Semester V						
Sr No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	MA 307	Rings and Modules	2	1	0	6
2	MA 308	Introduction to Complex Analysis	2	1	0	6
3	MA 309	General Topology	2	1	0	6
4	CS 403	Graph Theory and Combinatorics	3	0	0	6
5		Program Elective-II				6
		Total Credits				**30**

1	**Title of the course (L-T-P-C)**	**Rings and Modules (2-1-0-6)**
2	**Pre-requisite courses(s)**	**Group Theory**
3	**Course content**	Definition of rings, Homomorphisms, basic examples (Polynomial ring, Matrix ring, Group ring), Integral domain, field, Field of fractions of an integral domain Ideals, Prime and Maximal ideals, Quotient Rings, Isomorphism theorems, Chinese Remainder theorem, Applications Principal ideal domains, Irreducible elements, Unique factorization domains, Euclidean domains, examples Polynomial rings, ideals in polynomial rings, Polynomial rings over fields, Gauss' Lemma, Polynomial rings over UFDs, Irreducibility criteria, Hilbert's basis theorem Definition of modules, submodules, The group of homomorphisms, Quotient modules, Isomorphism theorems, Direct sums, Generating set, Noetherian modules, free modules, Simple modules, vector spaces Free modules over a PID, Finitely generated modules over PIDs, Applications to finitely generated abelian groups and Rational and Jordan canonical forms time permits) Closed subsets of affine space, coordinate rings, correspondence between ideals and closed subsets, affine varieties, Hilbert's nullstellensatz
4	**Texts/References**	M. Artin, Algebra, Prentice Hall of India, 1994. M. F. Atiyah and I. G. Macdonald, Introduction to Commutative Algebra, Addison Wesley, 1969. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John Wiley, 2002. N. Jacobson, Basic Algebra I and II, 2nd Edition, W. H. Freeman, 1985 and 1989. S. Lang, Algebra, 3rd Edition, Springer (India), 2004. O. Zariski and P. Samuel, Commutative Algebra, Vol. I, Springer, 1975.

1	**Title of the course (L-T-P-C)**	**Introduction to Complex Analysis (2-1-0-6)**
2	**Pre-requisite courses(s)**	**Real analysis and calculus OR Instructor's consent**
3	**Course content**	Definition and properties of analytic functions. Cauchy- Riemann equations, harmonic functions. Power series and their properties. Elementary functions. Cauchy's theorem and its applications. Taylor series and Laurent expansions. Evaluation of improper integrals. Conformal mappings. Inversion of Laplace transforms. Isolated singularities and residues. Residues and the Cauchy residue formula. Zeroes and poles, Maximum Modulus Principle, Argument Principle, Rouche's theorem.
4	**Texts/References**	**1.** E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999) **2.** R. V. R. V. Churchill and J. W. Brown, Complex variables and applications (7th Edition), McGraw-Hill (2003) **3.** Theodore Gamelin, Complex Analysis – Springer Undergraduate texts in Mathematics (2003) **4.** J.B Conway, Functions of one complex variable, Springer, 7th printing 1995 edition.

1	**Title of the course (L-T-P-C)**	**General Topology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	**Calculus, Linear Algebra, Real Analysis and Elements of Metric Space Theory or Instructor's consent**
3	**Course content**	**Topological Spaces:** open sets, closed sets, neighbourhoods, bases, sub bases, limit points, closures, interiors, continuous functions, homeomorphisms. **Examples of topological spaces:** subspace topology, product topology, metric topology, order topology. Quotient Topology: Construction of cylinder, cone, Moebius band, torus, etc. **Connectedness and Compactness:** Connected spaces, Connected subspaces of the real line, Components and local connectedness, Compact spaces, Heine-Borel Theorem, Local -compactness. **Separation Axioms:** Hausdorff spaces, Regularity, Complete Regularity, Normality, Urysohn Lemma, Tychonoff embedding and Urysohn Metrization Theorem, Tietze Extension Theorem. Tychnoff Theorem, One-point Compactification. Complete metric spaces and function spaces, Characterization of compact metric spaces, equicontinuity, Ascoli-Arzela Theorem, Baire Category Theorem. Applications: space filling curve, nowhere differentiable continuous function.
4	**Texts/References**	**1.** J. R. Munkres, Topology, 2nd Edition, Pearson Education (India), 2001. **2.** G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963. **3.** M. A. Armstrong, Basic Topology, Springer (India), 2004

1	**Title of the course (L-T-P-C)**	**Graph Theory and Combinatorics (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Discrete Structures**
3	**Course content**	Fundamentals of graph theory. Topics include: connectivity, planarity, perfect graphs, coloring, matchings and extremal problems. Basic concepts in combinatorics. Topics include: counting techniques, inclusion-exclusion principles, permutations, combinations and pigeon- hole principle.
4	**Texts/References**	"An Introduction to Quantum Field Theory", Michael Peskin and Daniel Schroeder (Addison Wesley) "Introduction to Quantum Field Theory", A. Zee "Quantum Field Theory", Lewis H. Ryder "Quantum Field Theory and Critical Phenomena", by Jean Zinn-Justin. "Quantum field Theory for the Gifted Amateur", T. Lancaster and Stephen J. Blundell NPTEL lectures in Quantum Field Theory (https://nptel.ac.in/courses/115106065/)