



**JSS MAHAVIDYAPEETHA**

**JSS SCIENCE AND TECHNOLOGY UNIVERSITY**

**SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU**

**JSS TECHNICAL INSTITUTIONS CAMPUSMYSORE-570 006**



**Faculty of Engineering and Technology**

# **Ph.D. in Computer and Information Science Engineering**

**Coursework Syllabus**

**2022 – 23**

## Faculty of Engineering and Technology

### Ph.D. in Computer and Information Science Engineering

Sl. No.	Code	Course Title	Total Credits	Examination	
				Total Marks	Duration in Hrs.
1	CSED01	Advanced Computer Networks	4	100	3.0
2	CSED02	Advanced Data Structures & Algorithms	4	100	3.0
3	CSED03	Advanced Database Management Systems	4	100	3.0
4	CSED04	Advanced Operating Systems and Distributed Computing	4	100	3.0
5	CSED05	Digital Image Processing and Analysis	4	100	3.0
6	CSED06	Internet of Things	4	100	3.0
7	CSED07	Linear Algebra and Applications	4	100	3.0
8	CSED08	Machine Learning	4	100	3.0

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**Ph.D. in Computer and Information Science Engineering**

<i>Course Code</i>	<i>CSED01</i>	<i>Total Credits</i>	<i>4</i>	<i>Course Type</i>	<i>Domain-Specific Course</i>
<i>Course Title</i>	<i>Advanced Computer Networks</i>				
<i>Course assessment method</i>	<i>Semester End Exam [ 100 Marks, 3 Hours]</i>				

**Course Outcomes(COs)**

CO#	Course Outcomes
CO1	Understand network architecture, protocol implementation issues and performance metrics in network design.
CO2	Analyze and Implement various protocols in internetworking
CO3	Design exterior and interior routing algorithms.
CO4	Develop efficient packet scheduling algorithms for network layer.
CO5	Analyse the issues of congestions to provide Quality of Service

**Course Content / Syllabus:**

UNIT No.	Content
1	<b>Foundation:</b> Building a Network, Requirements, Perspectives, Scalable Connectivity, Cost Effective Resource sharing, Support for Common Services, Manageability, Protocol layering, Performance, Bandwidth and Latency, Delay X Bandwidth Product, Classes of Links, Reliable Transmission, Stop and- Wait, Sliding Window protocol.
2	<b>Internetworking-I :</b> Switching and Bridging, Datagram's, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Basic Internetworking (IP), What is an Internetwork ? Service Model, IP version 4 (IPv4) Header format, Global Addresses, Datagram Forwarding in IP, subnetting and classless addressing, Address Resolution Protocol (ARP).
3	<b>Internetworking-II :</b> Dynamic Host Configuration Protocol (DHCP), Error Reporting(ICMP), Virtual Networks and Tunnels. Network as a Graph, Distance Vector (RIP), Link State(OSPF), Metrics, The Global Internet, Routing Areas, Exterior Routing protocol: Boarder Gateway Protocol (BGP), IP Version 6(IPv6).
4	<b>End-to-End Protocols :</b> Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connection Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission, Queuing Disciplines, FIFO, Fair Queuing, TCP Congestion Control, Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery.

5	<b>Congestion Control and Resource Allocation</b> : Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. The Domain Name System(DNS), Electronic Mail(SMTP,POP, IMAP, MIME), World Wide Web(HTTP), Network Management(SNMP).
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### Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Larry Peterson and Bruce S Davis	Computer Networks: A System Approach	6 <sup>th</sup> Edition, Elsevier - 2021.

### Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Douglas E Comer	Internetworking with TCP/IP, Principles, Protocols and Architecture	6th Edition, PHI – 2014
2	Uyless Black	Computer Networks, Protocols, Standards and Interfaces	2nd Edition - PHI, 2016.
3	Behrouz A Forouzan	TCP/IP Protocol Suite	4th Edition – Tata McGraw-Hill, 2009
4	Leon-garcia, Widjaja	Communication networks: Fundametal concepts and key architectures	2 <sup>nd</sup> edition, Tata McGraw-Hill publication, 2012

### Web Resources:

Sl. No.	Web Link
1	<a href="https://nptel.ac.in/courses/106105183">https://nptel.ac.in/courses/106105183</a>
2	<a href="https://nptel.ac.in/courses/106106243">https://nptel.ac.in/courses/106106243</a>

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<i>Course Code</i>	<i>CSED02</i>	<i>Total Credits</i>	<i>4</i>	<i>Course Type</i>	<i>Domain-Specific Course</i>
<i>Course Title</i>	<i>Advanced Data Structures &amp; Algorithms</i>				
<i>Course assessment method</i>	<i>Semester End Exam [ 100 Marks, 3 Hours]</i>				

**Course Outcomes(COs)**

CO#	Course Outcomes
CO1	Analyze the complexity of the algorithms.
CO2	Solve the problems by applying suitable algorithm design strategy.
CO3	Apply suitable searching technique for a given application
CO4	Use appropriate data structure to solve a given problem.
CO5	Perform amortized analysis of various algorithms, Design and develop randomized and online algorithms.

**Course Content / Syllabus:**

UNIT No.	Content
1	<b>The Complexity of Algorithms and the lower bounds of problems:</b> Introduction, The time complexity of an algorithm, The best, average and worst case analysis of algorithm, The lower bound of a problem, the worst-case lower bound of sorting, Heap sort : The average-case lower bound of sorting, Improving a lower bound through oracles, Finding the lower bound by problem transformation
2	<b>Divide and Conquer Strategy:</b> Introduction, The 2-dimensional maxima finding problem, The closest pair problem, The convex hull problem. <b>The Greedy method:</b> The 2-way merge problem, The minimum cycle basis problem, The 2-terminal one to any problem. <b>Dynamic Programming:</b> The resource allocation problem, The longest common subsequence problem
3	<b>Tree Searching Strategies:</b> Breadth-first search, Depth-first search, Hill climbing, Best-first search strategy, Branch and Bound strategy, The personal assignment problem, The traveling salesperson problem ,0/1 knapsack problem and The job scheduling problem solved Branch and Bound strategy, A* algorithm

4	<b>Advanced Data Structures:</b> Priority Queues (Heaps): Binary Heap, d-Heap, Leftist heap, Skew Heap, Binomial Queues. Splay Trees, Red-Black Trees, Skip Lists.
5	<b>Amortized Analysis:</b> Introduction, amortized analysis of Binomial queue, Skew heaps, Fibonacci heaps, Splay trees. <b>Randomized Algorithms:</b> Random number generator, Skip List, Primality Testing. <b>Online Algorithms:</b> Approximate Bin packing problem.

**Text Books:**

Sl. No.	Author/s	Title	Publisher Details
1	R.C.T.Lee , S.S Tseng, R.C Cbang, Y.T Tsai	Introduction to the Design and Analysis of Algorithms	McGraw Hill Education(India) Edition 2012
2.	Mark Allen Weiss	Data Structures and Algorithm Analysis,	3rd Edition, Pearson, 2013

**Reference Books:**

Sl. No.	Author/s	Title	Publisher Details
1	Ellis Horowitz and Sartaj Sahni	Fundamentals of Data Structures in C	2 <sup>nd</sup> edition, Universities Press, 2014
2	Seymour Lipschutz	Data Structures Schaum's Outlines	Revised First edition, McGraw Hill. 2014
3	T.H Cormen, C E Leiserson, R L Rivest and C Stein	Introduction to Algorithms, 3rd Edition,	Prentice-Hall of India,2010

**Web Resources:**

Sl. No.	Web Link
1	<a href="https://nptel.ac.in/courses/106102064/">https://nptel.ac.in/courses/106102064/</a>
2	<a href="https://nptel.ac.in/courses/106105085/">https://nptel.ac.in/courses/106105085/</a>

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<i>Course Code</i>	<i>CSED03</i>	<i>Total Credits</i>	<i>4</i>	<i>Course Type</i>	<i>Domain-Specific Course</i>
<i>Course Title</i>	<i>Advanced Database Management Systems</i>				
<i>Course assessment method</i>	<i>Semester End Exam [ 100 Marks, 3 Hours]</i>				

**Course Outcomes (COs)**

CO#	Course Outcomes
CO1	Select the appropriate high performance database for the given application
CO2	Design and analyze the real world data using object oriented database
CO3	Appraise the architectures for parallel and distributed databases
CO4	Design and implement data warehousing, perform data mining to present various views.
CO5	Choose and design database for recent applications database for better interoperability

**Course Content / Syllabus:**

UNIT No.	Content
1	<b>Review of Relational Data Model</b> and Relational Database Constraints: Relational model concepts; Relational model constraints and relational database schemas; Update operations, transactions and dealing with constraint violations. <b>The Enhanced Entity–Relationship (EER) Model:</b> Subclasses, Superclasses, and Inheritance, Specialization and Generalization, Constraints and Characteristics of Specialization and Generalization Hierarchies, Modeling of UNION Types Using Categories, Mapping EER to Relational Mapping.
2	<b>Object and Object-Relational Databases:</b> Overview of Object Database Concepts, Object Database Extensions to SQL , The ODMG Object Model and the Object Definition Language ODL, Object Database Conceptual Design, The Object Query Language OQL, Overview of the C++ Language Binding in the ODMG Standard. Comparing RDBMS, OODBMS and ORDBMS.
3	<b>Parallel and Distributed Databases:</b> Architectures for parallel databases; Parallel query evaluation; Parallelizing individual operations; Parallel query optimizations; <b>Distributed Database Concepts:</b> Data Fragmentation, Replication, and Allocation Techniques for Distributed Database Design, Overview of Concurrency Control and Recovery in Distributed Databases, Overview of Transaction Management in Distributed Databases, Query Processing and Optimization in Distributed Databases, Types of Distributed Database Systems, Distributed Database Architectures, Distributed Catalog Management.
4	<b>Data Warehousing and Data Mining:</b> Introduction, Definitions, and Terminology, Characteristics of Data Warehouses, Data Modeling for Data Warehouses, Building a Data Warehouse, Typical Functionality of a Data Warehouse, Data Warehouse versus Views, Difficulties of Implementing Data Warehouses. Overview of Data Mining Technology, Association Rules, Classification, Clustering, Approaches to Other Data Mining Problems, Applications of Data Mining.



5	<b>Enhanced Data Models</b> for Some Advanced Applications: Active database concepts and triggers; Temporal, Spatial, and Deductive Databases – Basic concepts. More Recent Applications: Mobile databases; Multimedia databases; Geographical Information Systems; Genome data management.
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### Text Books:

Sl. No.	Author/s	Title	Publisher Details
1	Elmasri and Navathe	Fundamentals of Database Systems	Pearson Education, 7 <sup>th</sup> edition 2017
2.	Raghu Ramakrishnan and Johannes Gehrke	Database Management Systems	3 <sup>rd</sup> Edition, McGraw-Hill, 2016.

### Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Abraham Silberschatz, Henry F. Korth, S. Sudarshan	Database System Concepts	7 <sup>th</sup> Edition, McGraw Hill, 2017.
2	C.J. Date, A. Kannan, S. Swamynatham	An Introduction to Database Systems	8 <sup>th</sup> Edition, Pearson Education, 2016.
3	Carlos Coronel, Steven Morris and Peter Rob	Database Systems design, Implementation, and Management	9 <sup>th</sup> Edition, Cengage Learning, 2016
4	Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer Widom	The Database Systems – The Complete Book	Pearson Prentice Hall, 2017

### Web Resources:

Sl. No.	Web Link
1	<a href="http://nptel.ac.in/courses/106106093/">http://nptel.ac.in/courses/106106093/</a>
2	<a href="https://nptel.ac.in/courses/106/104/106104135/">https://nptel.ac.in/courses/106/104/106104135/</a>



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<b>Course Code</b>	<b>CSED04</b>	<b>Total Credits</b>	<b>4</b>	<b>Course Type</b>	<b>Domain-Specific Course</b>
<b>Course Title</b>	<b>Advanced Operating Systems and Distributed Computing</b>				
<b>Course assessment method</b>	<b>Semester End Exam [ 100 Marks, 3 Hours]</b>				

**Course Outcomes (COs)**

CO#	Course Outcomes
CO1	Comprehend the concept of Distributed operating system and lamp port logical clock
CO2	Analyze and design suitable Mutual Exclusion algorithm in designing distributed System.
CO3	Design and implement resource management in a Distributed Environment.
CO4	Understand and comprehend distributed system, design recovery, protection and Security model.
CO5	Design and apply operating system algorithms in multiprocessor and database Operating system environment.

**Course Content / Syllabus:**

UNIT No.	Content
1.	<b>Introduction:</b> Review of core Operating systems, network Operating systems, Real-time Operating systems, Mobile Operating system. Distributed Operating System- Introduction, design issues, Communication primitives, Limitations of distributed system. Lamp ports logical clocks – vector clocks – casual ordering of messages – global state – cuts of a distributed computation – termination detection.
2.	<b>Distributed Mutual Exclusion:</b> Token based Algorithms, non-taken based algorithms, comparative analysis, Deadlock handling Strategies, Classification of agreement Problems.
3	<b>Distributed File system, shared Memory and Distributed scheduling:</b> Distributed File system-Mechanisms, design issues, Distributed Shared Memory: Architecture, Algorithms for implementing DSM, Memory coherence, coherence protocols, Design issues. Distributed Scheduling Issues, Components, Load distributing algorithms, Performance comparison.
4.	<b>Failure Recovery, Fault Tolerance, Protection and Security:</b> Failure Recovery and Fault Tolerance –Basic concepts, Classification of failures, Backward and forward recovery, Basic approaches, recovery in concurrent systems, Fault tolerance issues, Atomic actions & protocols, Commit, nonblocking, voting-static, dynamic protocols. <b>Protection &amp; Security:</b> Preliminaries, Access matrix model, Implementation and safety, Data security- model, conventional, modern, private-public key Cryptography, multiple encryptions, Authentication.

5.	<p><b>Multiprocessor Operating Systems and Database Operating system:</b> multiprocessor Operating System: Introduction, Architecture, Interconnection networks for Multiprocessing, Caching, Structure of multiprocessing Operating System, Threads. Various types of Threads, processor synchronization.</p> <p><b>Database operating systems:</b> Introduction, requirements of Database OS, database systems, Concurrency control-model, problem, distributed database systems Concurrency control algorithms – synchronization primitives, lock based, timestamp based and data replication algorithms.</p>
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**Text Book:**

Sl. No.	Author/s	Title	Publisher Details
1	Mukesh Singhal, Niranjan G.Shivaratri	Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems	1993,Tata Mac-Graw-hill publications.
2.	Silberschatz-Galvin	Operating System Concepts	6 <sup>th</sup> edition, Addison Willey Publications

**Reference Books:**

Sl. No.	Author/s	Title	Publisher Details
1	Andrew S.Tanenbaum	Modern operating system	4 <sup>th</sup> edition, PHI publications,2009.
2	Pradeep K.Sinha	Distributed operating system- Concepts and design	3 <sup>rd</sup> edition, PHI publications, 2007.
3	Andrew S.Tanenbaum	Distributed operating system	2 <sup>nd</sup> edition, Pearson publications, 2013.
4	George Coulouris, Jean Dollimore and Tim Kindberg	Distributed Systems: Concepts and Design	5 <sup>th</sup> Edition, Pearson Education, 2011.

**Web Resources:**

Sl. No.	Web Link
1	<a href="https://www.youtube.com/watch?v=EFpwjVg-ODU">https://www.youtube.com/watch?v=EFpwjVg-ODU</a>
2	<a href="https://www.youtube.com/watch?v=cQP8WApzIQQ&amp;list=PLrw6a1wE39_tb2fErI4-WkMbsvGQk9_UB">https://www.youtube.com/watch?v=cQP8WApzIQQ&amp;list=PLrw6a1wE39_tb2fErI4-WkMbsvGQk9_UB</a>

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<b>Course Code</b>	<b>CSED05</b>	<b>Total Credits</b>	<b>4</b>	<b>Course Type</b>	<b>Domain-Specific Course</b>
<b>Course Title</b>	<b>Digital Image Processing and Analysis</b>				
<b>Course assessment method</b>	<b>Semester End Exam [ 100 Marks, 3 Hours]</b>				

**Course Outcomes(COs)**

CO#	Course Outcomes
CO1	Explain basic concepts and techniques of image processing
CO2	Design spatial domain image enhancement techniques.
CO3	Implement frequency domain image enhancement techniques.
CO4	Analyse various image restoration techniques.
CO5	Apply image morphology and segmentation approaches to solve practical problems.

**Course Content / Syllabus:**

UNIT No.	Content
1	<b>Fundamentals of Image Processing</b> Origins of Digital Image Processing, examples, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, A Simple Image Formation Model, Basic Concepts in Sampling and Quantization, Representing Digital Images, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.
2	<b>Image Enhancement using Spatial Domain</b> Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.
3	<b>Image Enhancement in Frequency Domain</b> Image Enhancement in the Frequency Domain, Introduction to the Fourier Transform and the Frequency, Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering.
4	<b>Image Restoration</b> A Model of the Image degradation/Restoration process, Noise Models, Restoration in the Presence of Noise Only–Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations , Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering.

5	<p><b>Morphology and Image Segmentation</b></p> <p>Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms. Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation, Patterns and Pattern Classes, Recognition Based on Decision-Theoretic Methods, Structural Methods.</p>
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### Text Books:

Sl. No.	Author/s	Title	Publisher Details
1	Rafel C Gonzalez and Richard E. Woods	Digital Image Processing	4 <sup>th</sup> Edition, Pearson Education, 2017.

### Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Anil K. Jain	Fundamentals of Digital Image Processing	Pearson, 2005.
2	S.Jayaraman, S.Esakkirajan and T.Veerakumar	Digital Image Processing	Tata McGraw Hill, 2011.

### Web Resources:

Sl. No.	Web Link
1	<a href="https://nptel.ac.in/courses/106105032">https://nptel.ac.in/courses/106105032</a>
2	<a href="https://nptel.ac.in/courses/117105079">https://nptel.ac.in/courses/117105079</a>

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<i>Course Code</i>	<i>CSED06</i>	<i>Total Credits</i>	4	<i>Course Type</i>	<i>Domain-Specific Course</i>
<i>Course Title</i>	<i>Internet of Things</i>				
<i>Course assessment method</i>	<i>Semester End Exam [ 100 Marks, 3 Hours]</i>				

**Course Outcomes(COs)**

CO#	Course Outcomes
CO1	Explain the Architectural Overview of IoT, the IoT reference architecture and real world design constraints.
CO2	Analyze the various IoT Protocols: Datalink, Network, Transport, Session.
CO3	Apply various data model of IoT, design and demonstrate the various IoT solutions.
CO4	Build IoT based real time and smart applications.
CO5	Apply real time data analysis tools and techniques for IoT.

**Course Content / Syllabus:**

UNIT No.	Content
1	<b>IoT-An Architectural Overview</b> – Building an architecture, main design principles and needed capabilities, An IoT architecture outline, standards considerations. Reference Model and IOT Architecture - Architecture Reference Model – IOT Reference Architecture. Physical design of IOT, Logical Design of IOT, IOT enabling technologies, IOT Levels & Deployment Templates.
2	<b>Introduction:</b> M2M, Difference between IoT and M2M, SDN and NFV for IOT. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.
3	<b>Developing Internet of Things:</b> Introduction, IoT Design Methodology, Case Study on IoT System for Weather Monitoring. IOT and Related Issues - IOT & Related Future Internet Technologies – Networks & Communication – Processes & Data Management - Security, Privacy & Trust - Protocol Convergence.
4	<b>IoT Prognostics for Industrial applications:</b> IOT Smart Applications, Cloud Service Management and IOT - Connecting IOT to cloud – Cloud Storage for IoT – Data Analytics for IoT – Software & Management Tools for IOT.

5	<p><b>The Art of Data Science for IoT:</b> Volume, Velocity, Variety; Machine Learning; Supervised and Unsupervised Learning; Predictions and Forecasts. Data Pre-processing: Data Transformations for Individual Predictors, Centering and Scaling, Transformations to Resolve Skewness. Over-Fitting and Model Tuning: The Problem of Over-Fitting; Model Tuning; Data Splitting; Resampling Techniques, k-Fold Cross-Validation, Repeated Training/Test Splits, The Bootstrap. Measuring Performance in Regression Models: Quantitative Measures of Performance; The Variance-Bias Trade-of.</p>
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### Text Books:

Sl. No.	Author/s	Title	Publisher Details
1	Bernd Scholz-Reiter, Florian Michahelles	Architecting the Internet of Things	Springer, 2011
2	OvidiuVermesan, Peter Friess,	Internet of Things – From Research & Innovation to Market Deployment	River Publishers, 2014

### Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle	From Machine-to-Machine to the Internet of Things: Introduction to a NewAge of Intelligence	1 <sup>st</sup> Edition, Academic Press, 2014.
2	ArshdeepBahga, Vijay Madiseti	Internet of Things: A Hands on Approach	Universities Press., 2015

### Web Resources:

Sl. No.	Web Link
1	<a href="http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html">http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html</a>
2	<a href="https://nptel.ac.in/courses/106105166">https://nptel.ac.in/courses/106105166</a>



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<i>Course Code</i>	<i>CSED07</i>	<i>Total Credits</i>	<i>4</i>	<i>Course Type</i>	<i>Domain-Specific Course</i>
<i>Course Title</i>	<i>Linear Algebra and Applications</i>				
<i>Course assessment method</i>	<i>Semester End Exam [ 100 Marks, 3 Hours]</i>				

**Course Outcomes(COs)**

CO#	Course Outcomes
CO1	Solve linear equations through matrix representation.
CO2	Identify the vector space and subspace.
CO3	Test for orthogonality and apply Eigen vectors to solve differential equations.
CO4	Justify linear inequalities in the vector subspace.
CO5	Apply analytic methods to solve different linear equations.

**Course Content / Syllabus:**

UNIT No.	Content
1	<b>Introduction:</b> Introduction, The Geometry of Linear Equations, An Example of Gaussian Elimination, Matrix Notation and Matrix Multiplication, Triangular Factors and Row Exchanges, Inverses and Transposes, Special Matrices and Applications.
2	<b>Vector Space:</b> Vector Spaces and Subspaces, Solving $Ax = 0$ and $Ax = b$ , 3 Linear Independence, Basis, and Dimension, The Four Fundamental Subspaces, Graphs and Networks, Linear Transformations, Review Exercises.
3	<b>Orthogonality :</b> Orthogonal Vectors and Subspaces, Cosines and Projections onto Lines, Projections and Least Squares, Orthogonal Bases and Gram-Schmidt, The Fast Fourier Transform.
4	<b>Eigenvalues and Eigenvectors :</b> Introduction to Eigenvalues, Diagonalizing a matrix, applications to differential equations, symmetric matrices, positive definite matrices, similar matrices, singular value decompositions, least square methods.
5	<b>Computations with Matrices :</b> Introduction, Matrix Norm and Condition Number, Computation of, Iterative Methods for $Ax = b$ .



**Text Books:**

Sl. No.	Author/s	Title	Publisher Details
1	Gilbert Strang	Introduction to Linear Algebra	5 <sup>th</sup> Edition 2016, Wellesley-Cambridge Press

**Reference Books:**

Sl. No.	Author/s	Title	Publisher Details
1	David C Lay	Linear Algebra and its Application	4 <sup>th</sup> edition, Addison Wesley,

**Web Resources:**

Sl. No.	Web Link
1	<a href="https://math.mit.edu/~gs/linearalgebra/">https://math.mit.edu/~gs/linearalgebra/</a>
2	<a href="https://nptel.ac.in/courses/111106051">https://nptel.ac.in/courses/111106051</a>

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<i>Course Code</i>	<i>CSED08</i>	<i>Total Credits</i>	4	<i>Course Type</i>	<i>Domain-Specific Course</i>
<i>Course Title</i>	<i>Machine Learning</i>				
<i>Course assessment method</i>	<i>Semester End Exam [ 100 Marks, 3 Hours]</i>				

**Course Outcomes(COs)**

CO#	Course Outcomes
CO1	Explain the basic principles of learning theories.
CO2	Use the principles of supervised learning.
CO3	Develop a wide variety of dimensionality reduction techniques.
CO4	Analyze various clustering algorithms.
CO5	Apply multilayer perceptron learning algorithms to solve engineering problems.

**Course Content / Syllabus:**

UNIT No.	Content
1	<b>Introduction &amp; Bayesian Decision Theory :</b> What Is Machine Learning?, Challenges, Examples of Machine Learning Applications, Present Research Avenues, Introduction to Bayesian Decision Theory, Classification, Losses and Risks, Discriminant Functions, Utility Theory, Association Rules.
2	<b>Supervised Learning:</b> Learning a Class from Examples, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of Supervised Machine Learning Algorithm, Non-Parametric Methods: Histogram Estimator, Kernel Estimator, K-Nearest Neighbor Estimator.
3	<b>Dimensionality Reduction:</b> Introduction, Subset Selection, Principal Component Analysis PCA, Factor Analysis, Singular Value Decomposition and Matrix Factorization, Multidimensional Scaling, Linear Discriminant Analysis LDA.
4	<b>Unsupervised Learning:</b> Introduction, Hierarchical Clustering: Agglomerative Clustering Algorithm, The single Linkage Algorithm, The Complete Linkage Algorithm, The Average – Linkage Algorithm, Partitional Clustering: Forgy’s Algorithm, The K-Means Algorithm.

5	<b>Multilayer Perceptron:</b> The Perceptron, training a Perceptron, Learning Boolean Functions, Multilayer Perceptrons, Back Propagation Algorithm, Training Procedures, Tuning Network size.
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**Text Books:**

Sl. No.	Author/s	Title	Publisher Details
1	Ethem Alpaydin	Introduction to Machine Learning	2 <sup>nd</sup> Edition, PHI Learning Publisher, 2013.
2.	Sergios Theodoridis and Konstantinos Koutroumbas	Pattern Recognition	4 <sup>th</sup> Edition, Academic Press Publisher, 2014.

**Reference Books:**

Sl. No.	Author/s	Title	Publisher Details
1	Tom M. Mitchell	Machine Learning	McGraw-Hill Publishers, 1997.
2	Du Zhang and Jeffrey J. P. Tsai	Machine Learning Applications in Software Engineering	World Scientific Publishers, 2005.
3	Christopher M. Bishop	Pattern Recognition and Machine Learning	Springer Publishers, 2011.

**Web Resources:**

Sl. No.	Web Link
1	<a href="https://nptel.ac.in/courses/106106139">https://nptel.ac.in/courses/106106139</a>
2	<a href="https://nptel.ac.in/courses/106106202">https://nptel.ac.in/courses/106106202</a>