enumerate), Creating simple tables with tabular Formatting tables (borders, spacing, alignment).

7 Inserting Graphics and Figures - ncluding images with \includegraphics Adjusting image size, placement, and captions (figure environment) Creating and labeling figures.

8 Referencing and Citations - Cross-referencing sections, equations, figures, and tables (\label, \ref, \cite), Using bibliography and citation styles (BibTeX, \bibliography).