MATHEMATICS DEPARTMENT
VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.A. (Mathematics) EXTERNAL

Scheme of Teaching and Examination

Second Year

Subject Code	Subject	Scheme Of Teaching		
		L	**P**	**Total**
501	Differential Geometry and Linear Algebra	4	--	4
502	Numerical Analysis	4	--	4
503	Abstract Algebra	4	--	4
504	Advanced Functional Analysis	4	--	4
500*	Elective Group	4	--	4
500*		4	--	4
	Total	24	--	24

Elective group – 1	5001	Integral Transforms
	5002	Advanced Integral Transform
Elective group - 2	5003	Special Functions - I
	5004	Special Functions - II

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Syllabus to be offered at M. A. Mathematics External Second Year w.e.f. June 2014-15

Paper :501
Differential Geometry and Linear Algebra

L T P 4-1-0

Curves with Torsion:

Tangent, Principal Normal. Curvature, Binormal Torsion Serret-Frenet formulae, Helices, Spherical indicatrix of tangent, etc., Involutes, Evolutes, Bertrand curves,

Envelops Developable Surfaces:

Surfaces, Tangent Plane Normal, Envelope Characteristics, Edge of regression, Developable Surfaces, Osculating developable, Envelope Characteristic points,

Curvilinear Coordinates

Curvilinear coordinates, First order magnitudes, Directions on a surface, The normal, Second order magnitudes, Derivatives of **n**, Curvature of normal section. Meunier's theorem.

Linear operator

Functions, linear operators, null space and range, rank and nullity theorem, operator inverses, application to matrix theory, computation of null space and range of a matrix, matrix of an operator, change of basis and similar matrices.

Preliminaries:

Definitions and examples,

Orthogonal sets:

Fourier coefficients and partial, Identity, gram-Schmidt process, QR factorization,

Approximation and Orthogonal projection:

Equivalence of the problems, Computations using orthogonal and nonorthogonal sets, normal equations, projection operators, M-k

Orthogonal complements:

Decomposition of the vector space, applications to an approximations and matrix theory,

The Gram Matrix and Orthogonal Change of Basis: matrix representation of an inner products, orthogonal change of bases, rank of gram matrix.

References:

Linear Algebra

1. J. T. Scheick, Linear algebra with application, Mc- Hill international addition, 1997.
2. S. Biswas Matrix algebra, New Age II edition 1997.
3. A. R. Rao Linear Algebra Tata - Mc-Graw-hill 1996.

Differential Geometry

1. Whetherburn C.E. : "Differential Geometry of 3-D", Radha Publishing, Calcutta. 1988
2. Bansilal : "Differential Geometry, 1994 Atma Ram and sons, Allahabad. 1994
3. S.C. Mittal and D. C. Agrawal : Differential Geometry, Krishna Publication, 1976
4. S. Kumaresan : A Course in Differential Geometry and Lie Groups Hindustan Book Agency, 2002
5. Sinha B.B. : An Introduction to Modern Differential geometry, Kalyani Publishers, New Delhi, 1982

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Paper :502
Numerical Analysis

L T P
4-1-0

- **Transcendental and polynomial Equations :**
  Introduction
  Bisection Method
  Iteration Method base on first degree equation
  Iteration methods based on second degree equation
  Rate of convergence
  Iteration methods
  Method for complex roots
  Polynomial equations, model problems

- **System of Linear algebraic equations and Eigen value problems**
  Introduction
  Direct methods
  Iteration methods
  Eigenvalues and Eigenvectors
  Model problems

- **Interpolation and Approximation**
  Introduction
  Lagrange and Newton Interpolations
  Finite Difference operators
  Interpolating Polynomials using finite differences
  Model problems

- **Differentiation and Intergration**
  Introduction
  Numerical Differentiation
  Partial Differentiation
  Numerical Integration

Methods based on Interpolation
Method based on undetermined coefficients
Composite Integration methods
Romberg Integration
Double Integration

- **Ordinary Differential Equations** :
  Initial value problems
  Numerical methods
  Singlestep methods
  Multistep methods
  Predictor-corrector methods

- **Ordinary differential Equations** :
  Boundary value problem
  Initial value problem method
  Finite Difference methods
  Finite Element methods

References:

1. Jain, Iyenger & Jain : Numerical Methods, for Scientific and Engineering Computation, New-Age International. 1999

2. Froberg C. E. : Introduction to Numerical Analysis, Addison-Wesley, 1970

3. Philips and Taylor :Theory and Applications of Numerical Analysis Academic Press,1996

4. Gourdin and Boumhart :Applied Numerical Analysis, P.H.I., 1996

5. Householder A. S. :Theory of Matrices in Numerical Analysis, Blarsedell - New York.

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Syllabus to be offered at M. A. Part-I w.e.f. June 2015-16

Paper : 503
Abstract Algebra

L T P
4-1-0

Group Theory:

Conjugate of an element, class equation, and Cauchy theorem, First part of Sylow's theorem, Third part of Sylow's theorem, Application of Sylow's theorem, and direct product of a group.

Ring Theory:

A particular Euclidean ring, Fermat's theorem, polynomial rings, primitive polynomials, Guass lemma, the Eisenstein criterion, polynomial rings over commutative rings, unique factorization domain.

Field Theory:

Extension fields, Finite extension field, Algebraic extension, Algebraic number, Roots of polynomials, splitting fields, Uniqueness of Splitting fields, construction with Straightedge and compass, More about roots, Simple extension, Fixed fields, Elementary symmetric functions, normal extension, Galois group, The fundamental theorem of Galois theory.

Normal Series and Conjugacy and G.Sets :

Normal series, solvable groups, Nilpotent groups.

Ideals and homeomorphisms:

Ideal of a ring, principal ideal ring, finitely generated ideal, Quotient ring, Ring homomorphism, Fundamental theorem of Homomorphism, Correspondence theorem, Anti-homomorphism, Anti-isomorphism, The opposite ring of a ring, sum and direct sum of ideals, Maximal and prime ideals, Product of two ideals, Nilpotent and nil ideals.

Modules:

Modules, sub-modules, finitely generated module. Direct sum of sub-modules, Homomorphism and quotient modules, Fundamental theorem of R-homomorphism, completely reducible modules, Schur's lemma, Free modules, Noetherian and artinian modules, Hilbert basis theorem, Wedderbum-Artin theorem, Maschket's theorem, Uniform modules, Primary modules. Noether-Lasker theorem.

References:

1. Herstein I.N., Topics in Algebra, Wiley eastern Ltd.
2. Bhattacharya P. B. Basic Abstract Algebra, II edition Cambridge university press, 1995.
3. ChonP.N. Algebra Vol. I & II, John wiley 1974.
4. Artin M. Algebra, Prentice Hall, Englewood, Cliffs NJ,. 1991

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Syllabus to be offered at M. A. Part-I w.e.f. June 2015-16

Paper : 504
Advanced Functional Analysis

L T P
4-1-0

Inner product spaces and Hilbert spaces

Total Orthonormal Sets and Sequences, Representation of functional on Hilbert spaces, Hilbert-Adjoint operator, Self-adjoint, Unitary and Normal Operators

Fundamental theorems for Normed and Banach spaces

Zorn's Lemma, Hahn - Banach theorem, Hahn - Banach theorem for complex vector spaces and normed spaces, applications to Bounded linear functional on C [a , b], Adjoint operator, Reflexive spaces, Category theorem and uniform boundedness theorem, Strong and weak convergence, Convergence of sequences of operators and functional, Weak convergence, Open mapping theorem, Closed linear operators, Closed Graph theorem.

Compact Linear operators on Normed spaces and Their Spectrum:

Compact Linear Operators on Normed Spaces, Further Properties of Compact Linear Operators, Spectral Properties of Compact Linear Operators on Normed Spaces, Further Spectral Properties of Compact Linear Operators, Operator Equations Involving Compact Linear Operators, Further Theorems of Fredholm Type, Fredholm Alternative,

Spectral Theory of Bounded Self-Adjoint Linear Operators:

Spectral Properties of Bounded Self-Adjoint Linear Operators, Further Spectral Properties of Bounded Self-Adjoint Linear Operators, Positive Operators, Square Roots of a Positive Operator, Projection Operators, Further Properties of Projections, Spectral

Family, Spectral Family of a Bounded Self-Adjoint Linear Operator, Spectral Representation of Bounded Self-Adjoint Linear Operators, Extension of the Spectral Theorem to Continuous Functions, Properties of the Spectral Family of a Bounded Self-Adjoint Linear Operators,

Unbounded Linear Operators in Hilbert Space:

Unbounded Linear Operators and their Hilbert-Adjoint Operators, Hilbert-Adjoint Operators, Symmetric and Self-Adjoint Linear Operators, Closed Linear Operators and Closures, Spectral Properties of Self-Adjoint Linear Operators, Spectral Representation of Unitary Operators, Spectral Representation of Self-Adjoint Linear Operators, Multiplication Operators and Differentiation Operators.

References:

1. E. Kreyszig: Functional Analysis and its application, John Wiley and sons.
2. B.V. Limaye: Functional Analysis, Wiley Eastern Ltd.
3. G.F. Simmons: Introduction to Topology and Modern Analysis, McGraw - Hill.
4. J.N. Sharma & A Vashistha: Functional Analysis.

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Paper : 5001
Integral Transform

L T P
4-1-0

Laplace Transforms:

- Introduction and definition of Laplace transforms with examples,
- Existence condition and basic properties of Laplace transforms,
- The convolution theorem and properties of convolution,
- Differentiation and integration of Laplace transforms,
- The inverse Laplace transforms and examples,
- Tauberian theorem and Watson's lemma,
- Laplace transforms of fractional integrals and fractional derivatives,.

Finite Laplace Transforms:

- Introduction,
- Definition of finite Laplace transforms with examples,
- Basic operational properties of finite Laplace transforms,

Applications of Laplace Transforms

- Application of Laplace transforms to ordinary and partial differential equations;
- Initial and boundary value problems and Integral equations;
- Evaluation of definite integral
- Solution of difference as well as differential equations.

- Application of finite Laplace transforms and Tauberian theorem.

Fourier Transforms:

- Introduction,
- Basic concepts and definitions,
- The Fourier Integral formulae,
- Definition and examples of Fourier transforms,
- Basic properties of Fourier transforms,
- Applications of Fourier transforms to ordinary differential equations; integral equations and partial differential equations,
- Fourier cosine and sine transforms with examples,
- Properties of Fourier cosine and sine transforms,

Finite Fourier Cosine and Sine Transforms:

- Introduction and definition of finite cosine and sine transforms with examples,
- Basic properties of finite Fourier cosine and sine transforms

Applications of Fourier Transforms:

- Application of Fourier cosine and sine transforms to partial differential equations
- Evaluation of definite integrals.
- Application of finite Fourier cosine and sine transforms.

References:

1) Ian Sneddon : The use of Integral Transform. TMIH, 1979.
2) Lokenath Debnath: Integral Transform and their applications, CRC Pub., 1995.
3) B. Davies : Integral Transforms and their applications, Springer - Verlag, 1978.
4) Boss M. L. : Mathematical Methods in Physical Sciences, John Wiley & Sons, 1983.
5) Andrews, L. G. & Shivamoggi B. K. : Integral Transforms for Engineers, PHI, 2003.

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Paper : 5002
Advanced Integral Transform

L T P
4-1-0

Hankel Transforms:

- Introduction and definition of Hankel transforms with examples,
- Operational properties of the Hankel transforms

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Finite Hankel Transforms:

- Introduction and definition of the finite Hankel transforms with examples,
- Basic operational properties

Application Hankel transforms:

- Application of Hankel transforms to partial differential equations
- Applications of finite Hankel transforms.

Hilbert and Stieltjes Transforms (HST):

- Introduction and definition of HST with examples,

- Basic operational properties of HST,
- Hilbert transform in the complex plane and its applications,
- Inverse theorem for Stieltjes transform and its application,
- Asymptotic expansion of the one sided Hilbert transform,
- The generalized Stieltjes transform,
- Basic properties of the generalized Stieltjes transforms with applications.

Mellin Transforms:

- Introduction and definition of Mellin transforms with examples,
- Basic operational properties
- Applications of the Mellin transforms,
- Mellin transforms of the Weyl fractional integrals
- Weyl fractional derivatives
- Application of Mellin transforms to summation of series.

Z-Transforms:

- Introduction,
- Dynamic linear systems
- and Impulse response,
- Definition of the Z-transforms and examples,
- Basic operational properties,
- The inverse Z-transform and examples,
- Application of Z-transforms to finite difference equations.

References:

1) Ian Sneddon : The use of Integral Transform. TMIH, 1979.
2) Loknath Debnath : Integral Transform and their applications, CRC Pub., 1995.
3) B. Davies : Integral Transforms and their applications, Springer - Verlag, 1978.
4) Boss M. L. : Mathematical Methods in Physical Sciences, John Wiley & Sons, 1983.
5) Andrews, L. G. & Shivamoggi B. K. : Integral Transforms for Engineers, PHI, 2003.

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Paper : 5003
Special Functions - I

L T P
4-1-0

Infinite Products :

Definition of an Infinite product, A necessary condition for convergence, The associated series of logarithms, Absolute convergence, Uniform convergence.

THE GAMA AND BETA FUNCTIONS:

The Euler or Mascheroni constant γ, The Gama function, A series for $\Gamma'(z)/\Gamma(z)$, Evaluation of $\Gamma(1)$ and $\Gamma'(1)$, The Euler product for $\Gamma(z)$, The difference equation $\Gamma(z+1) = z\Gamma(z)$, The order symbols o and O, Evaluation of certain infinite products, Euler integral for $\Gamma(z)$, The Beta function, The value of $\Gamma(z)\ \Gamma(1-z)$, The factorial function, Legendre's duplication formula, Gauss' multiplication theorem, A summation formula due to Euler, The behavior of $\log \Gamma(z)$ for large $|z|$.

THE HYPERGEOMETRIC FUNCTION:

The function F(a, b; c; z), A simple integral form, F(a, b; c; 1) as a function of the parameters, Evaluation of F(a, b; c; 1), the contiguous function relations, The hypergeometric differential equation, Logarithmic solutions of the hypergeometric equation, F(a, b; c; z) as a function of its parameters, Simple transformations, Relation between functions of Z and 1-Z, A quadratic transformation, other quadratic transformations, a theorem due to Kummer, Additional properties.

ORTHOGONAL POLYNOMIALS:

Simple set of polynomials, Orthogonality, an equivalent condition for Orthogonality, zeros of orthogonal polynomials , Expansion of polynomials, The three term recurrence relations, The Christoffel-Darboux formula, Normalization; Bessel's inequality.

LEGENDRE POLYNOMIALS:

A generating function, differential recurrence relations, The pure recurrence relations, Legendre's differential equation, The Rodrigues formula, Bateman's generating function, Additional generating functions, Hypergeometric forms of $P_n(X)$, Brafman's generating functions, Special properties of $P_n(X)$, More generating functions, Laplace's first integral form, Some bounds on $P_n(X)$, Orthogonality, An expansion theorem, Expansion of Xn , Expansion of analytic functions,

HERMITE POLYNOMIALS:

Definition of Hn(x), Recurence relations, The Rodrigues formula, Other generating functions, Integrals, The Hermite polynomial as a ${}_2F_0$, Orthogonality, Expansion of polynomials, More generating functions.

Reference:

1. E. D. Rainville, Special Functions, McMillan, New York, 1990.
2. I. N. Sneddon, Special functions of Mathematical Physics and Chemistry, Oliver Boyd.
3. N. N. Lebdev, Special Functions and their applications, Dover Pub. 1972.
4. R. K. Saxena and D. C. Gokhroo, Special Functions, Khanna Pub.

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Paper : 5004
Special Functions - II

L T P
4-1-0

GENERALIZED HYPERGEOMETRIC FUNCTIONS:

The function ${}_pF_q$, The exponential and binomial functions, A differential equation, Other solutions of the differential equation, The contiguous function relations, A simple integral, The ${}_pF_q$ with unit argument, Saalschutz' theorem, Whipple's theorem, Dixen's theorem, Contour integrals of Barns' type, The Berns' integrals and the function ${}_pF_q$, A useful integral.

BESSEL FUNCTIONS:

Remarks, Definition of $J_n(z)$, Bessel's differential equation, Differential recurrence relations, A pure recurrence relations, A generating function, Bessel's integral, Index half of an integer, Modified Bessel functions, Neumann polynomials, Neumann series.

THE CONFLUENT HYPERGEOMETRIC FUNCTION:

Basic properties of the ${}_1F_1$, Kummer's first formula, Kummer's second formula.

GENERATING FUNCTIONS:

The generating function concept, Generating functions of the form G($2xt - t^2$), sets generated by $e^t \psi(xt)$, the generating functions $A(t)\exp(-xt/(1-t))$, another class of generating functions, Boas and Buck generating functions, An extension.

LAGUERRE POLYNOMIALS:

The polynomial Ln(X), Generating functions, Recurrence relations, The Rodrigues formula, The differential equation, Orthogonality, Expansion of polynomials, Special properties, Other generating functions, The simple Laguerre polynomials.

JACOBI POLYNOMIALS:

The Jacobi polynomials, Bateman's generating functions, The Rodrigues formula, Orthogonality, Differential recurrence relations, The pure recurrence relations, Mixed relations, Appell's functions of two variables, An elementary generating functions, Brafman's generating functions, Expansion in series of polynomials.

ELLIPTIC FUNCTIONS:

Doubly periodic functions, Elliptic functions, Elementary properties, Order of an elliptic function, The Weierstrass function P(Z), Other elliptic functions, A differential equation for P(Z), Connection with elliptic integrals.

Reference:

1. E. D. Rainville, Special Functions, McMillan, New York, 1990.
2. I. N. Sneddon, Special functions of Mathematical Physics and Chemistry, Oliver Boyd.
3. N. N. Lebdev, Special Functions and their applications, Dover Pub. 1972.
4. R. K. Saxena and D. C. Gokhroo, Special Functions, Khanna Pub.