S.K.C.G. (AUTONOMOUS) COLLEGE

PARALAKHEMUNDI,GAJAPATI-761200

COURSES OF STUDIES

Choice Based Credit System (CBCS)

P.G.- MATHEMATICS

FOR P.G. PART-1 ADMISSION: 2020-21 AND ONWARDS

DISTRIBUTION OF MARKS

End Semester Examination

Full Marks:80

SECTION-A 08 Short Answer Questions (SAQ) (50 words) out of 12 Questions covering the entire Syllabus.	08x02 = 16 marks
SECTION-B 04 Short Answer Questions (SAQ) (100 words) each Question with one alternative set unit wise.	04x04 = 16 marks
SECTION-C* 04 Long Answer Questions (LAQ) (500 words) each Question with one alternative set unit wise.	04x12 = 48 marks
	Total → 80 marks

SECTION – C*

Q.No.1- **Unit-I**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks
Q.No.2- **Unit-II**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks
Q.No.3- **Unit-III**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks
Q.No.4- **Unit-IV**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks

COURE STRUCTURE

PAPER	TOPIC	Marks
	SEMESTER-I	
	Core Course (CC)	
MAT-101	Differential Equations	100(80+20)
MAT-102	Real Analysis	100(80+20)
MAT-103	Linear Algebra	100(80+20)
MAT-104	Complex Analysis	100(80+20)
MAT-105	Numerical Analysis	100(80+20)
	SEMESTER-II	
	Core Course (CC)	
MAT-206	Measure Theory	100(80+20)
MAT-207	Topology	100(80+20)
MAT-208	Abstract Algebra	100(80+20)
MAT-209	Probability Theory	100(80+20)
MAT-210	Mathematical Software (Practical)	100(50+30+20)
	SEMESTER-III	
	Core Course (CC)	
MAT-311	Functional Analysis-I	100(80+20)
MAT-312	Mathematical Statistics	100(80+20)
MAT-313	Number Theory	100(80+20)
	Core Elective (CE)	
	(*A student is allowed to opt any two papers.)*	
MAT-314	Calculus of Variations and Integral Equations	100(80+20)
MAT-315	Commutative Algebra	100(80+20)
MAT-316	Fuzzy Sets and Its Applications	100(80+20)
MAT-317	Fourier Analysis	100(80+20)
MAT-318	Fluid Dynamics-I	100(80+20)

Semester-IV

Core Course (CC)

MAT-419	Graph Theory	100(80+20)
MAT-420	Functional Analysis-II	100(80+20)
MAT-421	Dissertation, Seminar Presentation and Viva (Topic will be selected as per the direction of the Supervisor)	100(50+30+20)

Core Elective (CE)

(*A student is allowed to opt any two papers.)*

MAT-422	Discrete Mathematics	100(80+20)
MAT-423	Operations Research	100(80+20)
MAT-424	Cryptography	100(80+20)
MAT-425	Operator Theory	100(80+20)
MAT-426	Fluid Dynamics-II	100(80+20)

80 Credits (04 credits each)

CC - Core Course - 1600 (Mandatory with no choice)

CE - Core Elective - 400 (Mandatory with choice departmentally)

PG DEPARTMENT OF MATHEMATICS

The PG-Mathematics course shall comprise of four Semesters each consisting of five (Theory, Practical and Dissertation) papers. In Sem-I and Sem-II, five papers(CC) are mandatory whereas in Sem-III and Sem-IV, three papers(CC) are mandatory and two papers (CE) can be chosen from the given five papers. Each theory paper carries 100 marks out of which 80 marks for End-Semester Examination and 20 marks for Mid-Semester/Internal Assessment/Seminar/Project/Home Assignment etc. The duration of End-Semester Examination for each theory paper shall be Three Hours and Practical paper shall be Three Hours. In Sem-IV, for paper MAT-21, the students are advised to consult the supervisors for deciding the topic of the Dissertation.

COURSES OF STUDIES

SEMESTER-I

PAPER- MAT-101

DIFFERENTIAL EQUATIONS

Unit-I	The Sturm Separation Theorem ,The Sturm Comparison Theorem, Linear Systems, Homogeneous Linear Systems with Constant Coefficients.
Unit-II	Legendre Polynomials – Properties of Legendre Polynomials – Bessel Functions-The Gamma Function - Properties of Bessel Function
Unit-III	The Cauchy Problem, Homogeneous Wave Equations, Initial Boundary-Value Problems, Equations with Non-homogeneous Boundary Conditions, Separation of Variables, The Vibrating String Problem, The Heat Conduction Problem, The Laplace and Beam Equations.
Unit-IV	Boundary-Value Problems, Maximum and Minimum Principles, Uniqueness and Continuity Theorems, Dirichlet Problem for a Circle, Dirichlet Problem for a Circular Annulus, Neumann Problem for a Circle, Dirichlet Problem for a Rectangle ,The Neumann Problem for a Rectangle.

TEXT BOOKS:

1. Simmons: Differential Equations with Applications and Historical Notes, McGraw Hill Book Company,1991, 2nd Edition
   Sections: 24,25,55,56,44-47.
2. Linear Partial Differential Equations for Scientists and Engineers. TynMyint-U & Lokenath Debnath (Birkhauser Pub.), 4th Edition.

   Chapters: 5(5.1,5.3,5.4,5.5), 7(7.2,7.3,7.5,7.7),9(9.1-9.7,9.9).

REFERENCE BOOKS:

1. Partial Differential Equations of Mathematical Physics : Tynmyint-U (Elsevier)
2. Elements of Partial Differential Equations : Ian N. Sneddon

.

PAPER- MAT-102

REAL ANALYSIS

Unit-I	Metric Spaces - Compact Sets - Connected sets - Convergent Sequence - Subsequences - Cauchy Sequences - Upper and lower limits.
Unit-II	Limits of Functions - Continuous Functions - Continuity and Compactness - Continuity and Connectedness - discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity.
Unit- III	Sequences and series of functions, Weierstrass M-test, uniform convergence and its relation to continuity, Differentiation and Integration, Equicontinuity.
Unit- IV	Functions of Several Variables - Linear Transformation - Differentiation - The Contraction Principle.

TEXT BOOK:

Walter Rudin - Principles of Mathematical Analysis, Indian Edition, Third Edition.

Chapters: 2(2.15-2.38,2.45-2.47),3(3.1 to 3.19),4(4.1-4.34),7(7.1-7.25),9(9.1 to 9.23)

REFERENCE BOOKS:

1. An Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert
2. Methods of Real Analysis by Richard R. Goldberg
3. Fundamentals of Mathematical Analysis by G. Das and S. Pattanayak
4. Mathematical Analysis by S.C. Malik and Savita Arora
5. Understanding Analysis by Stephen Abbott
6. Mathematical Analysis by Tom M. Apostol

PAPER-MAT-103

LINEAR ALGEBRA

Unit-I	Dual Spaces, Inner Product Spaces, Modules
Unit-II	The Algebra of Linear Transformation, Characteristic Roots, Matrices.
Unit-III	Canonical Forms: Triangular Form, Nilpotent Transformations, Jordan Form.
Unit-IV	Trace and Transpose, Determinants, Hermitian, Unitary and normal Transformations, Real Quadratic Forms.

TEXT BOOK:

1. I.N. Herstein : Topics in Algebra, John Wiley and Sons, (2nd Edn.,) 2002.

Chapters : 4(4.3 - 4.5), 6(6.1 - 6.6 , 6.8-6.11)

REFERENCE BOOKS:

1. S.Singh and Q. Zameeruddin, ModernAlgebra,Vikas Publishing House,1590.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press,1995.
3. Linear Algebra - Kenneth Hoffman and Ray Kunze
4. Linear Algebra - Promode Kumar Saikia

PAPER-MAT-104

COMPLEX ANALYSIS

Unit-I	Topology of Complex plane, Sequences and Series. Functions, Bounded function, Concepts of Limit and Continuity, Riemann Sphere and Stereographic Projection, Differentiability, Holomorphic functions, Cauchy-Riemann equations and its polar form, Power series as an Analytic Functions.
Unit-II	Complex Integration- Curves in the Complex Plane, Complex line Integral, Cauchy-Goursat theorem, Morera's theorem, Cauchy's integral formula, Gauss Mean Value Theorem, Cauchy's integral formula for Derivatives, Cauchy's inequality. Zeros of Analytic Functions, Identity/Uniqueness Theorem.
Unit-III	Principles of Conformal Mapping, Basic Properties of Mobius Map, The Cross Ratio and its Invariance Property, Maximum Modulus Theorem, Minimum Modulus Theorem, Hadamard's three Lines Theorem, Hadamard's Three circles Theorem, Schwartz's Lemma , Liouville's Theorem, Fundamental Theorem of Algebra, Zeros of certain Polynomials. Classifications of Singularity- Isolated and non-isolated Singularities, Removable Singularities, Poles.
Unit- IV	Isolated Singularities at infinity ,Meromorphic Functions, Residue at a finite Point, Residue at the point of Infinity, Cauchy's Residue Theorem, Number of Zeros and Poles, Argument Principle, Rouche's Theorem. Infinite Sums and Meromorphic Functions –Mitage-Leffler's Theorem, Infinite Product of Complex Numbers.

TEXT BOOK:

Foundation of Complex Analysis - S.Ponnusamy Narosa Publishing House, 2nd Edition.

Chapters: *1(1.5 , 1.6(up to Example-1.40)), 2(2.1,2.2(up to Example-2.16),2.3(up to Remark-2.33)), 3(3.1(up to Theorem-3.17),3.2(3.44),3.3), 4(4.1,4.2(up to Example-4.6),4.3(Theorem-4.28),4.7(up to Example-4.83),4.8,4.11),5(5.1 ,5.2(up to Proposition-5.19)), 6 (6.1(up to Theorem-6.14),6.2(Theorem-6.21 & Theorem-6.23),6.3(Theorem-6.25),6.4(except Theorem-6.60) ,6.6,6.7),7(7.1,7.2,7.3,7.5,7.6),8(8.1-8.5),11(11.1,11.2).*

REFERENCE BOOKS:

1. Complex Variables and Applications - James Ward Brown and Ruel Churchill
2. John B. Conway: Functions of One Complex Variable, Second edition, 1980
3. Complex Analysis - Lars Ahlfors
4. R.P. Boas: Invitation to Complex Analysis, The Random House, 1987
5. B.C Palka: An Introduction to the complex Function Theory, Springer, 1991

PAPER-MAT-105

NUMERICAL ANALYSIS

Unit-I	Nonlinear Equations in One Variable: Fixed point iterative method – convergence Criterion -Aitken‘s Δ2- process - Sturm sequence method to identify the number of real roots – Newton - Raphson‘s methods convergence criterion Ramanujan‘s Method - Bairstow‘s Method
Unit-II	Linear and Nonlinear system of Equations: Gauss Eliminations with Pivotal Strategy Jacobi and Gauss Seidel Iterative Methods with convergence criterion. LU - decomposition methods – (Crout‘s, Choleky and DeLittle methods)– consistency and ill conditioned system of equations - Tri-diagonal system of equations –Thomas Algorithm. Iterative methods for Nonlinear system of equations, Newton Raphson, Quasi Newton and Over Relaxation methods for Nonlinear system of Equations.
Unit-III	Interpolation: Lagrange, Hermite, Cubic-spline‘s (Natural, Not a Knot and Clamped)- with uniqueness anderror term, for polynomial interpolation. Bivariate interpolation. Orthogonal polynomials Grams Schmidt Orthogonalization procedure and least square, Chebyshev and Rational function approximation. Numerical Integration: Gaussian quadrature method, Gauss-Legendre method and formula, Gauss-Chebeshev method and formula, Gauss Legure method, Gauss Hermite method .
Unit-IV	Numerical solution of ordinary differential equations:Initial value problems-Picard‘s and Taylor series methods – Euler‘s Method- Higher orderTaylor methods - Modified Euler‘s method – Runge- Kutta methods of second and fourth order – Multistep method - The Adams - Moulton method - stability - (Convergence and Truncationerror for the above methods).

TEXT BOOKS:

1. M. K. Jain, S. R. K. Iyengar and R.K. Jain: Numerical methods for scientific and engineering computation, New Age International PublishersSixth Edition
2. C.F. Gerald and P.O. Wheatley: Applied Numerical Methods, Low- priced edition, Pearson Education Asia, Sixth Edition, 2002
3. M.K. Jain: Numerical solution of differential equations,: Wiley Eastern, Second Edition, 1979

REFERENCE BOOKS:

1. S.C. Chapra and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi, 2000
2. S.S. Sastry: Introductory methods of Numerical analysis, Prentice - Hall of India, New Delhi, 1998

SECOND SEMESTER

PAPER-MAT-206

MEASURE THEORY

Unit-I	Open sets, Closed sets and Borel sets of Real numbers, Heine-Borel Theorem, Sigma Algebra, Nested set theorem, Lebesgue outer measure, Lebesgue measurable sets, Sigma Algebra of Lebesgue measurable sets.
Unit-II	Outer and Inner approximation of Lebesgue measurable sets, Countable additivity, Continuity, Borel-Cantelli Lemma, Non-measurable sets, Cantor set ,Cantor-Lebesgue function.
Unit-III	Lebesgue Measurable Function – sums, products and compositions. Sequential pointwise limits and Simple approximation , Littlewood's three principles , Egoroff's theorem, Lusin's theorem.
Unit-IV	Riemann integral, Lebesgue integral of a bounded measurable function over a set of finite measure, Bounded Convergence Theorem, Fatou's Lemma, Monotone Convergence Theorem ,General Lebesgue integral, Lebesgue Dominated Convergence Theorem.

TEXT BOOK:

H.L. Royden, P.M. Fitzpatrick - Real Analysis , PHI Learnig Pvt. Ltd., Fourth Edition.

Chapters-1(1.4), 2 , 3, 4(4.1-4.4).

REFERENCE BOOKS:

1. H.L. Royden, Real Analysis, Macmillan Publishing Company, 1988
2. Walter Rudin, Real and Complex Analysis, McGraw Hill Publishing Co. Ltd NewDelhi.10th Reprint, 1986 .
3.P.R. Halmos, Measure Theory, D. Van Nostrand Company, Inc. Princeton, N.J., 1950

PAPER-MAT-207

TOPOLOGY

Unit-I	Topological spaces – Discrete And Indiscrete Topology, Co-finite Topology , Co-countable Topology, Basis for a Topology- Lower Limit Topology, Standard Limit Topology, K-Topology, Sub-basis, Order Topology, Product Topology on X×Y, Subspace Topology.
Unit-II	Closed Sets and Limit Points- Closure and Interior of a Set, Neighborhood, Limit Points, Housdorff Space, Continuous Functions- Homeomorphisms, Rules for Constructing Continuous functions, Pesting Lemma, The Product Topology- Comparison of Box and Product Topologies.
Unit- III	Metric Topology Connectedness - Connected Space, Connected Subspaces of the Real Line, Intermediate Value Theorem, Path Connected Space. Compactness – Compact Space, Finite Intersection Property, Compact Subspaces of Real Line- Extreme Value Theorem, Lebesgue Number Lemma, Uniform Continuity Theorem, Tychonoff's Theorem
Unit- IV	Countability Axioms- First Countable Axiom, Second Countable Axiom, Lindelof Space. Separation Axioms- Regular Space, Completely Regular Space, Normal Space, Housdorff Space, Normal Space, Compact Housdorff Space, Metrizable Space, Urysohn's Lemma.

TEXT BOOK:

J.R.Munkres, Toplogy, PHI Learnig Pvt. Ltd., Second Edition.

Chapters: 2 (12 - 20), 3 (23, 24,26,27), 4 (30 - 33).

REFERENCE BOOKS:

1. G.F.Simmons , ―An Introduction to Topology and Modern Analysis,¦ McGraw-Hill Kogakusha, Tokyo, 1963
2. Introduction to general topology by K D Joshi
3. General Topology by Seymour Lipschutz

PAPER-MAT-208

ABSTRACT ALGEBRA

Unit-I	Automorphisms, Cayley's Theorem, Permutation Groups, Another Counting Principle.
Unit-II	Sylow's Theorems. More Ideals and Quotient Rings, The Field of Quotients of an Integral Domain. Euclidean Rings. A Particular Euclidean Ring.
Unit-III	Polynomial Rings, Polynomial Rings over the Rational Field, Polynomial Rings over commutative Rings, Extension Fields, Roots of Polynomials, More about Roots.
Unit- IV	The Elements of Galois Theory, Finite Fields.

TEXT BOOK:

I.N. Herstein : Topics in Algebra, John Wiley and Sons, (2nd Edn.,) 2002.
Chapters : 2(2.8 to 2.l2), 3(3.5 to 3.11), 5(5.1,5.3,5.5,5.6),7(7.1).

REFERENCE BOOKS:

1. Abstract Algebra - David S. Dummit and Richard M. Foote
2. Contemporary Abstract Algebra - Joseph A. Gallian
3. S.Singh and Q. Zameeruddin - ModernAlgebra,Vikas Publishing House,1590.
4. P. B .Bhattacharya. S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Cambridge University Press,1995

PAPER- MAT- 209

PROBABILITY THEORY

Unit-I	Algebra of sets - fields and sigma-fields, Inverse function – Measurable function –Probability measure on a sigma field – simple properties - Probability space – Randomvariables and Random vectors – Induced Probability space – Distribution functions –Decomposition of distribution functions, Expectation and moments – definitions and simple properties.
Unit-II	Moment inequalities –Holder, Jenson, Chebyshev, Markov Inequalities– Characteristic function – definition andproperties – Inversion formula Convergence of a sequence of random variables - convergence in distribution, convergence inprobability, almost sure convergence and convergence in quadratic mean– Weakconvergence of distribution functions.
Unit- III	Slustky theorem - Helly-Bray theorem, Definition of product space – Fubini's theorem (statement only) - Independence of twoevents, Independence of classes – Independence of random variables – properties – Borel zero –one law.
Unit- IV	Law of large numbers - Khintchin's weak law of large numbers, Kolmogorov strong law oflarge numbers (statement only) – Central Limit Theorem – Lindeberg – Levy theorem,Linderberg – Feller theorem (statement only), Liapounov theorem – Relation betweenLiapounov and Linderberg – Feller forms – Radon Nikodym theorem and derivative (withoutproof) – Conditional expectation – definition and simple properties.

TEXT BOOKS:

1. Bhat, B. R. (2007): Modern Probability Theory, 3rd edition, New Age International Pvt. Ltd.
2. Ash, R.B. (1972): Real Analysis and Probability, Academic Press.
3. Rohatgi, V.K. and Saleh (2002): An Introduction to Probability Theory and Mathematical Statistics, John Wiley

REFERENCE BOOKS:

1. Athreya K B and Lahiri S N (2005):Measure Theory, Hindustan Book Agency.
2. Tucker, H.G. (1967): A Graduate course in Probability, Academic Press.
3. Burill, C.W. (1972): Measure, Integration and Probability, McGraw Hill.
4. Chow, Y.S. and Teicher, H. (1979): Probability Theory, Springer.
5. Loeve, M. (1985). Probability Theory, 3rd edition, Springer..
6. Resnick S.I. (2001): A Probability Path, Birkauser.
7. Basu A K. and A Bandopadhyay (2012): Measure Theory and Probability, PHI Learning Pvt. Ltd.

PAPER-MAT-210

MATHEMATICAL SOFTWARE

Unit-I	LaTeX introduction- Installation – Math symbols and tables – TeX symbol and tables – Matrix and lists – Typing Math and text – Text environments.
Unit-II	Document structure – Latex Documents – The AMS articles document class – Beamer Presentation and PDF documents – Long Documents – BibTeX – Make index – Books in LaTeX colors and Graphics – TeXCAD – LaTeX CAD.
Unit-III	Starting with MATLAB- Variables Vectors, Matrices – Creating Array in MATLAB – Menu, Workspace, working Directory, Command window, Diary, Printing- Built-in function, User defined functions, Script M-files- Complex Arithmetic, Eigen values and Eigen vectors – Two and three dimensional Plots.
Unit-IV	Getting around with maple – Maple input and output - Programming in Maple. Maple: Abstract Algebra – Linear algebra – Calculus on Numbers – Variables- Complex Arithmetic, Eigen values and Eigen vectors – Two and three dimensional Plots.

NOTE:

Experiment	60 Marks
Record	20 Marks
Viva Voce	20 Marks

TEXT BOOKS:

1. G. Gratzer: More Math Into LATEX, 4th edition, Springer,2007
2. AMOS Gila: MATLAB an introduction with application, WILEY India Edition,2009
3. BrainRHunt,RonaldLLipsman:AGuidetoMATLABforbeginnersandExperiencedusers,
4. Cambridge University Press,2003
5. Ander Hec: Introduction in Maple, Springer,2007

THIRD SEMESTER

PAPER-MAT-311

FUNCTIONAL ANALYSIS-I

Unit-I	Normed spaces, Continuity of linear maps.
Unit-II	Hahn-Banach Theorems, Banach spaces.
Unit- III	Uniform Boundedness Principle, Closed Graph Theorem , Open Mapping Theorems.
Unit-IV	Spectrum of a Bounded operator, Duals and Transposes.

TEXT BOOK:

Functional Analysis —B. V. Limaye (New Age— International Limited, Publishers, Third Edition)

Chapter -II (5, 6, 7(Except Banach Limits) ,8) Chapter -III (9(Except Divergence of Fourier series of continuous Functions, Quadrature Formulae, Matrix Transformations and Summability Methods) ,10, 12 (up to theorem 12.6)), Chapter IV (13 (up to Theorem 13.7)).

REFERENCE BOOKS:

1. Functional Analysis - A First Course by M.Thamban Nair
2. Functional Analysis - A First Course by S.Kumaresan and D.Sukumar
3. Introductory Functional Analysis with Applications – Erwin Kreyszig

PAPER- MAT-312

MATHEMATICAL STATISTICS

Unit-I	Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data.Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart. Measures of central tendency,dispersion (including box and whisker plot), skewness and kurtosis. Data on twoattributes, independence and association of attributes in 2x2 tables. Linear regression andcorrelation (Karl Pearson's and Spearman's) and residual plots
Unit-II	Normal, Chi-square, t and F distributions and their relations. Population, random sample,parameter, statistic and sampling distribution. Sample mean and sample varianceassociated with a random sample from a normal distribution: their independence,sampling distributions, expectations and standard errors. Fitting of Binomial, Poisson andNormal distribution.
Unit- III	Statistical hypotheses, Type I and II errors, level of significance, test of significance,concept of p-value. Tests of significance for the parameters of normal distribution (onesample and two sample problems) and the relevant confidence intervals. Chi-square testof goodness of fit and independence of attributes. Test of significance for correlationcoefficient ($\rho = 0$, $\rho = \rho 0$) (one and two sample problem), Non-parametric location tests: One sample problem: Sign test, signed rank test, Kolmogrov-Smirnov test, Test of independence (Run test).
Unit- IV	Two sample problem: Wilcoxon-Mann-Whitney test, Median test, Kolmogorov-Smirnov test. Analysis of Variance and Covariance.

TEXT BOOKS:

1. A. M. Goon, M. K. Gupta and B. Dasgupta, Fundamentals of Statistics, Vol I and II, World Press, 2005.
2. W. W. Daniel and C. L. Cross, Biostatistics: A Foundation for Analysis in the Health Sciences, 10th Edition, Wiley & Sons, 2013.

REFERENCE BOOKS:

1. J. D. Gibbons, Non-parametric Statistical Inference, McGraw-Hill Inc, 1971.
2. R. V. Hogg, J. McKean and A. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012

PAPER-MAT-313

NUMBER THEORY

Unit-I	Divisibility Theory in the Integers – The Division Algorithm, the Greatest Common Divisor, Euclid Lemma, The Euclidean Algorithm, The Diophantine Equation: ax+by = c.
Unit-II	Primes and their Distributions- Fundamental Theorem of Arithmetic, Pythagoras Theorem, The Sieve of Eratosthenes, The Goldbach Conjecture, Dirichlet Theorem. Theory of Congruence's- Basic Properties of Congruence, Binary and Decimal Representation of Integers, Linear Congruence's and Chinese Remainder Theorem.
Unit- III	Fermat's Theorem, Wilson's Theorem, Number-Theoretic Functions- Sum and Number of Divisors, The Mobius Inversion Formula, The Greatest Integer Function, An Application to Calendar, Euler's Phi Function, Euler's Theorem, Some Properties of Phi Function. Primitive and Indices- The Order of an Integer modulo n, Primitive Roots for Prime, The Theory of Indices.
Unit- IV	The Quadratic Reciprocity Law- Euler's Criterion, The Legendre Symbol and Its Properties, Gauss Lemma, Quadratic Reciprocity Law. Numbers of Special Form- Perfect Numbers, Mersenne Prime and Amicable Numbers, Fermat Numbers. Certain Nonlinear Diophantine Equations: x^2+y^2=z^2, Fermat's Last Theorem.

TEXT BOOK:

David M Burton, Elementary Number Theory (McGraw Hill Education, 7thEdition (Indian Edition))
Chapters: 2(2.2 to 2.5), 3, 4(4.2 to 4.4), 5(5.2, 5.3), 6 (6.1 to 6.4), 7(7.2 to 7.4), 8(8.1, 8.2, 8.4), 9(9.1, 9.2 9.3), 11(11.2, 11.3, 11.4), 12(12.1, 12.2)

REFERENCE BOOKS:

1. T.M. Apostol, An Introduction to Analytical Number Theory (Springer International Student's Edition)
2. Ivan Niven and S.Zuckerman, An Introduction to the Theory of Numbers, John Wiley, New York, 2000

PAPER-MAT-314

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Unit-I	Variational Problems with Fixed Boundaries
Unit-II	Variational Problems with moving boundaries Sufficient condition for an extremum
Unit- III	Classification of Integral Equation and Equation of Convolution type
Unit-IV	Method of successive approximations

TEXT BOOKS:

1. Calculus of Variation with Application- A. S.Gupta.

   Chapters: 1(1.1-1.8), 2(2.1-2.3), 3(3.1-3.4)
2. Integral Equation- B. L. Moiseiwitsch, Dover Publication

   Chapters: 1(1.1-1.6), 3(3.1-3.6), 4(4.1, 4.2)

PAPER- MAT-315

COMMUTATIVE ALGEBRA

Unit-I	Rings and Ideals: Rings and Ring Homomorphisms, Ideals. Quotient rings, Zero-divisors, Nilpotent elements, Units, Prime ideals and maximal ideals, Nilradical and Jacobson radical.
Unit-II	Operations on ideals, Extension and contraction ,Modules and module homomorphism, Sub modules and quotient modules, Operations on sub modules, Direct sum and product, Finitely generated modules.
Unit- III	Exact sequences, Tensor product of modules, Restriction and extension of scalars. Exactness properties of the tensor product.
Unit- IV	Noetherian Rings, Artin Rings.

TEXT BOOK:

Introduction to Commutative Algebra - M. F. Atiyah and I.G. MacDonald

Chapters: 1, 2(expect Algebra,Tensor product of algebra), 7(expect Primary Decomposition in Noetherian Rings), 8.

REFERENCE BOOK:

N.S. Gopalakrishnan-Commutative Algebra.

PAPER- MAT-316

FUZZY SETS AND ITS APPLICATIONS

Unit-I	Crisp Sets Basic Definitions - Operations on crisp sets – Properties of crisp set – Crisp relations-Operations on crisp relations – Properties of Crisp relations – Composition of Crisp relations – Characteristic Function-Exercises
Unit-II	Fuzzy Sets Definition of Fuzzy sets - examples - Fuzzy Numbers- Characteristics of a Fuzzy Set-Basic Operations on fuzzy Sets- Properties of Fuzzy Sets- Membership functions-Algebraic Product and Sum of Fuzzy Sets – Power and Related Operations on Fuzzy Sets – The Extension Principle- Exercise
Unit-II	Fuzzy Relations Definition of Fuzzy Relation – Basic Operations on Fuzzy Relations – Direct Product – Projections of a Fuzzy Relation – Max-Min and Min-Max Compositions – Fuzzy Relations and Approximate Reasoning – Exercise-Fuzzy Relational Equation-Problem Partitioning – Solution method – Use of Neural Network in Fuzzy Relation
Unit-IV	Fuzzy control systems Introduction – Fuzzy Control Structure - Modeling and Control Parameters – If….and….Then Rules – Rule Evaluation – Conflict Resolution – Defuzzification – Fuzzy Controller with Matrix Representation - Exercises. Applications Fuzzy Control in Washing Machine – Fuzzy Decision Making in Forecasting – Fuzzy Decision Making in Industrial problems – Fuzzy control in Traffic control – Fuzzy Relational Equation in Medicine

TEXT BOOKS:

1. George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice-Hall of India, 1993
2. George J. Klir/Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India,2000

REFERENCE BOOKS:

1. George Bojadziev and Maria Bojadziev, Fuzzy Sets, Fuzzy Logic, Applications, World Scientific Publishing Co.Pte.Ltd, Singapore,1995
2. WitoldPedrycz& Fernando Gomide, An introduction to Fuzzy Set, Prentice-Hall of India, New Delhi, 2005
3. James J. Buckely, EsfandiarEslami, An introduction to Fuzzy Logic and Fuzzy Sets, Springer,2002
4. Abraham Kandel and Gideon Langholz, Fuzzy Control Systems, CRC Press, USA,1994
5. Fuzzy Sets and their Applications(UGC Model Curriculum) by S.K. Pundir & R.Pundir

PAPER-MAT-317

FOURIER ANALYSIS

Unit-I	Fourier Series: The Fourier series of a periodic function, A convergence theorem, Derivatives, integrals, and uniform convergence, Fourier series on intervals, Orthogonal Sets of Functions: Vectors and inner products, Functions and inner products,Convergence and completeness, More about L2 spaces; the dominated convergence theorem.
Unit-II	Regular Sturm-Liouville problems, Singular Sturm-Liouville problems. Some Boundary Value Problems: Some useful techniques, One-dimensional heat flow,One-dimensional wave motion, The Dirichlet problem,
Unit-III	Bessel Functions: Solutions of Bessel's equation, Bessel function identities, Asymptotics and zeros of Bessel functions, Orthogonal sets of Bessel functions. Orthogonal Polynomials: Legendre polynomials, Spherical coordinates and Legendre functions, Hermite polynomials.
Unit-IV	The Fourier Transform: Convolutions, The Fourier transform, Fourier transforms and Sturm-Liouville problems, Green's functions: Green's functions for ordinary differential operators, Green's functions and regular Sturm-Liouville problems.

TEXT BOOK:

Fourier Analysis And Its Applications by Gerald B. Folland
CHAPTERS: 2(2.1 to 2.4), 3, 4(4.1 to 4.4), 5(5.1 to 5.4), 6(6.2 to 6.4), 7(7.1, 7.2, 7, 4), 10(10.1, 10.3)

REFERENCE BOOKS:

1. FOURIER ANALYSISAn Introduction by Elias M. Stein, Rami Shakarchi
2. Fourier analysis by T.W. Körner
3. Functional Analysis, W. Rudin

PAPER-MAT-318

FLUID DYNAMICS-I

Unit-I	Streamlines, Path lines and Streak lines. The Material derivative and Acceleration Vorticity in Polar and Orthogonal Curvilinear Coordinates.
Unit-II	Fundamental equations of the flow of viscous compressible fluids, Equations of continuity, motion and energy is Cartesian coordinate systems.
Unit III	The equation of state. Fundamental equations of continuity, motion and energy in Cylindrical and Spherical coordinates.
Unit-IV	2-D and 3-D in viscid incompressible flow. Basic equations and concepts of flow. Circulation theorems, Velocity potential, Rotational and Irrotational flows. Integration of the equations of motion. Bernoulli's Equation, The momentum theorem and the moment of momentum theorem. Laplace's equations in different coordinate systems. Stream function in 2«D motion.

TEXT BOOK:

Foundations of Fluid Mechanics by S.W.Yuan, Publisher Prentice-Hall of India.

FOURTH SEMESTER

PAPER-MAT-419

GRAPH THEORY

Unit-I	Introduction to Graphs- Definition of graph, graphs as models, more definitions, vertex degrees, sub graphs, path and cycles, Matrix representation of graphs, Fusion.
Unit-II	Trees and Connectivity-Definitions and Simple properties, Bridges, Spanning Trees, Connector Problem, Shortest path problems, Cut vertices and connectivity
Unit-III	Euler Tours and Hamiltonian Cycles- Euler Tours, The Chinese Postman Problem, Hamiltonian Graphs, The Travelling Salesman Problem
Unit-IV	Planar Graphs- Plane and Planer Graphs, Euler's Formula, The Platonic Bodies.

TEXT BOOK:

John Clark and D.A. Holton A First Look at Graph Theory, World Scientific and Allied Publishers, Chapter: 1(1.1 to 1.8), 2(2.1to 2.6), 3(3.1 to 3.4), 5(5.1 to 5.3).

REFERENCE BOOKS:

1. N.Deo, Graph Theory and Applications to Engineering Anil Computer Sciences, Prentice Hall of India.
2. Graph Theory with Applications, Bondy J.A. and Murthy U.S.R., Mac Comp.

PAPER-MAT-420

FUNCTIONAL ANALYSIS-II

Unit-I	Compact Linear Maps,Spectrum of a Compact Operator.
Unit-II	Inner Product Spaces, Orthonormal Sets.
Unit-III	Approximation and Optimization Projection and Riesz Representation Theorems.
Unit- IV	Bounded Operators and Adjoints, Normal, Unitary and Self-Adjoint Operators.

TEXT BOOK:

Functional Analysis — B. V. Limaye (New Age—International Limited, Publishers, Third Edition)

Chapter -V (17, 18(upto Theorem-18.6)), Chapter –VI (21, 22, 23, 24), Chapter-VII (25 , 26 (26.1 to 26.4))

REFERENCE BOOKS:

1. Functional Analysis - A First Course by M.Thamban Nair
2. Functional Analysis - A First Course by S.Kumaresan and D.Sukumar
3. Introductory Functional Analysis with Applications – Erwin Kreyszig

PAPER-MAT-421

DISSERTATION, SEMINAR PRESENTATION AND VIVA

(Topic will be selected as per the direction of the supervisor)

Dissertation	60 marks
Seminar	20 marks
Viva voce	20 marks

PAPER-MAT-422

DISCRETE MATHEMATICS

Unit-I	Inclusion and equality of sets– Power Set – Cartesian Products - Relations - Equivalence Relations – Partial Ordering – Partially Ordered Set (representation and associated terminology) - Lattices as Partially Ordered Sets – Properties of Lattices – Lattices as Algebraic Systems – Sub lattices – Direct Product – Homomorphism.
Unit-II	Special Lattices (Complete lattices, bounded lattices, complemented lattices, distributive lattices and their properties) – Boolean Algebra – Subalgebra – Direct Product – Homomorphism.
Unit-III	Stone's representation Theorem – Boolean Forms – Free Boolean Algebra – Values of Boolean Expressions - a binary valuation process) – Boolean Functions – Symmetric Boolean Expressions.
Unit- IV	Matching's- Matching's, Matching's and Coverings in Bipartite Graphs, Perfect Matching's, applications, The Personnel Assignment Problem.

TEXT BOOKS:

1. Discrete Mathematical Structures with Applications to Computer Science, Trembley, J.P and Manohar, R : McGraw Hill Books Company,(1997)
Chap.-2: Sec.2-1.1, 2-1.2, 2-1.3, 2-1.4, 2-1.6, 2-1.8, 2-1.9, 2-3.1, 2-3.2, 2-3.5, 2-3.8, 2-3.9.
Chap.-4: Sec.4-1, 4-2, 4-3.
2. Graph Theory with Applications, Bondy J.A. and Murthy U.S.R., MacComp.
Chap-5: Sec. (5.1) to (5.4)

REFERENCE BOOKS:

1. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Pearson Edn Asia, Delhi, 2002
2. Kolman B., Busby R.C, and Ross S.C., Discrete Mathematical Structures, Pearson Edn Pvt. Ltd, New Delhi,2003
3. Rosen K., Discrete Mathematics and its Applications, Tata McGraw Hill Pub. Com. Ltd, New Delhi,2003
4. Liu C.L., Elements of Discrete Mathematics, McGraw Hill Book Company,1985
5. Seymour Lepschutz, Finite Mathematics, McGraw Hill Book Com (Int. Edn), New York,1983
6. Wiitala: Discrete Mathematics (A unified Approach), McGraw Hill Book Company.
7. Harary F. , Graph Theory Addison, Wesley Reading Mass,1969
8. Wilson R.J., Introduction to Graph Theory, Oliver and Boyd, Edinburgh,1972

PAPER- MAT-423

OPERATIONS RESEACH

Unit-I	Linear Programming Problem(LPP)- Simplex Method, Basic Solution, Basic Feasible Solution, Optimum Basic Feasible Solution, Fundamental Theorem of Linear Programming, Conditions of Optimality, Computational Procedure, Use of Artificial Variable, Two-Phase Method, Big-M Method.Duality in Linear Programming- General Primal-Dual Pair, Formulating a Dual Problem, Primal Dual Pair in Matrix Form, Duality Theorems, Duality and Simplex Method.
Unit-II	Integer Programming- Pure and Mixed Integer Programming Problems, Gomory's All-I.P.P. Methods, Fractional Cut Method (Integer L.P.P and Mixed Integer L.P.P), Branch and Bound Method. Goal Programming- Categorization of Goal Programming, Formulation of Linear Goal Programming Problem, Graphical Goal Attainment Method, Simplex Method for Goal Programming Problem.
Unit-III	Linear Programming Problem- Advanced Technique – Revised Simplex Method, Simplex Method versus Revised Simplex Method, Bounded Variable, Parametric Linear Programming. Transportation Problem- Solution of a Transportation Problem- North-West Corner Method, Least-Cost Method, Vogel's Approximation Method. Assignment Problem- Solution Methods of Assignment Problem.
Unit-IV	Non-Linear Programming- Formulation, General Non-Linear Programming Problem (NLPP), Constrained Optimization with Equality Constraint, Necessary and Sufficient Condition for a General NLPP, Constrained Optimization with Inequality Constraint. Non-Linear Programming Methods-Graphical Solution, Kuhn-Tucker Conditions with Non-Negative Constraints, Quadratic Programming, Wolfe's Modified Simplex Method, Beale's Method.

TEXT BOOK:

Operations Research: KantiSwarup, P.K. Gupta and Manmohan, Sultan Chand and Sons

Chapters: 4(4:1,4:2, 4:3, 4:4) , 5(5:2, 5:3, 5:4,5:5, 5:7), 7(7:2, to 7:7), 8(8:1 to 8:5), 9(9:2, 9:3, 9:4, 9:5), 10(10:8, 10:9), 11(11:3), 27(27:2, 27:3, 27:4, 27:5), 28(28:2, 28:3, 28:4, 28:5, 28:6)

REFERENCE BOOKS:

1. Hamdy A. Taha: Operations Research, Fourth Edition, 1971
2. J.K.Sharma: Mathematical Models in Operations research, Tata McGraw Hill, 1990

PAPER-MAT-424

CRYPTOGRAPHY

Unit-I	Basic concepts- Factoring and primality testing – Perfect numbers –Fermat's divisibility test–Fermat numbers, Computationalcomplexity.
Unit-II	Symmetric keycryptosystems An overview of congruence's – Block ciphers – The DES key Schedule –TheDES Cryptosystem
Unit- III	Public keycryptosystems Exponentiation, discrete logs and protocols – Public key cryptography – RSAsystem– Rabin system – Elgamal system.
Unit- IV	Authenticationandknapsack Digital signatures – Signature schemes related to public key CryptoSystems – Knapsack problem – Merkle Hellman system – ChorRivest system.

TEXT BOOK:

Richard A. Mollin: An Introduction to Cryptography, Chapman & Hall /CRC, Boca Raton, 2000

REFERENCE BOOK:

Dominic Walsh: Codes and Cryptography, Oxford SciencePublications,Clarendon Press, Oxford, 1988

PAPER-MAT-425

OPERATOR THEORY

Unit-I	Spectral Theory in dimensional normed spaces: Basic concepts, Spectral properties of Boundedlinear operators, Further properties of resolvant and spectrum.
Unit-II	Banach algebra, Further properties of Banach Algebra, Compact linear operator on normed spaces, Further properties of compact linear operators.
Unit-III	Spectral properties of compact linear operators, Further Spectral properties of compact linear operators, Operator Equations Involving Compact Linear Operators.
Unit-IV	Spectral properties of Bounded Self-Adjoint Linear Operators, Further Spectral properties of Bounded Self-Adjoint Linear Operators, Positive Operators , Square Roots of a Positive Operator, Projection Operators.

TEXT BOOK:

Introductory Functional Analysis with Applications-Erwin Kreyszig, Wiley Student Edition, Reprint- 2014

Chapter 7(7.1-7.4, 7.6, 7.7), 8(8.1-8.5), 9(9.1-9.5).

PAPER- MAT-426

FLUID DYNAMICS-II

Unit-I	Laminar Sow of viscous incompressible fluids. Similarity' of flows. The Reynolds number. Flow between parallel flat plates. Couette flow, plane Poiseuille flow. Steady flow in pipes, The Hagen-Poiseuille flow. Flow between two conxial Cylinders.
Unit-II	Flow between two Coaxial rotating cylinders. Steady flow around a sphere Theory of very slow motion. Unsteady motion of a flat plate.
Unit-III	The laminary boundary layer. Properties of Navier-Stokes equations. The boundary layer, equations in 2-D flow. The boundary layer along a flat plate. Boundarylayeronasurfacewithpressuregradient,Momentumintegraltheorems for the boundary layer.
Unit-IV	Von Karman-Pohlhausen method. Boundary layer for axially symmetrica' flow. Separation of boundary layer flow. Boundary layer control. Separation prevention by boundary layer suction, The origin of turbulence. Reynolds modification of the Navier-Stokes equations for trubulent flow. Reynolds equations and Reynolds stresses, PrandtPs mixing length theory. The universal velocity profile near a wall. Turbulent flow in pipes, Turbulent boundary layer over a smooth flat plate.

TEXT BOOK:

Foundations of Fluid Mechanics -S. W. Yuan, Publisher: Prentice-Hall of India.

*****