



## P.G. DEPARTMENT OF MATHEMATICS

Berhampur University, Bhanja Bihar, Berhampur :-760007,Ganjam,  
Odisha, India

### COURSE CURRICULUM & SYLLABI-2020

#### About the Department:

The Department of Mathematics came in to existence in the year 1972 with sixteen students on the roll for the course M.A./M.Sc. in Mathematics. Over the years new regular programmes such as M. Phil. and Ph. D., have been added in its activities. Sanctioned student strength has also increased. Occasionally scholars register for award of D.Sc./D.Litt., the highest degree of the country, under the auspices of this Department.

The alumni of the Department have excelled in public life in various prestigious capacities.

Through the dedicated efforts of research scholars and faculty, the Department has created for itself a niche in research in the fields of Differential Equations, Summability Theory, Sequence Spaces, Fourier Analysis, Complex Analysis, Fluid Dynamics, Cosmology and Gravitation. Faculty of the Department referee and review research papers in these areas for renowned international journals.

As a part of its co curricular activity the Department frequently hosts Conferences, Seminars, Refresher Courses, Workshops, PAC meetings and so on. The Department is a favourite destination for experts all over the country in the broad area of MATHEMATICAL Analysis.

The Department is a Zonal Coordinating centre for Mathematics Olympiad Tests conducted by the National Board for Higher Mathematics, Government of India. Under this outreach programme, about 1500 talented school going young students appear these tests every year in centres spread over nine districts under the jurisdiction of Berhampur University.

On the basis of the Department profile and academic achievements of the faculty, the Department has been selected for Department Research Support (DRS) under the Special Assistance Programme (SAP) of UGC Phase-I during 1994-99 and Phase-II during 2000-2005. A grant of Rs. 20.00 lakhs has been sanctioned by UGC under SAP in the Financial Year 2007-2008. The Department has been receiving library Grants from the National Board for Higher Mathematics (NBHM-DAE) since 1993.

## Core Research Areas:

The faculty members of the department are pursuing high quality research work in Advanced and emerging areas of the Mathematics like: Theory of Relativity and Cosmology, Summability Theory, Geometric Function Theory, Operator Theory and Inventory management.

## Student Strength:

**P.G Part -I: 50, P.G Part -II: 50, M.Phil-04, Ph.D : As per the availability of slots.**

## Faculty members:

Dr. Raghunath Patra, Ph.D: Berhampur University Mob: 9238720332, Email: <a href="mailto:raghunathpatra09@gmail.com">raghunathpatra09@gmail.com</a>	<b>Asst. Professor</b>	Theory of Relativity and Cosmology
Dr. Padmanava Samanta , M.Phil Ph.D: Berhampur University Mob: 9090512992, Email: <a href="mailto:dr.pns.MATH@gmail.com">dr.pns.MATH@gmail.com</a>	<b>Asst. Professor</b>	Summability Theory and inventory management
Dr. Madan Mohan Soren, M.Phil, Ph.D: Berhampur University Mob: 8210263060, Email: <a href="mailto:soren85@rediffmail.com">soren85@rediffmail.com</a>	<b>Asst. Professor</b>	Geometric Function Theory and Complex Analysis
Dr. Pabitra Kumar Jena, M.Phil, Ph.D: Utkal University, Postdoc: IMA, Bhubaneswar. Mob:9861841738, Email: <a href="mailto:pabitraMATH@gmail.com">pabitraMATH@gmail.com</a>	<b>Asst. Professor</b>	Operator Theory and Functional Analysis

**Programs Offered: M.A/M.Sc, M.Phil and Ph.D.**

## Facilities in the Department:

The Department is well furnished with infrastructural facility such as seminar library, computer lab., smart class room and seminar hall. The Department has its own library with near about 1000 books and different journals.



**P.G. DEPARTMENT OF MATHEMATICS**  
**Berhampur University, Bhanja Bihar, Berhampur :-760007, Ganjam, Odisha**

**Syllabus for M.A./M.Sc. MATHEMATICS 2020-22**  
**Detailed Course Structure**

Semester	Name of the Paper Code	Name of the Paper	No. of Credits	Marks 100	Remarks End Sem: 80 Marks + Mid Sem : 20
Semester-I	MATH C101	PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS	04	100	-Do-
	MATH C102	TOPOLOGY	04	100	-Do-
	MATH C 103	ALGEBRA-I	04	100	-Do-
	MATH C104	ELEMENTARY COMPLEX ANALYSIS-I	04	100	-Do-
	MATH C105	NUMERICAL ANALYSIS AND ITS APPLICATIONS	04	100	-Do-
Semester-II	MATH C201	ABSTRACT MEASURE	04	100	-Do-
	MATH C202	ADVANCED CALCULUS	04	100	-Do-
	MATH C203	ALGEBRA-II	04	100	-Do-
	MATH C204	ELEMENTARY COMPLEX ANALYSIS-I	04	100	-Do-
	MATH C205	MATHEMATICAL STATISTICS-I	04	100	-Do-
Semester-III	MATH C301	FUNCTIONAL ANALYSIS-I	04	100	-Do-
	MATH C302	FUZZY SETS AND FUZZY LOGIC	04	100	-Do-
	E	A Student is allowed to option any three Papers			
	MATH E303	OPTIMIZATION TECHNIQUES-I	04	100	-Do-
	MATH E304	NUMBER THEORETIC CRYPTOGRAPHY-I	04	100	-Do-
	MATH E305	ORDINARY DIFFERENTIAL EQUATIONS-I	04	100	-Do-
	MATH E306	MATRIX TRANSFORMATIONS IN SEQUENCE SPACES-I	04	100	-Do-
	MATH E307	FLUID DYNAMICS-I	04	100	-Do-
	MATH E308	ABSTRACT MEASURE AND PROBABILITY-I	04	100	-Do-
Semester-IV	MATH C401	GRAPH THEORY	04	100	-Do-
	MATH C402	FUNCTIONAL ANALYSIS-II	04	100	-Do-
	E	A Student is allowed to option any three Papers			
	MATH E403	OPTIMIZATION TECHNIQUES-II	04	100	-Do-
	MATH E404	NUMBER THEORETIC CRYPTOGRAPHY-II	04	100	-Do-
	MATH E405	ORDINARY DIFFERENTIAL EQUATIONS-II	04	100	-Do-
	MATH E406	MATRIX TRANSFORMATIONS IN SEQUENCE SPACES-II	04	100	-Do-
	MATH E407	FLUID DYNAMICS-II	04	100	-Do-
	MATH E408	ABSTRACT MEASURE AND PROBABILITY-II	04	100	-Do-

**Total Credit: 80**

**C- Core Course 1400 (Mandatory with no choice)**

**E- Elective 600 (Mandatory with choice departmentally)**

## DETAILED SYLLABUS

### FIRST SEMESTER

#### PAPER-MATH C101

#### PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS

Unit-I	Basic Concepts and Classifications of Second Order Equation.
Unit-II	The Cauchy Problem, The Method of Separation of Variables.
Unit-III	Eigen Value Problems, Boundary Value Problems.
Unit-IV	Fourier Transforms and Laplace Transforms.

#### BOOK PRESCRIBED:

Linear Partial Differential Equations for Scientists and Engineers. Tyn Myint, U & Lokenath Debnath (Birkhauser Pub.)4<sup>th</sup>Edition. Chapters:1(1.2 to 1.6), 4, 5(5.1 to 5.7), 8, 9, 12(12.1 to 12.6, 12.8 to 12.11).

#### BOOKS FOR REFERENCE:

Partial Differential Equations of MATHEMATICAL PHYSICS. Tyn Myint, U. (Elsevier Pub.)

#### PAPER-MATH C102

#### TOPOLOGY

Unit-I	Open sets and Limit points, Closed sets and Closure, Bases and relative Topologies.
Unit-II	Connected Sets and Components, Compact and Countable compact spaces, Continuous functions, Homeomorphisms.
Unit-III	$T_0$ -and $T_1$ -spaces & sequence, $T_2$ Spaces, Regular and Normal Spaces, Completely regular Spaces.
Unit-IV	Urysohn's lemma, Urysohn's metrization theorem, Finite products, Product invariant properties, Metric products, Product topology.

#### BOOK PRESCRIBED:

1. W. J. Pervin, Foundations of General Topology, Academic Press. Chapters: 3(3.1, 3.2 and 3.4), 4(4.1 to 4.4), 5(5.1, 5.2, 5.5 and 5.6), 8(8.1 to 8.4), 10(10.1 only).

#### BOOKS FOR REFERENCE:

1. J. R. Munkers, Topology-A First Course, Prentice Hall, 1996.
2. K. D. Joshi, Introduction to General Topology, Willey Eastern Ltd., 1983.

## PAPER- MATH C103

### ALGEBRA-I

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, Elementary Basic Concepts of Vector Space, Linear Independence and Bases.
Unit-IV	Extension Fields, The Transcendence of e, Roots of Polynomials, Construction with Straightedge and Compass, More about Roots.

#### BOOKS PRESCRIBED:

I. N. Herstein: Topics in Algebra, John Wiley and Sons, (2nd Edn.,) 2002.  
Chapters: 2(2.8 to 2.12), 3(3.5 to 3.10), 4(4.1 to 4.2), 5(5.1 to 5.5).

#### BOOKS FOR REFERENCE:

1. S. Singh end Q, Zameeraddin, Modern Algebra, Vikas Publishing House, 1590.
2. P. B .Bhattacharya. S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Cambridge University Press, 1995.

## PAPER- MATH C104

### ELEMENTARY COMPLEX ANALYSIS-I

Unit-I	Complex Numbers.
Unit-II	Complex Functions.
Unit-III	Conformality and Linear Transformations
Unit-IV	Complex Integration: Fundamental theorems, Cauchy's Integral formula, Local properties of analytic functions, Complex integration continued: General form of Cauchy's theorem.

#### BOOK PRESCRIBED:

Lars V. Ahlfors, Complex Analysis, Third Edition, McGraw-Hill International Editions.  
Chapters: 1, 2(2.1 to 2.4), 3 (3.1 to 3.3), 4 (4.1 to 4.4).

## PAPER- MATH C105

### NUMERICAL ANALYSIS AND ITS APPLICATIONS

Unit-I	Interpolation & Approximation: Introduction, Lagrange and Newton interpolations, finite difference operators, Interpolating Polynomials using finite differences, Hermite Interpolation, Piecewise and spline interpolation.
Unit-II	Interpolation and Approximation (contd.): Bivariate interpolations, Approximation, least square approximation, uniform approximation, Rational approximation, choice of the method.
Unit-III	Differentiation and Integration: Introduction, Numerical differentiation, Optimum choice of step length, extrapolation method, partial

	differentiation, Numerical Integration, Methods based on interpolation. Methods based on undetermined coefficients, Composite Integration methods, Romberg Integration, Double integration.
Unit-IV	Ordinary Differential Equations, Initial Value Problems: Introduction, Difference Equations, Ordinary Differential Equations, Initial Value Problem (contd.): Numerical methods, single step methods, stability analysis of single step methods, Multi step methods.

**BOOK PRESCRIBED:**

M. K. Jain, S. R. K. Iyengar and R.K. Jain : Numerical Methods for Science and Engineering Computations (Fourth Edition) New Age International Publishers, 2003., Chapters : 4, 5 and 6.

**SECOND SEMESTER**

**PAPER- MATH C201**

**ABSTRACT MEASURE**

Unit-I	Introduction, Outer Measure, Measurable sets and Lebesgue Measure, A non-Measurable set, Measurable functions, Littlehood's three Principle.
Unit-II	The Lebesgue Integral.
Unit-III	Differentiation and Integration.
Unit-IV	The classical Banach Spaces.

**BOOK PRESCRIBED:**

Real Analysis: H. L. Royden (Macmillan Pub.) Chapters: 3, 4, 5 and 6.

**PAPER- MATH C202**

**ADVANCED CALCULUS**

Unit-I	Derivatives for Functions on $R^n$ - Differentiation of composite functions, Taylors Theorem
Unit-II	Transformations, Linear function and transformations, Differentials of transformations, Inverse of transformations.
Unit-III	Implicit function theorems, functional dependence, set function transformation of multiple Integrals.
Unit-IV	Curves and Arc length, surfaces and surface area, Integrals over curves and surface, Differential forms, Theorem of Green, Gauss and stokes, exact form and closed form.

**BOOK PRESCRIBED:**

Advanced Calculus (third edition by R. C. Buck, McGraw Hill).  
Chapters: 3(3.1 to 3.3), 7(7.2 to 7.7), 8(8.2 to 8.6), 9(9.2, 9.4 and 9.5).

## PAPER MATH C203

### ALGEBRA-II

Unit-I	Dual Spaces, Inner Product Spaces, The Elements of Galois Theory, Solvability by Radicals.
Unit-II	The Algebra of Linear Transformation, Characteristic Roots, Matrices.
Unit-III	Canonical Forms 1 Triangular Form, Nilpotent Transformations, Jordan Form.
Unit-IV	Trace and Transpose, Determinants, Hermitian, Unitary and normal Transformations.

#### BOOK PRESCRIBED:

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

Chapters: 4(4.3 to 4.4), 5(5.6 to 5.7), 6(6.1 to 6.6, 6.8 to 6.10).

#### BOOKS FOR REFERENCE:

1. S. Singh end Q, Zameeraddin, Modern Algebra, Vikas Publishing House, 1590.
2. P. B.Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Cambridge University Press, 1995.

## PAPER- MATH C204

### ADVANCED COMPLEX ANALYSIS

Unit-I	Complex Integration Calculus of Residues.
Unit-II	Series and Product development: Power series expansion, partial fraction and factorization.
Unit-III	Series and product development continued: Entre function, Riemann Zeta Function.
Unit-IV	Elliptic Functions: Simple periodic functions and Double periodic functions, Elliptic Functions, Weirstrass Theory.

#### BOOK PRESCRIBED:

Lars V. Ahlfors, Complex Analysis, Third Edition, McGraw-Hill International Editions.

Chapters: 4 (4.5), 5 (5.1 to 5.2), 6 (6.3 to 6. 4), 7 (7.1 to 7.3).

## PAPER- MATH C205

### MATHEMATICAL STATISTICS-I

Unit-I	Elements of Theory of Probability : Classical definition of probability, Theorems on probability of union of events, Conditional probability : Theorem of compound probability, Independence of events, The Bayes Theorem, Statistical and empirical definition of probability, Geometric probability, Axiomatic definition of probability, Conditional probability (Axiomatic definition of probability).Exercises.
Unit-II	Probability distribution on R: Random variables, probability distribution of a r. v. , discrete and continuous random variables, independent random

	variables, lebesgue-stieltjes integrals, Integration of a random variables. Exercises.
Unit-III	Some characteristic of probability distribution : Expectation, Moments, some inequalities concerning moments , Different measures of central tendency , measures of dispersion , Measures of skewness and kurtosis , some probability inequalities . Exercises.
Unit-IV	Generating functions: probability generating function, Moment generating function , Factorial generating function , Cummulant generating function , characteristic function, Exercises, Some discrete distribution on R: The discrete uniform distribution , the Bernoulli distribution, the binomial distribution , The hypergeometric distribution , The Poisson distribution ,The geometric distribution, The negative binomial distribution ,The power series distribution, Exercises.

**BOOK PRESCRIBED:**

Parimal Mukhopadhyay, MATHEMATICAL STATISTICS, Books and Allied (P) Ltd., No1-E(1). Subham Plaza, First Floor, 83/1 Belgachia Main road, Kolkata 700010.  
 Chapters: 1, 2, 3, 4 and 5.

**BOOKS FOR REFERENCE:**

1. Robert V. Hogg and Allen T. Craig, Introduction to MATHEMATICAL STATISTICS, Pearson Education Asia, Indian Branch :482 F.I.E Pratapganj, Delhi 110092
2. John E. Freund and Ronald E. Walpole, MATHEMATICAL STATISTICS, Prentice Hall India Pvt. Ltd. New Delhi-110001

**THIRD SEMESTER**

**PAPER- MATH C301**

**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 and Open Mapping Theorems, Bounded Inverse Theorem.
Unit-IV	Spectrum of a Bounded operator, Duals and Transposes.

**BOOK PRESCRIBED:**

Functional Analysis by B. V. Limayee (New Age International Limited, Publishers, Second Edition) Chapters : 5, 6, 7(Except Banach Limits), 8, 9(Except Divergence of Fourier Series of continuous Functions and Matrix Transformations and Summability Methods), 10, 11, 12 (upto theorem 12.6) and 13 (upto Theorem 13.5).



**PAPER-MATH C302**  
**FUZZY SETS AND FUZZY LOGIC**

Unit-I	From Classical (CRISP) sets to Fuzzy sets: Fuzzy sets: Basic types, Basic concept. Fuzzy sets versus crisp sets: Additional properties of $\alpha$ -cuts, Representations of fuzzy sets, extension principle of fuzzy sets.
Unit-II	Operations on Fuzzy sets: Types of operations, Fuzzy complements, Fuzzy intersections: t-norms, Fuzzy unions: t-conorms, Combinations of Operations, Aggregation operations.
Unit-III	Fuzzy Arithmetic: Fuzzy numbers, linguistic variables, Arithmetic operations on Intervals and Fuzzy numbers, Lattice of Fuzzy numbers, Fuzzy equations.
Unit-IV	Fuzzy Relation: Crisp versus Fuzzy relations, Projections and cylindric extensions, Binary Fuzzy relations, Binary relations on a single set, Fuzzy equivalence relations, compatibility relations and ordering relations, Fuzzy morphisms, Sup- $i$ compositions of Fuzzy relations, Inf- $w_i$ compositions of Fuzzy relations.

**BOOK PRESCRIBED:**

Fuzzy sets and Fuzzy Logic Theory and Applications by George J. Klir & Bo Yuan, Prentice Hall PTR under Saddle River, New Jersey 07458.  
Chapters: 1, 2, 3, 4 and 5.

**BOOKS FOR REFERENCE:**

1. Fuzzy sets and their applications by S.K. Pundir and R. Pundir, A Pragati Editions, 8th Editions.
2. Fuzzy set theory fuzzy logic and their applications by A.K. Bhargava, Pub: S. Chand & Co, New Delhi

**PAPER- MATH E303**  
**OPTIMIZATION TECHNIQUES-I**

Unit-I	Integer Programming: Gomory's Algorithm for pure integer linear programs, Gomory's mixed integer- continuous variable algorithm, Branch and Bound methods.
Unit-II	Kuhn-Tucker optimality conditions: Some theorem, Kuhn-Tucker first order Necessary optimality conditions, Second order optimality condition, Lagranges method.
Unit-III	Convex programming problem, Sufficiency of Kuhn-Tucker conditions, Legrangian saddle point and duality, duality for convex programs.
Unit-IV	Game Theory : Game theory problem, Two person zero sum Game, Finite matrix Game, Graphical method for $2 \times n$ and $m \times 2$ matrix games, Some theorems, Dominance principal.

**BOOK PRESCRIBED:**

MATHeMatical Programming by N. S. Kambo. Chapters: 6(6.4 to 6.6), 7(7.1 and 7.4), 8, 16.

### PAPER- MATH E304

#### NUMBER THEORETIC CRYPTOGRAPHY-I

Unit-I	Time estimates for doing arithmetic, Divisibility and Euclidean algorithm, Congruences, Some applications to factoring.
Unit-II	Finite fields, Quadratic residues and Reciprocity.
Unit-III	Some simple Cryptosystems, Enciphering Matrices.
Unit-IV	The idea of public key Cryptography, RSA.

#### BOOKS PRESCRIBED:

Neal Koblitz: A Course In number theory and Cryptography, Springer Verlag, GTM No. 114; 1987). Chapters: 1, 2, 3, 4(4.1 to 4.2).

#### BOOKS FOR REFERENCE:

A. J. Menezes. P. C. Van Oorchot and Scoff A. Vanstone, Hand Book of Applied Cryptography, CRC Press (1997).

### PAPER- MATH E305

#### ORDINARY DIFFERENTIAL EQUATIONS-I

Unit-I	Basic Concepts and Linear Equations of the First Order.
Unit-II	Linear Differential Equations of Higher Order.
Unit-III	Systems of Linear Differential Equations, Systems of First Order Equations, Existence and Uniqueness Theorems, Fundamental Matrix Non Homogeneous Linear Systems, Systems of Linear Differential Equations, Continued Linear Systems with Constant Coefficients, Linear System with Periodic Coefficients.
Unit-IV	Equations with Deriving Arguments, Existence and Uniqueness of Solutions.

#### BOOK PRESCRIBED:

Text Book of Ordinary Differential Equations (Second Edition) by S, G. Deo. V. Lakhimikantbam, V. Raghavendra, Tata-Mc Graw-Hill Publishing Company Limited. New Delhi., Chapters : 1, 2 (except 2.10), 4, 5, 11.

### PAPER- MATH E306

#### MATRIX TRANSFORMATIONS IN SEQUENCE SPACES-I

Unit-I	Limitation Methods: Limitation methods, Examples of Limitation Methods, Matrix Limitation Methods, Norlund and Riesz Musos.
Unit-II	Limitation Methods: Scbur Matrices: Consistency of Matrix Methods.
Unit-III	Some particular Limitation Matrices: Norlund Mean, Cesaro and Holder Matrices.
Unit-IV	Hausdorff Methods, Abels method, Tauberin Theorem, Banach Limits, Strongly Regular Matrices, Counting function.

**BOOK PRESCRIBED:**

Regular Matrix Transformation by G. N. Peterson McGraw-Hill Publishing Company.  
 Chapters: 1, 2, 3(3.1 to 3.3).

**PAPER- MATH E307****FLUID DYNAMICS-I**

Unit-I	Kinematics of Fluids, Methods describing Fluid motion. Lagrangian and Eulerian Methods. Translation Rotation and Rate of Deformation. Streamlines, Pathlines and Streaklines. 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 in 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 inviscid 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.

**BOOK PRESCRIBED:**

Foundations of Fluid Mechanics by S. W. Yuan, Publisher Prentice-Hall of India.  
 Chapters : 3, 5 (5.1 to 5.6), 7 (7.1 to 7.9).

**PAPER- MATH E308****ABSTRACT MEASURE AND PROBABILITY-I**

Unit-I	Sets and Events, Probability on $\sigma$ -Algebra, Probability Distributions and Elementary Random Variables, Repeated Trials and Statistical Independence, Poisson Approximation to the Binomial Distribution, Normal Approximation to Binomial Distribution.
Unit-II	Multivariate Normal Approximation to Multinomial Distribution, some applications of the normal approximation. Independent simple Random variables and central limit theorem, Conditional probability, Law of large numbers An application of the law of large numbers to a problem in Analysis.
Unit-III	$\sigma$ -algebra and Borel spaces, Monotone classes, Measures on Boolean semi-Algebra and Algebra Extension of Measure to $\sigma$ -Algebra, Uniqueness of extensions of measures.
Unit-IV	Extension and completion of measures, measures on metric spaces, probability contents, the Lebesgue measure on the Real line, Elementary properties of Borel Maps, Borel Maps into Metric Spaces, Borel Maps on measure Spaces.

**BOOKS PRESCRIBED:**

Introduction to probability and measure by K. R. Parthsarathy (Macmillan Company), Chapters: 1, 2(2.2 to 2.4), 3.

**FOURTH SEMESTER****PAPER- MATH C401****GRAPH THEORY**

Unit-I	Introduction to Graphs
Unit-II	Trees and Connectivity.
Unit-III	Euler Tours and Hamiltonian Cycles: Euler Tours, Hamiltonian graphs, Planar Graphs: Plane and Planar Graphs, Euler's Formula, Kuratowski's Theorem
Unit-IV	Colouring

**BOOK PRESCRIBED:**

John Clark and D.A. Holton, A First Look at Graph Theory, World Scientific and Allied Publishers. Chapters: 1, 2, 3(3.1, 3.3), 5(5.1, 5.2 and 5.4), 6.

**BOOK FOR REFERENCE**

N. Deo, Graph Theory and Applications to Engineering Anil Computer Sciences, Prentice Hall of India.

**PAPER- MATH C402****FUNCTIONAL ANALYSIS-II**

Unit-I	Weak and Weak *convergence Reflexivity.
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.

**BOOK PRESCRIBED:**

Functional Analysis by B. V. Limayee (New Age International Limited, Publishers, Second Edition) Chapters: 15, 16 (upto 16.3), 21, 22, 23, 24, 25 and 26 (Upto 26.5).

**PAPER- MATH E403****OPTIMIZATION TECHNIQUES-II**

Unit-I	Quadratic program, Weife's algorithm, Scales Algorithm, Fletchers method.
Unit-II	Dual quadratic program, complementarity problem.
Unit-III	Non linear programming methods; Frank-Wolfe method, Reduced Gvadieot method, Kelley's cutting plane method.
Unit-IV	Geometric programming: Proto type primal and dual Geometric Programs, Reduction to proto type Geometric program, Dynamic Programming:

	Principle of optimality, Reliability of system in series, Height of projectile, Cargo-Loading problem. Inventory problem.
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**BOOKS PRESCRIBED:**

MATHEMATICAL Programming by N. S. Kambo. Chapters: 10(10.1 to 10.5, 10.8), 11 (11.1 to 11.3), 12 (12.1 to 12.2), 15(15.1 to 15.5).

**PAPER- MATH E404**

**NUMBER THEORETIC CRYPTOGRAPHY-II**

Unit-I	Discrete log, Knapsack.
Unit-II	Zero knowledge protocol and oblivious transfer, pseudo primes.
Unit-III	The rho method, Fermat factorization and factor bases.
Unit-IV	The continued fraction method, The quadratic sieve method.

**BOOKS PRESCRIBED:**

Neal Koblitz, A Course on number theoretic Cryptography. Springer Verlag, GTM No. 114 (1987). Chapters: 4(4.3 to 4.5), 8.

**BOOK FOR REFERENCE**

J. Menezes. P. C. Van Oorschot and Scott A. Vanstone, Hand Book of Applied Cryptography, CRC Press (1997).

**PAPER- MATH E405**

**ORDINARY DIFFERENTIAL EQUATIONS-II**

Unit-I	Analysis and Methods of Nonlinear Differential Equations.
Unit-II	Boundary Value Problems.
Unit-III	Oscillations of Second Order Equations.
Unit-IV	Stability of Linear and Nonlinear, Systems: Elementary Critical Points, System of Equations with constant coefficients, linear Equations with constant coefficients, Stability of Linear and Nonlinear Systems (continued) Lyapunov stability, stability of Quasi-linear systems, Second Order Linear Differential Equations.

**BOOKS PRESCRIBED:**

Text Book of Ordinary Differential Equations (Second Edition) S. G. Deo. V. Lakshmikantham, V. Raghavendra, Tata Mc Graw Hill Publishing Company Limited. New Delhi. Chapters: 6, 7, 8 and 9.

**PAPER- MATH E406**

**MATRIX TRANSFORMATIONS IN SEQUENCE SPACES-II**

Unit-I	Strongly Regular Matrices: Some Matrices of a special Type, A universal Tauberian Theorem.
Unit-II	Bounded sequence, Uniformly limitable sequence, Intersection of Bounded Convergence Fluids.

Unit-III	Set of Matrices, Bounds on Limits of sequences, Matrix Norms, Pairs of consistent matrices.
Unit-IV	Matrix and linear transformations Algebras of matrices, Summability, Tauberian theorems.

**BOOKS PRESCRIBED:**

1. Regular Matrix Transformations by O. M. Peterson, Chapters: 3 (3.4 to 3.5), 4.
2. Elements of Functional Analysis by I. J. Maddox, Cambridge University Press, Chapter: 7.

**PAPER- MATH E407**

**FLUID DYNAMICS-II**

Unit-I	Laminar flow 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 coaxial 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. Boundary layer on a surface with pressure gradient, Momentum integral theorems for the boundary layer.
Unit-IV	Von Karman-Pohlhausen method. Boundary layer for axially symmetric 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 turbulent flow. Reynolds equations and Reynolds stresses, Prandtl's mixing length theory. The universal velocity profile near a wall. Turbulent flow in pipes, Turbulent boundary layer over a smooth flat plate.

**BOOK PRESCRIBED:**

Foundations of Fluid Mechanics by S. W. Yuan, Publisher: Prentice-Hall of India. Chapters: 8 (8.1 to 8.3, 8.7 to 8.8), 9, 10.

**PAPER- MATH E408**

**ABSTRACT MEASURE AND PROBABILITY-II**

Unit-I	Integration of non-negative Functions, Integration of Borel Functions, Riemann and Lebesgue Integrals.
Unit-II	Riesz Representation theorem, some Integral Inequality.
Unit-III	Transition Measures and Fubini's theorem, convolution of probability measure on $\mathbb{R}^n$ Lebesgue measure on $\mathbb{R}^n$
Unit-IV	Convolution Algebra $L^1(\mathbb{R}^n)$ approximation on $L^p$ spaces with respect to Lebesgue Measure on $\mathbb{R}^x$ , Elementary properties of Banach spaces, projections in Hilbert space, orthogonal sequences.

**BOOK PRESCRIBED:**

Introduction to probability and measure by K. R. Parthsarathy (MacMillan Company)  
Chapters: 4 (except 4.30, 4. 31), 5, 6 (6.40 to 6.42).

**Assessment and Expectations from Class:** Proctorial, attendance, discipline, punctuality, doubt clearing class.