

ANNEXTURE-II

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS OF M. Sc. (MATHEMATICS)

SEMESTER-IV

Effective from June-2018

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS FOR M. Sc. (MATHEMATICS)

Effective from June-2018

Semester	Subject Paper Number (PGMTH)	Subject Name	Lecture per Week	Credit	Marks
III	301	Functional Analysis-I	4	4	100 (70- External +30 Internal)
	302	Differential Equations	4	4	
	303	Calculus of Variations	4	4	
	304	Advanced Linear Algebra-I	4	4	
*IV	401	Functional Analysis-II	4	4	100 (70- External +30 Internal)
	402	Differential Geometry	4	4	
	403	Integral Equations	4	4	
	404	Advanced Linear Algebra-II	4	4	

\*Enclosed here with syllabus of M. Sc –Sem-IV

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**Semester-IV**

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**PGMTH-401(Functional Analysis – II)**

**L : T : P  
4 0 0**

**Inner product spaces and Hilbert spaces:**

Orthonormal Sets and Sequences, Total Orthonormal Sets and Sequences, Representation of Functionals 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, Adjoint Operator, Reflexive Spaces, Category theorem and uniform boundedness theorem, Strong and Weak convergence, Convergence of Sequences of operators and Functionals, Open Mapping Theorem, Closed Linear Operators, Closed Graph Theorem.

**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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**PGMTH-402 ( Differential Geometry)**

**L : T : P  
4 0 0**

**Curves:**

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

**Surfaces:**

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

**References:**

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

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**PGMTH–403 (Integral Equations)**

**L : T : P**  
**4 0 0**

**Preliminary Concepts:**

Integral equations, Classification of integral equations, Solution of integral equations, Some examples related to solutions of integral equations, Leibnitz's Rule (for differentiation under integral sign), Important formula for converting a multiple integral into a single ordinary integral, Classification of kernels, Regularity Conditions, Inner or Scalar product of functions.

**Conversion of ODE into Integral Equations:**

Method of converting IVP into Volterra integral equation, Alternative method of converting IVP into Volterra integral equation, Method of converting BVP into Fredholm integral equation.

**Fredholm Integral Equations of second kind with Separable kernel:**

Eigenvalues and Eigenfunctions, Solution of homogeneous Fredholm integral equations of second kind with Separable kernel, Solution of Fredholm integral equations of second kind with Separable kernel.

**Method of Successive approximations:**

Iterated Kernels, Resolvent kernels, An Important theorem on kernels, Solution of Fredholm integral equations of second kind by successive substitution, Solution of Volterra integral equations of second kind by successive substitution.

**References:**

1. M. D. Raisinghania: Integral Equations and Boundary Value Problems, S. Chand & Co., New Delhi (2007).
2. Shanti Swarup: Linear Integral Equations, Krishna Prakashan, Meerut.
3. Sudir K. Pundir and Rimple Pundir: Integral Equations and Boundary Value Problems, Pragati Prakashan, Meerut (2005).
4. Ram P. Kanwal: Linear Integral Equations Theory and Technique, Academic Press, Birkhäuser, New York (2013).
5. Corduneanu, C., Integral Equations and Applications, Cambridge University Press, 1991

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**PGMTH-404 (Advanced Linear Algebra – II)**

**L : T : P**

**4 0 0**

**Canonical Forms:**

Similar linear transformations, Triangular form, Nilpotent transformations, Invariants, Jordan Canonical form, Rational Canonical form, Companion Matrix.

**More about Linear Transformations:**

Trace and its properties, Transpose and its properties, Symmetric and Skew Symmetric matrices, Adjoint and Hermitian Adjoint, Determinant and its properties, Hermitian, Unitary and Normal transformations.

**References:**

1. I.N. Herstein: Topics in Algebra 4thEd., John Wiley Sons.
2. Kenneth Hoffman and Ray Kunze: Linear Algebra, Eastern Economy Editions.
3. D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley & Sons, 2004.
4. N. Jacobson: Lectures in Abstract Algebra Vol. I (1951),II(1952), Van Nostrand Co., New York.

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**SEMESTER : IV**

**Group of Optional Papers**

**Effective from June-2018**

**Structure :**

**SEM-IV**

<b>GROUP</b>	<b>PAPER NO.</b>	<b>TITLE OF PAPER</b>	
GROUP – 1	PGMTH4001	Computational Fluid Dynamics	Practical
	PGMTH4002	Mathematical Modelling	
GROUP – 2	PGMTH4003	Non-Linear programming	Practical
	PGMTH4004	Advanced Operation Research	Practical
GROUP-3	PGMTH4005	Integral Transforms-II	
	PGMTH4006	Advanced Integral Transforms-II	
GROUP-4	PGMTH4007	Advanced Number Theory-II	
	PGMTH4008	Introduction to Partition Theory and Cryptography	
GROUP-5	PGMTH4009	Special Functions-II	
	PGMTH4010	Advanced Special Functions-II	

THEORY LECTURE : 4

PAPER WITH PRACTICAL : THEORY (4) + PRACTICAL (4)

**Marking scheme**

1. All papers except paper with practical  
Internal exam (30) + External Exam( 70) = Total (100)
2. Practical paper  
Theory: 18 (Internal) 42(External)  
Practical: 12 (Internal) 28(External)  
Total: 30 (Internal) 70(External)

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**Semester: IV**

**Effective from June -2018**

**PGMTH-4001(Computational Fluid Dynamics)**

**L : T : P**  
**4 0 4**

- Introduction to CFD, Applications;  
Governing equations and assumptions, Equation types, Model equations, potential flow, Heat conduction, Wave equation, Burgers equation, Euler equations.
- Finite Differences, Algorithms, Errors and Accuracy, Consistency, Stability and Convergence, Finite Volumes, Explicit algorithms, Implicit algorithms, Numerical boundary conditions, Method of lines, Shock Jump Relations, Shock capturing.
- One dimensional Euler equations, Lax – Wendroff Scheme, Mc-Cormack Scheme, Implicit - method, Pseudo One Dimensional Euler Equations, boundary conditions, Flux – Splitting, Artificial viscosity, Flux limiters.
- Multidimensional Euler equations, Lax- Wendroff and Mc-Cormack schemes, stability of multidimensional schemes, Operator splitting Implicit algorithms, Beam - Warming algorithm.
- Practical: Numerical methods for discretizing fluid flow equations: Finite differences

**Reference Books:**

1. R. J. Leveque: Numerical methods for conservation Laws, BirkhauserVerlag, Basel, 1992.
2. J. D. Anderson: Computation Fluid dynamics, Mc-Graw – Hill, New York, 1995.
3. H. K. Versteeg and W. Malasekera: An Introduction to Computational Fluid Dynamics: The finite volume method, Longman Scinetific and technical Essex, England, 1995.
4. J. Chorin and J. E. Marsden: A Mathematical Introduction to Fluid Mechanics
5. P. D. Lax: hyperbolic systems of conservation laws and mathematical theory of shock waves, 1973.

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**PGMTH-4002: (Mathematical Modeling)**

**L : T : P**  
**4 0 0**

- Needs and Techniques of mathematical modeling: Idea of mathematical modeling, need for mathematical modeling, steps in mathematical modeling, Characteristics of mathematical modeling, Interpretation
- Models in mechanical vibration :Spring mass system, pendulum problems
- Models in population dynamics:One species model, logistic model, growth model in time delays, Predator-Prey models, Volterra-Lotka models
- Models of chemical processes, Electrical network and Diffusion processes
- Traffic flow models

**COMPUTATIONAL MODELING**

- Modeling dynamical systems: differential equations and their numerical solution, linear and non-linear dynamics, stability, convergence, attractors.
- Physical systems: System types and characteristics behaviour, Continuous time, discrete – time and discrete -event systems, linear and non linear systems
- Exploration of behaviour through simulation:
- Developing simulations of dynamical systems using Matlab: representation and visualization of simulation experiments, analyzing behavioural characteristics for a range of classes of physical and computational systems eg. Predictor- prey models, evolutionary systems and cellular systems

**Reference Books:**

1. J.N.Kapur: Mathematical Modelling, Wiley eastern Ltd., 1994.
2. M.M. Gibbons: A concrete approach to Mathematical Modeling, John Wiley and sons, 1995.
3. H. Neunzert and A.H. Siddiqui: Topics in Industrial Mathematics, Kluwer Academic Publishers, London, 2000
4. P. E. Wellstead : Introduction to Physical System Modeling, Academic Press, 1979.
5. Richard Haberman: Mathematical Models, Practice- Hall Inc., NJ, 1979.

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**PGMTH-4003(Non – Linear Programming)**

**L : T : P**  
**4 0 4**

**One - Dimensional Non- Linear Programming Methods:**

Unimodal Function, Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Search, Golden Section Method, Comparison of Elimination Methods, Quadratic Interpolation, Direct Search Method.

**Classical Optimization Methods:**

Unconstraint Optimization, Constrain Multi - Variable Optimization with Equality Constrains, Constrain Multi - Variable Optimization with Inequality Constrains.

**Non- Linear Programming Methods:**

Introduction, General Non - Linear Programming Problems, Graphical Solution Method, Quadratic Programming, Application of Quadratic Programming, Separable Programming.

**Geometric Programming:**

Introduction, Geometric – Arithmetic Mean Inequality, Unconstrained Geometric Programming Problem, Constrained Geometric Programming Problem.

**References:**

1. Kantiswarup, P.K.Gupta and Manmohan: Operations Research ,Sultan chand and Sons.
2. S.D. Sharma: Operations Research, KedarNath, Ram Nath& Co.
3. S. S. Rao: Optimization Theory and Applications, Wiley Eastern, 1984.
4. J. K. Sharma: Operation Research: Theory and Applications, Macmillan India Ltd., Third Edition, 2007.

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**PGMTH-4004 ( Advanced Operations Research )**

**L : T : P**  
**4 0 4**

**Queuing Theory:**

Definition and Characteristic of a Queuing System, Poisson Process and Exponential Distribution, Classification of Queues, Detailed Study of M/M/1 and M/M/s Queuing Models.

**Sequencing Problems:**

Problems of Sequencing, Problems with n-jobs and 2-machines, Problems with n-jobs and 3-machines, Problems with n-jobs and m-machines.

**Theory of Replacement:**

Introduction, Replacement of Equipment that Deteriorate Gradually, Replacement of Equipment that Fails completely, Other Replacement Problems.

**Games and Strategies:**

Introduction, Two-person Zero-Sum Games, The Maximum-Minimum Principle, Games Without Saddle Points-Mixed Strategies.

**References:**

1. Kantiswarup, P.K.Gupta and Manmohan: Operations Research ,Sultan chand and Sons.
2. S.D. Sharma: Operations Research, KedarNath, Ram Nath& Co.
3. S. S. Rao: Optimization Theory and Applications, Wiley Eastern, 1984.
4. J. K. Sharma: Operation Research: Theory and Applications, Macmillan India Ltd., Third Edition, 2007.

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**PGMTH-4005 ( Integral Transforms-II )**

**L : T : P**  
**4 0 0**

**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) Loknath Debnath: Integral Transform and their applications, CRC Pub., 1995.
- 3) Poularikas, A.D. : The Transforms and Applications Handbook: Second Edition. Boca Raton: CRC Press LLC, 2000
- 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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**PGMTH-4006 (Advance Integral Transforms-II )**

**L : T : P**  
**4 0 0**

**Mellin Transforms:**

- Introduction and definition of Mellin transforms with examples,
- Mellin Inversion theorem
- Basic operational properties
- Convolution theorems for Mellin transform.
- Applications of the Mellin transforms,
- 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) Poularikas, A.D. : The Transforms and Applications Handbook: Second Edition. Boca Raton: CRC Press LLC, 2000
- 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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**PGMTH-4007(Advanced Number Theory – II)**

**L : T : P**  
**4 0 0**

**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.

**Diophantine equations:** Diophantine equation  $ax + by = c$  and its positive solutions, Pell's equation, Continued fractions solution of Pell's equation, Pythagorean equation  $x^2 + y^2 = z^2$ , the case  $n = 4$  in Fermat's Last Theorem.

**Representation of integers as sum of squares:**

Necessary and sufficient conditions for a positive integer to be represented as the sum of two squares, Fermat's theorem, positive integers represented as difference of two squares, integers that are not expressible as the sum of three squares, Euler's identity, primes represented as the sum of four squares, Lagrange's theorem.

**References:**

1. David M. Burton : Elementary Number Theory, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 7<sup>th</sup> edition, 2012.
2. S.G.Talang : Number Theory, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 5<sup>th</sup> reprint, 2004.
3. Neville Robbins : Beginning Number Theory, Narosa Pub. House, New Delhi, 2<sup>nd</sup> Ed., 2006.
4. Martin Erickson, Anthony Vazzana : Introduction to Number Theory, Chapman & Hall/CRC, New York, 2008 Ed.
5. I. Niven, S.Zuckerman & L. Montgomery: An Introduction to the Theory of Numbers, 6<sup>th</sup> edition, John Wiley and Sons, Inc., New York, 2003.
6. George Andrews : Number Theory, The Hindustan Pub. Corp., New Delhi.

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PGMTH-4008 (Introduction to Partition Theory and Cryptography)

L : T : P  
4 0 0

**Partition theory:** An introduction, generating functions, partitions into exactly  $k$  parts, recurrence relations for  $p(n, k)$  and  $P(n, k)$  and relation between them, an inequality for  $p(n, k)$ .

Graphs of partitions, Euler's identity, a recursion formula for  $p(n)$ , Durfee's identity, two line partitions, the formula for  $R(A, B)$ .

**Cryptography:** Cesar Cipher, Vigenère cipher, Autokey cipher, Hill's cipher, RSA algorithm.

Knapsack problem, Superincreasing knapsack problem, Knapsack cryptosystem, An application of primitive roots to cryptography.

**References:**

1. Hansraj Gupta: Selected Topics in Number Theory, Abacus Press, England, 1980 Ed.
2. Tom M. Apostol : Introduction to Analytic Number Theory, Narosa Pub. House, New Delhi, 1998 Ed.
3. George Andrews, Kimmo Eriksson : Integer Partitions, Cambridge Univ. Press, UK, 2004 Ed.
4. David M. Burton : Elementary Number Theory, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 7<sup>th</sup> edition, 2012.
5. Martin Erickson, Anthony Vazzana : Introduction to Number Theory, Chapman & Hall/CRC, New York, 2008 Ed.

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**PGMTH-4009 (Special Functions-II)**

**L : T : P  
4 0 0**

**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  $X^n$ , Expansion of analytic functions,

**HERMITE POLYNOMIALS:**

Definition of  $H_n(x)$ , Recurrence 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. Lebedev, Special Functions and their applications, Dover Pub. 1972.
4. R. K. Saxena and D. C. Gokhroo, Special Functions, Khanna Pub.

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**PGMTH-4010 (Advanced Special Functions-II)**

**L : T : P**  
**4 0 0**

**LAGUERRE POLYNOMIALS:**

The polynomial  $L_n(X)$ , 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. Lebedev, Special Functions and their applications, Dover Pub. 1972.
- 4 R. K. Saxena and D. C. Gokhroo, Special Functions, Khanna Pub.