Semester IV						
Sr No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	MA 220	Real Analysis	2	1	0	6
2	MA 221	Group Theory	2	1	0	6
3	MA 202	Advanced Linear Algebra	2	1	0	6
4		Program Elective-I				6
5		Program Elective-II				6
		Total Credits				**30**

1	**Title of the course (L-T-P-C)**	**Real Analysis (2-1-0-6)**
2	**Pre-requisite courses(s)**	**Calculus and Linear Algebra or Instructor's consent**
3	**Course content**	Review of basic concepts of real numbers: Archimedean property, Completeness. Metric spaces, compactness, connectedness, (with emphasis on Rn). Continuity and uniform continuity. Monotonic functions, Functions of bounded variation; Absolutely continuous functions. Derivatives of functions and Taylor's theorem. Riemann integral and its properties, characterization of Riemann integrable functions. Improper integrals, Gamma functions. Sequences and series of functions, uniform convergence and its relation to continuity, differentiation and integration. Fourier series, pointwise convergence, Fejer's theorem, Weierstrass approximation theorem.
4	**Texts/References**	W. Rudin, Principles of Mathematical Analysis, 3rd Edition, McGraw-Hill, 1983 T. Apostol, Mathematical Analysis, 2nd Edition, Narosa, 2002. S. Abbott, Understanding Analysis, 2nd Edintion, Springer Verlag New York, 2015 S. R. Ghorpade and B. V. Limaye, A course in Calculus and Real Analysis, 2nd Edition, Springer international publishing, 2018

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 Definition of group, basic properties, examples, Homomorphisms, Isomorphisms, subgroups, subgroup generated by a set, Cyclic groups, subgroups of cyclic groups, Review of Equivalence relations, Cosets, Lagrange's theorem, Normal subgroup, Quotient Group, Examples, Isomorphism theorems, Automorphisms Group actions, conjugacy classes, orbits and stabilizers, faithful and transitive actions, centralizer, normalizer, Cayley's theorem. Conjugation, Class equation, Cauchy's theorem, Applications to p-groups, Conjugacy in S 5 Sylow theorems, Simplicity of An and other applications Direct products, Structure of Finite abelian groups Semi-Direct products, Classification of groups of small order Normal series, Composition series, Solvable groups, Jordan- Holder theorem, Insolvability of S_5 Lower and upper central series, Nilpotent groups, Basic commutator identities, Decomposition theorem of finite nilpotent groups (if time permits) 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. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, JohnWiley, 2002. J. A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa, 1999. I.N. Herstein, Topics in Algebra, Wiley, 2nd Edition, 1975. K. D. Joshi, Foundations of Discrete Mathematics, Wiley Eastern, 1989.S.Lang, Undergraduate Algebra, 2nd Edition, Springer, 2001.S.Lang, Algebra, 3rd Edition, Springer (India), 2004.

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: 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. Abstract vector spaces over fields, subspaces, bases and dimension. Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley Hamilton Theorem, triangulation, diagonalization, rational canonical form, Jordan canonical form. Inner product spaces, Gram-Schmidt orthonormalization, orthogonal projections, linear functionals and adjoints, Hermitian, self-adjoint, unitary and normal operators, Spectral Theorem for normal operators Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness.
4	**Texts/References**	H. Anton, Elementary linear algebra and applications, 8th edition, John Wiley, 1995. M. Artin, Algebra, Prentice Hall of India, 1994. S. Kumaresan, Linear algebra - A Geometric Approach, Prentice Hall of India, 2000. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003. S. Lang, Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989. G. Strang, Linear algebra and its applications, 4th edition, Thomson, 2006.