Re-Accredited 'B++' 2.86 CGPA by NAAC
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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–: પરિપત્ર :–

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન અનુસ્નાતક અભ્યાસક્રમ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓને તથા વિભાગીય વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૩–૨૪ થી અમલમાં આવનાર M.Sc. Mathematics Sem.-3 & 4 નો પેટા સમિતિ દ્વારા તૈયાર કરેલ અભ્યાસક્રમ અંગે ગણિતશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૨૮/૦૬/૨૦૨૩ ની સભાનાં ઠરાવ ક્રમાંક : ૨ અન્વયે કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિજ્ઞાન વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખા વતી મંજુર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૦૭/૦૭/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંકઃ ૧૨ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

ગણિતશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૧૩/૦૩/૨૦૨૩ની સભાનાં ભલામણ ક્રમાંકઃ૨

:: આથી ઠરાવવામાં આવે છે કે,શૈક્ષણિક વર્ષ ૨૦૨૩–૨૪ થી અમલમાં આવનાર M.Sc. Mathematics Sem.- 3 & 4 નો પેટાસમિતિ દ્વારા તૈયાર કરવામાં આવેલ અભ્યાસક્રમ જરૂરી સુધારા વધારા સાથે સર્વાનુમતે મંજૂર કરી તે મંજૂર કરવા વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૦૭/૦૭/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંકઃ ૧૨

:: **આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩–૨૪ થી અમલમાં આવનાર M.Sc. Mathematics Sem.-3 & 4 નો પેટા સમિતિ દ્વારા તૈયાર કરેલ અભ્યાસક્રમ અંગે ગણિતશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૨૮/૦૬/૨૦૨૩ ની સભાનાં ઠરાવ ક્રમાંક : ૨ અન્વયે કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિજ્ઞાન વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખા વતી મંજુર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ સ્વીકારી M.Sc. Mathematics Sem.-3 & 4 નો અભ્યાસક્રમ મંજૂર કરવામાં આવે છે.**

(બિડાણઃ ઉપર મુજબ)

ક્રમાંક : એસ./સાયન્સ/પરિપત્ર/૧૭૬૫૦/૨૦૨૩
તા.૧૨–૦૭–૨૦૨૩

કુલસચિવ

પ્રતિ,
૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન અનુસ્નાતક અભ્યાસક્રમ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ.
..... આપશ્રીની કોલેજના સંબંધિત શિક્ષકોને જાણ કરી અમલ કરવા સારૂ.
૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
.....તરફ જાણ તેમજ અમલ સારૂ.

એકેડમિક કાઉન્સિલ તા. 07/07-2023
આઇટમ 12 વિદ્યાપરિષદ 08

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS FOR M.Sc. (MATHEMATICS)
SEMESTER – III
Effective from June 2023

Theory Paper/Practical	Teaching schedule Hrs/week	Exam Schedule				Credit
		Duration Hrs.	Internal Marks	External Marks	Total Marks	
Papers:						
1: Core Paper-I PGMTH-301: Functional Analysis – I	4	3	30	70	100	4
2: Core Paper-II PGMTH-302: Advanced Numerical Analysis	4	3	30	70	100	4
3: Core Paper-III PGMTH-303: Calculus of Variation	4	3	30	70	100	4
4: Inter/Multi-Disciplinary Elective Paper PGMTH-3041: Fluid Dynamics PGMTH-3042: Advanced Operations Research PGMTH-3043: Advanced Integral Transforms-I PGMTH-3044: Diophantine Equations PGMTH-3045: Advanced Special Functions-I	4	3	30	70	100	4
5. Practical based on 301 to 304 PGMTH-305: Practical	12	10-15	50	100	150	6
6. Skilled based elective paper / Swayam / other MOOC courses **Skilled based elective papers:** 1. Basics of Financial Mathematics 2. Basics of Data Science 3. Algorithmic Mathematics 4. Curve Theory	2	0	20	30	50	2
		Total:	190	410	600	24

Chairman
B.Sc
MATHS

28/06/2023

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH-301: Functional Analysis – I

Unit I:

Metric Space, Further Examples of Metric Spaces, Completeness, Examples, Completeness proofs, Completion of Metric Spaces

Unit II:

Vector Space, Normed Space, Banach Space, Further properties of Normed Spaces, Finite Dimensional Normed Spaces and Subspaces, Compactness and Finite Dimension, Linear Operators

Unit III:

Bounded and Continuous Linear Operators, Linear Functionals, Linear Operators and Functionals on Finite Dimensional Spaces, Normed Spaces of Operators, Dual space

Unit IV:

Inner Product Space, Hilbert Space, Properties of Inner Product Spaces, Orthogonal Complements and Direct Sums, Orthogonal Sets and Sequences

Syllabus is covered from the following reference books:

1. E. Kreyszig: Introductory Functional Analysis with applications, John Wiley and Sons.
2. B. V. Limaye: Functional Analysis, New Age International Limited, Publishers
3. G. F. Simmons: Introduction to Topology and Modern Analysis, Tata McGraw - Hill.
4. A. R. Vashistha, J. N. Sharma: Functional Analysis, Krishna Prakashan Media (P) Ltd.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH-302: Advanced Numerical Analysis

Unit I:

Transcendental and Polynomial Equations: Direct Methods (Introduction), Iterative Methods (Muller Method, Chebyshev Method), Rate of convergence (Definition), First and second order General Iteration Methods.

System of Linear Algebraic Equations: Introduction, Direct Methods (Cramer Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization Method), Iteration methods (Jacobi Iteration Method, Gauss-Seidel Iteration Method).

Unit II:

Eigen Values Problems: Eigen values and Eigen vectors, Jacobi method for symmetric matrices, Power method, Inverse power method.

Numerical Differentiation: Methods based On Interpolation (Non-uniform Nodal Points, Uniform Nodal Points), Optimum Choice of Step Length.

Unit III:

Numerical Integration: Methods based on interpolations (Newton-Cotes Method), Methods based on Undetermined coefficients (Newton-Cotes Method, Gauss Quadrature Method, Gauss-Legendre Integration Method, Gauss-Chebyshev Integration Method).

Unit IV:

Numerical Solution of Ordinary Differential Equations: Initial Value Problem, Single step methods (Explicit Runge-Kutta Methods).

Boundary Value Problem, Finite Difference Methods: linear Second Order Differential Equations, Solution of Tridiagonal System.

Syllabus is covered from the following reference books:

1. M. K. Jain, S. R. K. Iyenger, R. K. Jain: Numerical Methods for scientific and engineering computations, VI edition, New Age International Publishers.
2. Philips, Taylor: Theory and Applications of Numerical Analysis, Academic Press, 1996.
3. Gourdin, Boumhart: Applied Numerical Analysis, P.H.I., 1996.
4. A. S. Householder: Theory of Matrices in Numerical Analysis, Blarsedell – New York.
5. Jacques, Colin: Numerical Analysis, Chapman & Hall, New-York, 1987.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH–303: Calculus of Variations

Unit I:

Variational Problems with Fixed Boundaries: The concept of Variation and its properties, Euler's Equation, Fundamental lemma of Calculus of Variation.

Unit II:

Functionals: Functionals dependent on several functions of independent variable, Functionals dependent on Higher-Order derivatives, Functionals dependent on functions of several independent variables, Variational problems in parametric form.

Unit III:

Variational Problems with Moving Boundaries: Variation of Functional with moving boundary, Variational problem with a movable boundary for a functional dependent on two functions, One-Sided Variations, Reflection and Refraction of Extremals.

Unit IV:

Sufficient Conditions for an Extremum: Field of Extremals, Jacobi Condition, Weirstrass Function, Legendre Condition, Second Variation, Canonical Equations and Variational Principles, Complementary Variational Principles.

Syllabus is covered from the following reference books:

1. A. S. Gupta: Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., New Delhi.
2. Robert Weinstock: Calculus of Variations with Applications to physics.
3. ElsGok L. D.: Calculus of Variation.
4. Mariano Giaquinta, Stefan Hildebrandt: Calculus of Variations-I, Springer Science & Business Media, 2004.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH–3041: Fluid Dynamics

Unit I:

Vector Concept of Fluid Dynamics: Scalar and vector properties, cross product and dot product of vectors, magnitude and direction of a vectors, gradient, curl and divergent operators.

Unit II:

Fluid Statics: Basic Definitions of fluid, Pascal's law, basic property of a static fluid, pressure at the vertical level, Equality of pressure at the same level, General equation for the variation of pressure, Buoyancy.

Unit III:

Kinematics of fluid: Flow descriptions (Lagrangian, Eulerian, Material derivative), Motion of Fluid particles (rate of dilation, rate of shear, rate of rotation), Uniform flow, non-uniform, steady, unsteady flow, One, two and Three Dimensional Flow, Rotational and irrational flow, Laminar and turbulent flow, Line of flow(Stream line, Path line, Strake line, Time line)

Unit IV:

Dynamics of fluid: Velocity of a fluid particle at a point, stream tube, Euler Equation, Bernoulli Equation, Conservation Laws, Potential equation, Reynold's transport theorem, Conservation of mass, Conservation of momentum, Conservation of energy, Navier-stokes equation.

Syllabus is covered from the following reference books:

1. Batchelor G. K.: An Introduction to Fluid Dynamics, Cambridge University Press,1999.
2. Emanuel G.: Analytical Fluid Dynamics, CRC Press, Boca Raton, Second Edition, FL, 1999.
3. Panton R. L., Incompressible Flows, Wiley Interscience, 1984
4. Currie I. G.: Fundamental Mechanics of Fluids, McGraw-Hill, New York, 1993.
5. Chorin: Mathematical introduction to Fluid Mechanics, Springer Verlag, Fourth Edition.

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VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH-3042: Advanced Operations Research

Unit I:

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.

Unit II:

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.

Unit III:

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

Unit IV:

Information Theory: Introduction, Communication Processes, A Measure of Information, Measure of other Information Quantities, Channel Capacity, Efficiency and Redundance.

Syllabus is covered from the following reference books:

1. J. K. Sharma: Operations Research: Theory and Applications, Macmillan India Ltd., Sixth Edition, 2017.
2. Kantiswarup, P. K. Gupta, Manmohan: Operations Research, Sultan Chand and Sons.
3. S. D. Sharma: Operations Research, Kedar Nath, Ram Nath & Co.
4. S. S. Rao: Optimization Theory and Applications, Wiley Eastern, 1984.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH-3043: Advanced Integral Transforms – I

Unit I:

Introduction, Definition of the Z-transforms and examples, Basic operational properties of Z-transforms, Summation of Infinite series.

Unit II:

The inverse Z-transform and examples, Applications of Z-transforms to Finite Difference Equations.

Unit III:

Introduction, Definition of Mellin transforms and examples, Basic operational properties of Mellin Transforms.

Unit IV:

Applications of the Mellin transforms, Application of Mellin transforms to summation of series.

Syllabus is covered from the following reference books:

1. Lokenath Debnath, Dambaru Bhatta: Integral Transforms and their Applications, CRC Pub., Second Ed., 2007.
2. Ian Sneddon: The use of Integral Transforms, TMH Edition, 1979.
3. B. Davies: Integral Transforms and their applications, Springer - Verlag, 1978.
4. M. L. Boss: Mathematical Methods in Physical Sciences, John Wiley & Sons, 1983.
5. L. G. Andrews, B. K. Shivamoggi: Integral Transforms for Engineers, PHI, 2003.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH – 3044 Diophantine Equations

Unit I:

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.

Unit II:

Diophantine Equations: Diophantine equation $ax + by = c$ and its positive solutions, Pell's equation, Fundamental solutions, Solution of Pell's equation using Continued fraction

Unit III:

Fermat's Equation: Diophantine equations $x^2 + y^2 = z^2$ and its solutions, Fermat's equation $x^n + y^n = z^n$ for the cases $n = 3, 4$, Fermat's Last Theorem.

Unit IV:

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.

Syllabus is covered from the following reference books:

1. David M. Burton: Elementary Number Theory, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 7th edition, 2012.
2. S. G. Talang: Number Theory, The Tata McGraw Hill Co. Ltd., New Delhi, 5th reprint, 2004.
3. S. K. Pundir, R. Pundir: Theory of Numbers, Pragati Prakashan, Meerut, 6th edition, 2019.
4. Neville Robbins: Beginning Number Theory, Narosa Pub. House, New Delhi, 2nd edition, 2006.
5. George Andrews: Number Theory, The Hindustan Pub. Corp., New Delhi.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III

Syllabus to be in force from June 2023

PGMTH–3045: Advanced Special Functions-I

Unit I:

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

Unit II:

Bessel functions: Remarks, Definition of Jn(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.

Unit III:

The Confluent Hypergeometric function: Basic properties of the ${}_1F_1$, Kummer's first formula, Kummer's second formula.

Unit IV:

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

Syllabus is covered from the following reference books:

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, D. C. Gokhroo: Special Functions, Khanna Pub.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Basics of Financial Mathematics

Unit I:

Interest and interest rate: Origin of the concept of interest, Various forms of interest rate,

Accumulation with simple and compound interest: Meaning and significance of simple and compound interest, formulae, Calculations under simple and compound interest rates, simple and compound interest rates with equivalency, effective rate of interest.

Unit II:

Present value: Present value, net present value and future value, their interpretation.

Annuities: Annuities, Calculating value of regular annuity, simple applications of regular annuities (up to 3 periods).

Unit III:

Tax: Tax, Calculation of tax and simple application of tax calculation in goods and service tax, income tax.

Bills: Bills, Tariff rates, fixed charge, surcharge, service charge, GST, Calculation and interpretation of electricity bill, water supply and other supply bills.

Syllabus is covered from the following reference books:

1. John McCutcheon, William F. Scott: An introduction to the mathematics of finance, Elsevier Butterworth-Heinemann, Burlington, 2005.
2. S. Chandra, S. Dharmaraja, Aparna Mehra, R. Khemchandani: Financial Mathematics: An Introduction, Narosa Book Distributors Pvt. Ltd., Bengaluru, 2013.
3. Mark H. A. Davis: Mathematical Finance: A Very Short Introduction, OUP Oxford, 2019.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Basics of Data Science

Unit I:

Measures of Central Tendency and Dispersion: Mean, Mode, Median, Standard Deviation, Variance, Range, Percentile, Quartile, Interquartile Range, Counting, Random variables, Quantiles, Mean variance.

Unit II:

Correlation and Regression: Measure the relationship between two variable, Linear relationship between two variables. Correlation coefficient, Positive and negative correlation, No correlation, Linear regression.

Unit III:

Testing of hypothesis: Simple and Composite Hypotheses Null and Alternative Hypotheses, Critical Region, Type-I and Type-II Errors, Level of Significance, One-Tailed and Two-Tailed Tests, Procedure of Testing a Hypothesis.

Syllabus is covered from the following reference books:

1. S. C. Gupta, V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2020.
2. D. L. Elhance, Veena Elhance, B.M. Aggarwal: Fundamentals of Statistics, Kitab Mahal, Revised Ed., 2018.
3. Sheldon Ross: Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press, Elsevier, 2014.
4. Rohatgi V. K., Saleh, A. K. Md. E.: An Introduction to Probability and Statistics. 2nd Edn. (Reprint), John Wiley and Sons, 2009
5. Goon A. M., Gupta M. K., Das Gupta B.: Fundamentals of Statistics, Vol. I, World Press, Calcutta, 2005.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Algorithmic Mathematics

Unit I: Describing and analyzing algorithms, Algorithms for sorting: insertion sort and merge sort, analyzing algorithms, running-time analysis, Designing algorithms.

Unit II: Asymptotic notation, Asymptotic notation in equations, Comparisons of functions, Standard notations and common functions.

Unit III: Recurrence, one or more base recurrence, itself recurrence, Master method, The hiring problem, Indicator random variables, Randomized algorithms.

Syllabus is covered from the following reference books:

1. Cormen, Thomas, Charles Leiserson, Ronald Rivest, Clifford Stein: Introduction to Algorithms, MIT Press, 3rd Ed., 2009. ISBN: 9780262033848.
2. Miller, Bradley, David Ranum: Problem Solving with Algorithms and Data Structures Using Python, Franklin, Beedle & Associates, 2nd ed., 2011, ISBN: 9781590282571.
3. Stefan Hougardy, Jens Vygen: Algorithmic Mathematics, Springer: ISBN 9783319395579.
4. Venugopal Temberveni: Design and Analysis of Algorithms, B S Publications

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Curve Theory

Unit I:

Space curves, Tangent, Arclength, Principal Normal, Binormal, Fundamental Planes, Curvature, Torsion, Serret-Frenet formulae.

Unit II:

Cylindrical Helices, Circular helix, Osculating circle, osculating sphere.

Unit III:

Involutes, Evolutes, Spherical Indicatrices, Bertrand curves.

Syllabus is covered from the following reference books:

1. C. E. Whetherburn: Differential Geometry of 3-D, Radha Publishing, Calcutta.
2. T. J. Willmore: An Introduction to Differential Geometry, Oxford University Press (India).
3. S. C. Mittal, D. C. Agrawal: Differential Geometry, Krishna Publication.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS FOR M.Sc. (MATHEMATICS)
SEMESTER – IV
Effective from June 2023

Theory Paper/Practical	Teaching schedule Hrs/week	Exam Schedule				Credit
		Duration Hrs.	Internal Marks	External Marks	Total Marks	Duration Hrs.
Papers:						
1: Core Paper-I PGMTH-401: Functional Analysis – II	4	3	30	70	100	4
2: Core Paper-II PGMTH-402: Advanced Linear Algebra	4	3	30	70	100	4
3: Core Paper-III PGMTH-403: Integral Equations	4	3	30	70	100	4
4: Inter/Multi-Disciplinary Elective Paper PGMTH-4041: Computational Fluid Dynamics PGMTH-4042: Nonlinear Programing PGMTH-4043: Advanced Integral Transforms-II PGMTH-4044: Partition Theory and Cryptography PGMTH-4045: Advanced Special Functions-II	4	3	30	70	100	4
5. Practical based on 401 to 404 PGMTH-405: Practical	12	10-15	50	100	150	6
6. Skilled based elective paper / Swayam / other MOOC courses **Skilled based elective papers:** 1. Basics of Financial Mathematics 2. Basics of Data Science 3. Algorithmic Mathematics 4. Curve Theory	2	0	20	30	50	2
		Total:	190	410	600	24

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-401: Functional Analysis – II

Unit I:

Total Orthonormal Sets and Sequences, Representation of Functionals on Hilbert Spaces, Hilbert-Adjoint Operator, Self-Adjoint, Unitary and Normal Operators.

Unit II:

Zorn's Lemma, Hahn-Banach theorem, Hahn-Banach theorem for Complex Vector Spaces and Normed Spaces, Adjoint Operator.

Unit III:

Reflexive Spaces, Category Theorem and Uniform Boundedness Theorem, Strong and Weak Convergence.

Unit IV:

Convergence of Sequences of Operators and Functionals, Open Mapping Theorem, Closed Linear Operators, Closed Graph Theorem, Banach Fixed Point Theorem.

Syllabus is covered from the following reference books:

1. E. Kreyszig: Introductory Functional Analysis with applications, John Wiley and Sons.
2. B. V. Limaye: Functional Analysis, New Age International Limited, Publishers
3. G. F. Simmons: Introduction to Topology and Modern Analysis, Tata McGraw - Hill.
4. A. R. Vashistha, J. N. Sharma: Functional Analysis, Krishna Prakashan Media (P) Ltd.

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-402: Advanced Linear Algebra

Unit I:

Hom (V, W), Dual Space of Vector Space, Second Dual, Annihilator of subspace, Dimension of annihilator of a subspace and its application to homogeneous linear equations.

Unit II:

Algebra, Algebra of linear transformations $A(V)$, Relation between algebra A and $A(V)$, Minimal polynomial for linear transformation, Regular and Singular linear transformations, Rank of linear transformation.

Unit III:

Characteristic Roots and Characteristic Vectors, Algebra of Matrices, Similar linear transformations, Triangular form.

Unit IV:

Nilpotent transformations, Invariants, Jordan Canonical form, Rational Canonical form.

Syllabus is covered from the following reference books:

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

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-402: Integral Equations

Unit I:

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.

Unit II:

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.

Unit III:

Fredholm Integral Equations of second kind with Separable kernel: Eigen values and Eigen functions, Solution of homogeneous Fredholm integral equations of second kind with Separable kernel, Solution of Fredholm integral equations of second kind with Separable kernel.

Unit IV:

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.

Syllabus is covered from the following reference books:

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, Rimple Pundir: Integral Equations and Boundary Value Problems, Pragati Prakasan, Meerut, 2005.
4. Ram P. Kanwal: Linear Integral Equations Theory and Technique, Academic Press, Birkhäuser, New York, 2013.
5. Córdumenau, C.: Integral Equations and Applications, Cambridge University Press, 1991.

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-4041: Computational Fluid Dynamics

Unit I:

Introduction and Classification of PDE's: Introduction to PDEs', Types of PDEs', Classification of PDEs', Introduction to CFD, Applications, Scope of CFD, Governing equations and assumptions, Equation types, Model equations, Discretization of the Domain, Numerical boundary conditions.

Unit II:

Heat Equation: Introduction to heat Equations, Schmidt method, Richardson Method, Crack- Nicolson method, Du-fort Franek method, stability of schemes, convergence of scheme.

Unit III:

Wave Equations: 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.

Unit IV:

Laplace and Poison Equation: Finite Differences, Algorithms, Errors and Accuracy, Consistency, Stability and Convergence, Implicit algorithms.

Syllabus is covered from the following reference books:

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

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-4042: Nonlinear Programming

Unit I:

One - Dimensional Nonlinear 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.

Unit II:

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

Unit III:

Nonlinear Programming Methods: Introduction, General Nonlinear Programming Problems, Graphical Solution Method, Quadratic Programming, Application of Quadratic Programming, Separable Programming.

Unit IV:

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

Syllabus is covered from the following reference books:

1. J. K. Sharma: Operations Research: Theory and Applications, Macmillan India Ltd., Sixth Edition, 2017.
2. Kantiswarup, P. K. Gupta, Manmohan: Operations Research, Sultan Chand and Sons.
3. S. D. Sharma: Operations Research, Kedar Nath, Ram Nath & Co.
4. S. S. Rao: Optimization Theory and Applications, Wiley Eastern, 1984.

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-4043: Advanced Integral Transforms-II

Unit I:

Basic concepts and Definitions, The Fourier Integral formulae, Definition of Fourier transforms and examples, Basic properties of Fourier transforms.

Unit II:

Definitions of Fourier Cosine and Sine transforms with examples, Properties of Fourier Cosine and Sine transforms, Evaluation of definite integrals, Solutions of integral equations.

Unit III:

Definition of finite Cosine and Sine transforms with examples, Basic properties of finite Fourier Cosine and Sine transforms, Applications of finite Fourier Cosine and Sine transforms.

Unit IV:

Applications of Fourier transforms to partial differential equations, Applications of Fourier Cosine and Sine transforms to partial differential equations.

Syllabus is covered from the following reference books:

1. Lokenath Debnath, Dambaru Bhatta: Integral Transforms and their Applications, CRC Pub., Second Ed., 2007.
2. Ian Sneddon: The use of Integral Transforms, TMH Edition, 1979.
3. B. Davies: Integral Transforms and their applications, Springer - Verlag, 1978.
4. M. L. Boss: Mathematical Methods in Physical Sciences, John Wiley & Sons, 1983.
5. L. G. Andrews, B. K. Shivamoggi: Integral Transforms for Engineers, PHI, 2003.

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-4044: Partition Theory and Cryptography

Unit I:

Partition Theory: An introduction, Partitions into exactly k parts, Geometric representation of partitions, Generating functions, Recurrence relations for $p(n,k)$, Value of $p(n,k)$ for some special cases, Euler's Pentagonal number theorem.

Unit II:

Partition Theory: Euler's recursion formula for $p(n)$, Durfee's identity, Jacobi's identity, Upper bound of $p(n)$, Two-line partitions, Formula for $R(A,B)$.

Unit III:

Cryptography: The Objectives of Cryptography, Encryption Schemes, Classification of Attacks, Cesar Cipher, Vigenère cipher, Autokey cipher, Hill's cipher.

Unit IV:

Cryptosystems: RSA algorithm, Knapsack problem, Superincreasing knapsack problem, Knapsack cryptosystem, ElGamal Cryptosystem.

Syllabus is covered from the following reference books:

1. Hansraj Gupta: Selected Topics in Number Theory, Abacus Press, England, 1980 Ed.
2. David M. Burton: Elementary Number Theory, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 7th edition, 2012.
3. George Andrews, Kimmo Eriksson: Integer Partitions, Cambridge Univ. Press, UK, 2004 Ed.
4. Johannes A. Buchmann: Introduction to Cryptography, Springer-Verlag, NY, Second Edition, Sixth Indian Reprint, 2013.
5. Tom M. Apostol: Introduction to Analytic Number Theory, Narosa Pub. House, New Delhi, 1998 Ed.

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M.Sc. (Mathematics) Semester: IV

Syllabus to be in force from June 2023

PGMTH-4045: Advanced Special Functions-II

Unit I:

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.

Unit II:

The Jacobi polynomials, Bateman's generating functions, The Rodrigues formula, Orthogonality, Differential recurrence relations, The pure recurrence relations, Mixed relations.

Unit III:

Appell's functions of two variables, An elementary generating functions, Brafman's generating functions, Expansion in series of polynomials.

Unit IV:

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.

Syllabus is covered from the following reference books:

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, D. C. Gokhroo: Special Functions, Khanna Pub.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Basics of Financial Mathematics

Unit I:

Interest and interest rate: Origin of the concept of interest, Various forms of interest rate,

Accumulation with simple and compound interest: Meaning and significance of simple and compound interest, formulae, Calculations under simple and compound interest rates, simple and compound interest rates with equivalency, effective rate of interest.

Unit II:

Present value: Present value, net present value and future value, their interpretation.

Annuities: Annuities, Calculating value of regular annuity, simple applications of regular annuities (up to 3 periods).

Unit III:

Tax: Tax, Calculation of tax and simple application of tax calculation in goods and service tax, income tax.

Bills: Bills, Tariff rates, fixed charge, surcharge, service charge, GST.

Syllabus is covered from the following reference books:

1. John McCutcheon, William F. Scott: An introduction to the mathematics of finance, Elsevier Butterworth-Heinemann, Burlington, 2005.
2. S. Chandra, S. Dharmaraja, Aparna Mehra, R. Khemchandani: Financial Mathematics: An Introduction, Narosa Book Distributors Pvt. Ltd., Bengaluru, 2013.
3. Mark H. A. Davis: Mathematical Finance: A Very Short Introduction, OUP Oxford, 2019.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Basics of Data Science

Unit I:

Measures of Central Tendency and Dispersion: Mean, Mode, Median, Standard Deviation, Variance, Range, Percentile, Quartile, Interquartile Range, Counting, Random variables, Quantiles, Mean variance.

Unit II:

Correlation and Regression: Measure the relationship between two variable, Linear relationship between two variables. Correlation coefficient, Positive and negative correlation, No correlation, Linear regression.

Unit III:

Testing of Hypothesis: Simple and Composite Hypotheses Null and Alternative Hypotheses, Critical Region, Type-I and Type-II Errors, Level of Significance, One-Tailed and Two-Tailed Tests, Procedure of Testing a Hypothesis.

Syllabus is covered from the following reference books:

1. S. C. Gupta, V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2020.
2. D. L. Elhance, Veena Elhance, B. M. Aggarwal: Fundamentals of Statistics, Kitab Mahal, Revised Ed., 2018.
3. Sheldon Ross: Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press, Elsevier, 2014.
4. Rohatgi V. K., Saleh, A. K. Md. E.: An Introduction to Probability and Statistics. 2nd Edn. (Reprint), John Wiley and Sons, 2009
5. Goon A. M., Gupta M. K., Das Gupta B.: Fundamentals of Statistics, Vol. I, World Press, Calcutta, 2005.

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M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Algorithmic Mathematics

Unit I: Describing and analyzing algorithms, Algorithms for sorting: insertion sort and merge sort, Running-time analysis, Designing algorithms.

Unit II: Asymptotic notation, Asymptotic notation in equations, Comparisons of functions, Standard notations and common functions.

Unit III: Recurrence, One or more base recurrence, Itself recurrence, Master method, The hiring problem, Indicator random variables, Randomized algorithms.

Syllabus is covered from the following reference books:

1. Cormen, Thomas, Charles Leiserson, Ronald Rivest, Clifford Stein: Introduction to Algorithms, MIT Press, 3rd Ed., 2009. ISBN: 9780262033848.
2. Miller, Bradley, David Ranum: Problem Solving with Algorithms and Data Structures Using Python, Franklin, Beedle & Associates, 2nd ed., 2011. ISBN: 9781590282571.
3. Stefan Hougardy, Jens Vygen: Algorithmic Mathematics, Springer. ISBN 9783319395579.
4. Venugopal Temberveni: Design and Analysis of Algorithms, B S Publications

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M.Sc. (Mathematics) Semester: III, IV

Syllabus to be in force from June 2023

Skill Based Elective Course: Curve Theory

Unit I:

Space curves, Tangent, Arclength, Principal Normal, Binormal, Fundamental Planes, Curvature, Torsion.

Unit II:

Serret-Frenet formulae, Cylindrical Helices, Circular helix, Osculating circle, Osculating sphere.

Unit III:

Involutes, Evolutes, Spherical Indicatrices, Bertrand curves.

Syllabus is covered from the following reference books:

1. C. E. Whetherburn: Differential Geometry of 3-D, Radha Publishing, Calcutta.
2. T. J. Willmore: An Introduction to Differential Geometry, Oxford University Press (India).
3. S. C. Mittal, D. C. Agrawal: Differential Geometry, Krishna Publication.