University of Delhi

Examination Branch

Date: 13-05-2009

Check List of New Course Evaluation for AC Consideration

S.No.	Parameters	Status
1.	Affiliation	√
2.	Programme Structure	√
3.	Codification of Papers	√
4.	Scheme of Examinations	√
5.	Pass Percentage	√
6.	Promotion Criteria	√
7.	Division Criteria	√
8.	Qualifying Papers	X
9.	Span Period	√
10.	Attendance Requirements	X
11.	Course Content for each paper	√
12.	List of Readings	√

M Sc

SYL

MASTER OF ARTS / SCIENCE

MATHEMATICS

TWO-YEAR FULL-TIME PROGRAMME

RULES, REGULATIONS AND COURSE CONTENTS

DEPARTMENT OF MATHEMATICS
FACULTY OF MATHEMATICAL SCIENCES
UNIVERSITY OF DELHI
DELHI-110007
2009

7685

MASTER OF ARTS / SCIENCE
(MATHEMATICS)

TWO-YEAR FULL-TIME PROGRAMME

AFFILIATION

The proposed programme shall be governed by the Department of Mathematics, Faculty of Mathematical Sciences, University of Delhi, Delhi-110007.

PROGRAMME STRUCTURE

The master's programme in Mathematics is divided into two parts as hereunder. Each Part will consist of two Semesters.

Part I	First Year	Semester – 1	Semester – 2
Part II	Second Year	Semester – 3	Semester – 4

The courses prescribed for various semesters shall be the following:

PART I: Semester- 1

Math 101 – Topology
Math 102 – Module Theory
Math 103 – Complex Analysis
Math 104 – Differential Equations

PART I: Semester– 2

Math 201 – Measure and Integration
Math 202 – Functional Analysis
Math 203 – Field Theory
Math 204 – Fluid Dynamics

PART II: Semester– 3

Math 301: Any course out of the following

(i) Introduction to Algebraic Topology
(ii) Advanced Measure theory

Math 302: Any course out of the following

(i) Advanced Group Theory

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(ii) Theory of Non-commutative Rings
(iii) Algebraic Number Theory
(iv) Introduction to Harmonic Analysis
(v) Theory of Operators
(vi) Theory of Frames
(vii) General Topology

Math 303: Any course out of the following

(i) Mechanics
(ii) Dynamical Systems
(iii) Computational Fluid Dynamics
(iv) Coding Theory
(v) Mathematical Programming
(vi) Computational Methods for Ordinary Differential Equations
(vii) Applied Numerical Analysis

Math 304: Any course out of the following

(i) A course of equivalent credit offered by another department.
(ii) Differential Geometry
(iii) Representation of Finite Groups

Part II: Semester – 4

Math 401: Any course out of the following

(i) Advanced Complex Analysis
(ii) Introduction to Differential Manifolds.

Math 402: Any course out of the following

(i) Homology Theory
(ii) Theory of Semi-rings
(iii) Homological Algebra
(iv) Abstract Harmonic Analysis
(v) Spectral Theory of Unbounded Operators
(vi) Banach Algebras
(vii) Operators on Hardy - Hilbert Spaces
(viii) Advanced Functional Analysis
(ix) Complex Dynamics

Math 403: Any course out of the following

(i) Methods of Applied Mathematics
(ii) Bio Fluid Mechanics
(iii) Advanced Coding Theory

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(iv) Optimization Techniques and Control Theory
(v) Computational Methods for Partial Differential Equations
(vi) Graph Theory
(vii) Cryptography

Math 404 Any course out of the following

(i) A course of equivalent credit offered by another department
(ii) Commutative Algebra
(iii) Probability Theory

NOTES : (1) **Each course will have 5 credits: 4 lectures, 1 discussion and 1 tutorial per week.**

(2) **In the beginning of the respective semesters, the Department will announce the list of elective courses which will be offered during the semester depending upon the availability of lecturers and the demand of electives.**

SCHEME OF EXAMINATIONS

2. English shall be the medium of instruction and examination.

3. Examinations shall be conducted at the end of each Semester as per the Academic Calendar notified by the University of Delhi.

4. Each course will carry 100 marks and have two components: Internal Assessment 30% marks and End-Semester Examination 70% marks.

5. The system of evaluation shall be as follows:

4.1 Internal assessment will be based on classroom participation, seminar, term courses, tests, quizzes. The weightage given to each of these components shall be decided and announced at the beginning of the semester by the individual teacher responsible for the course. No special classes will be conducted for a student during other semesters, who fails to participate in classes, seminars, term courses, tests, quizzes and laboratory work.

4.2 The remaining 70 marks in each paper shall be awarded on the basis of a written examination at the end of each semester. The duration of written examination for each paper shall be three hours.

6. Examinations for courses shall be conducted only in the respective odd and even Semesters as per the Scheme of Examinations. Regular as well as Ex-Students shall be permitted to appear/re-appear/improve in courses of Odd

Semesters only at the end of Odd Semester and courses of Even Semesters only at the end of Even Semesters.

PASS PERCENTAGE

Minimum marks for passing the examination in each semester shall be 40% in each paper and 45% in aggregate of a semester. However, a candidate who has secured the minimum marks to pass in each paper but has not secured the minimum marks to pass in aggregate may reappear in any of the paper/papers of his choice in the concerned semester in order to be able to secure the minimum marks prescribed to pass the semester in aggregate.

No student would be allowed to avail of more than 3 chances to pass any paper inclusive of the first attempt.

PROMOTION CRITERIA

SEMESTER TO SEMESTER: Students shall be required to fulfill the Part to Part Promotion Criteria. Within the same Part, students shall be allowed to be promoted from a Semester to the next Semester, provided she/he has passed at least half of the courses of the current semester.

PART TO PART :

I TO II : Admission to Part-II of the Programme shall be open to only those students who have successfully passed at least 75% papers out of papers offered for the Part-I courses comprising of Semester–1 and Semester–2 taken together. However, he/she will have to clear the remaining papers while studying in Part-II of the Programme.

DIVISION CRITERIA

Successful candidates will be classified on the basis of the combined results of Part-I, Part-II examinations as follows:

Candidates securing 60% and above	:	Ist Division
Candidates securing between 50% and above and less than 60%	:	IInd Division
All others	:	IIIrd Division

SPAN PERIOD

No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of four years from the date of admission to the Part-I/Semester –1 of the master's programme in Mathematics.

Math 101 - Topology

Topological spaces, basis and subbasis for a topology, order topology, subspaces, continuous functions, homeomorphism, product topology and quotient topology. Connected spaces, components, local connectedness, path connected spaces, path components, local path connectedness. Compactness, Bolzano- Weierstrass property, local compactness.

First countable spaces, second countable spaces and Lindelöf spaces. Hausdorff, regular, normal and completely regular spaces, Urysohn lemma, Urysohn metrization theorem and Tietze extension theorem.

References:

[1] J. Dugundji, Topology, Universal Book Stall, 2002.
[2] J.L. Kelley, General Topology, Springer–Verlag, 1991.
[3] J. R. Munkres, Topology, second edition, Pearson Education, 2000.
[4] S. Willard, General Topology, Addison-Wesley, 2004.

Math 102 - Module Theory

Modules, basic concepts. homomorphisms and exact sequences, direct products and direct sums, free modules, modules over principal ideal domain, semi-simple modules, chain conditions, Noetherian rings, Hilbert basis theorem. Categories and functors. Hom functors, tensor product of modules, projective and injective modules.

References:

[1] W.A. Adkins and S.H. Weintraub, Algebra: An Approach via Module Theory, Springer-Verlag, 1992.
[2] P.M.Cohn, Classic Algebra, John Wiley & Sons, Ltd., 2000.
[3] P.M. Cohn, Basic Algebra, Springer International Edition, 2003.
[4] D.S. Dummit and R.M. Forte, Abstract Algebra, Prentice Hall, 1991.
[5] T.W. Hungerford, Algebra, Springer- Verlag, 1981.
[6] N. Jacobson, Basic Algebra, Vol. II, Hindustan Publishing Co., 1989.

Math 103 - Complex Analysis

Lines and half planes in the complex plane, the extended complex plane and its spherical representation.

Power series, analytic functions, analytic functions as mappings, conformal mapping, Mobius transformations.

Riemnann-Stieltjes integrals, Taylor series, power series representation of analytic functions, zeroes of an analytic function, the index of a closed curve, Cauchy's theorem and integral formula, the homotopic version of Cauchy's theorem and simple connectedness, counting zeroes, the open mapping theorem.

Classification of singularities, Laurent series, residues, contour integration, argument principle, maximum modulus theorem, Schwartz lemma.

References:

[1] M.J. Ablowitz, Complex Variables, Introduction and Applications, Cambridge University Press, 2003.
[2] L.V. Ahlfors, Complex Analysis, McGraw Hill Co.,New York, 1988.
[3] J.B. Conway, Functions of one Complex Variable, Narosa, Delhi, 2000.
[4] T.W. Gamelin, Complex Analysis, Springer-Verlag, 2008.
[5] S. Lang, Complex Analysis, Springer-Verlag, 2003.

Math 104 - Differential Equations

Existence and uniqueness of solution of ordinary differential equation of first order. Picard's method, Cauchy Lipschitz method. Existence theorem in complex plane. Existence and uniqueness theorem for simultaneous differential equations of first order. Existence and uniqueness theorem for ordinary differential equations of higher order. Sturm comparison and separation theorems, homogeneous linear systems, nonhomogeneous linear systems, linear systems with constant coefficients. Two point boundary value problems, Green's functions, construction of Green's functions, Sturm-Liouville systems, eigen-values and eigen functions.

Stability of autonomous system of differential equations, critical points of an autonomous system and their classification as stable, asymptotically stable, strictly stable and unstable. Stability of linear systems with constant coefficients. Linear plane autonomous systems, perturbed systems. Method of Lyapunov for nonlinear systems.

Boundary value problems, maximum and minimum principles, uniqueness and continuity theorems, Laplace equation in two-dimensions, Dirichlet and Neumann problem for half plane, Dirichlet and Neumann problem for a circle , Green's function for Laplace equation in two dimensions, Dirichlet problem for sphere and semi-infinite space, Greens function for three-dimensional Laplace equation.

Wave equation, D'Alembert's solution for one-dimensional wave equation, Helmholtz's first and second theorems. Green's function for wave equation.

Diffusion equation, solution of initial boundary value problems for the diffusion equation, Green's function for the diffusion equation.

References:

[1] G.F.Simmons: Ordinary Differential Equations with applications and Historical notes, Tata McGraw Hill, 2005.
[2] Lan Sneddon, Elements of Partial Differential Equations, McGraw- Hill,1986
[3] Tyn Myint-U, Ordinary Differential Equations, Elsevier North-Holland, 1978.
[4] Tyn Myint-U, Le Debnath, Linear Partial Differential Equations for Scientists and Engineers, Birkhauser, 2007.

Math 201 - Measure and integration

Lebesgue outer measure. Measurable sets, regularity, measurable functions, Borel and Lebesgue measurability. Non-measurable sets. Integration of non-negative functions. The general integral, integration of Series, Riemann and Lebesgue Integrals. The Dini derivatives, functions of Bounded variations, Lebesgue differentiation theorem, differentiation and integration. Measures and outer measures, extension of a measure, uniqueness of extension, completion of a measure, measure spaces, integration with respect to a measure.

The L^p-spaces, convex functions, Jensen's inequality, the inequalities of Holder and Minkowski, completeness of L^p-spaces, convergence in Measure, almost uniform convergence. Egorov's theorem, Lusin's theorem.

References:

[1] G.De Barra. Measure Theory and Integration. Wiley Eastern Limited, 1981.
[2] E. Hewitt and K. Stromberg, Real and Abstract Analysis, Springer, Berlin, 1969.
[3] H.L. Royden, Real Analysis, Pearson, 2008.

Math 202 - Functional analysis

Normed spaces, Banach spaces, properties of normed spaces, finite dimensional normed spaces and subspaces, compactness and finite dimension, linear operators, bounded and continuous linear operators, linear functionals, linear operators and functionals on finite dimensional spaces, normed spaces of operators, dual spaces.

Inner product spaces, Hilbert spaces, properties of inner product spaces, orthogonal complements and direct sums, orthonormal sets and sequences, series related to orthonormal sequences and sets, total orthonormal sets and sequences, representation of functionals on Hilbert spaces, Hilbert-adjoint operator, self-adjoint, unitary and normal operators.

Hahn-Banach theorems for real/complex vector spaces and normed spaces. application to bounded linear functionals on C[a,b], adjoint operators, reflexive spaces, category theorem, uniform boundedness theorem, strong and weak convergences, open mapping theorem, closed graph theorem.

Banach's fixed point theorem, spectrum of an operator and its non-emptiness.

References:

[1] Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons (Asia), Pvt. Ltd., 2006.

[2] George Bachman and Lawrence Narici, Functional Analysis, Dover, 2000.

[3] John B. Conway, A course in Functional Analysis, second edition, Springer-Verlag, 2006.

[4] Martin Schechter, Principles of Functional Analysis, second edition, AMS Book store, 2002.

[5] V.S. Sunder, Functional Analysis, Spectral Theory, Birkhauser Texts, Basel, 1997.

Math 203 – Field Theory

Fields and their extensions, splitting fields, the algebraic closure of a field, separability, automorphisms of field extensions, the fundamental theorem of Galois theory, roots of unity, finite fields, primitive elements; norm and trace, Galois theory of equations, the solution of equations by radicals.

References:

[1] P.M. Cohn, Classic Algebra, John Wiley & Sons Ltd., 2000.

[2] P.M. Cohn: Basic Algebra, Springer International Edition, 2003.

[3] N. Jacobson, Basic Algebra I and II, Hindustan Publishing Co., 1989.

[4] T.W. Hungerford, Algebra, Springer-Verlag, 1981.

Math 204 - Fluid Dynamics

Classification of fluids, the continuum model, differentiation following fluid motion. Irrotational flow, vorticity vector, equi-potential surfaces. Streamlines, pathlines, streak lines of the particles, stream tube and stream surface. Mass flux density, conservation of mass leading to equation of continuity (Euler's form). Conservation of momentum and its mathematical formulation: Euler's form. Integration of Euler's equation under different conditions. Bernoulli's equation, steady motion under conservative body forces.

Theory of irrotational motion, Kelvin's minimum energy and circulation theorem, potential theorems. Some two and three dimensional flows, sources, sinks, doublets and vortices, their images with respect to a plane and sphere. Milne–Thompson circle theorem. Butlers sphere theorem, Kelvin's inversion theorem and Weiss's sphere theorem. Axi-symmetric flows and stream function. Motion of cylinders and spheres. Two dimensional flows of irrotational, incompressible fluids; complex potential and its applications to two dimensional singularities. Blasius theorem. D'Alembert's paradox.

Viscous flow, stress and strain analysis. Stokes hypothesis, the Navier-Stokes equations of motion. Some exactly solvable problems in viscous flows, steady flow between parallel plates, Poiseuille flow, steady flow between concentric rotating cylinders.

References:

[1] D.E. Rutherford: Fluid Dynamics, Oliver and Boyd Ltd, London, 1978.

[2] L.M. Milne Thomson, Theoretical Hydrodynamics, The Macmillan company, USA, 1996.

[3] N.E. Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, Ellis Horwood Ltd, 1986.

[4] N.E. Neill and F. Chorlton, Viscous and Compressible Fluid Dynamics, Ellis Horwood Ltd, 1986.

[5] P.K. Kundu and I.M. Cohen, Fluid Mechanics, Academic Press, 2005.

Math 301 (i) - Introduction to Algebraic Topology

Homotopic maps, homotopy type, retraction and deformation retract. Fundamental group. Calculation of fundamental groups of n-sphere, n ≥1, the cylinder, the torus, and the punctured plane. Applications: the Brouwer fixed-point theorem, the fundamental theorem of algebra.

Covering projections, the lifting theorems, relations with the fundamental group, classification of covering spaces, universal covering space. The Borsuk-Ulam theorem, free groups, Seifert–Van Kampen theorem and its applications.

References:

[1] M. A. Armstrong, Basic Topology, Springer-Verlag, 1983.
[2] G.E. Bredon, Geometry and Topology, Springer-Verlag, 1993.
[3] W.S. Massey, A Basic Course in Algebraic Topology, Springer-Verlag, 2007.
[4] J.J. Rotman, An Introduction to Algebraic Topology, Springer-Verlag, 1988.
[5] E.H. Spanier, Algebraic Topology, Springer-Verlag, 1989.

Math 301(ii) - Advanced measure theory

Signed measures, complex measures, Hahn decomposition theorem, Jordan decomposition theorem, mutually singular measures. Radon-Nikodym theorem. Lebesgue decomposition, Riesz representation theorem, extension theorem (Caratheodory), Lebesgue-Stieltjes integral, cummulative distribution function, product measures, Fubini's theorem. Tonelli theorem, Differentiation and integration.

Baire sets, Baire measures, continuous functions with compact support, regularity of measures on locally compact spaces, integration of continuous functions with compact support, Riesz Markov representation theorem.

References:

[1] J.M. G Fell and R. S. Doran, Representation of · - algebras, locally compact groups and Banach · - Algebraic Bundles, Vol I, Academic press Inc , 1988.
[2] P. R. Halmos, Measure Theory, East-West Press Private Ltd., 1978.
[3] E. Hewitt and K.A Ross, Abstract Harmonic Analysis. Vol.I,Springer Verlag, fourth edition, 1993.
[4] H.L. Royden. Real Analysis, Pearson, 2008.

Math 302 (i) - Advanced Group Theory

Simplicity of A_n, left regular, coset and conjugate representations, group actions and applications, groups of motions of the Euclidean n-space, groups of small order, normal series, refinements, composition series, Zassenhaus lemma, Schreier's theorem on refinements, the Jordan-Holder theorem.

Solvable groups, supersolvable groups, minimal normal subgroups, Hall's theorems, Hall subgroup, *p*-complements, nilpotent groups, Schur's theorem, Fitting subgroup, Jacobi identity, three subgroups lemma, Frattini subgroup, Burnside basis theorem.

Indecomposable groups, group with ascending and descending chain conditions, Fitting's lemma, Krull-Schmidt theorem, subnormal subgroups, semidirect products, Schur-Zassenhaus lemma, transfer and Burnside normal complement theorem and its consequences.

References:

[1] T.W. Hungerford, Algebra, Springer-Verlag, New York, 1981.
[2] D.J.S. Robinson, A Course in the Theory of Groups, Springer-Verlag, New York, 1996.
[3] J.S. Rose, A Course on Group Theory, Dover publications, New York, 1994.
[4] J.J. Rotman, An Introduction to the Theory of Groups, Springer-Verlag, New York, 1995.
[5] M. Suzuki, Group Theory I, Springer-Verlag, Berlin, 1982.

Math 302 (ii) - Theory of Noncommutative Rings

Basic terminology and examples, semisimplicity, structure of semisimple rings, Wedderburn–Artin's theorem, Jacobson radical, prime radical, prime and semiprime rings, structure of primitive rings, density theorem, direct products, subdirect sums, commutativity theorems and local rings.

References:

[1] I.N. Herstein, A First Course in Noncommutative Rings, Carus Monographs of AMS 1968.
[2] Louis H. Rowen, Ring Theory, Academic Press, 1991.
[3] T.W. Hungerford, Algebra, Springer Verlag, New York, 1981.
[4] T.Y. Lam, A first course on Non-Commutative Rings, Springer-Verlag, 1991.

Math 302 (iii) - Algebraic Number Theory

Algebraic numbers, number fields, conjugates and discriminants, algebraic integers, integral bases, norms and traces, rings of integers, quadratic fields and cyclotomic fields.

Trivial factorizations, factorization into irreducibles, examples of non-unique factorization into irreducibles, prime factorization, Euclidean domains and Euclidean quadratic fields, consequences of unique factorization, the Ramanujan-Nagell theorem. Prime factorization of ideals, norm of an ideal, non-unique factorization in cyclotomic fields.

Lattices of dimension *m*, the quotient torus, Minkowski's theorem, two-squares theorem, four-squares theorem, the space L^{st}. The class-group, finiteness of the class-group, unique factorization of elements in an extension ring, factorization of a rational prime, Minkowski's constants, class-number calculations.

References:

[1] K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer-Verlag, 1990.

[2] S. Lang, Algebraic Number Theory, Springer-Verlag, New York Inc., 1994.

[3] D.A. Marcus, Number Fields, Springer-Verlag, New York Inc., 1987.

[4] I. N. Stewart and D. O. Tall, Algebraic Number Theory, Chapman and Hall, London, 1987.

Math 302(iv) - Introduction to Harmonic Analysis

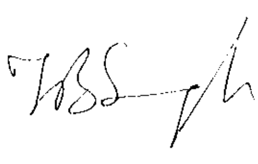
Convergence and divergence of Fourier series. Fejer's theorem. Approximate identities. The classical kernels : [Fejer's, Poisson's and Dirichlet's Summability in norm and pointwise summability], Fatou's Theorem. The inequalities of Hausdorff and Young. Examples of conjugate function series. The Fourier transform. Kernels on R. Basic properties of topological groups, separation properties, subgroups, quotient groups and connected groups. Notion of Haar Measure on topological groups with emphasis on R, **T**, Z and some simple matrix groups. L^1 (G) and convolution with special emphasis on L^1 (R), L^1 (T), L^1 (Z). Plancherel theorem on abelian groups. Plancherel measure on R, T, Z. Maximal ideal space of L^1(G) (G an abelian topological group).

References:

[1] H. Helson, Harmonic Analysis, Addison-Wesley, 983, Hindustan Pub. Co., 1994.

[2] E. Hewitt and K.A. Ross, Abstract Harmonic Analysis Vol. I, Springer-Verlag. 1993.

[3] Y. Katznelson, Introduction to Harmonic Analysis, John Wiley, 2004.



Math 302 (v) - Theory of Operators

The spectrum, point spectrum, continuous spectrum, approximate point spectrum, residual spectrum of operators. Uniform, weak and strong convergence. Compact linear operators on normed linear spaces. The ideal of compact operators. The separability of the range and spectral properties of a compact operator. Operator equations involving compact operators. Fredholm type theorems. The Fredholm alternative.

Spectral properties of bounded self-adjoint linear operators. Positive operators. Square root of a positive operator. Projection operators. Spectral families. Spectral family of a bounded self-adjoint linear operator. spectral representation of bounded self-adjoint linear operators. Extension of the spectral theorem to continuous functions. Properties of the spectral family of a bounded self-adjoint linear operator.

Numerical range of an operator, spectral radius, subnormal and hyponormal operators. Partial isometries, polar decomposition.

References:

[1] G. Bachman and L.Narici, Functional Analysis, Academic Press, 2000.

[2] J.B.Conway, A Course in Operator Theory, Graduate Studies in Mathematics, Volume 21, American Mathematical Society Providence, 1999.

[3] P. R. Halmos, A Hilbert Space Problem Book, D.Van Nostrand Company Inc., 1982.

[4] E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, 2001.

[5] A.E. Taylor and D.C.Lay, Introduction to Functional Analysis, John Wiley and Sons, 1980.

Math 302 (vi) - The Theory of Frames

Frames in finite dimensional Hilbert spaces: Frame bounds, frame algorithms, discrete Fourier transform, pseudo inverses and the singular value decomposition.

Infinite dimensional vector spaces and sequences: Banach spaces and bases in $L^2(R)$. Fourier transform. Operators on $L^2(R)$. Bases in Banach spaces. Riesz bases, Fourier series, Gabor bases, Wavelet bases. Limitations of bases.

Frames in Hilbert spaces: Frames and their properties. Frames and operators. Frames and bases. Characterisation of frames. Dual frames, tight frames, continuous frames. Frames and signal processing. Comparisons between frames and Riesz bases. Sampling theory.

References:

[1] Ole Christensen, An Introduction to Frames and Riesz Bases, Birkhauser Verlag, 2002.

[2] D. Han, K. Kornelsen, D. Larson & E. Weber, Frames for Undergraduates, American Mathematical Society (Student Library Volume 40). 2008.

[3] D. Han & D. R. Larson, Frames, Bases and Group Representations, Memoirs of the American Mathematical Society, (147). 2000.

Math 302 (vii) - General Topology

Nets and filters, Tychonoff's theorem, the Stone–Čech compactification, paracompactness, characterizations of paracompactness in regular spaces, the Nagata-Smirnov metrization theorem,Smirnov metrization theorem.

Function spaces, topology of pointwise convergence, compact open topology, exponential law, topologies of uniform convergence, compact convergence and continuous convergence, equicontinuity, Arzela-Ascoli theorem.

References:

[1] J. Dugundji, Topology, Universal Book Stall 2002.

[2] R. Engelking, General Topology, Polish scientific Publishers, 1977.

[3] J.L. Kelley, General Topology, Springer-verlag, 1991.

[4] J.R. Munkres, Topology, Pearson Education, 2000.

[5] S. Willard, General Topology, Addison-Wesley, 2004.

Math 303 (i) - Mechanics

Generalised coordinates. Holonomic and non-holonomic systems. Scleronomic and Rheonomic systems. Generalised potential. Lagrange's equation of first kind and second kind. Uniqueness of solution. Energy equation for conservative field.

Hamilton's variables, Donkin's theorem, Hamilton canonical equations, cyclic coordinates, Routh's equations, Poisson's Bracket, Poisson's identity, Jacobi Poisson theorem.

Hamilton's principle, principle of least action, Poincare Cartan integral invariant, Whittaker's equations, Jacobi's equations, Lee Hwa Chung's theorem.

Small oscillations of conservative system. Lagrange's equation for small oscillations. Nature of roots of frequency equation. Principal oscillations. Normal coordinates.

Canonical transformations, free canonical transformations, Hamilton Jacobi equation, Jacobi theorem. Method of separation of variables. Lagrange's Bracket, condition of canonical character of a transformation in terms of Lagrange's Bracket and Poisson's Bracket. Invariance of Lagrange's Bracket and Poisson's Bracket under canonical transformation.

Lagrange's theorem on the stability of equilibrium position, Lyapunov theorem and Chetayev theorem, asymptotic stability of an equilibrium position.

References:

[1] F. Gantmacher, Lectures in Analytic Mechanics, MIR publisher, Moscow, 1975.

[2] H. Goldstein, C.P. Poole and J.L. Safco, Classical Mechanics, third edition, Addison Wesley, 2002.

[3] J.R. Taylor, Classical Mechanics, University Science Books, 2004.

Maths 303 (ii) - Dynamical Systems

Orbit of maps, hyperbolicity, the quadratic family $F_\mu(x)=\mu x(1-x)$, phase portraits, symbolic dynamics, topological conjugacy.

Chaos, structural stability, Sarkovskii's theorem, the Schwarzian, derivative, bifurcation theory. The saddle-node bifurcation and period doubling bifurcation, map of the circle: the rotation number and illustrative examples.

The period-doubling route of chaos, genealogy of periodic points, higher dimensional dynamics : some illustrative examples, the dynamics of linear maps : two and three dimensions.

The horseshoe map, hyperbolic toral automorphisms: homoclinic points and Markov partition, attractors: construction of solenoid, the stable and unstable manifold theorem, the Hopf bifurcation, the Henon map. Hopf bifurcation theorem, homoclinic bifurcation, strange attractors, global results and hyperbolic sets, Moser-Twist theorem.

References :

[1] R. L. Devaney: An Introduction to Chaotic Dynamical Systems, second Edition, Westview Press, 2003.

[2] B. Hasselblatt and A. Kotok: A First Course in Dynamical : with a Panorama of Recent Developments, Cambridge University Press, 2003.

[3] M.W. Hirsch, S. Smale, Robert L. Devaney : Differential Equations, Dynamical systems, and Introduction to Chaos, Academic Press, New York, 2003.

[4] C. Robinson: Dynamical System, Boca Raton: CRC Press, 1995.

[5] S. Strogats: Nonlinear Dynamics and Chaos, Perseus Press, 1994.

Math 303 (iii) - Computational Fluid Dynamics

Mathematical description of the physical phenomena. Governing equations-mass, momentum, energy, species. General form of the scalar transport equation, Elliptic, parabolic and hyperbolic equations. Methods for deriving discretization equations by finite difference and finite volume method. Method for solving discretization equations. One-dimensional and two dimensional diffusion Equation, unsteady diffusion, explicit, implicit and Crank-Nicolson scheme. Two dimensional conduction, accuracy, stability and convergence.

Convection and diffusion, steady one-dimensional convection and diffusion, upwind, exponential, hybrid, power, QUICK scheme, two-dimensional convection-diffusion, accuracy of upwind scheme; false diffusion and dispersion, boundary conditions. Flow field calculation, pressure-velocity coupling, vorticity-stream function formulation, staggered grid, SIMPLE family of algorithms.

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Numerical methods for radiation, radiation exchange in enclosures composed of diffuse gray surfaces, finite volume method for radiation, coupled radiation-conduction for participating media, grid generation.

References:

[1] J. D. Anderson, Computational Fluid Dynamics, McGraw-Hill, 1995.
[2] J.H. Ferziger, Peric M, Computational Methods for Fluid dynamics, Springer, 2001.
[3] S. V. Patankar, Numerical Head Transfer and Fluid Flow: Taylor and Francis, 2004.
[4] J.C. Tanehill, Dale A Anderson, and Richard H Pletcher, Computational Fluid Mechanics and Head Transfer, Taylor and Francis, 1997.

Math 303 (iv) - Coding Theory

The communication channel. The coding problem, types of codes, block codes, error-detecting and error-correcting codes, linear codes. The Hamming metric, description of linear block codes by matrices. Dual codes, standard array, syndrome, step-by-step decoding, modular representation. Error-correction capabilities of linear codes. Bounds on minimum distance for block codes, Plotkin bound, Hamming sphere packing bound, Varshamov-Gilbert-Sacks bound, bounds for burst-error detecting and correcting codes. Important linear block codes, Hamming codes, Golay codes, perfect codes, quasi-perfect codes, Reed-Muller codes. Codes derived from Hadamard matrices. Product codes. Concatenated codes.

References:

[1] Raymond Hill, A First Course in Coding Theory, Oxford University Press, 1990.
[2] W.W. Peterson and E.J. Weldon, Jr.. Error-Correcting Codes. M.I.T. Press, Cambridge, Massachusetts, 1972.
[3] Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
[4] F.J. Macwilliams and N.J. A. Sloane, The Theory of Error Correcting Codes, North-Holland, 2006.

Math 303 (v) - Mathematical Programming

Non–linear programming, uses of non-linear programming. Identifying an optional point, a direction vector. Concavity, convexity, characterization of concavity, convexity of feasible region with concave constraints. Pseudoconcavity and quasi-concavity. Kuhn-Tucker necessary conditions. Sufficient form of Kuhn-Tucker conditions. Lagrangian duality and saddle point criteria.

Introduction to quadratic programmimg with development of Beale's method and discussion of Wolfe's method as an application of Kuhn-Tucker conditions.

The first convergence theorem. The algorithm and its convergence properties. Decomposition of the algorithmic map. Unconstrained problems. Feasible direction methods and the maps M and D. Closedness of map M^1.

The convex simplex method. The algorithmic procedure. Degeneracy. Application of convex simplex method for solving the linear fractional programming.

References:

[1] Mokhtar S. Bazara, Hanif D. Sherali, C.M. Shetty, Non Linear Programming, Theory and Algorithms, John Wiley and Sons, 2006.
[2] Roger Fletcher, Practical Methods of Optimization, John Wiley and Sons, 2001.
[3] Dimitri P. Berstekas, Nonlinear programming, Athena Scientific, 1999.

Math 303 (vi) - Computational Methods for Ordinary Differential Equations

Initial value problems (IVPs) for the system of ordinary differential equations (ODEs): difference equations, numerical Methods, local truncation errors, stability analysis, interval of absolute stability, convergence and consistency.

Single-step methods: Taylor series method, explicit and implicit Runge-Kutta methods and their stability and convergence analysis, extrapolation method, Runge-Kutta method for the second order ODEs, Stiff-system of differential equations.

Multi-step Methods: Explicit and Implicit multi-step methods, General linear multi-step methods and their stability and convergence analysis, Adams-Moulton method, Adams-Bashforth method, Nystorm method, Multi-step methods for the second order IVPs.

Boundary Value Problems(BVPs): Two point non-linear BVPs for second order ordinary differential equations, Finite difference methods, Convergence analysis, Difference scheme based on quadrature formula, Difference schemes for linear eigen value problems, Mixed boundary conditions, Finite element methods, Assemble of element equations, Variational formulation of BVPs and their solutions, Collocation method, Galerkin method, Ritz method, Finite element solution of BVPs.

Note: Computer practical (record book) will be a part of internal assessment.

References:

1. J.C. Butcher, Numerical Methods for Ordinary Differential Equations, John Wiley & Sons, New York, 2003.
2. J.D. Lambert, Numerical Methods for Ordinary Differential Systems: The Initial Value Problem, John Wiley and Sons, New York, 1991.
3. K. Atkinson, W. Han and D.E. Stewart, Numerical solution of ordinary Differential Equations, John Wiley, New York, 2009.

Math 303 (vii) - Numerical Analysis

Numerical solution of non-linear equations: Iterative methods based on second degree equation, Muller method, Chebyshev method, rate of convergence, acceleration of convergence, methods for complex roots, Newton-Raphson method for system of non-linear equations, multiple roots.

Numerical solution of system of linear equations and eigen value problems: Ill-conditioned systems and conditioned number, block-iterative methods (Jacobi, Gauss-Seidel and SOR), determination of optimal relaxation parameter, convergence analysis, eigen value and eigen vectors, Jacobi method, Given's method and Householder method for symmetric matrices, Rutishausher method for arbitrary matrices, Power method, Inverse power method.

Interpolation and approximations: piecewise and spline interpolations, quadratic and cubic spline interpolation, Least-square approximation, Gram-Schmidt orthogonalizing process, uniform (minimax) polynomial approximation, Pade' approximation.

Numerical integration: Method based on undetermined coefficients, Newton cotes method, Gauss quadrature methods, Gauss-Legendre, Gauss-Chebyshev, Gauss-Hermite, Gauss-Laguerre, Lobatto and Radau integration methods, composite integration, double integration, extrapolation method.

Note: Computer practical (record book) will be a part of internal assessment.

References:

[1.] K. Atkinson and W. Han, Elementary Numerical Analysis, John Wiley, 2006.
[2.] C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Addison-Wesley, Boston, 2003.
[3.] J.H. Mathews and K.D. Fink, Numerical Methods using MATLAB, Prentice Hall of India, New Delhi, 2007.

Math 304 (i)

A course of equivalent credit offered by the departments of Computer Science, Statistics, Operational Research, Physics and Astrophysics, financial Studies, Management Studies, Electronic Science, Economic Genetics.

7138-71

Math 304 (ii) - Differential Geometry

Graph and level sets, vector fields, the tangent space, surfaces, orientation, the Gauss map, geodesics, parallel transport, the Weingarten map, curvature of plane curves, arc length and line integrals, curvature of surfaces, parametrized surfaces, surface area and volume, surfaces with boundary, the Gauss-Bonnet Theorem.

References

[1] Wolfgang Kuhnel: Differential Geometry-curves-surfaces-Manifolds. AMS 2006.

[2] A: Mishchenko and A. Formentko. A course of Differential Geometry and topology, Mir Publishers Moscow, 1988.

[3] Andrew Pressley: Elementary Differential Geometry. SUMS (Springer), 2004.

[4] I.A. Thorpe: Elementary Topics in Differential Geometry. Springer, 2004

Math 304 (iii) - Representation Theory of Finite Groups

Representation of groups, right regular representation, coset representation. matrix representation, linear representation, trivial representation, equivalent matrix representations, *G*-modules, automorphism representation, characters, class function, reducibility, reducible and irreducible *G*-modules, contragradient representation, permutation representations. Complete reducibility, Maschke's theorem for matrix representations and *G*-modules, completely reducible matrix representations and *G*-modules, Schur's lemma for matrix representations and *G*-modules, commutant (endomorphism) algebra.

Elementary property of group characters, orthogonality relations, inner product for functions on a group *G*, orthogonal functions, character relations of the first kind, simple and compound characters, group algebra. Character table, character relations of the second kind, character table for finite abelian groups, the lifting process, linear characters.

Induced representations, induced characters, restricted character, reciprocity theorem of Frobenius, character tables for alternating groups of degree *4* and *5*, conjugate characters, Clifford's theorem, tensor products and Mackey's theorem. Algebraic numbers and conjugates, algebraic integers and their properties, representation of group algebras, Burnside's (*p*, *q*)-theorem, Frobenius groups.

References:

[1] Charles W. Curtis and Irving Reiner, Representation Theory of finite groups and associative algebras, AMS Chelsea Publishing, American Mathematical Society reprint, 2006.

[2] William Fulton and Joe Harris, Representation Theory: a first course, Springer-Verlag, New York Inc., 1991.

[3] James Gordon and Martin Liebeck, Representations and characters of groups, Cambridge University Press, Cambridge, 2001.

[4] I Martin Issacs, Character Theory of finite groups, AMS Chelsea Publishing, American Mathematical Society reprint, 2006.

[5] Walter Ledermann, Introduction to group characters, Cambridge University Press, Cambridge, 1987.

Math 401(i) - Advanced Complex Analysis

Cauchy theorem (homotopy and homology froms), Hadamards three circles theorem, Phragmen - Lindel of theorem, spaces of analytic functions, Hurwitz theorem, Montel's theorem, Riemann mapping theorem, the gamma function, the Riemann functional equation, Runge's theorem, simply connected region, Miittag-Leffler's theorem, Schwarz reflection principle, monodromy theorem. Harmonic functions in a disk. Harnack's inequality, Dirichlet problem, Green's function, Jensen's formula, Poisson- Jensen formula.

References:

[1.] J.B.Conway. Functions of one complex variable. Narosa Publishing House. New Delhi, 2000.

[2.] T. W. Gamelin, Complex Analysis, Springer-Verlag, 2008.

[3.] S. Lang, Complex Analysis, fourth edition, Addison Wesley. 1999.

[4.] R. Narasimhan and Yves. Nievergelt, Complex analysis in one variable, Birkhauser Boston, Inc., Boston, MA, 2001.

Math 401 (ii) - Introduction to Differential Manifolds

The derivative, continuously differentiable functions, the inverse function theorem, the implicit function theorem. Topological manifolds, partitions of unity, imbeddings and immersions, manifolds with boundary, submanifolds. Tangent vectors and differentials. Sard's theorem and regular values, vector fields and flows, tangent bundles, smooth maps and their differentials. Smooth manifolds, smooth manifolds with boundary, smooth sub-manifolds, construction of smooth functions.

References:

[1] G.E. Bredon, Topology and Geometry, Springer-verlag, 1993.
[2] L. Conlon, Differentiable Manifolds, Second Edition, Birkhauser, 2003.
[3] A. Kosinski, Differential Manifolds, Academic Press, 1992
[4] J.R. Munkres, Analysis on Manifolds, Addison-Wesley Publishing Company, 1991.
[5] M. Spivak, A Comprehensive Introduction to Differential Geometry, Vol. I; Publish or Perish, 1979.

Math 402 (i) - Homology Theory

Geometric simplexes, geometric complexes and polyhedra. Simplicial maps, barycentric subdivision, simplicial approximation of continuous maps, contiguous maps, abstract simplicial complex.

Orientation of geometric complexes, homology groups. Computation of homology groups, the homology of n-sphere, $n \geq 1$. The structure of homology groups, the chain complexes, chain mappings, chain derivation, chain homotopy. The homomorphism induced by continuous maps between two polyhedra.

Singular complex and homology groups, functorial properties, the Eilenberg-Steenrod axioms of homology theory. The reduced homology groups, the Mayer-Vietoris sequence. The degree of self mappings of S^n, the Brouwer's fixed point theorem, the Euler-Poincaré theorem and Lefschetz fixed point theorem.

References:

[1] H. Agoston, Algebraic Topology, Marcel Dekker, 1976.
[2] G.E. Bredon, Geometry and Topology, Springer-Verlag, 1993.
[3] F.H. Croom, Basic Concepts of Algebraic Topology, 1976.
[4] A. Dold, Lectures on Algebraic Topology, Springer-Verlag, 1980.
[5] J.J. Rotman, An Introduction to Algebraic Topology, Springer-Verlag, 1988.

Math 402 (ii) - Homological Algebra

Categories and functors, duality, natural transformation, products and coproducts, pull-backs and push-outs, adjoint functors and universal constructions, abelian categories, projective, injective and free objects .

Chain complexes, long exact sequences, chain homotopy, resolutions, derived functors. Elementary properties of Ext, computation of some Ext groups, Ext^n and n-extentions. Elementary properties of Tor, Tor and torsion, universal coefficient theorem.

Homological dimensions, ring of small dimensions, change of rings theorems, Koszul complexes and logical cohomology.

Exact couples and five-term sequence, derived complex and spectral sequences.

References:

[1] P.J. Hilton and U. Stammback, A Course in Homological Algebra, Springer-Verlag, Berlin, 1971.

[2] S. Maclane, Categories for Working Mathematician, Springer-Verlag, Berlin, Heidelberg, 1971.

[3] D.G. Northcott, A First course of Homological Algebra, CUP, 1973.

[4] J.J. Rotman, An Introduction to Homological Algebra, Academic Press, New York, 1979.

[5] C.A. Weibel, An Introduction to Homological Algebra, CUP, 1994.

Math 402 (iii) - Theory of Semirings

Semirings, ideals, subtractive ideals, partitioning ideals, factor semirings, homomorphisms of semirings, maximal homomorphisms, fundamental theorem of homomorphism, isomorphism theorems, prime and semiprime ideals in semirings, semirings of fractions. Euclidean semirings, polynomial semirings and Noetherian semirings.

References:

[1] J.S. Golan, Semirings and their applications, Kluwer Academic Publishers, Dordrecht 1999.

[2] U. Hebisch and H.J. Weinert, Semirings Algebraic. Theory and Applications in Computer Science, World Scientific Publishing Co. Pte. Singapore, 1998.

788 - A.

Math 402(iv) - Abstract Harmonic Analysis

Introduction to representation theory of involutive Banach algebra. Unitary representation of locally compact groups, Gelfand-Raikov theorem.

Representation of some special groups SU(2), Lorentz group, the group of linear transformations of the real line. Unitary representation of compact groups. Schur's lemma, the orthogonality relations.

Characters of finite dimensional representation. Weyl-Peter theorem, convolution of bounded regular complex measures.

The convolutive Banach algebra M(G). Fourier-Stieltjes transform. Positive definite functions. Bochner's theorem.

References:

[1] J.M.G. Fell and R.S. Doran, Representation of * Algebras. Locally compact Groups I and Banach* Algebraic Bundles. Vol. I, II, Academic Press Inc.,1988.

[2] E. Hewitt and K.A. Ross, Abstract Harmonic Analysis, Vol. I.,II Springer Verlag, 1993.

[3] W. Rudin, Fourier Analysis on Groups, Interscience Publisher,1990.

Math 402 (v)- Spectral Theory of Unbounded Operators

Unbounded linear operators and their Hilbert adjoint operators. Hellinger-Toeplitz theorem. Closed linear operators, Closable operators and their closures on Banach spaces. Hermitian, symmetric and self-adjoint linear operators. Maximally symmetric operators Cayley transform. The deficiency indices. Resolutions of the Identity.

Spectral properties of self-adjoint linear operators. Multiplication and differentiation operators. Spectral theorem for self-adjoint linear operators. Maximally normal operators. spectral theorem for normal operators.

Semigroups of operators on Banach spaces, Uniformly continuous and strongly continuous semigroups. generator of semigroups, semigroups of normal operators, uniqueness of the generator, Landau's inequality, Hille-Yosida theorem. Yosida approximation, generator of C_0-semigroup via Yosida approximation, resolvent set of operators, characterization of generator of C_0-semigroup, dissipative linear operators on Banach spaces and its characterization, closable dissipative linear operators, Lumer-Phillip theorem.

References:

[1] S.Goldberg, Unbounded Linear Operators: Theory and Applications, Dover Books on Mathematics, 2006.

[2] E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, 2001.

[3] A. Pazy, Semigroups of Linear Operators and Applications to Partial Differential Equations, Springer-Verlag, New York Inc., 1992.

[4] W. Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company Ltd, 1988.

[5] V.S.Sunder, Functional Analysis (Spectral Theory), Hindustan Book Agency, 1997.

Math 402(vi) - Banach Algebras

Elementary properties and examples of Banach algebras, ideals and quotients, the spectrum of an element, dependence of spectrum on the algebra, abelian Banach algebras.

Elementary properties of C*- Algebras and examples, abelian C*- algebras and the functional calculus, positive elements,ideals and quotients, representations of C*- algebras and the Gelfand-Naimark-Segal construction.

Spectral measures and representations of abelian C*- algebras, The spectral theorem, topologies on B(H); The double commutant theorem and abelian Von-Neumann algebras.

References:

[1] J.B. Conway, A Course in Functional Analysis, Springer (1990).

[2] R.V. Kadison and J.R. Ringrose, Fundamentals of the Theory of Operator Algebras, AMS (1997)

[3] G.I. Murphy, C* Algebras and Operator Theory, Academic (1990).

7/3S-7/6

Math 402 (vii) - Operators on the Hardy-Hilbert Space

The Hardy-Hilbert Space: Basic definitions and properties.

The unilateral shift and factorization of functions: Shift operators. Invariant and reducing subspaces. Inner and outer factorization. Balschke factors. Singylar inner functions. Outer functions.

Toeplitz operators: Basic properties of Toeplitz operators. Spectral structure.

Hankel operators: Bounded Hankel operators. Hankel operators of finite rank. Compact Hankel operators. Self adjointedness and normaility of Hankel operators. Relation between Hankel and Toeplitz operators.

References:

[1] R. G. Douglas, Banach Algebra Techniques in Operator Theory; Graduate Texts in Mathematics 179, Springer, 1998.

[2] R. A. Martinez-Avedano & P. Rosenthal, An Introduction to the Hardy-Hilbert Space, Graduate Texts in Mathematics 237, Springer, 2007.

[3] N. K. Nikolskii, Operators, Functions and Systems: An Easy Reading, Volume I, Mathematical Surveys and Monographs 92, American Mathematical Society, 2002.

Math 402(viii) - Advanced functional analysis

Introduction to topological vector spaces and locally convex spaces, linear operators, uniform boundedness principle, closed graph theorem, open mapping theorem, Hahn-Banach theorem, extreme points and Krein-Milman theorem.

Geometry of Banach spaces: vector measures, Radon-Nikodym property and geometric equivalents, Choquet theory. Weak compactness and Eberlein-Smulian theorem, Schauder basis.

References:

[1] J. Diestel and J. J. Uhl, Jr., Vector measures. Mathematical Surveys, No. 15. American Mathematical Society, 1998.

[2] N. Dunford and J. T. Schwartz, Linear operators. Part II: Spectral theory. Self adjoint operators in Hilbert space. Interscience Publishers John Wiley & Sons 1963.

[3] Walter Rudin, Functional analysis. International Series in Pure and Applied Mathematics. McGraw-Hill, Inc., 1991.

[4] K. Yosida, Functional analysis. Grundlehren der Mathematischen Wissenschaften, 123. Springer-Verlag, 2008.

Math 402 (ix) – Complex Dynamics

Riemann surface, Schwarz lemma, Liouville theorem, Mobius transformations, conformal automorphism groups, universal coverings and hyperbolic metric, normal families, Montel's theorem. Elliptic functions, Picard's theorem, Infinite products, iteration of Mobius transformations, Iteration of functions Z^2+c, Z(Z+1), Z+1/Z, 2Z-Z. Newton's approximations.

Rational maps, conjugacy, fixed and critical points, topology on rational functions, the Fatou and the Julia sets, completely Invariant sets, exceptional points.

Properties of the Julia and Fatou sets, rational maps with empty Fatou sets, components of the Julia and the Fatou sets, Euler characteristics, the Riemann-Hurwitz formula.

The classification of periodic points, cycles, the existence of periodic points, the Julia sets and periodic points, local conjugacy.

Forward invariant components (the five possibilities), wandering domain, limit functions, parabolic domains, Siegel discs, Herman rings, connectivity of invariant components.

References:

[1] L.V. Ahlfors: Complex Analysis, third edition, McGraw-Hill, 1979.

[2] A.F. Beardon: Iteration of Rational Functions, GTM 132, Springer–Verlag, New York, Inc., 1991.

[3] L. Carleson and T. Gamelin: Complex Dynamics, Springer–Verlag, New York, 1993.

[4] J. Milnor: Dynamics in One Complex Variable, Princeton University Press, New Jersey, 2006.

[5] N. Steinmetz: Rational Iteration: Complex Analytic Dynamical Systems, de Gruyter, Berlin, 1993.

Math 403 (i) - Methods of Applied Mathematics

Solution of PDEs by method of integral transforms. Perturbation methods, regular perturbations, singular perturbations, applications of perturbation methods to fluid mechanics.

Volterra integral equations, relationship between linear differential equations and Volterra integral equations, resolvent kernel of Volterra integral equation, solution of integral equations by resolvent kernel. The method of successive approximations, convolution type equations. Solutions of integral equations with the aid of Laplace transformation.

Fredholm integral equations, iterated kernels, constructing the resolvent kernel with the aid of iterated kernels. Integral equations with degenerate kernels, characteristic numbers and eigen functions, solution of homogeneous integral equations with degenerate kernel, non homogeneous symmetric equations, Fredholm alternative.

Extrema of functional, the variation of a functional and its properties. Euler's equation and its generalization, sufficient conditions for the extremum of a functional, conditional extremum, moving boundary problems, Ritz method.

Refrences:

[1.] M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice Hall, Inc., 2000.
[2.] F.B. Hildebrand, Methods of Applied Mathematics, Dover Publication, 1992.
[3.] M.L. Krasnov, Problems and Exercises in Integral Equations, Mir Publication Moscow, 1971.
[4.] D. Logan: Applied mathematics: A Contemporary Approach, John Wiley and Sons, New York, 1997.
[5.] I. Sneddon, The Use of Integral Transforms, Tata McGraw Hill, 1979.

Math 403 (ii) - Bio- Fluid Mechanics

Relevance of micro flows in nature and technology, cardiovascular system, macro and micro fluidic devices in life sciences, bio-fluid flow systems, physiological fluid dynamics; flow through arteries and veins. Dimensional analysis (gastrointestinal and renal applications). Constitutive equations and Newtonian/Non-Newtonian bio-fluid models (blood and mucus examples), flow and wave propagation in flexible tubes (cardio-pulmonary applications), oscillatory and pulsatile flows (cardio-pulmonary examples). High Reynolds number flows and boundary layers (cardio-pulmonary applications), low Reynolds number flows (biotechnology examples), Lubrication theory (hemodynamic of red blood cells, synovial fluid in joints), flow in porous media (,synovial joint lubrication and flow through capillary).

References:

[1] A.Beskok and G. Karniadakis, Micro flows, Cambridge University Press,1996.
[2] T.J. Pedley, The Fluid Mechanics of Large Blood Vessels, Cambridge University Press, 1980.
[3] M. Stanley, Transport Phenomenon in Cardiovascular System, 1972.
[4] R.L. Whitmore, Rheology of circulation, Pergamon Press, 1968.

Math 403 (iii) - Advanced Coding Theory

Tree codes, convolutional codes, description of linear tree and convolutional codes by matrices, standard array, bounds on minimum distance for convolutional codes, V-G-S bound, bounds for burst-error detecting and correcting convolutional codes. The Lee metric, packing bound for Hamming code w.r.t. Lee metric. The algebra of polynomials, residue classes, Galois fields, multiplicative group of a Galois field, cyclic codes. Cyclic codes as ideals, matrix description of cyclic codes, Hamming and Golay codes as cyclic codes, error detection with cyclic codes, error-correction procedure for short cyclic codes, shortended cyclic codes, pseudo cyclic codes, code symmetry, invariance of codes under transitive group of permutations. Bose-Chaudhary-Hocquenghem (BCH) codes, BCH bounds, Reed-Solomon (RS) codes, majority-logic decodable codes, majority-logic decoding, singleton bound, The Griesmer bound, maximum-distance separable (MDS) codes, generator and parity-check matrices of MDS codes, weight distribution of MDS code. Necessary and sufficient conditions for a linear code to be an MDS code, MDS codes from RS codes, Abramson codes, closed-loop burst-error correcting codes (Fire codes). Error locating codes.

References:

[1] E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1984.

[2] W.C. Huffman and V. Pless, The Theory of Error Correcting Codes, Cambridge University Press, 1998.

[3] F.J. Macwilliams and N.J. A. Sloane, Theory of Error Correcting Codes, North-Holland Publishing Company, 2006.

[4] W.W. Peterson and E.J. Weldon, Jr., Error-Correcting Codes, M.I.T. Press, Cambridge, Massachusetts, 1972.

Math 403 (iv) - Optimization Techniques and Control Theory

Generalized convexity, subdefinite matrices and quadratic forms. Arcwise connected sets and convex transformable functions. Local and global minima.

Conjugate functions, optimality conditions and Largrange multipliers. Duality and optimality of convex programs.

Dynamic programming. Bellman's principle of optimality, shortest route problem, optimum division of a line into segments.

Optimal controllability, optimal control, the rocket car, the Pontryagain maximum principle for autonomous system. Applying the maximum principle. Dynamic programming and maximum principle.

References:

[1] Mordecai Avriel, Nonlinear Programming. Analysis & Methods, Dover Publication, Inc., Englewood, Mineola, New York, 2003.

[2] E.M.L. Beale, Introduction to Optimization, John Wiley & Sons, 1988.

[3] D.E. Kirk, Optimal Control Theory, An Introduction Dover Publications, 2004.

[4] J. Macki and A. Strauss, Introduction to Optimal Control Theory, Springer-Verlag. N.Y., 1982.

Math 403 (v) – Computational Methods for Partial Differential Equations

Finite difference methods for 2D and 3D elliptic boundary value problems (BVPs) of second and fourth order approximations, finite difference approximations to Poissons equation in cylindrical and spherical polar coordinates, solution of large system of algebraic equations corresponding to discrete problems and iterative methods (Jacobi, Gauss-Seidel and SOR), alternating direction methods.

Different 2-level and 3-level explicit and implicit finite difference approximations to heat conduction equation, stability analysis (energy method, matrix method and Von-Neumann method), compatibility, consistency and convergence of the difference methods, difference scheme based on derivative boundary conditions and its stability condition, ADI methods for 2D & 3D parabolic equations, finite difference approximations to heat equation in polar coordinates.

Methods of characteristics for evolution problem of hyperbolic type, Von-Neumann method for stability analysis, Operator splitting methods for 2D and 3D wave equations, explicit and implicit difference schemes for first order hyperbolic equations and their stability analysis, System of equations for first order hyperbolic equations, conservative form.

Finite element methods for second order elliptic BVPs, finite element equations, variational problems, triangular and rectangular finite elements, standard examples of finite elements, mixed finite element methods.

Note:
Computer practical (record book) will be a part of internal assessment.

References:

[1] J.C. Strickwerda, Finite Difference Schemes and Partial Differential Equations, SIAM publications, 2004.

[2] J.W.Thomas, Numerical Partial Differential Equations: Finite Difference Methods, Springer and Verlag, Berlin, 1998.

[3] J.W.Thomas, Numerical Partial Differential Equations: Conservation Laws and Elliptic Equations, Springer and Verlag, Berlin, 1999.

Math 403 (vi) - Graph Theory

Graphs: Vertices of graphs, walks and connectedness, degrees, Operations on graphs, blocks, cut-points, bridges and blocks, block graphs and cut-point graphs.

Trees: Elementary properties of trees, centers and centroids, block-cut point trees, independent cycles and cocycles.

Connectivity and Traversability: Connectivity and line connectivity, Menger's theorems, Eulerian graph, Hamiltonian graphs.

Planarity and Coloring: Planar graphs, outer planar graphs, Kuratowski's theorem, dual graphs, chromatic number, five color theorem.

References:

[1] R. Balakrishnan and K. Renganathan, A textbook of Graph theory, Springer, 2000.
[2] B. Bollobas, Modern Graph Theory Springer, 2002.
[3] G. Chartrand, L. Lesniak, Graphs & digraphs, Fourth edition, Chapman & Hall/CRC, 2005.
[4] F. Harary, Graph theory, Narosa Publishing House, New Delhi, 2001.
[5] R. J. Wilson, Introduction to Graph Theory (fourth edition), Addison Wesley, 1996.

Math 403 (vii) - Cryptography

Secure communications. Shift ciphers, affine ciphers, Vigenere cipher key, symmetric key, public key, block ciphers, one-time pads, secure random bit generator, linear feedback shift register sequences.

Differential cryptanalysis, modes of DES, attack on DES, advanced encryption standard.

RSA, attacks on RSA, Diffie-Hellman key exchange, ElGamal public key cryptosystem, cryptographic hash function. RSA signatures, ElGamal signature, hashing and signing, digital signature algorithm.

References:

[1] Johannes A. Buchmann, Introduction to Cryptography, Springer 2000.
[2] Douglas Robert Stinson, Cryptography – Theory and Practice, Chapman Hall / CRC 2006.
[3] Wade Trappe and Lawrence C. Washington, Introduction to Cryptography with Coding Theory, Pearson Prentice Hall, 2006.

Math 404 (i)

A course of equivalent credit offered by the departments of Computer Science, Statistics, Operational Research, Physics and Astrophysics, financial Studies, Management Studies, Electronic Science, Economic Genetics.

Math 404 (ii) - Commutative Algebra

The spectrum of a ring, extension and contraction, rings and modules of fractions, primary decomposition.

Properties of extension rings, flatness, completion and Artin-Rees lemma, integral extensions.

Valuations rings: General valuations, discrete valuation rings and Dedekind rings, Krull rings.

The Hilbert Nullstellensatz. Dimension Theory: Graded rings, the Hilbert function and the Samuel function, systems of parameters and multiplicity the dimension of extension rings. Krull principal ideal theorem.

Regular sequences: regular sequences and the Koszul complex, Cohen Macaulary rings, Gorenstein rings.

References

[1] M.F. Atiyah, I.G. Macdonald, Introduction to Commutative Algebra, Addison Wesley, 1969.

[2] D. Eisenbud, Commutative Algebra with a view towards algebraic Geometry . Springer-Verlag, 1995

[3] T.W. Hungerford, Algebra, springer-verlag, 1981

[4] H. Matsumura, Commutative Ring Theory, Cambridge University Press, 1980

[5] R.Y. Sharp: Steps in Commutative Algebra, Cambridge University Press, 1990

Math 404 (iii) - Probability Theory

Algebra of events, Axiomatic approach to probability theory, Probability function and its properties. Probability space. Random variable, vectors, sequence and function. Conditional expectation. Moments, Inequalities for moments, Jensen's Inequality. Probability distributions in general, Induced probability space. Distribution function and decomposition theorem.

Convergence of a sequence of random variables, convergence in probability, almost surely, in the r-th mean and in distribution, their relationships. Characteristic function of a real and a vector valued random variable and their properties. Inversion formula, Fourier inversion formula. Uniqueness theorem, Continuity and limit theorems. Increment, Truncation and related inequalities on characteristic functions. Characteristic function of a sum of random variables. Convolution theorem.

Sum of independent random variables. Independent classes and independent functions. Borel function theorem, sequences of independent random variables, Borel zero-one law, Borel-Cantelli Lemma. Markov's and Chebychev's inequalities, Bernoulli's and Khintchine's weak law of large numbers; Kolmogorov's inequality, strong law of large numbers and kolmogorov's criterion. Central limit theorems-Linderberg-Levy's and Liapunov's forms.

References

1. K.L. Chung, A Course in Probability Theory, Academic Press, New York, 2001.
2. P.G. Laha & V.K. Rohtagi, Probability Theory, John Wiley, 1979.
3. H. Loeve, Probability Theory, Springer -Verlag, 1987.