Curriculum for M.Tech.

Computer Science and Engineering
with Specialization in
Data Science and Artificial Intelligence

(From The Academic Year 2021)

Approved by Senate-44 & 45

Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram

Chennai-600 127

Curriculum & Syllabus

Semester 1							
S.No	Course Code	Course Name	Category	L	T	P	C
1	CS5000	Mathematical Foundations of Computer Science	PCC	3	1	0	4
2	CS5001	Advanced Data Structures and Algorithms	PCC	3	1	0	4
3	CS5002	Analytics and Systems of Big Data	PCC	3	1	0	4
4		Elective Course 1	ELC	3	1	0	4
5		Elective Course 2	ELC	3	1	0	4
6	CS5004	Analytics and Systems of Big Data Practice	PCC	0	0	4	2
7	CS5003	Advanced Data Structures and Algorithms Practice	PCC	0	0	4	2
							24.0
Semester 2							
S.No	Course Code	Course Name	Category	L	T	P	C
1		Elective Course 2	ELC	3	1	0	4
2		Elective Course 3	ELC	3	1	0	4
3		Elective Course 4	ELC	3	1	0	4
4		Elective Course 5	ELC	3	1	0	4
5		Elective Course 6	ELC	3	1	0	4
							20.0
Semester 3							
S.No	Course Code	Course Name	Category	L	T	P	C
1	CS6000	Project I (Summer Project)	PCD	0	0	32	16
	CS6001	Project II	PCD	0	0	20	10
							26.0
Semester 4							
S.No	Course Code	Course Name	Category	L	T	P	C
1	CS6002	Project III	PCD	0	0	32	16
							16.0

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Semester wise Credit Distribution

Category	Semester wise Credits						
	S1	S2	Summer	S3	S4	Total	%
Professional Core Course (PCC)	16	0	0	0	0	16	18.6
Elective Course (ELC)	8	20	0	0	0	28	32.6
Professional Career Development (PCD)	0	0	10	16	16	42	48.8
Total	24.0	20.0	10.0	16.0	16.0	86.0	**100.0**
	24.0	44.0	54.0	70.0	86.0		

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Course Name	Mathematical Foundations of Computer Science	Course Code	CS5000			
Offered by Department	Computer Science and Engineering	Structure (LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	Discrete Mathematics	Approved In	Senate-44			
Learning Objectives	To learn to reason out logical arguments, proving logical arguments and identifying inconsistencies in arguments. To introduce proof techniques and study mathematical/algebraic structures.					
Learning Outcomes	• Ability to understand and appreciate the power of mathematics in computing. • The importance of mathematical abstraction in solving computational problems that arise in various domains.					
Course Contents (with approximate breakup of hours for lecture/ tutorial/practice)	• Logic: Propositional Logic, Predicate and First Order Logic, Second Order Logic, Monadic Second Order Logic. (7L, 2T) • Proof Techniques: Discussion on proof techniques for problems that arise in CS. Proof by contradiction, Mathematical Induction, Loop in-variants in proving correctness of algorithms, Pigeon hole principle and its applications in Ramsey theorem, design of fault-tolerant networks, Principle of inclusion and exclusion, derangements, counting onto functions. (10L, 3T) • Introduction to algebraic structures; groups, subgroups, posets, lattices, fields, vector spaces, eigen values/vectors, Orthogonality: Inner Product, Orthogonality, Gram-Schmidt Orthogonalization, Vector and Matrix Norms (12L, 3T) • Counting sets, countable and uncountable sets, the role of graph theory in computing; bipartite graphs, planar graphs, matching, colouring. Modelling CS case studies as graph theoretic problems (10L, 3T) • Introduction to Probability - Random variables, Distribution - Conditional, Joint probability distributions (6L, 2T)					
Essential Reading	1. D. F. Stanat and D. F. McAllister, "Discrete Mathematics in Computer Science," Prentice Hall, 1977, ISBN 13: 9780132161503 **2.** Linear Algebra and Its Applications - Gilbert Strang- Fourth Edition- Cengage Learning, 2006, ISBN-10; **0030105676**					
Supplementary Reading	1. K. H. Rosen, "Discrete Mathematics and its Applications," McGraw Hill, 6 th Edition, 2007, ISBN: 9780070648241 2. R. L. Graham, D. E. Knuth, and O. Patashnik, "Concrete Mathematics," Addison 3. Wesley, 1994, **ISBN** 0-201-14236-8 4. Busby, Kolman, and Ross, "Discrete Mathematical Structures," PHI, 6 th Edition, 2008. **ISBN** 13: 9780132154185 5. 4. C. L. Liu, "Elements of Discrete Mathematics," Tata McGraw Hill, 1995. **ISBN** 81 – 7808 – 279 - 9					

Curriculum & Syllabus

Course Name	Advanced Data Structures and Algorithms	Course Code	CS5001			
Offered by Department	Computer Science and Engineering	Structure(LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	Discrete Mathematics, Data structures and algorithms	Approved In	Senate-44			
Learning Objectives	To introduce mathematical models, advanced data structures and algorithm design strategies. To introduce various analysis in the design of algorithms					
Learning Outcomes	• The ability to design and analyse algorithms for computational problems that arise in CS. • To understand and appreciate the notion of solvability and insolvability. • The ability to gauge easy vs hard instances of a computational problem.					
Course Contents (with approximate breakup of hours for lecture/ tutorial/practice)	• Mathematical Models and Encoding: Mathematical models - Turing Machine, Random Access Machine along with their input encoding/representation. The notion input size/magnitude, time/space complexity analysis in terms of input size. Introduction to asymptotic analysis. (5L,2T) • Recursive vs Iterative Algorithms, Recurrence relations, solving recurrence relations - guess method, substitution method (review). The recurrence tree method, Proof of Master theorem, solving recurrence relations using characteristic equation method. The number of binary search trees, Catalan number (5L,2T) • Advanced data structures; Min-Max Heap, Deap, leftist trees, Symmetric Heaps - design and analysis of algorithms for basic operations. Applications. (7L,2T) • Introduction to probabilistic analysis; Average Case analysis of search, sorting problems. Lower bound theory arguments for search and sorting problems. Order Statistics and its applications (5L,2T) • Introduction to amortized analysis; potential function method. Binomial-Heaps and Fibonacci Heaps, Splay trees, dynamic tables (7L,2T) • Algorithm design; Case studies following greedy algorithms and dynamic programming. Introduction to graph algorithms - application of BFS/DFS, topological sorting, strongly connected components. Proof of correctness of greedy algorithms (7L,2T) • Introduction to NP-completeness, NP, NP-Hardness result of well-known problems (6)					
Essential Reading	1. T. H. Cormen, C. E. Leiserson, and R. L. Rivest, "Introduction to Algorithms," Prentice Hall India, 2 nd Edition, 2001. **ISBN** 978-0-262-53305-8 2. 2. E. Horowitz, S. Sahni, and S. Rajasekaran, "Computer Algorithms," 2 nd Edition, Galgotia Publications, 2007. **ISBN** 0-7167-8316-9					
Supplementary Reading	1. Aho, Hopcroft, and Ullmann, "Data Structures & Algorithms," Addison Wesley, 1983. ISBN13: 9780201000238 2. 2. Algorithm Design , Eva Tardos and Kleinberg, Pearson, 2006, ISBN-13 : 978-0321295354					

Curriculum & Syllabus

Course Name	Analytics & Systems of Big Data	Course Code	CS5002			
Offered by Department	Computer Science and Engineering	Structure (LTPC)	3	1	0	4
To be offered for	M.Tech	Course Type	Core			
Prerequisite	Database Systems, DSA	Approved In	Senate 44			
Learning Objectives	The course intends to expose computer engineering students to recent advances in storage and analytics involved with big data. Topics related to Map reduce, globally distributed storage systems and analytics such as feature extraction, learning, similarity, etc. are dealt with to expose the students to current trends in data storage & analytics.					
Learning Outcomes	• The course shall equip students with required storage mechanisms / analytics algorithms for large distributed data intensive applications • Ability to understand, visualize and perform analytics of huge data • Ability to design and test drive big data and descriptive cum predictive analytics solutions for real life scenarios.					
Course Contents (with approximate breakup of hours for lecture/ tutorial/practice)	• Descriptive Statistics – Data Visualization & Interpretation – Data Pre-processing Techniques – Dimensionality Reduction Techniques - Inferential Statistics [9L, 2T] • Predictive Analytics –Supervised v/s Unsupervised Learning - Basic algorithms for Association Rules, Data Classification, Clustering, Prediction, Outlier Analysis - Measures of Performance / Interestingness as applicable to each predictive analytics technique - domain specific feature extraction, similarity measures, Recent advances in Data Mining such as closed, maximal item sets, bucket brigade classifiers, clustering paradigms [12L, 4T] • Map reduce abstraction, Cluster and Data centre network, Distributed Storage, • Data deduplication storage systems, Venti and DDFS - Shingles and minhashing, locality sensitive hashing - Clustering in high dimensional space [10L, 2T] • Mining Data Streams - Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream Web link analysis [11L, 3T]					
Essential Reading	1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, Second Edition, 2014, ISBN 978-1316638491					
Supplementary Reading	2. J Han, M Kamber, Data Mining Concepts & Techniques, Elsevier, 3rd Edition, 2007, ISBN: 9780123814791 3. Raj Kamal, Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, McGraw Hill, 2019, ISBN 9789353164973 4. www.cs.princeton.edu/courses/archive/spring13/cos598C/index.html - Princeton University Course Webpage.					

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Course Title	Analytics & Systems of Big Data Practice	Course No	CS5004			
Offered by Department	Computer Science and Engineering	Structure (LTPC)	0	0	4	2
To be offered for	M.Tech	Course Type	Core			
Prerequisite	Database Systems, DSA	Approved In	Senate-44			
Learning Objectives	The course intends to expose computer engineering students to recent advances in storage and analytics involved with big data. Topics related to Map reduce, globally distributed storage systems and analytics such as feature extraction, learning, similarity, etc. are dealt with to expose the students to current trends in data storage & analytics.					
Learning Outcomes	• Ability to understand, visualize and perform analytics of huge data • Ability to design and test drive big data and descriptive cum predictive analytics solutions for real life scenarios. • Handle and Design Live and Big Data to support analytics solutions					
Course Contents (with approximate breakup of hours for lecture/ tutorial/practice)	Exercises using R / Python on Descriptive Statistics, Predictive Analytics - association rule mining, classification, clustering where in various existing algorithms are tested over benchmark datasets – Exercises on Map Reduce Frame work – Hadoop / Pyspark - Selected algorithms of Predictive analytics using Map Reduce Framework for Big Data - Similarity Measures – LSH Implementation – Link Analysis - Page Rank computation					
Essential Reading	1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, Second Edition, 2014, SBN 978-1316638491					
Supplementary Reading	2. J Han, M Kamber, Data Mining Concepts & Techniques, Elsevier, 3rd Edition, 2007, ISBN: 9780123814791 3. Raj Kamal, Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, McGraw Hill, 2019, ISBN 9789353164973 4. www.cs.princeton.edu/courses/archive/spring13/cos598C/index.html - Princeton University Course Webpage.					

Curriculum & Syllabus

Course Title	Advanced Data Structures and Algorithms Practice	Course No	CS5003			
Offered by Department	Computer Science and Engineering	Structure(LTPC)	0	0	4	2
To be offered for	M.Tech	Course Type	Core			
Prerequisite	NIL	Approved In	Senate-44			
Learning Objectives	To design time or space efficient algorithms using well known paradigms. To get practical exposure on design and analysis of algorithms					
Learning Outcomes	• Students are expected to design efficient algorithms using paradigms such as divide and conquer, dynamic programming, greedy method etc. • To be able to implement advanced data structures and revisit classical algorithms using these data structures					
Course Contents (with approximate breakup of hours for lecture/ tutorial/practice)	• The laboratory component will require the student to write computer programs using a careful choice of data structures and algorithmic paradigms (in C++/Java language) from scratch, based on the concepts learnt in the theory course. • Case studies in respect of different paradigms discussed in theory shall be implemented in C++/Java • Paradigms – Divide and conquer, dynamic programming, greedy, backtracking. Order Statistics, Probabilistic Algorithms					
Essential Reading	1. T. H. Cormen, C. E. Leiserson, and R. L. Rivest, "Introduction to Algorithms," Prentice Hall India, 2 nd Edition, 2001. **ISBN** 978-0-262-53305-8 2. E. Horowitz, S. Sahni, and S. Rajasekaran, "Computer Algorithms," 2 nd Edition, Galgotia Publications, 2007. **ISBN** 0-7167-8316-9					
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