Curriculum for M.Tech

Computer Science & Engineering with Specialization in Data Science & Aritifical Intelligence (DSAI)

From The Academic Year 2025

(Approved in Senate 61)

Indian Institute of Information Technology Design and Manufacturing, Kancheepuram

Chennai-600 127

Semester 1					
Category	**Course Name**	**L**	**T**	**P**	**C**
PCC	Mathematical Foundations of Computer Science	3	1	0	4
PCC	Advanced Data Strucures & Algorithms	3	1	0	4
PCC	Analaytics & Systems of Big Data	3	1	0	4
PCC	Advanced Data Strucures & Algorithms Practice	0	0	4	2
PCC	Analytics & Systems of Big Data Practice	0	0	4	2
PEC	Program Elective Course 1	3	0	2	4
PEC	Program Elective Course 2	3	0	2	4
					24
Semester 2					
Category	**Course Name**	**L**	**T**	**P**	**C**
PEC	Programme Elective Course 3	3	0	2	4
PEC	Programme Elective Course 4	3	0	2	4
PEC	Programme Elective Course 5	3	0	2	4
PEC	Programme Elective Course 6	3	0	2	4
PEC	Programme Elective Course 7	3	0	2	4
					20
Summer					
PCD	M Tech Dissertation (MTD) Phase I	0	0	8	4
					4
Semester 3					
Category	**Course Name**	**L**	**T**	**P**	**C**
PCD	M Tech Dissertation (MTD) Phase II	0	0	24	12
					12
Semester 4					
Category	**Course Name**	**L**	**T**	**P**	**C**
PCD	M Tech Dissertation (MTD) Phase III	0	0	28	14
					74

Semester wise Credit Distribution	**Credits**						
Category	**S1**	**S2**	**Summer**	**S3**	**S4**	**Total**	**%**
Program Core Course (PCC)	16	0	0	0	0	16	21.6
Program Elective Course (PEC)	8	20	0	0	0	28	37.8
Professional Career Development (PCD)	0	0	4	12	14	30	40.5
Total	24	20	4	12	14	74	100
Cumulative Credits	**24**	**44**	**48**	**60**	**74**	**74**	

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<table>
<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Mathematical Foundations of Computer Science</td></tr>
<tr><td rowspan="2">Dept./Faculty proposing the course</td><td rowspan="2">Computer Science & Engineering</td><td rowspan="2">Structure (LTPC)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td rowspan="2">To be offered for</td><td rowspan="2">M. Tech CSE(DSAI)</td><td>Type</td><td colspan="2">Core ■</td><td colspan="2">Elective □</td></tr>
<tr><td>Status</td><td colspan="2">New □</td><td colspan="2">Modification ■</td></tr>
<tr><td>Pre-requisite</td><td></td><td colspan="3">Submitted for approval</td><td colspan="2">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">To learn to reason out logical arguments, proving logical arguments and identifying inconsistencies in arguments. To introduce proof techniques and study mathematical/algebraic structures.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">• 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.</td></tr>
<tr><td>Contents of the course
(With approximate break-up of hours for L/T/P)</td><td colspan="6">Logic: Propositional Logic, Predicate and First Order Logic, Second Order Logic, Monadic Second Order Logic. (L7, T2)
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. (L10, T3)
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 (L12, T3)
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 (L10, T3)
Introduction to Probability - Random variables, Distribution - Conditional, Joint probability distributions (L6, T2)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. D. F. Stanat and D. F. McAllister, “Discrete Mathematics in Computer Science,” Prentice Hall, 1977, ISBN: 9780132161503.
2. Linear Algebra and Its Applications - Gilbert Strang- Fourth Edition- Cengage Learning, 2006, ISBN: 9780030105676.</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. K. H. Rosen, “Discrete Mathematics and its Applications,” McGraw Hill, 6th Edition, 2007, ISBN: 9780070648241.
2. R. L. Graham, D. E. Knuth, and O. Patashnik, “Concrete Mathematics,” Addison Wesley, 1994, ISBN: 9780201142368.
3. Busby, Kolman, and Ross, “Discrete Mathematical Structures,” PHI, 6th Edition, 2008. ISBN: 9780132154185.
4. C. L. Liu, “Elements of Discrete Mathematics,” Tata McGraw Hill, 1995. ISBN 9788178082799.</td></tr>
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<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Advanced Data Structures and Algorithms</td></tr>
<tr><td rowspan="2">Dept./Faculty proposing the course</td><td rowspan="2">Computer Science & Enginering</td><td rowspan="2">Structure (LTPC)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td>Status</td><td colspan="2">New □</td><td colspan="2">Modification ■</td></tr>
<tr><td>Pre-requisite</td><td></td><td colspan="2">Submitted for approval</td><td colspan="2">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">To introduce mathematical models, advanced data structures and algorithm design strategies. To introduce various analysis in the design of algorithms.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">• 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.</td></tr>
<tr><td>Contents of the course
(With approximate break-up of hours for L/T/P)</td><td colspan="6">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. (L5,T2)
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 (L5,T2)
Advanced data structures; Min-Max Heap, Deap, leftist trees, Symmetric Heaps -design and analysis of algorithms for basic operations. Applications. (L7,T2)
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 (L5,T2)
Introduction to amortized analysis; potential function method. Binomial-Heaps and Fibonacci Heaps, Splay trees, dynamic tables (7L,T2)
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 (L7,T2)
Introduction to NP-completeness, NP, NP-Hardness result of well-known problems (L6)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. T. H. Cormen, C. E. Leiserson, and R. L. Rivest, “Introduction to Algorithms,” Prentice Hall India, 2 nd Edition, 2001. ISBN 9780262533058.
2. E. Horowitz, S. Sahni, and S. Rajasekaran, “Computer Algorithms,” 2 nd Edition, Galgotia Publications, 2007. ISBN 9780716783169.</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. Aho, Hopcroft, and Ullmann, “Data Structures & Algorithms,” Addison Wesley, 1983. ISBN: 9780201000238.
2. Algorithm Design, Eva Tardos and Kleinberg, Pearson, 2006, ISBN: 9780321295354.</td></tr>
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<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Analytics & Systems of Big Data</td></tr>
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<tr><td>Pre-requisite</td><td></td><td colspan="2">Submitted for approval</td><td colspan="3">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">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.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">• 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.</td></tr>
<tr><td>Contents of the course
(With approximate break-up of hours for L/T/P)</td><td colspan="6">Descriptive Statistics – Data Visualization & Interpretation – Data Pre-processing Techniques – Dimensionality Reduction Techniques - Inferential Statistics [L9, T2] 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 [L12, T4]
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 [L10, T2]
Mining Data Streams - Stream Data Model – Sampling Data in the Stream –Filtering Streams – Counting Distance Elements in a Stream Web link analysis [L11, T3]</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, Second Edition, 2014, ISBN 9781316638491</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. J Han, M Kamber, Data Mining Concepts & Techniques, Elsevier, 3rd Edition, 2007, ISBN: 9780123814791.
2. Raj Kamal, Big Data Analytics, Introduction to Hadoop, Spark, and MachineLearning, McGraw Hill, 2019, ISBN 9789353164973.
3. www.cs.princeton.edu/courses/archive/spring13/cos598C/index.html - Princeton University Course Webpage.</td></tr>
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<tr><td>Pre-requisite</td><td>NIL</td><td colspan="3">Submitted for approval</td><td>Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">To design time or space efficient algorithms using well known paradigms. To get practical exposure on design and analysis of algorithms</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">• 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.</td></tr>
<tr><td>Contents of the course
(With approximate break-up of hours for L/T/P)</td><td colspan="6">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 [P28]</td></tr>
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<tr><td>Learning Outcomes</td><td colspan="6">• 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</td></tr>
<tr><td>Contents of the course (With approximate break-up of hours for L/T/P)</td><td colspan="6">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 –SQL for Big Data solutions - Selected algorithms of Predictive analytics using Map Reduce Framework for Big Data - Similarity Measures – LSH Implementation – Link Analysis - Page Rank computation. [P28]</td></tr>
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