| Semester VI | | | | | | |
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| **SL. No** | **Course code** | **Course name** | **L** | **T** | **P** | **C** |
| **1** | MA107T | Advanced Linear Algebra | 3 | 1 | 0 | 6 |
| **2** | MA303T | Group Theory | 2 | 1 | 0 | 6 |
| **3** | MA408T | Introduction to Mathematical Finance 2 | 3 | 0 | 0 | 6 |
| **4** | | Elective | | | | 6 |
| **5** | | Elective | | | | 6 |
| **6** | MA409T | Numerical Linear Algebra | 3 | 0 | 0 | 6 |
| **Total credits** | | | | | | **36** |

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| 1 | **Title of the course (L-T-P-C)** | **Group Theory (2-1-0-6)** |
| 2 | **Pre-requisite courses(s)** | **Nill** |
| 3 | **Course content** | Symmetries of plane figures, translations, rotations and reflections in the Euclidean plane, composing symmetries, inverse of a symmetry, Cayley tables<br><br>Definition of group, basic properties, examples, Homomorphisms, Isomorphisms, subgroups, subgroup generated by a set,<br><br>Cyclic groups, subgroups of cyclic groups,<br><br>Review of Equivalence relations, Cosets, Lagrange's theorem, Normal subgroup, Quotient Group, Examples, Isomorphism theorems, Automorphisms<br><br>Group actions, conjugacy classes, orbits and stabilizers, faithful and transitive actions, centralizer, normalizer, Cayley's theorem.<br><br>Conjugation, Class equation, Cauchy's theorem, Applications to p-groups, Conjugacy in S 5<br><br>Sylow theorems, Simplicity of A_n and other applications Direct products, Structure of Finite abelian groups<br>Semi-Direct products, Classification of groups of small order<br><br>Normal series, Composition series, Solvable groups, Jordan- Holder theorem, Insolvability of S_5<br>Lower and upper central series, Nilpotent groups, Basic commutator identities, Decomposition theorem of finite nilpotent groups (if time permits)<br><br>Three dimensional symmetries: platonic solids and their dual, symmetries of a tetrahedron, symmetries of a cube and octahedron, symmetries of icosahedron and dodecahedron, classification of finite subgroups of SO (3) (if time permits). |
| 4 | **Texts/References** | • M. Artin, Algebra, Prentice Hall of India, 1994.<br>• D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John Wiley,2002.<br>• J. A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa, 1999.<br>• I.N. Herstein, Topics in Algebra, Wiley, 2nd Edition, 1975.<br>• K. D. Joshi, Foundations of Discrete Mathematics, Wiley Eastern, 1989.<br>• S.Lang, Undergraduate Algebra, 2nd Edition, Springer, 2001.S.Lang, Algebra, 3rd Edition, Springer (India), 2004. |

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| **1.** | **Title of the course** (L-T-P-C) | **Numerical Linear Algebra** **(3-0-0-6)** |
| **2** | **Pre-requisite courses(s)** | Calculus, Linear Algebra |
| **3** | **Course content** | Vector and Matrix Norms, Gram Schmidt Orthogonalization, Singular Value Decomposition, QR factorization, Householder Triangularization<br>Floating point number system, Condition number and Stability, Stability of Back substitution, Gauss Elimination and Householder methods<br><br>Numerical techniques for finding eigenvalues, Rayleigh Quotient, QR methods, Divide and Conquer strategies<br>Krylov subspace techniques, GMRES and Conjugate Gradient |
| **4** | **Texts/References** | 1. Lloyd N. Trefethen and David Bau, Numerical Linear Algebra, SIAM, US, 1997.<br>2. Gene Golub and Charles Van Loan, Matrix Computations, 4th Edition, John Hopkins<br>3. University Press, US, 2013 Iterative Methods for Sparse Linear Systems,<br>4. Yousef Saad, 2 Edition, SIAM, US, 2003 |

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| **1** | **Title of the course** (L-T-P-C) | **Advanced Linear Algebra** **(2-1-0-6)** |
| **2** | **Pre-requisite courses(s)** | MA 102 or Instructor's consent |
| **3** | **Course content** | Review of Linear algebra from MA 102:<br>Systems of linear equations, matrices, rank, Gaussian elimination, Linear transformations, representation of linear transformations by matrices, rank-nullity theorem, duality and transpose, Determinants, Laplace expansions, cofactors, adjoint, Cramer's Rule.<br><br>Abstract vector spaces over fields, subspaces, bases and dimension.<br><br>Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley Hamilton Theorem, triangulation, diagonalization, rational canonical form, Jordan canonical form.<br><br>Inner product spaces, Gram-Schmidt orthonormalization, orthogonal projections, linear functionals and adjoints, Hermitian, self-adjoint, unitary and normal operators, Spectral Theorem for normal operators<br><br>Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness. |
| **4** | **Texts/References** | 1. H. Anton, Elementary linear algebra and applications, 8th edition, John Wiley, 1995.M. Artin, Algebra, Prentice Hall of India, 1994<br>2. S. Kumaresan, Linear algebra - A Geometric Approach, Prentice Hall of India, 2000.<br>3. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003.<br>4. S. Lang, Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989.<br>5. G. Strang, Linear algebra and its applications, 4th edition, Thomson, 2006. |

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| 1 | **Title of the course (L-T-P-C)** | **Introduction to Mathematical Finance 2 (3-0-0-6)** |
| 2 | **Pre-requisite courses(s)** | Calculus, Linear Algebra, Probability, Statistics, Stochastic Models or Instructor's consent |
| 3 | **Course content** | Basics, Risk Assessment and Diversification<br><br>Single period utility analysis, Mean-variance portfolio analysis, Graphical Analysis of portfolios and efficient portfolios, Efficient portfolios with and without risk-free assets,<br>Single, two and multi-index models<br><br>Risk management: Concept of VaR, measuring VaR and estimating volatilities via simple moving averages and GARCH, Var in Black-Scholes, Average VaR in Black- Scholes<br><br>Capital Asset Pricing Model and its extensions, Continuous- time asset pricing, Arbitragepricing |
| 4 | **Texts/References** | **1.** J. C. Francis and D. Kim, Modern Portfolio Theory: Foundations, Analysis, and New Developments, John Wiley and Sons, 2013<br>**2.** M. J. Capinski and E. Kopp, Portfolio Theory and Risk Management, Cambridge University Press, 2014<br>**3.** J.Cvitanic and F. Zapatero, Introduction to the Economics and Mathematics of Financial Markets, MIT press, 2004<br>**4.** E. J. Elton, M. J. Gruber, S. J. Brown, W. N. Goetzmann, Modern Portfolio Theory and Investment Analysis, 9th Edition, John Wiley and Sons, 2014 |