Course code: PHMAT1C006T

Course title: Algebraic Topology

Course Credits: 4

Unit-1

- Homotopy, retract, deformation retract, contractible spaces and homotopy type, fundamental group and its properties, The fundamental group of circle

Unit-2

- Simplicial complexes, polyhedra and triangulations, barycentric subdivision and simplicial approximation theorem.

Unit-3

- Orientation of simplicial complexes, simplicial chain complex and homology, properties of integral homology groups, induced homomorphisms.
- Invariance of simplicial homology groups.

Unit-4

- van Kampen theorem (statement only), applications of van Kampen theorem.
- Degree of maps on S^n; $(n \geq 1)$, and its applications, Lefschetz fixed point theorem. Borsuk-Ulam theorem.

Unit-5

- Definition and examples of covering spaces. path lifting and homotopy lifting property.
- Covering homomorphisms, deck transformations, classification of coverings. existence of universal covering (statement without proof).

Recommended Texts:

1. Satya Deo, Algebraic Topology: A Primer, Texts and Readings in Mathematics Vol. 27. Hindustan Book Agency, 2003.
2. Joseph J. Rotman, An introduction to Algebraic Topology, Springer (Graduate Texts in Mathematics, 119), First Indian Reprint 2004.
3. William Massey, Algebraic Topology: An Introduction, Springer (Graduate Texts in Mathematics, Vol. 127), 1977.
4. Glen E.Bredon, Topology and Geometry, Springer (Graduate Texts in Mathematics, 139)
5. Allen Hatcher, Algebraic Topology, Cambridge University Press, 2002.
6. M. Greenberg and J. Harper, Algebraic Topology: A First Course, Addision-Wesley, 1981.
7. H. Seifert and W. Threlfall, A Textbook of Topology, Academic Press, 1980.

Course Title: Information Theory Course Code: PHMAT1CC
Course Type: Ph.D. Course Credits: 04

Unit-I

Information Measures: Entropy, Joint Entropy, Conditional Entropy, Relative Entropy, Mutual Information, Relationship Between Entropy and Mutual Information, Chain Rules for Entropy, Relative Entropy, and Mutual Information.

Unit-II

Asymptotic Equipartition Property (AEP), AEP for Continuous Random Variables, Divergence, Differential Entropy, Relation of Differential Entropy to Discrete Entropy, Properties of Differential Entropy, Relative Entropy, and Mutual Information.

Unit-III

Data Compression, Kraft Inequality, Optimal Codes, Bounds on the Optimal Code Length, Kraft Inequality for Uniquely Decodable Codes, Huffman Codes, Some remarks related to Huffman Codes, Optimality of Huffman Codes.

Unit-IV

Channel Capacity- Examples of Channel Capacity, Symmetric Channels, Properties of Channel Capacity, Preview of the Channel Coding Theorem, Jointly Typical Sequences, Channel Coding Theorem, Zero-Error Codes, Feedback Capacity, Source–Channel Separation Theorem.

Unit-V

Gaussian Channel: Definitions, Converse to the Coding Theorem for Gaussian Channels, Band limited Channels, Parallel Gaussian Channels.

Suggested Textbook:

Thomas M. Cover, Joy A. Thomas: Elements of Information Theory, 2nd Edition, Wiley.

ISBN: 978-0-471-24195-9, 2006.

Additional References:

1. R. Gallager, Information Theory and Reliable Communication, Wiley, 1968.

2. J.M. Wozencraft and I.M. Jacobs, Principles of Communication Engineering, Wiley, 1965.

3. C.E. Shannon, The Mathematical Theory of Communication, University of Illinois Press, 1949.

4. I. Csiszár and J. Körner, Information Theory, Cambridge, 2011.

5. R. Yeung, Information Theory and Network Coding, Springer, 2008.

Ph.D. Course: Stochastic Processes and Queueing Models

Course Code: PHMAT1C009T

Credits: 4

Unit-1 Definitions and Examples of Stochastic Processes, Types of Stochastic Processes with examples, Expectation, Covariance, Co-relation, Stationary Processes, Sum of Stochastic Processes and its properties.

Unit-2 Definitions and Examples of Markov Processes, Markov Chain, Classification of States, Regular Markov Chain, Ergodicity, n-step transition probabilities, Transition Probability Matrix (TPM) and its properties.

Unit-3 Some Distributions namely Binomial, Geometric, Exponential, Poisson, Erlang, Poisson Processes, Generating functions, Probability Generating Functions (PGF), Expectation and Variance in terms of PGF, Pure Birth Processes, Pure Death Processes, Birth and Death Processes.

Unit-4 Queueing Systems and its Characteristics, Finite and Infinite capacity Queueing Models: M/M/1, M/M/C, M/M/1/K, M/M/C/K and the evaluation of their Performance Measures.

Unit-5 Queues with Bulk arrivals and services and its performance evaluation, Some Non-Markovian Queueing Models as M/G/1 etc., Series Queues and its Performance measures.

Recommended Books:

1. **Palaniammal, S.**, Probability and Queueing Theory, PHI Learning Private Limited, New Delhi, 2012.
2. **Medhi, J.**, Stochastic Processes, New Age International Publishers New Delhi, Third Edition, 2009.
3. **Gross, D. and Hariss, C. M.,** Fundamentals of Queueing Theory, Second Edition, John Wiley and Sons, New York, 1985.

Course Title: Bergman Spaces **Course Code** PHMAT1C007
Course Type: Ph.D. Course **Credit: 04**

Unit-I

Bergman spaces, Point evaluation as bounded linear functional on Bergman spaces, Bergman spaces as closed subspaces of $L^p(\mathbf{D}, dA)$, Dilation function, Approximation of function in Bergman spaces by dilation functions and by polynomials, Orthonormal basis and reproducing Kernel functions.

Unit-II

Bergman metric, Duality of Bergman spaces, Equivalent norms for Bergman spaces, Atomic decomposition.

Unit-III

Bloch spaces, Little Bloch spaces, Analytic Besov spaces, Growth spaces..

Unit-IV

The Berezin transform. Some properties of Berezin transform, Toplitz operators. Toeplitz operators and Berezin transform, Carleson measures and vanishing Carleson measures.

Unit-V

Definition of inner functions in Bergman spaces, Examples of inner functions, Zero set for Bergamn spaces, Notion of density, Necessary and sufficient conditions for Zero sets of Growth and Bergman spaces

Text Books:

- H.Hedenamal, B.Korenblum and K.Zhu, Theory of Bergman spaces, Springer, 2000.
- K.Zhu, Operator theory in function spaces, CRC press, 1990.