FAKIR MOHAN UNIVERSITY

PG Department of Mathematics

M.A/M.Sc. (Mathematics) COURSE STRUCTURE

(Effective from 2019-20 Session)

SEMESTER I

PAPER NO.	PAPER NAME	MARKS		CREDIT
		End Sem Assessment	Internal Assessment	
M101	Linear Algebra	40	10	04
M102	Real Analysis	40	10	04
M103	Complex Analysis	40	10	04
M104	Ordinary Differential Equations and Special Functions	40	10	04
M105	Mathematical Methods	40	10	04
ML106	Introduction to C Programming Language (Lab)	50		04
TOTAL		300		24

SEMESTER II

PAPER NO.	PAPER NAME	MARKS		CREDIT
		End Sem Assessment	Internal Assessment	
M201	Advanced Abstract Algebra	40	10	04
M202	Optimization Theory	40	10	04
M203	Topology	40	10	04
M204	Partial Differential Equations	40	10	04
M205	Theory of Probability and Stochastic Processes	40	10	04
ML206	Mathematical Methods Practical	50		04
TOTAL		300		24

SEMESTER III

PAPER NO.	PAPER NAME	MARKS		CREDIT
		End Sem Assessment	Internal Assessment	
M301	Mechanics	40	10	04
M302	Numerical Analysis	40	10	04
M303	Functional Analysis	40	10	04
M304	Introduction to Statistical Methods (CBCS)	40	10	04
M305	Elective -I	40	10	04
ML306	Numerical Analysis using C++ (Lab)	50		04
TOTAL		300		24
Fakir Mohan Studies(Non-Credit Course)				

SEMESTER IV

PAPER NO.	PAPER NAME	MARKS		CREDIT
		End Sem Assessment	Internal Assessment	
M401	Discrete Mathematics	40	10	04
M402	Mathematical Statistics	40	10	04
M403	Differential Geometry	40	10	04
M404	Elective-II	40	10	04
MPL405	Project Work (Thesis/Report, Seminar, Presentation, Viva-Voce)	100		08
TOTAL		300		24

Elective -I	Elective -II
A. Numerical Solutions of Differential Equation B. Operations Research C. Number Theory and Cryptography	A. Computational Fluid Dynamics B. Theory of Computation C. Computational Finance

Course Title: Linear Algebra
Course Code: M101

UNIT-I

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations, Liner equations consistency conditions.

UNIT-II

Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms, Elementary transformation on a matrix to obtain Diagonal form, Triangular form, Jordan canonical form.

UNIT-III

Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms

UNIT-IV

Modules, Sub modules, R-Homomorphism, Quotient Modules, Completely reducible modules, free modules

RECOMMENDED BOOKS:

1. V .Krishnamurthy etal, Linear algebra
2. Herstein, I.N., Topics in Algebra, 2nd Edition. New Delhi: Wiley, 2006.
3. Singh, Surjeet, and Zameeruddin, Q., Modern Algebra, 7th Edition. New Delhi: Vikas Publishing House, 1993.
4. Artin, M., Algebra, 2nd Edition. Pearson Publications, 2010.
5. Hoffman and Kunze Linear Algebra, pearson
6. Serge Lang, Linear Algebra Third edition, Springer
7. Linear Algebra 4th edition, Schaum's series 2015

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Course Title: Real Analysis
Course Code: M102

Unit-I

Metric space , Sequence and Series of functions, Uniform convergence, Continuity, Integrability, Differentiability, Equicontinous functions,Weirstrass approximation theorem.

Unit-II

Measures and integration: Open sets, cantor like sets, Lebesgue outer measure, Measurable sets, regularity, Measurable functions, Borel and Lebesgue measurability, integration of non-negative functions, the general integral, Integration of series , Riemann and Lebesgue integrals

Unit-III

The four derivatives, Functions of bounded variation, Lebesgue differentiation theorem, Differentiation and integration, the Lebesgue set

Unit-IV

The L^P spaces, Convex functions, Jensen's inequality, The inequalities of Holder and Minkowski, Completeness of $L^P(\mu)$, convergence in measure, Almost uniform convergence, Convergence diagrams , Counter examples

Books recommended

1. W Rudin Principle of Mathematical Analysis, Chapter 2,7
2. G. De Barra Measure theory and Integration Willey Eastern Ltd.
3. Ricahrd R Goldberg, Methods of Real Analysis, Oxford and IBH 1970
4. Mathematical Analysis, Apstol, 2nd Ed Narosa Pub house 2002
5. S.C. Malik, Savita Arora, Mathematical Analysis, New Age International Publisher 2017

Course Title: Complex Analysis
Course Code: M103

UNIT-I

Function of complex variable, continuity and differentiability, Analytic functions, Cauchy Riemann equation (Cartesian and polar form). Harmonic functions, Harmonic conjugate, Construction of analytic functions. Exponential function, Trigonometric and inverse trigonometric functions, Logarithmic function, Complex powers, Branches of multivalued functions with reference to arg(z), log(z), z^c . Stereographic projection and the spherical representation of the extended complex plane.

Unit-II

Complex line integral, Cauchy_Goursat theorem, independence of path; Cauchy's integral formulas and their consequences, Cauchy inequality, Liouville's theorem, Fundamental theorem of algebra, Morera's theorem, Maximum modulus principle, Schwarz lemma, Poisson's integral formula.

Unit-III

Power series: circle of convergence, radius of convergence. Taylor's series and Taylor's theorem, Laurent'z series and Laurent theorem, Zeros and singularities of complex functions, classification of singularities: removable singularity, poles, essential singularities, Residue at a pole and at infinity, Cauchy's Residue theorem and its applications in evaluation of real integrals: integration around unit circle, integration over semi-circular contours (with and without real poles), integration around rectangular contours, Argument principle, Rouche's theorem

Unit-IV

Conformal transformations, Bilinear transformations, Critical points, Fixed points, Problems on crossratio and bilinear transformation.

RECOMMENDED BOOKS:

1. Ahlfors, L.V., Complex Analysis, 2nd Edition. McGraw-Hill International Student Edition, 1990.
2. Copson, E.T., An Introduction to the Theory of functions of a complex Variable. Oxford university press, 1995.
3. Zill, D.G. and Shanahan, P.D., A First Course in Complex Analysis with Applications, 2 nd Edition. New-Delhi: Jones and Bartlett.
4. Shastri , A.R., An Introduction to Complex Analysis. Macmillan India Ltd., 2003.
5. Ponnusamy, S. and Silverman, H., Complex Variables and Applications. Birhkäuser, 2006.
6. Churchill, R. and Brown, J.W., Complex Variables and Applications, 6 th Edition. New-York: McGraw-Hill, 1996.

Course Title: Ordinary Differential Equations and Special Functions
Course Code: M104

UNIT-I

Review of linear differential equations with constant & variable coefficients, Fundamental existence and uniqueness theorem for system and higher order equations (Picard's and Piano theorems), System of linear differential equations, an operator method for linear system with constant coefficients, Phase plane method.

UNIT-II

Homogeneous linear system with constant coefficients, Eigenvalues and eigen functions, orthogonality of eigen functions, Complex eigenvalues, repeated eigenvalues, Ordinary differential equations of the Sturm-Liouville problems, Expansion theorem, Extrema properties of the eigen values of linear differential operators, Formulation of the eigen value problem of a differential operator as a problem of integral equation, Linear homogeneous boundary value problems

UNIT-III

Power series solution of differential equations: about an ordinary point, solution about regular singular points, the method of Frobenius, Bessel equation and Bessel functions, Recurrence relations and orthogonal properties., Series expansion of Bessel Coefficients, Integral expression, Integral involving Bessel functions, Modified Bessel function, Ber and Bei functions, Asymptotic expansion of Bessel Functions, Legendre's differential equations, Legendre Polynomials , Rodrigue's formula, Recurrence relations and orthogonal properties.

UNIT-IV

The Hermite polynomials, Chebyshev's polynomial, Laugrre's polynomial: Recurrence relations, generating functions and orthogonal properties.

RECOMMENDED BOOKS:

1. Ross, S.L., Differential Equations, 3rd Edition. John Wiley & Sons, 2004.
2. Boyce, W.E. and Diprima, R.C., Elementary Differential Equations and Boundary Value problems, 4th Edition. John Wiley and Sons, 1986.
3. Sneddon, I.N., Special Functions of Mathematical Physics and Chemistry. Edinburg: Oliver & Boyd, 1956.
4. Andrews, G.E., Askey, R. and Roy, R. Special Functions. Cambridge Univ. Press, 1999.
5. Andrews, L., Special Functions for Engineers and Applied Scientists. Mcmillan, 1985.
6. Bell, W.W., Special Functions for Scientists and Engineers. Dover, 1986.

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Course Title: Mathematical Methods
Course Code: M105

UNIT-I

Integral Transforms: Laplace Transform, Properties of Laplace Transform, Inverse Laplace Transform, Convolution theorem, Laplace transform of periodic functions, unit step function and impulsive function, application of Laplace Transform in solving ordinary and partial differential equations and Simultaneous linear equations; Fourier transform, properties of Fourier transform, inversion formula, convolution, Parseval's equality, Fourier transform of generalized functions, application of Fourier transforms in solving heat, wave and Laplace equation. Fast Fourier transform.

UNIT II

Hankel Transforms and its applications in boundary value problems, z-transforms, relation of ztransform with Fourier transform, geometrical interpretation of z-transform, Region of convergence, inverse z-transform, Convolution, Deconvolution, solving difference equations by z-transforms, double z-transforms and modified z-transforms.

UNIT III

Integral Equations: Integral equations of Fredholm and Volterra type, solution by successive substitution and successive approximation, integral equations with degenerate kernels. Integral equations of convolution type and their solutions by Laplace transform, Fredholm's theorems, integral equations with symmetric kernel, Eigen values and Eigen functions of integral equations and their simple properties.

UNIT IV

Calculus of Variations: The extremum of functionals, variation of functional, Euler equation in one and several independent variables, sufficient conditions for the extremum of a functional, moving end problems, variation problems with constraints, problem of geodesics and isoperimetric, Rayleigh-Ritz method, Galerkin's method and Kantorovich method of solving differential equations.

RECOMMENDED BOOKS:

1. Sneddon, I.N., The Use of Integral Transforms. McGraw Hill, 1985.
2. Goldberg, R.R., Fourier Transforms. Cambridge University Press, 1970.
3. Smith, M.G., Laplace Transform Theory. Van Nostrand Inc., 2000.
4. Elsegolc, L., Calculus of Variation. Dover Publications, 2010.
5. Kenwal, R.P., Linear Integral Equation; Theory and Techniques. Academic Press, 1971.
6. Hildebrand, F.B., Methods of Applied Mathematics (Latest Reprint). Dover Publications.
7. Pal, S. and Bhunia, S.C., Engineering Mathematics. Oxford University Press, 2015.

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Course Title: Introduction to C Programming Language (Lab)
Course Code: M106

List of programs :

1. Program in C to find the sum and average of the given numbers using for loop, while loop, and do-while loop.
2. Program in C to sum the series $X^1+X^2+X^3+X^4+X^5+\ldots\ldots\ldots+X^n$.
3. Program in C to construct pyramid of digits.
4. Program in C to find average of n numbers using an array.
5. Program in C to print the sum of first 'n' even natural numbers.
6. Program in C to read a two-dimensional array and find the sum of the elements in the row-wise and column-wise separately and display the sums of the rows and columns.
7. Program in C to print the numbers and its cube from 1 to 10 using following control statements a) if-then-else b) for loop c) while loop d) do-while loop.
8. Program in C to read a two dimensional square matrix A and display its transpose.
9. Program in C that prints the factorial of given numbers using i) for loop ii) while loop iii) do…while loop.
10. Program to read data from the keyboard, write it to a file called INPUT, again read the same data from the INPUT file, and display it on the screen.
11. Program in C that print a given numbers whether it is prime or not using i) for loop ii) while loop iii) do…while loop.
12. Program in 'C' to read the students name and its average marks. If a student gets less than 40 then declare that he fails or else the passes. Prepare a computers list of give the list of names in alphabetical order separately for passed and failed students.
13. Program in C to display a name 27 times using the nested for loop.
14. Program to initialize the member of a structure and to display the contents of the structure on the screen.
15. Program in C to find the sum of given the two numbers using the global variable declaration.
16. A file named DATA contains a series of integer number. Code a program to read these numbers and then write all "odd" numbers to a file to be called ODD and all "even" numbers to a file to be called EVEN.
17. Program in C to display the number and its square from 0 to 10 using register variables.
18. Program to read a character from the keyboard and to display it on to the screen using the getchar ( ), getch ( ), putchar ( ) and putch ( ).
19. Program in C to fund the factorial of the given numbers using the recursive function.
20. Program in C to find Fibonacci sequence by recursion.
21. Program in C to find the sum of two nonnegative numbers recursively.
22. Program in C to find minimum and maximum of numbers using recursion.

23. Program in C to search for an element using binary search with recursion.
24. Program to declare a union as a pointer data type and display the contents of the union using pointer operator.
25. Program in C to find the sum of a given non-negative integers using a recursive function.
    a. Sum = 1 + 2 + 3 + 4 + …… n.
26. Program assigns some values to the members of a structure and to display a structure and to display the structure on the video screen using the structure tag.

27. Program in C to find the sum of given the two numbers using the global variable declaration.
28. Program to display the memory address of a variable using pointer before incrimination and after incrimination.
29. Program in C to find the largest and smallest element in a vector.
30. Program in C to find second largest and smallest element in a vector.
31. Program in C to delete duplicates in a vector.
32. Program in C to add two matrices.
33. Program in C to sort the elements of a vector in ascending order.
34. Program in C to insert an element into the vector.
35. Program in C to delete an element from the vector.
36. Program in C to find the smallest element in an array using pointers.
37. Program to read a character from the keyboard and to display it on to the screen using the getchar ( ), getch ( ), putchar ( ) and putch ( ).

Course Title: Advanced Abstrsct Algebra

Course Code-M201

UNIT-I

Normal Subgroups: Isomorphism theorems, Automorphisms, Permutation groups: Cyclic decomposition and alternating group A_n. Structure theorems for groups, Invariants of a finite abelian group, Sylow theorems

UNIT-II

Unique Factorization domains and Euclidean domains: Unique factorization domains, Principal ideal domains, Euclidean domains, Polynomial rings over UFD, Algebraic extension of fields: Irreducible polynomials and Eisentein criterion, Adjunction of roots, algebraic extensions, Algebraic closed fields, Normal and separable extensions: Splitting fields, Normal extensions, Multiple roots , Finite fields.

UNIT-III

Galois theory: Automorphism groups and fixed field (Only statement and no proof), Fundamental theorem of Galois theory, Application of Falois theory to classical problems: Roots of unity and cyclotomic polynomials, Cyclic extensions, Polynomials solvable by radicals.

UNIT-IV

Modules, Direct Sums, Free modules (cyclic modules), vector spaces, Quotient modules, Homomorphism, Simple modules, Semi simple modules, Schur's modules

RECOMMENDED BOOKS:

1. Bhattarchaya,S K Jain and S R Nagpaul Basic abstract algebra, Cambridge University press
2. C. Musili- Introduction to Rings and Modules

Course Title: Optimization Theory

Course Code-M202

UNIT- I

One dimensional Optimization**:** Introduction, function comparision methods , polynomial interpolation , iterative method.

UNIT-II

Gradient based optimization methods (I): Calculus of R^n ,method of steepest descent6, conjugate gradient method, The generalized gradient method,gradient projection method
Gradient based optimization methods (I I): Newton type methods (Newton's method , Marquardt's method),Quasi- Newton- methods.

UNIT-III

Linear programming: Convex analysis,simplex method , two phase simplex method, Duality, Dual Simplex method.

UNIT-IV

Constrained optimization methods :Lagrangr multipliers, Kuhn –Tucker conditions, Convex optimization ,Penalty function techniques, methods of multiplier, linear constrained Problems-cutting plane method

Text book:-

M.C.Joshi and K. Moudgalya, Optimization Theory and Practice, Narosa Publishing House, New Delhi,2004

2.J,A. Snyman, Pratical Mathematical Optimization ,Spinger Sciences,2005

UNIT

Course Title: Topology
Course Code-M203

Unit-I

Basis,Topological spaces, Basis and subbasis, The order topology, Subspace topology, Closed sets. Countability axioms, Limit points, Convergence of nets in topological spaces

Unit-II

Continuous functions, homomorphisms. The product topology, box topology, Metric topology, Quotient topology. Dense sets, subspace and product topology, separation axioms

Unit-III

Connectedness and compactness, Connected spaces, Connected sets in R, Components and path components, Compact spaces, Compactness in metric spaces, Local compactness, One point compactification.

Unit-IV

Separation axioms, Uryshon's lemma, Uryshon's metrization theorem, Tietz extension theorem. The Tychonoff theorem, Completely regular spaces, Stone -Czech compactification.

Text Books:

1. Munkres J.R. Topology, Pearson Education
2. Royden H. L. Real Analysis,Prentice Hall of India

Reference Books:

1. Armstrong M. A. Basic Topology, Springer
2. Kelley J.L. and Nostrand V. General Topology, Princeton
3. Simmons G.F. Introduction to Topology and Modern Analysis, McGraw-Hill

Course Title: Partial Differential Equations
Course Code: M204

UNIT-I

First Order Partial Differential Equations:- Basic definitions, Origin of PDEs, Classification, Geometrical interpretation. The Cauchy problem, the method of characteristics for Semi linear, quasi linear and Non-linear equations, complete integrals, Examples of equations to analytical dynamics, discontinuous solution and shockwaves

UNIT-II

Second Order Partial Differential Equations:- Definitions of Linear and Non-Linear equations, Linear Superposition principle, Classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, Reduction to canonical forms , solution of linear Homogeneous and non-homogeneous with constant coefficients, Variable coefficients, Monge's method.

UNIT-III

Laplace equation:- Solution by the method of separation of variables and transforms. Dirichlet's, Neumann's and Churchills problems, Dirichlet's problem for a rectangle, half plane and circle, Solution of Laplace equation in cylindrical and spherical polar coordinates

UNIT-IV

Diffusion equation:-Fundamental solution by the method of variables and integral transforms, Duhamel's principle, Solution of the equation in cylindrical and spherical polar coordinates. Solution of boundary value problems:- Green's function method for Hyperbolic, Parabolic and Elliptic equations

RECOMMENDED BOOKS:

1. I. N. SNEDDON, Elements of PDE's , McGraw Hill Book company Inc., 2006.
2. L DEBNATH , Nonlinear PDE's for Scientists and Engineers, Birkhauser , Boston, 2007.
3. F. John, Partial differential equations, Springer, 1971.

Course Title: Theory of probability and stochastic processes
Course Code: M205

UNIT-I

Random Variables: Discrete random Variables , Continuous random variables, Function of random variables,Joint Distributions: Discrete random VariableContinuous random variables, Independent Random Variables, Conditional Distribution, Function of jointly Distribured random Variables.

UNIT-II

ExpectedValues: Expected value of random variable, Variance and Standard devition, Covariance and Correlation, Conditional expectation, moment generating function, Limit Theorems,Law of large numbers,convergence in distribution,central limit theorem, Distribution derived from normal distribution: chi-square, t and F distributions,

UNIT-III

Sample mean and Variance, Estimation of parameter: Parameter estimation,Method of moments, The method of maximum likelihood, Efficiency and the Cramer Rao Lower bound ,Sufficiency, Factorization Theorem ,The Rao-Balckwell Theorem.

UNIT-IV

Testing Of Hypothesis: The Neyman- Pearson Paradigm ,Some Notation and Specification of Stochastic process, Stationary Process, Markov process with discrete state space, PoissonProcess, Properties of Poisson Process,,Poisson process & related Distribution.

RECOMMENDED BOOKS:

1. Mathematical stastistics And Data analysis: John A Rice , Cengage Learning
2. Stochastic Process by J. Medhi, Wiley Eastern.

Course Title: MATHEMATICAL METHODS PRACTICALS

Course Code: M206
(MATLAB/SCILAB)

1. Plotting of functions.
2. Matrix operations, vector and matrix manipulations, Matrix Computation and its applications.
3. Data analysis and curve fitting.
4. Solution of equations.
5. 2-D Graphics and 3-D Graphics - general purpose graphics functions, colour maps and colour controls.
6. Numerical integration
7. Nonlinear Equations and Optimization functions.
8. Differential equations.
9. Sparse Matrices - Iterative methods for sparse linear equations, Eigen values of sparse matrices, Game of life.
10. Linear Programming, Integer Programming and Quadratic Programming - Modelling and Simulation Techniques.

Course Title: Mechanics
Course Code: M301

UNIT-I

Mechanics of a Particle - Mechanics of a System of Particles - Constraints - D' Alembert's Principle and Lagrange's Equations - Velocity-Dependent Potentials and the Dissipation Function - Simple Applications of the Lagrangian Formulation.

UNIT-II

Hamilton's Principle - Some Techniques of the Calculus of Variations - Derivation of Lagrange's Equations from Hamilton's Pnnciple - Extension of Hamilton's Principle to Nonholonomic Systems .

UNIT-III

Reduction to the Equivalent One-Body Problem - The Equations of Motion and First Integrals – The Equivalent One-Dimensional Problem, and Classification of Orbits - The Virial Theorem - The Differential Equation for the Orbit, and Integrable Power-Law Potentials - Conditions for Closed Orbits (Bertrand's Theorem)

UNIT-IV

The Kepler Problem: Inverse-Square Law of Force - The Motion in Time in the Kepler Problem – The Laplace-Runge-Lenz Vector
Legendre Transformations and the Hamilton Equations of Motion - Cyclic Coordinates and Conservation Theorems - Derivation of Hamilton's Equations from a Variational Principle - The Principle of Least Action.

RECOMMENDED BOOKS:

1. F. Chorlton, Textbook of Dynamics, second edition, Ellis Horwood Series: Mathematics and itsApplications, Halsted Press (John Wiley & Sons, Inc.), New York, 1983.
2. D. T. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
3. John A. Synge and Byron A. Griffith, Principles of Mechanics, McGraw-Hill Book Company, INC,Second Edition, Newyork, 1949.

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Course Title: Numerical Analysis
Course Code: M302

UNIT-I

Numerical computation and Error analysis: Numbers and their accuracy, Floating point arithmetic, Errors in numbers, Error estimation, General error formulae, Error propagation in computation. Inverse problem of error analysis and Numerical instability. Algebraic and transcendental equations: Bisection method, Iteration method, Regula-Falsi method, Secant method, Newton-Raphson's method. Convergence of these methods. Lin-Bairstow's method, Muller's method, Graeffe's root squaring method, Solution of system of nonlinear equations, Complex roots by Newton-Raphson's method.

UNIT-II

System of linear algebraic equations: Gauss elimination method without pivoting and with pivoting, Gauss-Jordon method, LU-factorization method, Jacobi and Gauss-Seidal methods, Convergence of iteration methods, Round-off errors and refinement, ill-conditioning, Partitioning method, Inverse of matrices. Eigen values and eigen vectors: Rayleigh Power method, Given's method and Householder's method.

UNIT-III

Interpolation: Finite differences, Newton's interpolation formulae, Gauss, Stirling's and Bessel's formulae, Lagrange's, Hermite's and Newton's divided difference formulae. Numerical differentiation and integration: differentiation at tabulated and non-tabulated points, Maximum and minimum values of tabulated function, Newton-Cotes Formulae-Trapezoidal, Simpson's, Boole's and Weddle' rules of integration with errors, Romberg integration, Gaussian integration, Double integration by Trapezoidal and Simpson's rules.

UNIT-IV

Ordinary differential equations: Taylor series and Picard's methods, Euler's and modified Euler methods, Runge-Kutta methods, Predictor-Corrector methods: Adams-Bashforth's and Milne's methods. Error analysis and accuracy of these methods. Solution of simultaneous and higher order equations, Boundary value problems: Finite difference and Shooting methods.

RECOMMENDED BOOKS:

1. Rajaraman, V., Computer Oriented Numerical Analysis. Prentice-Hall of India Pvt. Ltd., 2002.
2. Sharma, J.N., Numerical Methods for Engineers and Scientists, 2nd Edition. Narosa Publ. HouseNew Delhi/Alpha Science International Ltd., Oxford UK, 2007.
3. Balagurusamy, E., Numerical Methods. New Delhi: Tata McGraw Hill, 1999.
4. Bradie, B., A Friendly Introduction to Numerical Analysis. Pearson Prentice Hall, 2006.
5. Atkinson, K.E., Introduction to Numerical Analysis, 2nd edition. John Wiley, 1989.
6. Conte, S.D. and Boor, C. De, Elementary Numerical Analysis: An Algorithmic Approach, 3rd edition. New York: McGraw Hill, 1980.
7. Scarborough, J.B., Numerical Mathematical Analysis. Oxford & IBH Publishing Co., 2001.

Course Title: Functional Analysis

Course Code: M-303

Unit I

Fundamentals of normed linear spaces: Normed linear spaces, Riesz lemma, characterization of finite dimensional spaces, Banach spaces. Bounded linear maps on a normed linear spaces: Examples, linear map on finite dimensional spaces, finite dimensional spaces are isomorphic, operator norm.

Unit II

Hahn-Banach theorems: Geometric and extension forms and their applications. Three main theorems on Banach spaces: Uniform boundedness principle, divergence of Fourier series, closed graph theorem, projection, open mapping theorem, comparable norms.

Unit III

Dual spaces and adjoint of an operator: Duals of classical spaces, weak and weak* convergence, Banach Alaoglu theorem, adjoint of an operator. Hilbert spaces : Inner product spaces, orthonormal set, Gram-Schmidt ortho-normalization, Bessel's inequality, Orthonormal basis, Separable Hilbert spaces. Projection and Riesz representation theorem: Orthonormal complements, orthogonal projections, projection theorem, Riesz representation theorem.

Unit IV

Bounded operators on Hilbert spaces: Adjoint, normal, unitary, self adjoint operators, compact operators, eigen values, eigen vectors, Banach algebras. Spectral theorem: Spectral theorem for compact self adjoint operators, statement of spectral theorem for bounded self adjoint operators.

Text Books:

1. Kreyzig E. *Introduction to Functional Analysis with Applications*, John Wiley & Sons
2. Conway J. B. *A Course in Functional Analysis*, Springer, Berlin

Reference Books:

1. Limaye B.V. *Functional Analysis*, New Age International
2. Taylor A. and Lay D. *Introduction to Functional Analysis*, Wiley
3. Rudin W. *Functional analysis*, McGraw-Hill
4. Goffman C. and Pedrick G. *A First Course in Functional Analysis*, Prentice-Hall

Course Title: Introduction to Statistical Methods

Course Code: M-304 (CBCS)

UNIT I

Idea of population and sample, measures of central tendency, mean, median, mode, partition values, measures of dispersion, moments, skeweness and krtosis

UNIT II

Bivariate distribution, regression lines, regression coefficients, correlation coefficient ,rank correlation, partial and multiple correlations, Regression plane

UNIT III

Basic concept of sampling distribution, large sample theory and small sample theory: point estimation of parameters, concepts of bias and standard errors of an estimate, standard errors of sample mean and sample proportion.

UNIT IV

Test of significance: Null and alternative hypotheses level of significance, Type –I error & Type-II error, Distributions and chi-square, t and F statistics, (without derivations) test of mean and variance of normal population

Text Books:

1.V.K. Kapoor and S.C. Gupta: Fundamental of Mathematical Statistics

Reference Books:

1.C.B. Gupta: Fundamental of Statistical Methods

2. A.M. Goon, M.K. Gupta and B. Dasgupta: Fundamentals of Statistics

Course Title: ELECTIVE –I (Numerical solution of Differential equation)

Course Code: M305

UNIT I

Problems for ODE: Multiple-step Methods, Variable Step Size Multistep Methods, Extrapilation Methods, Higher-order Equations and Systems of Differential equations, Stability, BV problems for ODE: Linear shooting Method, The shooting Method for Non-Linear problems, Finite Difference Methods for Linear Problems.

UNIT-II

Finite Difference Methoods for Parabolic equation in One-Space Variable (Explicit method and its convergence, Fourier Analysis of the error, Implicit and Weighted average methods and their convergence), Finite Difference Methoods for Hyperbolic equation in One Space dimension,Characteristics, The CFL condition, Fourier Error analysis of the upward Scheme, The Lax-wendroff Scheme and its Application to Conservation Laws

UNIT-III

Consistency, Convergance and Stability of Finite Difference Methods, Introduction to Finite Volume Method, Two Dimensional parabolic equations: Neumann boundary conditions, Convergence, Consistency, stability(stability of initial value Implicit schemes, Peaceman, Richford Scheme, Initial Value Problems, two- dimensional hyperbolic equations, Lax-wendroff scheme, Crack-Nocdson scheme, Stability analysis of two dimensional hyperbolic equation

UNIT-IV

Finite Element Method for elliptic model problems, finite element method for the model problem with piecewise linear functions, an error estimate for finite element method for model problem, finite element method for the Poisson equation.

Course Title: Elective –I (Number Theory and Cryptography)

Course Code: M305

UNIT-I

Congruences: linear and polynomial congruences; prime numbers: counting primes, numbers of special forms, pseudo-primes and primality testing

UNIT-II

Factorization: factorization algorithms; arithmetic functions: multiplicative and additive functions, Euler's phi function, sum and number of divisors functions, the Mobius function and other important arithmetic functions, Dirichlet products; primitive roots and quadratic residues: primitive roots, index arithmetic, quadratic residues, modular square roots

UNIT-III

Diophantine equations: linear Diophantine equations, Pythagorean triples, Fermat's last theorem, Tell's, Bachet's and Catalan's equations, sums of squares; Diophantine approximations: continued fractions, convergent, approximation theorems; quadratic fields: primes and unique factorization

UNIT-IV

History and overview of cryptography, one time pad and stream, Block ciphers, Block cipher abstractions, PRPs and PRFs, Message integrity, public key encryotion.

RECOMMENDED BOOKS:

1. Koshy, Elementary Number Theory with Applications, Academic Press
2. Burton D.M. Elementary Number Theory, McGraw Hill
3. Rosen K. H. Elementary Number Theory (and it’s applications, Pearson Addison- Wesley
4. Niven I., Zuckerman H.S . and Montgomery, H.L. An Introduction to the Theory of Numbers, Wiley

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Course Title:Elective-I (Operation Research)
Course Code: M305

UNIT-I

Formulation LPP, Solve the LPP by Graphical Method , Simplex Method ,BIG-M –Method ,Two Phase Simplex Method, Duality Theory, Dual Simplex Method , Sensitive Analysis, Branch and Bounded Cutting Plane method. Solve Integer Programming Problem by Simplex method.

UNIT-II

Revised Simplex method, Transportation Problem :Introduction , Solution of TP(North West Corner Rule, Least Cost Method ,Vogels Approximation Method)Test for optimality, Degeneracy in TP, Transportation Algorithm (MODI Method).

UNIT:-III

Assignment Problem, Hungarian Method ,The travelling salesman problem, Sequence Problem: introduction, processing of n Jobs Through two machine .Queing –Madel , General Characteristic , Markovian Queuing Model ,M/M/1 Model, Limited Queue Capacity, Queue Displine

UNIT -IV

Network Scheduling by PERT /CPM, Introduction, Network and basic Components, Logical sequencing, Rule of Network Construction, Critical path analysis. Nonlinear programming methods: Introduction ,binary search ,Fibonacci Search & Golden Search Method, Lagrangian multiplier Method.

RECOMMENDED BOOKS:

1. Kanti Swarup,P.K. Gupta & Manmohan, Operation Research, Sultan Chand & sons Publisher ,New Delhi
2. J.A. Suyman-Pratical Mathematical Optimization, Springer Science-2005.
3. S.D. Sharma, Operation Research . Kedar Nath & Ram Nath & Co.Publisher,Meerut


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Course Title: Numerical Analysis using C++ (Lab)
Course Code: ML306

List of programs :

1. Fixed Point iterative method
2. Newton-Raphson's method
3. Ramanujan's method
4. Gauss Elimination method
5. Gauss-Seidel iterative method
6. Thomas Algorithm
7. Lagrange Interpolation method
8. Cubic Spline Interpolation method
9. Rational function approximation of Pade Numerical integration over rectangular region
10. Gaussian Quadrature method
11. Gauss-Chebyshev method
12. Euler's Method and Modified Euler's Method
13. Runge-Kutta 2nd and 4th Order methods
14. Adam's Predictor-corrector method
15. Finite difference method for BVP (ODE)
16. Finite difference method Laplace/Poisson equations
17. Schmidt Method 8. Crank-Nicolson method
18. Shooting method for BVPs ODE.
19. Explicit Finite difference method for 1-d wave equation

RECOMMENDED BOOKS:

1. M.K. Jain: Numerical solution of differential equations, Wiley Eastern (1979), Second Edition.
2. C.F. Gerald and P.O. Wheatley : Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), Sixth Edition

Course Title: Discrete Mathematics

Course Code: M401

UNIT I

Fundamentals of logic, Logical interferences, Methods of proof of logical interferences, First order logic, Interference for quantified propositions, Order relations, Posets, Lattices, Enumerations,. Boolean algrbra, Boolean functions, Switching mechanisms, Canonical forms, Minterms, Minimization of Boolean functions,

UNIT II

Generating Function of Sequences , Recurrence Relations, Solving Recurrence Relation Substitution and Generating Function, The method of characteristic roots, solution of non homogeneous & homogeneous recurrence relations, Warshall's Algorithm , Partial Ordering.

UNIT III

Graphs: Basic concepts, Isomorphic graphd, Sub-Graphs, Trees and Properties, Spanning Trees, Directed trees and Binary trees,Planar graphs, Euler formula, Hasse diagrams, Path and closure, adjacency metrices, Multi graphs and Euler circuits, Hamiltonian graphs, Chromatic numbers, Network flows: Graphs as models of flow of commodities, flows, Maximal flows and minimal cuts, Max-flow Min-cut theorem.

UNIT IV

Modelling computation : Languages and Grammars, Finite State Machine with Output, NFA

RECOMMENDED BOOKS:

1. J.L. Mott, A. Kendel and T.P Baker Discrete mathematics for Computer Scientists and Mathematicians
2. C.L.LIU, Elements of Discrete Mathematics, Tata Mc Grow hill Publisher, New Delhi.
3. E.Rosen, Discrete Mathematics & its Application,Mc Grow Hill International.

Course Title: Mathematical Statistics

Course Code: M402

UNIT I

Confidence Intervals, shortest expected length confidence intervals, relations with testing of hypotheses, uniformly most accurate confidence intervals

UNIT-II

Quality control ,acceptance sampling, Marcov chains, :Basic concepts, applications of Neyman-Pearson Lemma for testing simple and composite hypotheses. Likelihood ratio tests for parameters of univariate normal distribution

UNIT-III

Distributions derived from normal distributions: chi-square , t and F distributions, sample mean and variance , survey sampling , population parameters, simple random sampling, estimation of ratio

UNIT –IV

Testing Hypothesis : The Neyman-Pearson paradigm, optimal test, The Neyman-Pearson lemma, The duality of Confidence Intervals and Hypothesis Tests, The generalized likelihood ratio tests, likelihood ratio for multinomial distribution, Test for Normality.

TEXT BOOK:

Mathematical Statistics and Data Analysis : John A Rice , Cengage Learning

Reference books

1. Hogg, R. V. and Craig, T. T. (1978). Introduction to Mathematical Statistics (Fourth Edition) (Collier- McMillan
2. C. R. Rao (1995). Linear Statistical Inference and Its Applications (Wiley Eastern) Second Edition
3. Rohatgi, V. K. (1988). Introduction to Probability Theory and Mathematical Statistics (Wiley Eastern)
4. Introduction to mathematical statistics sc Gupta,VK kapoor

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Course Title: Differential Geometry

Course Code: M403

UNIT I

Preliminary comments on Rn, Topological Manifolds, Differentiablity for Functions of several variables, Differentiablity of Mappings and Jacobians, The Space of Tangent Vectors at a point of Rn, Another definition of TA(Rn), Vector Fields on Open Subsets of Rn, The Inverse function theorem.

UNIT II

Definition of a Differential Manifold, Example of Differential Manifolds, Differentiable Functions and Mappings, The Tangent space at a point of a Manifold, Vector Fields, Tangent convectors on Manifolds, Covector Fields and Mappings, Bilinear forms, The Riemann metric, Riemann Manifolds as metric spaces, Tensors on a vector space.

UNIT III

Tensor Fields, mapping and Covariant Tensors, Symmetrising and Alternating Transformations, Multiplication of Tensor Fields, Exterior Multiplication of Alternating Tensor, Exterior Algebra on Manifolds, Exterior Differentiation.

UNIT IV

Differentiation of vector fields along curves in Rn, The Geometry of Space Curves, Differentiation of vector fields on Submanifolds of Rn, Formulas for Covariant, Derivatibes, Differentiation on Riemann Manifolds, The Curvature Tensor, The Riemann Connection and Exterior, Differential forms, Baisc properties of Riemann Curvature Tensor, The Curvature Forms and the equations of structure.

RECOMMENDED BOOKS:

1. William Boothby: An Introduction to Differential manifolds and Riemann Geometry, Academic Press , NewYork

Course Title: Elective – II (Computational Fluid Dynamics)

Course Code: M404

UNIT I

Fluid dynamics: The Governing Equations: Physical properties of Fluids equations of motion continuity equation, Momentum Equations inviscid Flow, , Momentum Equations viscous Flow, Energy equation , Dynamic similarity, Useful Simplifications Incompressible Inviscid flow Incompressible Boundary Layer Flow Turbulent Boundary Layer Flow, Boundary layer separation, Incompressible Viscous flow : laminar flow, Turbulent flow, Compressible flow

UNIT II

Inviscid Flow : Panel method ; Panel method for inviscid incompressible flow. Panel: Numerical implementation ;, Panel method for inviscid compressible flow, Supersonic inviscid flow, Predictor-corrector scheme, SHOCK :Propagating shock wave computation, Transonic inviscid flow, General considerations .

UNIT III

Boundary Layer flow: Simple Boundary Layer flow : implicit scheme, LAMBL: Laminar boundary layer flow , Keller box scheme, Complex Boundary Layer flow : Change of variables, Unsteady flow, staggered Grid, Mac formulation ,steady flow, artificial compressibility.

UNIT IV

Compressible viscous flow, Physical simplifications, Eddy viscosity Turbulence Modelling, Constant Total enthalpy flow, Thin layer approximations, Explicit schemes , explicity MacCormark scheme, Runge-kutta schemes, Implicit schemes, Implicit MacCormark scheme

RECOMMENDED BOOKS:

C . A. J Fltcher :Computational techniques for Fluid dynamics

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Course Title:Elective – II (Theory of Computation)
Course Code: M404

UNIT I

Introduction to Automata and computability theorem, mathematical preliminaries, Finite Automata and Non-determinism.

UNIT II

Regular expressions, Pumping lemma for regular languages, applications for regular language

UNIT III

Turing machine, variants of Turing machine

UNIT IV

Context-free Grammars, Parse trees, ambiguity in grammar and languages, pushdown automation, the language of PDA, Equivalence of PDAs and CFSs, determinestic pushdown automata, Change key normal form,

RECOMMENDED BOOKS:

1. Michael Sipser
2. J E. Hoperoft, R MOtwani J.D. Uliman- Introduction to Automata computation 2nd edition Pearson Education 2001

Course Title: Elective –II (Computational Finance)

Course Code: M404

UNIT I

Basic Concepts of Financial derivatives (forwards and futures, stock options, speculation, hedging), Putcall parity, Principle of non-arbitrage pricing, Black-scholes Option pricing formula and the 'Greeks', Implied Volatility Hedging strategies, American option pricing modele.

UNIT II

Stochastic Processes, Marcov Processes, Random walks, Arithmetic Brownian motion, Geometric Brownian motion, Martingles, Stochastic integrals, Ito integral, Ito's lemma, Mean-reverting processes, Derivation of Black-sholes Differential equation, Kolmogorov equations.

UNIT III

Finite difference methods for partial differential equations-finite difference approximation to derivatives, Local truncation error, Convergence, Consistency and stability, Explicit implicit and ADI schemes for parabolic equations, Finite difference methods for elliptic equations, Solution of sparse system of linear equations.

UNIT IV

Numerical schemes for pricing options, Bionomial pricing models and extensions, Explicit and Implicit Finite Difference methods for Europian and American options, Monte Carlo stimulation.

RECOMMENDED BOOKS:

1. J. Bax and G Chacko-Financial Derivatibes: Pricing, Applications and Mathematics-Cambridge Univ. Press,2004.
2. Steven Sgreve

Course Title: Project Work (Thesis/Report, Seminar, Presentation, Viva-Voce)

Course Code: MPL405

The fourth semester students are to write reports to present before a committee of professional experts and explain the content of the report as seminar talk after getting the remark and comments from the professional experts the students has to write the final report dissertation to be submitted to Mathematics department of FM University.

The content of report may be topics either from the subjects not taught during the four years of teaching lectures or the application of the subjects, methods learned by the student.

The report content and dissertation cover pages will be formatted by the FM University Mathematics department faculty who serves as mentor to the course.

The submission of the dissertation last date is the after last day of theory examination.


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