S.No	New Course code	Name of Course	L-T-P-C	Proposed Level (UG/PG)
2	MA 902	Perfect Graphs and Graph Algorithms	3-1-0-8	PG
3	MA 903	Algebraic Topology	3-0-0-6	PG
4	MA 904	Advanced Algebra	3-1-0-8	PG
6	MA 906	Advanced Numerical Analysis of Ordinary and Partial Differential Equations	4-0-0-8	PG
8	MA 908	Seminar	0-0-4-4	
9	MA 909	Functional Analysis	3-0-0-6	
10	MA 910	Homological Algebra	3-1-0-4	PG
11	MA 920	Introduction to Representation Theory	3-0-0-6	PG
12	MA 921	Differential Topology	3-0-0-6	PG
13	MA 922	Topology	3-1-0-8	PG
14	MA 923	Introduction to Graduate Algebra	3-1-0-8	PG
15	MA 924	Numerical Analysis of Partial Differential Equations	4-0-0-8	PG
16	MA 925	Advanced Commutative Algebra	3-1-0-8	PG
17	MA 926	Algebraic Geometry I	3-1-0-8	PG
18	MA 927	Algebraic Geometry II	3-1-0-8	PG
19	MA 928	Algebra	3-1-0-8	PG
20	MA 929	Random Schrodinger Operators	3-0-0-6	PG
21	MA 930	Advanced Graph Theory	3-1-0-8	PG
23	MA 931	Measure Theory	2-1-0-6	PG
24	MA 932	Linear Integral Equations	3-0-0-6	PG
25	MA 933	Theory of Perfect Graphs	3-0-0-6	PG
26	MA 701	Topics in Elliptic Partial Differential Equations	3-0-0-6	PG
27	MA 702	Numerical Solution of Integral Equations	3-0-0-6	PG
28	MA 934	Seminar II	0-0-4-4	
29	MA 601	Introduction to Diophantine Approximation	3-0-0-6	PG
30	MA 602	Introduction to Lie Algebras	3-0-0-6	PG
31	MA 603	Irrational and Transcendental Number	3-0-0-6	PG
32	MA 604	Algebraic Number Theory	3-0-0-6	PG
33	MA703	Complex Analysis with Applications to number theory	3-0-0-6	PG

1	**Title of the course** (L-T-P-C)	**Measure Theory** **(3-1-0-8) (old)**
2	**Pre-requisite courses(s)**	Real analysis
3	**Course content**	Construction of Lebesgue measure on Real line, Introduction to abstract measure theory, Measurable functions, Caratheodory's Extension Theorem, MCT, Fatou's Lemma, DCT, Product space, Product measure, Fubini's Theorem, Definition of signed measures, Positive and negative sets. Hahn-Jordan Decomposition. Absolute continuity of two σ- finite measures. Radon-Nikodyme Theorem and Lebesgue Decomposition.
4	**Texts/References**	• H. L. Royden; Real analysis. Third edition. Macmillan Publishing Company, New York, 1988. • W. Rudin; Real and complex analysis. Third edition. McGraw- Hill Book Co., New York, 1987. • S. Athreya and V.S. sunder; Measure & probability. CRC Press, Boca Raton, FL, 2018. • K.R. Parthasarathy; Introduction to probability and measure, Hindustan Book Agency, 2005.

1	**Title of the course** (L-T-P-C)	**Perfect graphs and graph algorithms (3-1-0-8)**
2	**Pre-requisite courses(s)**	Exposure to CS 201,211 Data Structures and Algorithms, Lab,CS 203 Discrete Structures or equivalent.
3	**Course content**	Perfect graphs, The Weak Perfect Graph Theorem, The Strong Perfect Graph Theorem (statement only), Chrodal graphs, Perfect Elemination Order and Scheme, Split graphs, degree sequence, Erdos-Gallai Theorem, Comparability graphs, Permutation graphs, Intersection graphs, Interval graphs and some of its properties, Circular arc graphs
4	**Texts/References**	M. C. Golumbic. Algorithmic Graph Theory and Perfect Graphs. Academic Press, New York, 1980.

1	**Title of the course** (L-T-P-C)	**Algebraic Topology** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Topology / Instructor's consent
3	**Course content**	Paths and homotopy, homotopy equivalence, contractibility, deformation retracts Basic constructions: cones, mapping cones, mapping cylinders, suspension Cell complexes, subcomplexes, CW pairs Fundamental groups. Examples (including the fundamental group of the circle) and applications (including Fundamental Theorem of Algebra, Brouwer Fixed Point Theorem and Borsuk-Ulam Theorem, both in dimension two). Van Kampen's Theorem. Covering spaces, liftingproperties, deck transformations, universal coverings Simplicial complexes, barycentric subdivision, stars and links, simplicial approximation. Simplicial Homology. Singular Homology. Mayer-Vietoris sequences. Long exact sequence of pairs and triples. Homotopy invariance and excision Degree, Cellular Homology Applications of homology: Jordan-Brouwer separation theorem, Invariance of dimension, Hopf's Theorem for commutative division algebras with identity, Borsuk-Ulam Theorem, Lefschetz Fixed Point Theorem Optional Topics: Outline of the theory of: cohomology groups, cup products, Kunneth formulas, Poincare duality
4	**Texts/References**	**1.** M.J. Greenberg and J. R. Harper, Algebraic Topology, Benjamin, 1981. **2.** W. Fulton, Algebraic topology: A First Course, Springer-Verlag, New York, 1995. **3.** A. Hatcher, Algebraic Topology, Cambridge Univ. Press, Cambridge, 2002. **4.** W. Massey, A Basic Course in Algebraic Topology, Springer-Verlag, Berlin, 1991. **5.** J. R. Munkres, Elements of Algebraic Topology, Addison-Wesley, Menlo Park, CA, 1984. **6.** J. J. Rotman, An Introduction to Algebraic Topology, Springer (India), 2004. **7.** H. Seifert and W. Threlfall, A Textbook of Topology, Academic Press, New York-London, 1980.

1	**Title of the course** (L-T-P-C)	**Advanced Algebra** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Introduction to Algebra
3	**Course content**	Semisimple and simple rings: Semisimple modules, Jacobson density theorem, semisimple and simple rings, Wedderburn-Artin structure theorems, Jacobson radical, the effect of a base change on semisimplicity Representations of finite groups: Basic definitions, characters, class functions, orthogonality relations, induced representations and induced characters, Frobenius reciprocity, decomposition of the regular representation, supersolvable groups, representations of symmetric groups Noetherian modules and rings: Primary decomposition, Nakayama's lemma, filtered and graded modules, the Hilbert polynomial, Artinian modules and rings, projective modules, Krull-Schmidt theorem, completely reducible modules
4	**Texts/References**	Dimmit, Foote: Abstract algebra, second edition, Wiley student editions, 2005 1. Jacobson: Basic algebra, I, Dover publications, 2009 2. Jacobson: Basic algebra, II, Dover publications, 2009 Lang: Algebra, third edition, Springer-Verlag, GTM 211, 2002

1	**Title of the course** (L-T-P-C)	**Engineering Mathematics for Advanced Studies (4-0-0-8)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Module-1:** Linear Algebra: Vector Spaces, Matrices, Linear algebraic equations, Eigenvalues and Eigenvectors of matrices, Singular-value decomposition **Module-2:** Tensor Algebra: Index Notation and Summation Convection, Tensor Algebra **Module-3:** Vector Calculus: Dot and Cross Product, Curves. Arc Length. Curvature. Torsion, Divergence and Curl of a Vector Field, Line Integrals, Green's Theorem, Stokes's Theorem, use of Vector Calculus in various engineering streams **Module-4:** Ordinary Differential Equations: Initial Value Problem, Method to solve first order ODE, Homogeneous, linear, 2nd order ODE, Nonhomogeneous, linear, 2nd order ODE, System of 1st order ODE **Module-5:** Laplace and Fourier transformation: First and Second Shifting Theorems, Transforms of Derivatives and Integrals, Fourier Cosine and Sine Transforms, Discrete and Fast Fourier Transforms **Module-6:** Partial Differential Equations: Basic Concepts of PDEs, Modeling: Wave Equation, Heat Equation, Solution by Separating Variables, Solution by Fourier Series, Solution by Fourier Integrals and Transforms **Module-7:** Numerical Methods: Methods for Linear Systems, Least Squares, Householder's Tridiagonalization and QR-Factorization, Methods for Elliptic, Parabolic, Hyperbolic PDEs **Module-8:** Complex Analysis and Potential Theory: The Cauchy-Riemann Equations, Use of Conformal Mapping, Electrostatic Fields, Heat and Fluid Flow Problems, Poisson's Integral Formula for Potentials **Module-9:** Optimization and Linear Programming: Method of Steepest Descent, Linear Programming, , Fundamental theorem of linear inequalities, Cones, polyhedra. and polytopes, Farkas' lemma, LPduality, max-flow min-cut, Simplex Method, primaldual, Fourier-Motzkin elimination, relaxation methods **Module-10:** Probability Theory and Statistics: Experiments, Outcomes, Events, Permutations and Combinations, Probability Distributions, Binomial, Poisson, and Normal Distributions, Distributions of Several Random Variables, Testing Hypotheses, Goodness of Fit, $\chi 2$-Test **Module-11:** Abstract Algebra: Groups, Sub-groups, Cosets and Lagrange's theorem, Group actions, direct and semi-direct products
4	**Texts/References**	• E. Kreyszig. Advanced Engineering Mathematics, John Wiley & Sons, 2011. • P.V. O'Neil. Advanced Engineering Mathematics, CENGAGE Learning, 2011. • D.G. Zill. Advanced Engineering Mathematics, Jones & Bartlett Learning 2016. • B. Dasgupta. Applied Mathematical Methods, Pearson Education, 2006. • A. Schrijver, Theory of Linear and Integer Programming, 1998. • D.S. Dummit, R.M. Foote, Abstract Algebra, 2004.

1	**Title of the course** (L-T-P-C)	**Advanced Numerical Analysis of Ordinary and Partial Differential Equations (4-0-0-8)**
2	**Pre-requisite courses(s)**	Real Analysis, Complex Analysis, Linear Algebra
3	**Course content**	**1.** Numerical ODE - Multi Step and Multi Stage methods, A-stability, Stiffness **2.** Numerical solution of linear equations – direct and iterative techniques **3.** Numerical solution of Elliptic Boundary value problems - Consistency, Stability and Convergence **4.** Numerical solution of Parabolic equations **5.** Numerical solution of Hyperbolic problems
4	**Texts/References**	Finite Difference Methods for Ordinary and Partial Differential Equations - Randall Leveque

1	**Title of the course** (L-T-P-C)	**Functional Analysis** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Basic topological concepts, Metric spaces, Measure theory
3	**Course content**	Stone-Weierstrass theorem, L^p spaces, Banach spaces,Bounded linear functionals and dual spaces, Hahn-Banachtheorem. Bounded linear operators, open-mapping theorem, closed graph theorem, uniform boundedness principle. Hilbert spaces, Riesz representation theorem. Bounded operators on aHilbert space. The spectral theorem for compact, self- adjoint, normal (including unbounded) operators.
4	**Texts/References**	J. B. Conway: A course in functional analysis, Springer-Verlag, New York, 1990 B.V.Limaye: Functional Analysis, New Age InternationalLimited,Publishers, New Delhi, 1996 Michael Reed, Barry Simon: Methods of modern mathematical physics. I. Functional analysis. Second edition.Academic Press, Inc, New York, 1980 E. Kreyszig: Introductory Functional Analysis withApplications, John Wiley & Sons, New York, 2001

1	**Title of the course** (L-T-P-C)	**Homological Algebra** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Basics of Group Theory, Ring Theory and Module Theory, Linear Algebra
3	**Course content**	Categories and functors: definitions and examples. Functors and natural transformations, equivalence of categories,. Products and coproducts, the hom functor, representable functors, universals and adjoints. Direct and inverse limits. Free objects. Homological algebra: Additive and abelian categories, Complexes and homology, long exact sequences, homotopy, resolutions, derived functors, Ext, Tor, cohomology of groups, extensions of groups.
4	**Texts/References**	**1.** M. Artin, Algebra, 2^{nd} Edition, Prentice Hall of India, 1994. **2.** N. Jacobson, Basic Algebra, Vol. 1, 2^{nd} Edition, Hindustan Publishing Corporation, 1985. **3.** N. Jacobson, Basic Algebra, Vol. 2, 2^{nd} Edition, Hindustan Publishing Corporation, 1989. **4.** S. Lang, Algebra, 3rd Edition, Addison Wesley, 1993. **5.** O. Zariski and P. Samuel, Commutative Algebra, Vol.1, Corrected reprinting of the 1958 edition, Springer-Verlag, New York, 1975. **6.** O. Zariski and P. Samuel, Commutative Algebra, Vol.1, Reprint of the 1960 edition, Springer-Verlag, 1975.

1	**Title of the course** (L-T-P-C)	**Introduction to Representation Theory** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	A course in (graduate) algebra
3	**Course content**	Basic notions of representation theory that includes irreducible modules and complete reducibility theorem. Character theory, Schur's orthogonality relations, isotopic components and the canonical decomposition. Group algebra and integrality, and the degree of an irreducible representation. Induced representations, Frobenius reciprocity, and Mackey theory. Various examples: Abelian groups, Dihedral groups, Symmetric groups in 3,4, and 5 letters.
4	**Texts/References**	• J.-P.Serre, Linear representations of finite groups, Graduate Texts in Mathematics, Vol. 42, Springer- Verlag, New York-Heidelberg 1977. • W. Fulton and J. Harris, Representation theory, A first course, Graduate Texts in Mathematics, 129. Readings in Mathematics, Springer-Verlag, New York, 1991. • Benjamin Steinberg, Representation theory of finite groups : introductory approach, Springer-Verlag, New York, 2012.

1	**Title of the course** (L-T-P-C)	**Differential Topology** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Multivariable Calculus, General Topology and Linear Algebra
3	**Course content**	Differentiable manifolds, smooth maps between manifolds, Tangent spaces and cotangent spaces, Vector fields, tangent and cotangent bundles, Vector bundles, Sub manifolds, submersion and immersions, Basic notion of Lie groups, Tensors and differential forms, Integration on manifolds and de Rham theory
4	**Texts/References**	John M. Lee, Introduction to Smooth Manifolds, Springer Verlag, New York, 2003. Frank Warner, Foundations of Differentiable Manifolds and Lie Groups, Springer Verlag, New York, 1983 . Glen Bredon, Topology and Geometry, Springer Verlag, New York, 1993.

1	**Title of the course** (L-T-P-C)	**Topology** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Undergraduate level calculus and some mathematical maturity
3	**Course content**	Topological spaces, open and closed sets, basis, closure, interior and boundary. Subspace topology, Hausdorff spaces. Continuous maps: properties and constructions; Pasting Lemma. Homeomorphisms. Product topology, Quotient topology and examples of Topological Manifolds. Connected, path- connected and locally connected spaces. Lindelof and Compact spaces, Locally compact spaces, one- point compactification and Tychonoff's theorem. Paracompactness and Partitions of unity. Countability and separation axioms. Urysohn's lemma, Tietze extension theorem and applications. Completion of metric spaces. Baire Category Theorem and applications. (If time permits) Urysohn embedding lemma and metrization theorem for second countable spaces. Covering spaces, Path Lifting and Homotopy Lifting Theorems, Fundamental Group.
4	**Texts/References**	**1.** J. R. Munkres, Topology: a first course, Prentice- Hall of India (2000). **2.** K. Janich, Topology, UTM, Springer (Indian reprint 2006). **3.** M. A. Armstrong, Basic Topology, Springer (Indian reprint 2004). **4.** G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw- Hill (1963). **5.** J. L. Kelley, General Topology, Springer (Indian reprint 2005). **6.** I. M. Singer and J. A. Thorpe, Lecture Notes on Elementary Topology and Geometry, UTM, Springer (Indian reprint 2004). **7.** J. Dugundji, Topology, UBS (1999).

1	**Title of the course** (L-T-P-C)	**Introduction to Graduate Algebra** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Basics of Group Theory, Ring Theory and Module Theory, Linear Algebra, Field Theory and Galois Theory
3	**Course content**	Review of Group theory: Sylow's theorem and Group Actions, Ring theory: Euclidean Domains, PID and UFD's, Module theory: structure theorem of modules over PID Review of field and Galois theory, Infinite Galois extensions, Fundamental Theorem of Galois theory for infinite extensions, Transcendental extensions, Luroth`s theorem Review of integral ring extensions, prime ideals in integral ring extensions, Dedekind domains, discrete valuations rings, Categories and functors, Basic Homological algebra: Complexes and homology, long exact sequences, homotopy, resolutions, derived functors, Ext, Tor, cohomology of groups
4	**Texts/References**	• Artin, Algebra, 2nd Edition, Prentice Hall of India, Delhi, 1994. • Jacobson, Basic Algebra, Vol. 1, 2nd Edition, Hindustan Publishing Corporation, Delhi, 1985. • Jacobson, Basic Algebra, Vol. 2, 2nd Edition, Hindustan Publishing Corporation, Delhi, 1989. • Lang, Algebra, 3rd Edition, Addison Wesley, Boston, 1993. • Zariski and P. Samuel, Commutative Algebra, Vol.1, Corrected reprinting of the 1958 edition, Springer-Verlag, New York, 1975. • Zariski and P. Samuel, Commutative Algebra, Vol.2, Reprint of the 1960 edition, Springer-Verlag, New York, 1975.

1	**Title of the course** (L-T-P-C)	**Numerical Analysis of Partial Differential Equations** **(4-0-0-8)**
2	**Pre-requisite courses(s)**	Analysis, ODE, PDE and Numerical Analysis
3	**Course content**	Numerical ODE - Multi Step and Multi Stage methods, A-stability, Stiffness Numerical solution of Elliptic Boundary value problems - Consistency, Stability and Convergence, Solution of Poisson's Equation in 2D, Numerical solution of Elliptic Eigenvalue problems Numerical solution of Conservation Laws – Local and Global Errors, Conservative Methods, Godunov Methods and High Resolution Methods, WENO scheme
4	**Texts/References**	Arieh Iserles, A first course in the numerical analysis of differential equations, 2^{nd} Edition, Cambridge University Press, UK, 2008 K. W. Morton & D. F. Mayers, Numerical solution of partial differential equations: An Introduction, 2^{nd} Edition, Cambridge University Press, UK, 2005 Randall J. LeVeque, Finite volume methods for Hyperbolic Problems, 2^{nd} Edition, Cambridge University Press, UK, 2002 Stig Larsson & Vidar Thomee, Partial Differential Equations with numerical methods, Text in Applied Mathematics, Springer-Verlag Berlin Heidelberg, 2003

1	**Title of the course** (L-T-P-C)	**Algebraic Geometry I** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Introduction to Algebra
3	**Course content**	Affine, projective varieties, Hilbert's nullstellensatz, morphisms, rational maps, blowing up of a variety at a point, non-singular varieties, non-singular curves, intersection multiplicity Bézout's theorem
4	**Texts/References**	**1.** S. S. Abhyankar, Algebraic Geometry for Scientists and Engineers, American Mathematical Society, Providence, RI, 1990. **2.** D. Eisenbud and J. Harris, The Geometry of Schemes, Springer-Verlag, 2000. **3.** W. Fulton, Algebraic Curves, Benjamin, 1969. **4.** J. Harris, Algebraic Geometry: A First Course, Springer-Verlag, 1992. **5.** R. Hartshorne, Algebraic Geometry, Springer- Verlag, 1977. **6.** I. R. Shafarevich, Basic Algebraic Geometry, Vol. 1 and 2, Second edition, Springer-Verlag, 1994.

1	**Title of the course** (L-T-P-C)	**Algebraic Geometry II** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Introduction to Algebra
3	**Course content**	Schemes: Sheaves, schemes, morphisms, separated and proper morphisms, sheaves of modules, divisors, Projective morphisms, differentials, formal scheme Cohomology: cohomology of sheaves, cohomology of a Noetherian affine scheme, Cech cohomology, the cohomology of projective space, the Serre duality theorem, flat morphism, smooth morphisms
4	**Texts/References**	**1.** R. Hartshorne, Algebraic Geometry, Springer- Verlag, 1977. **2.** D. Mumford. The red book of varieties and schemes expanded ed., Lecture Notes in Mathematics 1358, Springer, 1999. **3.** I. R. Shafarevich, Basic Algebraic Geometry, Vol. 1 and 2, Second edition, Springer-Verlag, 1994.

1	**Title of the course** (L-T-P-C)	**Algebra** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Basics of Group Theory, Ring Theory and Module Theory, Linear Algebra, Field Theory and Galois Theory
3	**Course content**	Categories and functors: definitions and examples. Functors and natural transformations, equivalence of categories, Products and coproducts, the hom functor, representable functors, universals and adjoints. Direct and inverse limits. Free objects. Homological algebra: Additive and abelian categories, Complexes and homology, long exact sequences, homotopy, resolutions, derived functors, Ext, Tor, cohomology of groups, extensions of groups, Review of field and Galois theory, Infinite Galois extensions, Fundamental Theorem of Galois theory for infinite extensions, Transcendental extensions, Luroth`s theorem, Review of integral ring extensions, prime ideals in integral ring extensions, Dedekind domains, discrete valuations rings.
4	**Texts/References**	• M. Artin, Algebra, Prentice Hall of India, 1994 • N. Jacobson, Basic Algebra, Vol. 1 and 2, Hindustan Publishing Corporation. • S. Lang, Algebra, 3rd Ed., Addison Wesley, 1993. • O. Zariski and P. Samuel, Commutative Algebra, Vol.1 and 2, Springer-Verlag, 1975.

1	**Title of the course** (L-T-P-C)	**Random Schrodinger Operators** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Real analysis, Measure theory, Functional analysis and Probability Theory
3	**Course content**	Review of spectral theorem and functional calculus of self-adjoint operator on Hilbert space, Borel (or Stieltjes) transform of measure, The Anderson Model: Discrete Schrodinger operators, random potentials, Ergodic operators, Wegner estimate, integrated density of states (proof of existence), Lifshitz tail, The spectrum, Anderson localization in large disorder, fractional moments of Green's function, Multiscale analysis.
4	**Texts/References**	**1.** Aizenman M, Warzel S: Random Operators: Disorder Effects on Quantum Spectra and Dynamics, Graduate Studies in Mathematics, vol. 168 , Amer. Math. Soc. 2015. **2.** Carmona C, Lacroix J: Spectral Theory of Random Schrodinger Operators, Birkhauser, Boston, 1990. **3.** Kirsch W: An Invitation to Random Schrodinger Operators, (With an appendix by Frederic Klopp) Panor. Syntheses, 25, Random Schrodinger operators, 1, Soc. Math. France, Paris, 1−119, 2008. **4.** Demuth M, Krishna M: Determining Spectra in Quantum Theory, Progress in Mathematical Physics, Vol. 44 (Birkhauser, Boston, 2005). **5.** Simon B: Trace Ideals and Their Applications Mathematical Surveys and Monographs, vol.20.American Mathematical Society, Providence (2005)

1	**Title of the course** (L-T-P-C)	**Advanced Graph Theory** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Real analysis, Measure theory, Functional analysis and Probability Theory
3	**Course content**	Fundamental concepts of graph theory, Trees and distances, Planar graphs, Graphs on surfaces, Coloring and chromatic numbers, Edge coloring and chromatic index, Total coloring and total chromatic number, List coloring and choosability, Graph minors, Directed and Oriented graphs, Graph homomorphisms, Graph homomorphisms and colorings, Graph homomorphisms and minors, Extremal graph theory, Random graphs.
4	**Texts/References**	**1.** D. B. West, Introduction to Graph Theory 2nd edition. Prentice Hall. **2.** Harary. Graph Theory. Reading, MA: Perseus Books, 1999. **3.** R. Diestel, Graph Theory, 5th edition. Springer.

1	**Title of the course** (L-T-P-C)	**Measure Theory** **(2-1-0-6) New**
2	**Pre-requisite courses(s)**	Real Analysis
3	**Course content**	Construction of Lebesgue measure on Real line, Introduction to abstract measure theory, Measurable functions, Caratheodory's Extension Theorem, MCT, Fatou's Lemma, DCT, Product space, Product measure, Fubini's Theorem, Definition of signed measures, Positive and negative sets. Hahn-Jordan Decomposition. Absolute continuity of two σ-finite measures. Radon-Nikodyme Theorem and Lebesgue Decomposition.
4	**Texts/References**	• H. L. Royden; Real analysis. Third edition. Macmillan Publishing Company, New York, 1988. • W. Rudin; Real and complex analysis. Third edition. McGraw-Hill Book Co., New York, 1987. • S. Athreya and V.S. sunder; Measure & probability. CRC Press, Boca Raton, FL, 2018. • K.R. Parthasarathy; Introduction to probability and measure, Hindustan Book Agency, 2005.

1	**Title of the course** (L-T-P-C)	**Linear Integral Equations** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Real Analysis
3	**Course content**	Different types of integral equations and their applications. Basic solution strategies like successive approximation Review of normed spaces, bounded and compact operator on normed spaces. linear integral operator with continuous and weakly singular kernel, compact linear integral operators Riesz theory and Fredholm theory and application to linear integral equations Boundary integral equations corresponding to interior and exterior problems of Laplace equations Cauchy Integral Operator, Singular integral equations with Cauchy Kernel Integral equations in the context of heat equations (If time permits)
4	**Texts/References**	**1.** Kress R., Linear Integral Equations (Applied Mathematical Sciences Book82), 2nd Edition, Springer New York, NY (1999). **2.** Kanwal Ram P., Linear Integral Equations: Theory and Technique, 2nd Edition, Springer Science+Business Media New York (1997). **3.** Hackbusch W., Integral Equations, Theory and Numerical Treatment, 1st Edition, Birkhäuser Basel (1995)

1	**Title of the course** (L-T-P-C)	**Theory of Perfect Graphs** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Basic Graph Theory
3	**Course content**	Perfect graphs, The Weak Perfect Graph Theorem, The Strong Perfect Graph Theorem (statement only), Chrodal graphs, Perfect Elemination Order and Scheme, Split graphs, degree sequence, Erdos-Gallai Theorem, Comparability graphs, Permutation graphs, Intersection graphs, Interval graphs and some of its properties, Circular arc graphs
4	**Texts/References**	**1.** M. C. Golumbic. Algorithmic Graph Theory and Perfect Graphs . Academic Press, New York, 1980. **2.** D. B. West, Introduction to Graph Theory 2nd edition. Prentice Hall.

1	**Title of the course** (L-T-P-C)	**Topics in Elliptic partial Differential equations (3-0-0-6)**
2	**Pre-requisite courses(s)**	Measure Theory, Metric spaces & Introductory Functional Analysis
3	**Course content**	Convolutions, mollifiers, cut-off functions & partitions of unity Elliptic and Uniformly Elliptic Operators, Maximum principles, Hopf's lemma, Uniqueness of boundary value problems of elliptic PDEs, Weak derivatives and their properties, Definition of Sobolev spaces, Global and local approximation of functions in W^{k,p} by smooth functions, Trace theorem, Sobolev inequalities, imbedding results Idea of weak solution of elliptic PDEs, Lax-Milgram theorem and existence and uniqueness of weak solutions of linear Elliptic pdes, Interior and boundary regularity of weak solutions
4	**Texts/References**	**1.** Evans L., Partial Differential Equations, 2nd Edition, GSM, Vol 19, AMS, Providence, Rhode Island (2010) **2.** Han Q. and Lin F., Elliptic Partial Differential Equations, 2nd Edition, Vol 1, CIMS and AMS, Providence, Rhode Island (2011) **3.** Renardy M. & Rogers R. C., An Introduction to Partial Differential Equations, 2nd Edition, Springer NY (2006) **4.** Gilberg D. & Trudinger N. S., Elliptic Partial DIfferential Equations of second order, 2nd ed. Springer-Verlag, Berlin (1983)

1	**Title of the course** (L-T-P-C)	**Numerical Solution of Linear Integral Equations (3-0-0-6)**
2	**Pre-requisite courses(s)**	Metric spaces & Introductory Functional Analysis
3	**Course content**	Operator approximations, approximations based on norm and pointwise convergence Method of degenerate kernels, degenerate kernels via Taylor expansion, orthogonal expansion and expansion by interpolation Theory of projection methods, Collocation and Galerkin techniques, their examples Nystrom technique for continuous and weakly continuous kernels Boundary integral equations of Laplace equation in 2 Dimension and 3 Dimension in domains with smooth boundary Multivariable integral equations and their numerical solutions
4	**Texts/References**	**1.** Kress R., Linear Integral Equations, 3rd Edition, Springer New York (2013). **2.** Atkinson K., The Numerical Solution of Integral Equations of the Second Kind, 1st Edition, Cambridge University Press, (1997). **3.** Hackbusch W., Integral Equations, Theory and Numerical Treatment, 1st Edition, Birkhäuser Basel (1995)

1	**Title of the course** (L-T-P-C)	**Introduction to Diophantine Approximation** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Linear algebra, prior knowledge of Field and Galois theory over Q is helpful, but not necessary as the course is self-contained
3	**Course content**	b-ary expansion, Continued fraction expansion, Legendre theorem, Dirichlet approximation theorem, Simultaneous approximation theorem, Minkowski's convex body theorem Linear independence criteria (including Siegel and Nesterenko's criterion), Liouville theorem, Transcendence of e and π, Roth's theorem on the approximation of algebraic numbers by rationals, Brief introduction to Schmidt Subspace theorem(higher dimensional generalization of Roth's Theorem) and some of its application, b-ary(or base b-expansion) expansion of algebraic numbers Finite Automata, Automatic Sequences and Transcendence
4	**Texts/References**	**1.** Allouche J. P. and Shallit J.. Automatic sequences: Theory, Applications, Generalizations, 1st Edition, Cambridge University Press (2003). **2.** Bugeaud Y., Approximation by algebraic numbers, 1st Edition, Cambridge University Press (2004). **3.** Ram Murty M. and Rath P., Transcendental numbers, 1st Edition, Springer, New York (2014). **4.** Natarajan S. and Thangadurai R., Pillars of Transcendental number theory, 1st Edition, Springer Verlag (2020). **5.** Niven I., Irrational numbers, Sixth printing, The Mathematical Association of America (2006). **6.** Schmidt W. M., Diophantine Approximation, 1st Edition, Springer Verlag, Lecture Notes in Mathematics 785 (1980). **7.** Waldschmidt M., Criteria for irrationality, linear independence, transcendence, and algebraic independence, Lecture Notes at CMI and IMSc, http://people.math.jussieu.fr/~miw/enseignements.htMl

1	**Title of the course** (L-T-P-C)	**Introduction to Lie Algebras** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Linear algebra. Familiarity with the basics of rings and modules is preferable but not mandatory.
3	**Course content**	Definition and examples of Lie algebras, namely, classical Lie algebras: general linear, special linear, symplectic, even-odd orthogonal Lie algebras. Elementary properties of Lie algebras: solvable and nilpotent. Theorems ofLie, Cartan, and Engel. Structure and classification of semisimple Lie algebras over the field of complex numbers. Root systems and their construction, Dynkyn diagrams. Representation theory of semisimple Lie algebras (if time allows): highestweight modules, Borel subalgebras and Verma modules. Course will have the rank two simple algebra (namely all two-by-two tracelessmatrices) as a running example.
4	**Texts/References**	**1.** Humphreys J. E., Introduction to Lie Algebras and Representation Theory,1st Edition, Springer-Verlag, 3rd printing (1980), **2.** Carter R., Lie Algebras of Finite and Affine Type, 1st Edition, Cambridge Studies in Advanced Mathematics, Cambridge University Press (2005) **3.** Harris J. and Fulton W., Representation Theory: A First Course, 1st Edition,GTM, Vol. 129, Springer Verlag NY (2004). **4.** Erdman K. and Wildon, M. J., Introduction to Lie Algebras, 1st Edition,Springer Undergraduate Mathematics Series, Springer London (2006)

1	**Title of the course** (L-T-P-C)	**Irrational and Transcendental Numbers** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Linear Algebra, Complex Analysis, and prior knowledge of Field and Galois theory over Q is helpful
3	**Course content**	Hermite Pade-Approximation, Transcendence of e and pi, Lindemann Weierstrass Theorem, Gelfond-Schneider Theorem, Six-Exponential Theorem, Schneider-Lang Theorem and its applications, Baker's theory of linear form in logarithm of algebraic numbers. Criterion for linear independence – Siegel and Nesterenko's methods, Irrationality of Reimann Zeta function at odd positive integers: Apery's irrationality proof of zeta(3) and Beukers's proof, Ball-Rivoal theorem, recent results about infinitely many odd zeta values are irrational due to Fischler-Zudilin-Sprang.
4	**Texts/References**	• Baker A., Transcendental Number Theory, Cambridge University Press, 1975. • Burger E. B. and Tubbs R., Making Transcendence Transparent: An intuitive approach to classical transcendental number theory, Springer NewYork, 2004. • Ram Murty M. and Rath P., Transcendental numbers, 1st Edition, Springer,New York (2014). • Natarajan S. and Thangadurai R., Pillars of Transcendental number theory,1st Edition, Springer Verlag (2020). • Ball, K. and Tanguy R., Irrationality of infinitely many values of the zeta function at odd integers, Invent. Math. (2001) • Fischler S., Johannes S. and Zudilin W., Many odd zeta values are irrational, Compos. Math. (2019)

1	**Title of the course** (L-T-P-C)	**Algebraic Number Theory** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Group Theory, Elementary Number Theory. We will also need some concepts about rings, modules, and Galois theory throughout the course.
3	**Course content**	Algebraic numbers and Algebraic integers, Number Fields and Number rings, Traces and Norms, Discriminant, Dedekind domains, Ideal class group, Unique factorization and prime decomposition in Number rings, Galois theory of Number Fields. Finiteness of ideal class group, Lattices, Minkowski Theory, Dirichlet unit theorem, p-adic numbers, Absolute values, Valuations and completions of number fields.
4	**Texts/References**	• Lang S., Algebraic Number Theory, Graduate Texts in Mathematics 110, Springer-Verlag, 1994. • Murty Ram M., and Esmonde J., Problems in Algebraic Number Theory, Graduate Texts in Mathematics, Springer-Verlag, New York, 2001. • Neukirch J., Algebraic Number Theory, Springer-Verlag, 1999. • Samuel P., Algebraic Theory of Numbers, Houghton Mifflin Co., Boston, MA, 1970. 109 pp. • Janusz G. J., Algebraic Number Fields, Graduate Studies in Mathematics American Mathematical Society, 1996. • Milne J.S., Algebraic Number Theory, Available at https://www.jmilne.org/math/CourseNotes/ANT.pdf, 2020.

1	**Title of the course** (L-T-P-C)	**Complex Analysis with Applications to Number Theory** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Real Analysis, Basic Complex Analysis
3	**Course content**	Introduction to holomorphic functions, Complex integration, Cauchy's Theorem, and its applications, Entire and Meromorphic functions, functions of finite order, Argument principle, Maximum modulus principle, Jensen's formula. Estimate for the number of zeros of an exponential polynomial inside a disc, zero density estimates (Use of three circle method, effect of small derivatives) to estimate growth of a function in terms of zero and derivatives, Hermite Interpolation formula. Weierstrass infinite product, Hadamard's factorization theorem, Gamma and Riemann Zeta functions, Euler product, Functional equation and Analytic continuation An introduction to Elliptic functions, Introduction of Jacobi theta functions, Hermite Pade-Approximation, Transcendental function, algebraically independent functions, Entire functions with rational values
4	**Texts/References**	**1.** Lang S., Complex Analysis, 4th Edition, Springer-Verlag, New York (1999). **2.** Stein E. M. and Shakarchi R., Complex Analysis, Vol. 2, 1st Edition Princeton Lectures in Analysis, Princeton University Press, Princeton, NJ (2003). **3.** Shorey T. N., Complex Analysis with Applications to Number Theory, 1st Edition, Springer, Singapore (2020) **4.** Ahlfors L., Complex Analysis, 3rd Edition, McGraw-Hill Book Co., New York (1978)