DEPARTMENT OF MATHEMATICS

SCHOOL OF PHYSICAL AND MATHEMATICAL SCIENCES

UNIVERSITY OF KERALA

M.Sc. Programme in Mathematics

Syllabus

(Under Credit and Semester System w.e.f 2017 Admissions)

DEPARTMENT OF MATHEMATICS

SCHOOL OF PHYSICAL AND MATHEMATICAL SCIENCES

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M.Sc. Programme in Mathematics

(Under Credit and Semester System w.e.f 2017 Admissions)

Programme Objectives

- Continuation of the study of concepts in UG programme
- Extension of domain knowledge
- Sharpening of mathematical concepts

Structure of the Programme

Sem. No	Course Code	Name of the course	No. of credits
I	Core courses		
	MAT-C-411	Linear Algebra	3
	MAT-C-412	Real Analysis	3
	MAT-C-413	Differential Equations	4
	MAT-C-414	General Topology	4
	MAT-C-415	Computer Methods	4
II	Core courses		
	MAT-C-421	Abstract Algebra	4
	MAT-C-422	Measure Theory	4
	MAT-C-423	Algebraic Topology	4
	Internal electives		
	MAT-E-424	Graph Theory	4
	MAT-E-425	Theory of wavelets	4
III	Core courses		
	MAT-C-431	Complex Analysis-I	4
	MAT-C-432	Functional Analysis	4
	MAT-C-433	Approximation Theory	4
	Internal electives		
	MAT-E-434	Differential Geometry	4
	MAT-E-435	Operations Research	4
	MAT-E-436	Galois theory	4
IV	Core courses		
	MAT-C-441	Complex Analysis-II	4
	MAT-C-442	Theory of linear operators	4
	Internal electives		
	MAT-E-443	Representation Theory of Finite Groups	4
	MAT-E-444	Number Theory	4
	MAT-E-445	Coding Theory	4
	Dissertation		
	MAT-D-446	Dissertation	6
Extra Departmental Elective Courses			
II	MAT-X-421	Complex Analysis	2
	MAT-X-422	Finite State Machines	2

SEMESTER: I
COURSE CODE: MAT-C-411
COURSE TITLE: LINEAR ALGEBRA
CREDITS: 3

AIM: This course is an introduction to vector spaces and linear transformations. The course has applications especially to matrix theory. This course is a pre-requisite for the study of normed linear spaces which comes under the course on Functional Analysis.

OBJECTIVES: To acquire knowledge about vector spaces, subspaces, bases and dimensions, linear transformations, their algebras, and their representation by matrices, linear functional and dual spaces, characteristic values of linear transformation, the analysis of characteristic (eigen) values, triangulable and diagonalizable transformations and primary decomposition theorem.

COURSE CONTENT

MODULE I : Vector space – subspaces – bases and dimensions

MODULE II : Co-ordinates – Summary of Row-Equivalence – Computations concerning subspaces.

MODULE III : Linear Transformation – The algebra of linear transformations – Isomorphism – Representation of linear transformation by Matrices.

MODULE IV : Linear functional – The Double Dual – The transpose of a linear transformation.

MODULE V : Elementary Canonical Forms – Introduction – Characteristic values – Annihilating polynomials – Invariant spaces.

MODULE VI : Simultaneous Triangulation – Simultaneous diagonalization – Direct sum – Decomposition – Invariant Direct sums – The Primary Decomposition theorem.

REFERENCE

- Kenneth Hoffman and Ray Kunze, Linear Algebra, Prentice Hall of India (Second Edition), New Delhi (1997)

ADDITIONAL REFERENCES

- COHN. P. M., Elements of Linear Algebra, Chapman and Hall, London (1994)
- HALMOS. P. R., Finite dimensional Vector spaces, Narosa Publishing House, New Delhi (1980)
- HERSTEIN. N., Topics in Algebra, Wiley Eastern Ltd Reprint (1991)
- LANG. S., Linear Algebra, Addison Wesley Pub. Co. Reading, Mass (1972)

SEMESTER: I
COURSE CODE: MAT-C-412
COURSE TITLE: REAL ANALYSIS
CREDITS: 3

AIM: This course aims to gain knowledge of concepts of modern analysis such as continuity, metric spaces, convexity and integration; develop a higher level of mathematical maturity combined with the ability to think analytically and be able to follow more advanced treatments of real analysis.

OBJECTIVES: This course is intended to provide a smooth transition from calculus to more advanced work in analysis. This serves to reinforce and deepen the reader's understanding of the basic concepts of analysis and at the same time, to provide a familiarity with the abstract approach to analysis which is valuable in many areas of applied mathematics.

COURSE CONTENT

MODULE I: Limits of functions, continuous functions, continuity and compactness, continuity and connectedness, discontinuities, monotonic functions

MODULE II: Derivative of a real function, Mean Value Theorems, The continuity of derivatives, L'Hospital's rule, Taylor's theorem, Differentiation of vector-valued functions

MODULE III: Riemann-Stieltjes Integral- Definition and existence of the integral, properties of the integral

MODULE IV: Integration and differentiation on Riemann-integrable functions, Integration of vector - valued functions, rectifiable curves

MODULE V: Uniform convergence of functions, uniform convergence and continuity of functions, uniform convergence and integration of functions, uniform convergence and differentiation of functions

MODULE VI: Power series, The exponential and logarithmic functions, the trigonometric functions, the algebraic completeness of the complex field, Fourier series

REFERENCE

- Walter Rudin, "Principles of Mathematical Analysis", Third edition

ADDITIONAL REFERENCES

- Apostol. T.M., "Mathematical Analysis", second edition, Narosa publishing House.
- Krantz. S.G., "Real Analysis and foundations", CRC Press.
- Malik. S.C., "Mathematical Analysis", Wiley Eastern Ltd.
- Potter. M.H., C.B.Morrey, "A first course in Real Analysis", Springer Verlag.
- Strichartz. R.S., "The way of Analysis", Jones and Barllel Publishers.

SEMESTER: I
COURSE CODE: MAT-C-413
COURSE TITLE: DIFFERENTIAL EQUATIONS
CREDITS: 4

AIM: The aim of this course is to provide students with an introductory yet comprehensive overview of basic theory of ordinary and partial differential equations, and to introduce the methods of classification and finding the solutions to different classes of differential equations.

OBJECTIVES: This course is intended to study on differential equations, both ordinary and partial. Topics include the solution of first and second order differential equations, homogenous and non-homogenous differential equations, physical applications, initial value problems, systems of linear differential equations, series solutions, formation of partial differential equations, solution of partial differential equations, wave equation etc.

COURSE CONTENT

MODULE I: Introduction, how differential equations arise, a simple equation, separable equations, initial and boundary value problems, linear dependence and Wronskian, basic theory for linear equations, method of variation of parameters ,Abel's formula , homogeneous linear equations with constant coefficients.

MODULE II: Solutions in power series, Second order linear equations with ordinary points, Legendre equation and Legendre polynomials, orthogonality of Legendre polynomials, series solution method to equations with regular singular points.

MODULE III: Bessel equations, orthogonality of Bessel functions, System of first order equations, existence and uniqueness theorem, fundamental matrix, non –homogeneous linear systems.

MODULE IV: Successive approximations, Picard's theorem, non uniqueness of solutions, continuation and dependence on initial conditions, existence of solutions in the large .

MODULE V: Surfaces and normals, curves and their tangents, formation of partial differential equation, solution of partial differential equations of first order, integral surfaces passing through a given curve, the Cauchy problem for first order equations, surfaces orthogonal to a given system of surfaces, first order non- linear equations, Cauchy method of characteristics, Charpit's method, special types of first order equations.

MODULE VI: Occurrence of the wave equation, derivation of one dimensional wave equation, solution of one dimensional wave equation by canonical reduction, the initial value problem; D'Alembert's solution, periodic solution of one dimensional wave equation in cylindrical coordinates, periodic solution of one dimensional wave equation in spherical polar coordinates, uniqueness of the solution for the wave equation.

REFERENCES

- Deo S G. and Ragavendra V, “Ordinary Differential Equations and Stability Theory”, first edition, Tata McGraw-Hill publishing company limited, New Delhi

- Sankara Rao K., “Introduction to Partial Differential Equations”, Second edition, PHI learning private limited.

ADDITIONAL REFERENCES

- Amaranath T., “An elementary course in partial differential equations”
- Coddington E.A., “An introduction to ordinary differential equations”
- Ian Sneddon, “Elements of partial differential equations”
- Phoolan Prasad & Renuka Ravindran, “Partial differential equations”.
- Simmons G.F., “Differential Equations with applications and historical notes”
- Somasundaram .D, “Ordinary differential equations-First Course”.

SEMESTER: I
COURSE CODE: MAT-C-414
COURSE TITLE: GENERAL TOPOLOGY
CREDITS: 4

AIM: To introduce the concept of distance neighbourhoods, limits etc. to other systems (topological spaces) and familiarize the students with separation axioms

OBJECTIVES: To understand the concepts of continuity, compactness etc. Separation axioms are also dealt in this course.

COURSE CONTENT

MODULE I : Open sets, Closed sets, Convergence, Completeness, Baires's Theorem, Continuous Mappings

MODULE II : Fundamental concepts of topological spaces, Neighborhoods, Bases and subspaces

MODULE III : Subspaces, Continuous functions, Product spaces and Weak topologies

MODULE IV : Inadequacy of Sequences, Nets, Filters

MODULE V : The separation axioms, Regularity and complete regularity, Normal Spaces

MODULE VI : Compact spaces, Locally compact spaces, Compactification

REFERENCES

- Simmons G. F., "Introduction to Topology and Modern Analysis", McGraw Hill-1983
- Willard S., "General Topology", Dover publication Inc, 2004

ADDITIONAL REFERENCES

- Croom F.H., "Principles of topology", Dover publications, 2016
- Joshi K. D., "Introduction to General Topology", New Age International (P) Ltd, New Delhi, 2004
- Kelley J. L., "General Topology", Springer-Verlag, Newyork, 1955
- Munkres J. R., "Topology", PHI, 2000

SEMESTER: I
COURSE CODE: MAT-C-415
COURSE TITLE: COMPUTER METHODS
CREDITS: 4

AIM: This course aims to create awareness among students about open source software. Also this course gives an opportunity to students to practice TEX as well as LATEX which are useful for preparing articles and in particular, the dissertation in their fourth semester.

OBJECTIVES: An overview of operating systems and a detailed study of the operating system Linux and the technical typesetting software TEX and LATEX.

COURSE CONTENT

MODULE I : Operating Systems & Linux, Linux shell & file structure, Basic Linux commands, Editors in Linux- Gedit, Emacs and Vi.

MODULE II : Introduction to LATEX, Preparing an input file, The input, Typesetting Mathematical Formulas, Running LATEX.

MODULE III : Defining commands and environments, Figures and tables, The table of contents, Cross-references, Bibliography and citation.

MODULE IV : Other document classes, Errors in LATEX, Pictures and colours, Math packages: amsmaths, amssymb etc.

MODULE V: Introduction to Python, Working with numbers, Basic mathematical operations, writing programs that do the math, programming challenges: enhanced multiplication table generator and fraction calculator

MODULE VI: Visualizing data with graphs, Creating graphs with Matplotlib, Plotting with formulas, Programming challenges, Exploring a quadratic function visually, Exploring the relationship between the Fibonacci sequence and the Golden Ratio.

REFERENCES

- Amit Saha, Doing Math with Python, No Starch Press, 2015
- Leslie Lamport, LATEX A Document Preparation System, Addison – Wesley 2000
- Richard Petersen, Linux, The Complete Reference, Tata McGraw Hill 1998

ADDITIONAL REFERENCES

- American mathematical society (2002) AMS-LATEX users guide URL ftp://ftp.ams.org/pub/tex/doc/amsmath/ams/doc.pdf
- Bill Ball, Linux in 24 Hours, Techmedia, New Delhi 1999
- Donald Knuth, The TEX Book. Addison – Wesley 1986
- Goosens, Mittelbach and Samari, The LATEX Companino, Addison – Wesley 2004
- Swaroop C. H., ‘A byte of Python’, A free book on Programming using the Python language

SEMESTER: II

COURSE CODE: MAT-C-421
COURSE TITLE: ABSTRACT ALGEBRA
CREDITS: 4

AIM: Introducing abstract ideas with a sufficient base of examples to render them credible or natural. Abstract Algebra is a contemporary subject – that its concepts and methodologies are being used by working mathematicians, computer scientists, physicists, and chemists. The study of abstract mathematical structures is most often dictated by the exigency of applicability to concrete situations, and perhaps to a lesser extent by purely aesthetic considerations.

OBJECTIVES: The course is mainly concentrated on some of the algebraic structures known as groups, permutation groups, rings and fields. Further interesting results and properties related to these structures are taken into consideration.

COURSE CONTENT

MODULE I: Definition of a group, some examples of groups, some preliminary lemmas, subgroups, a counting principle, normal subgroups and quotient groups, homomorphisms

MODULE II: Automorphisms, Cayley's theorem, Permutation groups, Another counting principle

MODULE III: Sylow's theorem, direct products, finite abelian groups

MODULE IV: Definition and examples of rings, some special classes of rings, homomorphisms, ideals and quotient rings, more ideals and quotient rings, the field of quotients of an integral domain

MODULE V: Euclidean rings,the particular Euclidean ring J[i], polynomial rings, polynomials over the rational field, polynomial rings over commutative rings

MODULE VI: Extension fields, roots of polynomials, Splitting fields, Simple extensions

REFERENCE

- Herstein I.N, "Topics in Algebra", Second edition.

ADDITIONAL REFERENCES

- Artin M., "Algebra", Prentice- Hall of India, New Delhi, 1999
- Gallian J.A., "Contemporary Abstarct Algebra", 8th edition, Cengage learning
- Jacobson N., "Basic Algebra", Vol-1, Hindustan Pub. Corporation (India) 1993.
- John B Fraleigh, "A first course in Abstract Algebra", Seventh edition Addison-Wesley pub.

SEMESTER: II
COURSE CODE: MAT-C-422
COURSE TITLE: MEASURE THEORY
CREDITS: 4
AIM: To introduce the concepts of measure and integral with respect to a measure, to show their basic properties and to provide a basis for further studies in analysis.

OBJECTIVES: Measure theory is the modern theory of integration, the method of assigning a 'size' to subsets of a universal set. It is more general, more powerful and more beautiful than the classical theory of Riemann integration. The course will be a reasonably, standard introduction to measure theory with some emphasis upon geometric aspects.

COURSE CONTENT

MODULE I : Lebesgue outer measure, measurable sets, regularity, measurable functions, Borel and Lebesgue measurability.

MODULE II : Integration of non-negative functions, the general integral, Riemann and Lebesgue integrals.

MODULE III : Differentiations, continuous non-differentiable functions, Lebesgue's differentiation theorem, differentiation and integration.

MODULE IV : Measures and outer measures, extension of a measure, uniqueness of the extension, completion of a measure, measure spaces, integration with respect to a measure (definition and Theorem 18 only).

MODULE V : The L^p spaces, convex functions, Jensen's Holder's and Minkowski's inequalities, completeness of L^p spaces, convergence in measure, almost uniform convergence, counter examples.

MODULE VI : Signed measures and the Hahn decomposition, Jordan decomposition, Radon-Nikodym theorem, measurability in a product space, product measures, Fubini's theorem (statement and examples only), Lebesgue measure in Euclidean space.

REFERENCE

- De Barra G., Measure Theory and Integration, New Age International (P) Ltd. Publishers, New Delhi, 2006

ADDITIONAL REFERENCES

- Athreya K. B. and Lahiri S. N., Measure Theory, Hindustan Book Agency, New Delhi, 2006.
- Bartle R. G., The Element of Integration, John Wiley, 1964.
- Berberian S. K., Measure and Integration, The McMillan Company, New York, 1965.
- Halmos P. R., Measure Theory, Springer Verlag.
- Rana K., An Introduction to Measure and Integration, Narosa Publishing company, New York, 1965.
- Royden H. L., Real Analysis, Prentice Hall India, 1988 (3rd edition).
- Rudin W., Real and Complex Analysis, Tata McGraw Hill, New Delhi, 2006.

SEMESTER: II
COURSE CODE: MAT-C-423
COURSE TITLE: ALGEBRAIC TOPOLOGY
CREDITS: 4

AIM: To familiarize students with homotopy theory and homology theory so that theory will be able to connect topological concepts with algebraic concepts.

OBJECTIVES: To make an elaborate study on the following concepts; connectedness and geometric complexes, simplicial homology groups, simplicial approximation, fundamental group and covering spaces.

COURSE CONTENT

MODULE I : Connected spaces, Geometric complexes and polyhedral, Orientation of geometric complexes, chains and cycles.

MODULE II : Chains, cycles and homology groups, Examples of homology groups, Structure of homology groups, Euler-Poincare theorem.

MODULE III : Simplicial approximation, Induced homomorphisms on the homology groups, Brouwer fixed point theorem and related results.

MODULE IV : Homotopic paths and the fundamental group

MODULE V : Covering homotopy property for S^1, Examples of fundamental groups.

MODULE VI : Basic properties of covering spaces, Classification of covering spaces, Universal covering spaces

REFERENCES

- Croom F. H., “Basic Concepts of Algebraic Topology”, Springer – Verlag, 1978
- Willard S., “General Topology”, Addison – Wesley

ADDITIONAL REFERENCES

- Armstrong M. A., “Basic Topology”, Springer – Verlag, 1983
- Hatcher, “Algebaic Topology”, Cambridge University Press, 2002
- Munkers J. R., “Elements of Algebraic Topology”, Addison – Wesley, 1984
- Spanier E., “Algebaic Topology”, Springer – Verlag, 1966

SEMESTER: II
COURSE CODE: MAT-E-424
COURSE TITLE: GRAPH THEORY
CREDITS: 4
AIM: To study how concepts in different fields of mathematics can be applied through graphs.

OBJECTIVES: To acknowledge graph as a mathematical model for any system involving a binary relation and thereby finding its applications in day to day life.

COURSE CONTENT

MODULE I: Vertices of graphs, walks and connectedness, degrees, intersection graphs, operations on graphs, cutpoints, bridges and blocks

MODULE II: Characterization of trees, centers and centroids, Connectivity and line connectivity, partitions

MODULE III: Eulerian graphs, Hamiltonian graphs, Some problems of line graphs, line graphs and traversability

MODULE IV: 1-factorization, 2-factorization, coverings and independence, critical points and lines

MODULE V: Plane and planar graphs, outer planar graphs, genus, thickness, coarseness, crossing number, the chromatic number, the five colour theorem, the four colour conjecture, critical graphs.

MODULE VI: The adjacency matrix, the incidence matrix, the cycle matrix, digraphs and connectedness, digraphs and matrices

REFERENCE

- Harary, “GRAPH THEORY”, Addison-Wesley,1989.

ADDITIONAL REFERENCES

- Bondy J.A and Murthy U.S.R, “Graph Theory with Applications”, The Macmillan Press limited.
- Gary Chartrand and Ping Zhang, “Introduction to Graph Theory”, Tata-McGraw-Hill Edition 2006.
- Suresh Singh G., “Graph Theory” PHI Learning Private Limited.
- Vasudev C., “Graph Theory Applications”,
- West D.B, “Introduction to Graph Theory”, PHI learning Private limited.

SEMESTER: II
COURSE CODE: MAT-E-425
COURSE TITLE: THEORY OF WAVELETS
CREDITS: 4

AIM: To familiarize the knowledge on applications of Fourier transforms

OBJECTIVES: Introduction of applied structure through wavelets.

COURSE CONTENT

MODULE I: Construction of Wavelets on Z_N the first stage

MODULE II: Construction of Wavelets on Z_n the iteration sets, Examples - Shamon, Daubiehie and Haar

MODULE III: l_2 (Z), Complete Orthonormal sets, $L_2[-\pi,\pi]$ and Fourier Series

MODULE IV: Fourier Transforms and convolution on l_2 (Z),

MODULE V: First stage wavelets on Z

MODULE VI: The iteration step for wavelets on Z, Examples, Shamon Haar and Daubiehie

REFERENCE

- Michael Frazier, An Introduction to Wavelets through Linear Algebra, Springer

ADDITIONAL REFERENCES

- Chui. C(1992), An Introduction to Wavelets, Academic Press, Boston 29
- Mayor (1993), Wavelets and Operators, Cambridge University Press

SEMESTER: III
COURSE CODE: MAT-C-431
COURSE TITLE: COMPLE X ANALYSIS-I
CREDITS: 4

AIM: The aim of the course is to familiarize the students with analytic functions and complex integration which are useful in other sciences like physics, statistics etc.

OBJECTIVES: In this course, the students are taught the principal techniques and methods of analytic function theory.

COURSE CONTENT

MODULE I : The extented plane and its spherical representation, Power Series, Analytic Function

MODULE II : Riemann – Stieltjes Integrals, Power Series representation of an analytic Function

MODULE III : Zeros of an analytic Function, The index of a closed curve, Cauchy's Theorem and Integral Formula

MODULE IV : Homotopic Version of Cauchy's Theorem, Simple Connectivity, Counting Zeros , The open mapping theorem, Goursat's Theorem.

MODULE V : Singularities ; Classification, Residues, The argument principles

MODULE VI : Analytic functions as mappings, Mobius transformations, the maximum principle, Schwarz's lemma.

REFERENCE

- John. B. Conway, Functions of Complex Variables, Springer – Verlag , New York, 1973. (Indian Edition ; Narosa)

ADDITIONAL REFERENCES

- Ahlfors L. V., Complex analysis, Mc – Graw Hill (1966)
- Lang S., Complex analysis, Mc – Graw Hill (1998)

SEMESTER: III
COURSE CODE: MAT-C-432
COURSE TITLE: FUNCTIONAL ANALYSIS
CREDITS: 4
AIM: To give an elaborate study on functional properties on various spaces

OBJECTIVES: To get an overview of normed spaces, linear maps and detailed study on Banach spaces

COURSE CONTENT

MODULE I : Normed spaces, Riesz lemma, continuity of linear maps, operator norm

MODULE II: Hahn Banach theorem, Hahn Banach separation theorem, Hahn Banach extension theorem, Banach spaces

MODULE III: Bounded linear maps on Banach spaces, Uniform boundedness principle, resonance theorem, closed graph theorem and open mapping theorem,

MODULE IV: spectrum of bounded operator, Gelfand Mazur theorem, Spectral radius formula

MODULE V: Duals and transposes, closed range theorem, weak and weak* convergences, Bolzano-Weierstrass property, reflexivity.

MODULE VI: Compact linear maps, spectrum of a compact operator

REFERENCE

- Limaye B.V., Functional Analysis, New Age International (P) Limited publishers, Second edition.

ADDITIONAL REFERENCES:

- Kreyszig E., Introductory Functional analysis with applications, John Wiley, 1978.
- Maddox I. J., Elements of Functional analysis, Universal book stall, New Delhi, Second edition.

SEMESTER: III
COURSE CODE: MAT-C-433
COURSE TITLE: APPROXIMATION THEORY
CREDITS: 4
AIM: To give an understanding of the fundamental methods and theoretical basis of approximation.
OBJECTIVES: The course, approximation theory covers a great deal of mathematical territory. In the present context, the focus is primarily on the approximation of real-valued continuous functions by some simpler class of functions such as algebraic or trigonometric polynomials. Approximation theory, as the name suggests, has both a pragmatic side, which is concerned largely with computational practicalities, precise estimations of error and so on and also a theoretical side, which is more concerned with existence and uniqueness questions and applications to other theoretical issues.

COURSE CONTENT
MODULE I : Metric spaces- an existence theorem for best approximation from a compact subset ; Normed linear spaces, Inner product spaces

MODULE II : Convexity – Caratheodary's theorem – Theorem on linear inequalities – an existence theorem for best approximation from finite dimensional subspaces – uniform convexity – strict convexity

MODULE III : The Tchebycheff solution of inconsistent linear equations – systems of equations with one unknown – three algebraic algorithms ; Characterization of best approximate solution for m equations in n unknowns – the special case m = n +1 ; Polya's algorithm.

MODULE IV : Interpolation – the Lagrange formula – Vandermonde's matrix – the error formula – Hermite interpolation ; The Weierstrass theorem – Bedrstein polynomials – Monotone operators – Fejer's theorem ; General linear families – characterization theorem – Haar conditions – alternation theorem.

MODULE V : Rational approximation – Conversion of rational functions to continued fractions; Existence of best rational approximation – extension of the classical theorem ; Generalized rational approximation – the characterization of best approximation – an alternation theorem – the special case of ordinary rational functions ; Unicity for generalized rational approximation.

MODULE VI : The Stone Approximation Theorem ; The Muntz Theorem – Gram's lemma ; Approximation in the mean – Jackson's Unicity Theorem – Characterization theorem – Markoff's theorem.
REFERENCE

- Cheney E.W., "Introduction to Approximation Theory" , MC Graw Hill

ADDITIONAL REFERENCE

- Davis P. J, "Interpolation and Approximation", Blaisdell Publ..

SEMESTER: III
COURSE CODE: MAT-E-434
COURSE TITLE: DIFFERENTIAL GEOMETRY
CREDITS: 4

AIM: Elaborate study of geometry in terms of calculus

OBJECTIVES: This course is a study of different concepts of geometry through calculus terminologies like vector fields, tangent maps, The Gauss map and so on.

COURSE CONTENT

MODULE I: Graphs and level sets, Vector fields,

MODULE II: Tangent Spaces, Surfaces, Vector fields on surfaces

MODULE III: Orientation, The Gauss map

MODULE IV: Geodesics, Parallel transport

MODULE V: The Weingarten map, Curvature of plane curve

MODULE VI: Arc length, Line integral, Curvature of surfaces

REFERENCE

- John. A. Thorpe, Elementary Topics in Differential Geometry, Springer-Verlag

ADDITIONAL REFERENCES

- Singer I and Thorpe J.A, Lecture notes on Elementary Topology and Geometry, Springer-Verlag

- Spivak M, Comprehensive Introduction to Differential Geometry (Vol. s 1 to 5), Publish or Perish Boston.

SEMESTER: III
COURSE CODE: MAT-E-435
COURSE TITLE: OPERATIONS RESEARCH
CREDITS: 4

AIM: This course aims to introduce students to use quantitative methods and techniques for effective decisions-making; model formulation and applications that are used in solving business decision problems.

OBJECTIVES: Operations Research is a scientific approach to problem solving. It requires the formulation of mathematical, economical and statistical models for decision and control problem, to deal with the situations arising out of risk and uncertainty. The subject provides the theoretical aspects with practical applications.

COURSE CONTENT

MODULE I: Two variable LP model, Solution of a maximization model, Solution of a minimization model, Converting inequalities into equations, Dealing with unrestricted variables, Iterative nature of the simplex method, Computational details of the simplex algorithm

MODULE II: M-Method, Two-Phase Method, Degeneracy ,Alternative optima, Unbounded solution, Infeasible solution, Duality in LPP, Simplex Tableau layout, optimal dual solutions, Simplex Tableau computations, primal and dual objective value.

MODULE III: Definition of the transportation model, determination of the starting solution: The North West corner cell method, Least Cost method, Vogel's approximation method, Loops in transportation model, iterative computations of the transportation algorithm, MODI method or U-V method.

MODULE IV: The assignment model, the Hungarian method, simplex explanation of the Hungarian method , Network definitions, Shortest route algorithms: Dijkstra's algorithm , Floyd's algorithm,linear programming formulation of the shortest route problem

MODULE V: Network representation, critical path(CPM) computations, construction of the time schedule, determination of floats, Red-Flagging rule, linear programming formulation of CPMelements of a queuing model, role of exponential distribution, pure birth model, pure death model.

MODULE VI: Generalized Poisson queuing model, Specialized Poisson Queues, Steady State measures of performances, Single server models; $(M/M/1) : (GD/\infty/\infty)$, $(M/M/1) : (GD/N/\infty)$, Multiple Server models; $(M/M/C) : (GD/\infty/\infty)$, $(M/M/C) : (GD/N/\infty)$; $C \leq N$, Self Service models, $(M/M/\infty) : (GD/\infty/\infty)$

REFERENCE

- Hamdy A. Taha, "OPERATIONS RESEARCH", Seventh edition, Pearson Education (Singapore) Pte.Ltd

ADDITIONAL REFERENCES

- Goel B.S and Mittal S.K "Operations Research" Pragati Prakashan, Meerut 1973
- Hardly G, "Linear Programming" Addison Wesley, Reading. Mass. 1962
- Kapoor V.K, "Operations Research" Sultan chand and sons, New Delhi 1985.
- Nita H.Shah, Ravi M.Gor, Hardik Soni, "Operations Research", Prentice Hall of India, New Delhi, 2007.
- Ravindran A, Don.T. Phillips, James.J.Solberg, "Operations research-Principles and Practice", Second edition, John Wiley and Sons (Asia) Pvt.Ltd., Singapore-2000

SEMESTER: III
COURSE CODE: MAT-E-436
COURSE TITLE: GALOIS THEORY
CREDITS: 4

AIM: To obtain wider knowledge about field extensions

OBJECTIVES: To draw an attention on various results of the different algebraic structures, in particular, properties of rings of polynomials, extension fields, splitting fields.

COURSE CONTENT

MODULE I: Rings of polynomials over a field, evaluation homomorphism, zeros of polynomials, Division algorithm, Irreducible polynomial, Prime and maximal ideals, prime fields.

MODULE II: Extension field and zeros of polynomials, Irreducible polynomial for elements

MODULE III: Algebraic extensions, algebraically closed field, algebraic closure.

MODULE IV: Automorphisms of splitting fields, separable extensions, perfect fields.

MODULE V: Galois group of a polynomial, Frobenius automorphism, primitive n^{th} roots of unity, solvability by radicals.

MODULE VI: Galois extension and intermediate fields, The fundamental theorem of Galois theory, Applications.

REFERENCES

- John B. Fraleigh, A First Course in Abstract Algebra, AWL, 1999 (5^{th} Edition)
- Joseph Rotman, Galois Theory, Springer, 1998

ADDITIONAL REFERENCES

- Hungerford T.W., Algebra, Springer, 1974
- Patrick Morandi, Field and Galois theory, Springer, 1996

SEMESTER: IV
COURSE CODE: MAT-C-441
COURSE TITLE: COMPLEX ANALYSIS-II
CREDITS: 4

AIM: This course aims to give the students an understanding of the space of analytic functions, harmonic functions and entire functions which are useful in boundary value problems.

OBJECTIVES: In this course, the students are taught about harmonic functions and entire functions. They are also familiarized with Riemann surfaces.

COURSE CONTENT

MODULE I : Compactness and Convergence in the space of Analytic functions, The space C(G,Ω), Space of Analytic functions, Riemann Mapping Theorem.

MODULE II : Weierstrass factorization Theorem, Factorization of sine function, The Gamma function.

MODULE III : Riemann Zeta function, Runge's Theorem, Simple connectedness, Mittag – Leffler's Theorem.

MODULE IV : Analytic continuation and Riemann surfaces, Schwarz Reflection Principle, Analytic continuation along a path, Monodromy Theorem.

MODULE V: Basic properties of Harmonic functions, Harmonic functions on a disc,

MODULE VI : Entire functions, Jensen's formula, The genus and order of an entire function, Hadamard factorization Theoerm.

REFERENCE

- John. B. Conway, "Functions of One Complex Variable", Springer – Verlag, New York, 1973. (Indian Edition : Narosa)

ADDITIONAL REFERENCES

- Ahlfors L. V., Complex Analysis, Mc-Graw Hill (1966)
- Rudin W., Real and Complex Analysis, Mc-Graw

SEMESTER: IV
COURSE CODE: MAT-C-442
COURSE TITLE: THEORY OF LINEAR OPERATORS
CREDITS: 4

AIM: To acquire knowledge on different kinds of functional operators

OBJECTIVES: Preliminary study on inner product spaces and orthonormal spaces. Detailed study on various linear operators viz. projections, bounded operators, adjoint, normal, unitary and self-adjoint operators and so on.

COURSE CONTENT

MODULE I : Inner product spaces, orthonormal sets

MODULE II : Projection and Riesz representation theorems, bonded operators and adjoints

MODULE III: Normal, unitary and self adjoint operators, Spectrum and numerical range

MODULE IV: Compact self adjoint operators

MODULE V: Orthogonal projections

MODULE VI: General preliminaries of Banach Algebras and the structure of commutative Banach algebras

REFERENCES

- Limaye V., Functional Analysis, New Age International Limited, 1997 (second edition)
- Limaye B. V., Functional Analysis, Wiley Eastern Limited, 1981.
- Simmons G. F., Topology and Modern Analysis, McGraw – Hill, Singapore.

ADDITIONAL REFERENCES

- Kreyszig E., Introductory Functional analysis with applications, John Wiley, 1978.
- Maddox J., Elements of Functional analysis, Universal book stall, New Delhi, Second edition.

SEMESTER: IV
COURSE CODE: MAT-E-443
COURSE TITLE: REPRESENTATION THEORY OF FINITE GROUPS
CREDITS: 4

AIM: The aim of this course is to learn what representation theory is and how to use it. Representation theory deals with symmetry in linear spaces and a special emphasis on finite groups.

OBJECTIVES: To study about abstract algebraic structures by representing their elements as linear transformation of vector spaces and studies modules over these abstract algebraic structures. In essence, representation makes an abstract algebraic object, more concrete by describing its elements by matrices and the algebraic operations in terms of matrix addition and matrix multiplication. Representation theory is a powerful tool because it reduces problem in abstract algebra to problems in linear algebra.

COURSE CONTENT

MODULE I : Introduction , G-modules, Characters, Reducibility, Permutation representations Complete reducibility, Schur's lemma.

MODULE II : The commutant (endomorphism) algebra, Orthogonality relations, The group algebra.

MODULE III : The character table, Finite abelian groups, The lifting process, Linear characters.

MODULE IV : Induced representations, The reciprocity law, The alternating group A_5, Normal subgroups.

MODULE V : Transitive groups, The symmetric group, Induced characters of S_n.

MODULE VI : Algebraic numbers, Representation of the group algebra, Burnside's (p,q) theorem, Frobenius groups.

REFERENCE

- Walter Ledermann, Introduction To Group Characters (second edition)

ADDITIONAL REFERENCES

- Faulton- The Representation Theory of Finite groups, Lecture notes in Maths No.682, Springer 1978.
- Kurtis W. and Reiner I. -Representation theory of finite groups and Associative algebras, John Wiley & sons, New York 1962.
- Musli C.- Representations of Finite groups,Hindustan Book Agency, New Delhi 1993.
- Schur I.-Theory of Group Characters, Academic Press, London 1977.
- Serre J.P.- Linear Representations of Finite Groups, Graduate text in Maths,Vol 42,Springer 1977

SEMESTER: IV
COURSE CODE: MAT-E-444
COURSE TITLE: NUMBER THEORY
CREDITS: 4

AIM: To study various properties of numbers in terms of functions

OBJECTIVES: This course is essential to show connections between number theory and other branches of mathematics including algebra, analysis and combinatorics.

COURSE CONTENT

MODULE I : Arithmetical functions and Dirichlet Multiplication

MODULE II: Multiplicative functions and completely multiplicative functions, Bell series

MODULE III : Congruences, Chinese Remainder theorem

MODULE IV: Periodic Arithmetic functions, Gauss sums

MODULE V : Quadratic residues, Reciprocity law, Jacobi symbol

MODULE VI : Primitive roots, existence and number of primitive roots

REFERENCE

- Apostol T.M., Introduction to Analytic Number Theory, Narosa Publishing House, New Delhi, 1990

ADDITIONAL REFERENCE

- Rose H. E., A Course in Number Theory (Second Edition), Clarendon press, Oxford, 1994.

SEMESTER: IV
COURSE CODE: MAT-E-445
COURSE TITLE: CODING THEORY
CREDITS: 4

AIM: To study the method of sending communication with security

OBJECTIVES: This course provides preliminary concepts on coding theory and a detailed study on error detection and correction.

COURSE CONTENT

MODULE I: Detecting and correcting error patterns, Information rate, The effects of error detection and correction, Finding the most likely code word transmitted, Weight and distance, MLD, Error detecting and Correcting codes.

MODULE II: Linear codes, bases for C = <S> and $C^{\perp}$, generating and parity check matrices, Equivalent codes, Distance of a linear code, MLD for a linear code, Reliability of IMLD for linear codes.

MODULE III: Perfect codes, Hamming code, Extended codes,

MODULE IV: Golay code and extended Golay code, Red Hulles Codes

MODULE V: Cyclic linear codes, Polynomial encoding and decoding, Dual cyclic codes

MODULE VI: BCH Codes, Cyclic Hamming Code, Decoding 2 error correcting BCH codes

REFERENCE

- Hoffman D.J etal., Coding Theory The Essentials, Published by Marcel Dekker Inc 1991

ADDITIONAL REFERENCES

- Berlekamp E.R, Algebriac Coding Theory, Mc Graw-Hill, 1968
- Cameron P.J and Van Lint J.H, Graphs, Coded and Designs CUP
- Hill H., A First Course in Coding Theory, OUP 1986.

SEMESTER: IV
COURSE CODE: MAT-D-446
COURSE TITLE: DISSERTATION
CREDITS: 6

AIM: To train the students to analyse some concepts by their own and to develop their writing skill.

OBJECTIVES: This course provides knowledge on methodology to write a dissertation.

SEMESTER: II
COURSE CODE: MAT-X-421
COURSE TITLE: COMPLEX ANALYSIS
CREDITS: 2

AIM: The aim of this course is to introduce the main ideas of complex analysis.

OBJECTIVES: The study of this paper provides a powerful tool for solving a wide array of problems arising in applications. Each of the four MODULEs of this course has been designed to stimulate students' interest in complex numbers through associative conceptual building blocks in the study and application of complex analysis to practical problem solving.

COURSE CONTENT

MODULE I : Power series, Radius of convergence, Analytic functions, Chain rule, Branch of the logarithm, Cauchy Riemann equations, Harmonic functions, Necessary & sufficient condition for a function to be analytic, Harmonic conjugate

MODULE II : Linear fractional transformation, Mobius transformations, Translation, Dilation, Rotation, Inversion, Cross-ratio, Symmetric points, Symmetry principle

MODULE III : Line integral along a path, Equivalent paths, Curve, Analogue of the fundamental theorem of calculus for line integrals, Power series representation of analytic functions, Leibnitz's rule, Cauchy's estimate

MODULE IV : zeros of analytic functions, Multiplicity of zeroes, entire functions, Liouville's theorem, fundamental theorem of algebra, maximum modulus theorem, The index of a closed curve

MODULE V: Cauchy's Theorem and Integral formula, Cauchy's integral formula (first version), Cauchy's theorem (first version), Morera's theorem, Goursat's Theorem

MODULE VI: Singularities, Classification of singularities, Laurent series development (without proof), Residues, Residue theorem, Calculation of certain integrals by means of residue theorem, The Argument Principle, Rouche's theorem

REFERENCE

- Conway J. B., Functions of One Complex Variable, Second edition, Springer – Verlag, New York, 1973

ADDITIONAL REFERENCES

- Ahlfors L. V., Complex Analysis, Mc-Graw Hill (1966)
- Lang S., Complex Analysis, Mc-Graw Hill (1968)

SEMESTER: II
COURSE CODE: MAT-X-422
COURSE TITLE: FINITE STATE MACHINES
CREDITS: 2

AIM: This course aims to give an introduction to the basic concepts in formal language theory.

OBJECTIVE: To give an introduction to Finite state machines and its application to other fields.

COURSE CONTENT

MODULE I: Graphs, languages, grammars and automata.

MODULE II: Deterministic finite acceptors and their transition graphs, languages and deterministic finite acceptors, regular languages.

MODULE III: Nondeterministic finite acceptors, equivalence of deterministic and nondeterministic finite acceptors, minimal automata.

MODULE IV: Regular expressions, languages associated with regular expressions, equivalence of regular expressions and regular languages.

MODULE V: Regular grammars, equivalence of regular grammars and regular languages.

MODULE VI: Closure properties of regular languages, elementary questions about regular languages, Pumping lemma.

REFERENCE

- Linz P., An introduction to formal languages and automata, Jones and Bartlet student edition, 2012

ADDITIONAL REFERENCES

- Anderson J. A., Automata Theory with Modern Applications, Cambridge University Press, 2006
- Hopcroft J. E., Motwani R., Ullman J. D, Introduction to Automata Theory, languages and computation, Pearson, 2013
- Sisper M., Introduction to the Theory of Computation, CENGAGE Learning, 2012