Guru Nanak Dev Engineering College, Ludhiana

Department of Computer Science & Engineering

Scheme & Syllabus

M. Tech. Computer Science & Engineering

(2014 Batch Onwards)

M.Tech. Computer Science and Engineering Course Scheme							
Sr. No	**Subject Code**	**Course Title**	**Type**	**Contact Hours**	**Credits**	**Distribution of Marks**	
				L-T-P		**Ext**	**Int**
First Semester							
1	MTCS501	Software Engineering Methodologies	Core	4-0-0	4	100	50
2	MTCS502	Databases and Data Mining	Core	4-0-0	4	100	50
3	MTCS503	Advanced Data Structures	Core	4-0-0	4	100	50
4	MTCS6xx	Programme Elective – I	Programme Elective	3-0-0	3	100	50
5	MTCS6xx	Programme Elective – II	Programme Elective	3-0-0	3	100	50
6	MTCS507	Lab - I (Software Engineering Methodologies + Advanced Data Structures)	Lab-I	0-0-4	2	50	50
Second Semester							
1	MTCS504	Distributed Computing Architecture	Core	4-0-0	4	100	50
2	MTCS505	Digital Image Processing	Core	4-0-0	4	100	50
3	MTCS506	Information Retrieval	Core	4-0-0	4	100	50
4	MTCS6xx	Programme Elective – III	Programme Elective	3-0-0	3	100	50
5	MTCS6xx	Open Elective – I	Open Elective	3-0-0	3	100	50
6	MTCS508	Lab - II (Digital Image Processing + Information Retrieval)	Lab-II	0-0-4	2	50	50
Third Semester							
1	MTCS6xx	Programme Elective – IV	Programme Elective	3-0-0	3	100	50
2	MTCS6xx	Open Elective – II	Open Elective	3-0-0	3	100	50
3	MTCS509	Pre-Thesis Seminar	Pre-Thesis Seminar	0-0-4	4	50	50
4	MTCS510	Pre-Thesis Project	Pre-Thesis Project	0-0-4	4	50	50
Fourth Semester							
1	MTCS511	Thesis	Thesis	0-0-14	14	200	100

List of Subjects					
Sr. No.	**Subject Code**	**Course Title**	**Type**	**L-T-P**	**Credits**
1	MTCS501	Software Engineering Methodologies	Core	4-0-0	4
2	MTCS502	Databases and Data Mining	Core	4-0-0	4
3	MTCS503	Advanced Data Structures	Core	4-0-0	4
4	MTCS504	Distributed Computing Architecture	Core	4-0-0	4
5	MTCS505	Digital Image Processing	Core	4-0-0	4
6	MTCS506	Information Retrieval	Core	4-0-0	4
7	MTCS507	Lab.-I (includes MTCS501 and MTCS 503)	Core	4-0-0	2
8	MTCS508	Lab.-II (includes MTCS505 and MTCS 506)	Core	4-0-0	2
9	MTCS509	Pre-Thesis Seminar	Pre-Thesis Seminar	0-0-4	4
10	MTCS510	Pre-Thesis Project	Pre-Thesis Project	0-0-4	4
11	MTCS511	Thesis	Thesis	0-0-14	14
12	MTCS601	Network Security	Programme Elective	3-0-0	3
13	MTCS602	Ad-hoc Networks	Programme Elective	3-0-0	3
14	MTCS603	Wireless Networks	Programme Elective	3-0-0	3
15	MTCS604	Parallel Computing	Programme Elective	3-0-0	3
16	MTCS605	Cloud Computing	Programme Elective	3-0-0	3
17	MTCS606	Big Data Analytics	Programme Elective	3-0-0	3
18	MTCS607	Advanced Operating System	Programme Elective	3-0-0	3
19	MTCS608	Object Oriented Analysis and Design Using UML	Programme Elective	3-0-0	3
20	MTCS609	Software Testing and Quality Assurance	Programme Elective	3-0-0	3
21	MTCS610	Compiler Design	Programme Elective	3-0-0	3
22	MTCS611	Pattern Recognition	Programme Elective	3-0-0	3
23	MTCS612	Machine Learning	Programme Elective	3-0-0	3

24	MTCS613	Bioinformatics	Programme Elective	3-0-0	3
25	MTCS614	Soft Computing	Programme Elective	3-0-0	3
26	MTCS615	Natural Language Processing	Programme Elective	3-0-0	3
27	MTCS616	Speech Processing	Programme Elective	3-0-0	3
28	MTCS617	Research Methodology	Programme Elective	3-0-0	3
29	MTCS618	Optimization Techniques	Programme Elective	3-0-0	3
30	MTCS619	Modeling and Simulation	Programme Elective	3-0-0	3
31	MTCS620	Neural Networks and Fuzzy Logic	Programme Elective	3-0-0	3
32	MTCS621	Project Management	Programme Elective	3-0-0	3
33	MTCS622	Human Resources Development and Training Methods	Programme Elective	3-0-0	3

Software Engineering Methodologies (MTCS501)

L	T	P
4	0	0

Software Engineering: Software process models - Waterfall model, Iterative waterfall model, Spiral model, RAD model, Prototype model. Requirement engineering - Requirement analysis and specification, Formal and informal requirement specification, Requirement specification languages.

Project Management and Scheduling: Empirical, Heuristic and analytical cost estimation Techniques. Software project scheduling: Work Break down Structure, Activity Chart, Gantt Charts, PERT Charts, Project Monitoring, Organization and Team Structures.

Software Design Methodologies: Function Oriented Design, Object Oriented Design, Structured Analysis and Design, Object Oriented Design Methodologies, Related Case Studies.

Testing and Quality Assurance: Verification and validation, Automated static analysis, system testing, Component testing, Test case design, Test automation, Quality assurance and standards, Quality planning and control.

Agile Software Development: The Genesis of Agile, Introduction and background, Agile Manifesto and principles, Overview of Scrum, Extreme programming, Feature driven development, Lean software development, Agile project management, Design and development practices in Agile projects, Test driven development, Continuous integration, Refactoring, Pair programming, Simple design, User stories, Agile testing.

Software Reuse and Component Based Software Engineering: The Reuse landscape, design patterns, Application frameworks, Application system reuse, Commercial–off-the-shelf component reuse**,** Components and component models, Component based software engineering process, Component composition, Component adaptation techniques.

Recommended Books:

1. I. Sommerville, “Software Engineering”, Pearson Education, 2010.
2. R. S. Pressman, “Software Engineering - A Practitioner’s Approach” McGraw Hill Education (India), 2009.
3. J. R. Rumbaugh, M. R. Blaha and W. Lorensen, “Object Oriented Modeling and Design”, Prentice Hall, 1991.
4. R. Mall, “Fundamentals of Software Engineering”, Prentice Hall India, 2009.
5. B. Hughes, M. Cortell, R. Mall, “Software Project Management”, Tata McGraw Hill, 2009.

Databases and Data Mining (MTCS502)

L	T	P
4	0	0

Distributed Database Management System (DDBMS): Introduction to distributed database, Advantages and disadvantages of distributed database, Homogenous and Heterogeneous distributed databases, Functions and architecture of DDBMS, Data fragmentation, Data allocation, Distributed transactions, Distributed concurrency control, Distributed deadlock management and Distributed database recovery.

Object Oriented Database Management System (OODBMS): Concepts of OODBMS, Storing objects in relational database, Object oriented data models and DBMS, Issues in OODBMS, Advantages and disadvantages of OODBMS.

Spatial and Temporal Data and Mobility: Motivations, Terms in databases, Spatial and geographic data, Multimedia database, Mobility and personal databases.

Data Warehousing and OLAP: Introduction to data warehousing, Data ware architecture, Data flows, warehousing tools, Data marts, Data warehouse design, Online Analytical Processing (OLAP benchmarks, benefits, representation of multi-dimensional data applications of OLAP, OLAP tools, categories of OLAP tools).

Data Mining: Introduction, Process of data mining, Data mining goals, Tasks and techniques (Prediction modeling, Database segmentation, Link analysis, Deviation detection), Applications of data mining.

Clustering: Introduction, Issues in clustering, Types of clustering: Hierarchal and partitioning clustering, K-means clustering applications of clustering.

Classification: Introduction, Applications of clustering, Classification technique**:** Decision trees.

Recommended Books:

1. A. K. Pujari, “Data Mining Techniques”, Universities Press, 2013.
2. V. Pudi and P. R. Krishna “Data Mining”, Oxford University Press India, 2009.
3. B. Connolly “Database Systems: A Practical Approach to Design, Implementation and Management.” Pearson Education, 2007.
4. R. Elmasri, S. Navathe, “Fundamentals of Database Systems”, Pearson Education, 2007.
5. H. F. Korth, A. Silberchatz, “Database Concepts”, Tata McGraw Hill, 2010.

Advanced Data Structure (MTCS503)

L	T	P
4	0	0

Introduction to Data Structures: Algorithm design strategies - Greedy, Divide and Conquer backtracking, Branch and bound, Heuristic. Complexity of algorithms - Algorithm analysis techniques, Amortized analysis, Basic data structures - Abstract Data Types (ADTs), stacks, queue and linked lists and their applications.

Searching and Sorting: Basic search algorithms, Hashing - Hash functions. Collision resolution methods - Open addressing, Chaining. Bubble sort, Insertion sort, Quick sort, Merge sort, Heap sort, Radix sort, Comparative analysis of sorting algorithms.

Trees: Binary search trees, AVL trees, Red black trees, B-Trees, Finger search trees, Biased search trees, Splay trees, Dynamic trees, Fibonacci heaps.

Graphs: Graph ADT, Graph traversals/search methods - DFS and BFS. Applications of Graphs-Minimum cost spanning tree using Prim and Kruskal's algorithm, Dijkstra's algorithm for single source shortest path problem.

Recommended Books:

1. M. A. Tanenbaum," Data Structures Using C", Prentice Hall of India, 1991.
2. M. A. Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education Asia, 2002.
3. S. Sahni, "Data Structures, Algorithms and Applications in C++", University Press (India) Pvt. Ltd, 1998.
4. L. Seymour, "Theory and problems of data structures", Tata McGraw Hill, 2002.
5. M. T. Goodrich, R. Tamassia and Mount, "Data Structures and Algorithms in C++", John Wiley and Sons, 2011.

Distributed Computing Architecture (MTCS504)

L	T	P
4	0	0

Introduction to Distributed Systems: Distributed systems – Scheduling and resource sharing, Web challenges. System models - Architectural models, Fundamental models, Characterization of distributed systems. Interprocess communication – Client/server communication, Distributed objects and remote invocation, Communication between distributed objects, Remote procedure call.

Distributed Computing Architecture: Client–server architecture, 3-tier architecture, n-tier architecture, Distributed objects, Loose coupling, Tight coupling, Client/server computing- building blocks, Infrastructure, Choice of client operating system or server operating system.

Distributed Operating Systems and File Systems: Operating system layer, Design issues, Protection, Processes and threads, Architecture of operating system, Distributed file systems, File service architecture, Name services, Domain name system, Case study of the global name service, X.500 Directory service, SUN network file systems, Andrewfile systems.

Distributed Shared Memory: Design and implementation issues, Sequential consistency and Release consistency and other consistency Models, Munin case study, Ivy case study.

Distributed Computing Paradigms: Overview of existing distributed computing paradigms, Cluster computing, Grid computing, Utility computing, Autonomic computing and Cloud computing, Essential characteristics of various computing paradigms and their comparison.

Recommended Books:

1. G. Coulouris, J. Dollimore and T. Kindberg, “Distributed Systems Concepts and Design”, Pearson Education, 2011.
2. S. Tanenbaum, “Modern Operating System”, PHI learning private limited, 2007.
3. M. L. Liu, “Distributed Computing: Principles and Applications”, Pearson/Addison-Wesley, 2003.
4. B. Sosinsky, “Cloud Computing Bible”, Wiley Publisher, 2011
5. S. Mahajan and S. Shah, “Distributed Computing”, Oxford University Press, 2010.
6. A. S. Tanenbaum and S. M. Van, “Distributed Systems: Principles and Paradigms”, Prentice-Hall, 2008.

Digital Image Processing (MTCS505)

L	T	P
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Introduction: Fundamental steps in Digital Image Processing, Components of an image processing system, Image sampling and quantization, Color models

Digital Image Processing Operations: Pixel relationships and distance metrics: Image coordinate system, Image topology, Connectivity, Relations, Distance measures. Classification of image processing Operations - Arithmetic, Logical, Geometrical (Translation, Scaling, Zooming, Linear Interpolation, Mirror or Reflection, Shearing, Rotation, Affine and Inverse transformation) Operations, Image interpolation Techniques (Downsampling and upsampling), Set operations, Statistical operations, Convolution and Correlation operations.

Image Enhancement in Spatial Domain: Image enhancement point operations: Linear and non-linear functions, Piecewise linear functions, Histogram processing. Spatial filtering - basics of filtering in the spatial domain, Vector representation, Smoothing linear and non-linear filters, sharpening filters

Image Enhancement in Frequency Domain: Basics of filtering in the frequency domain, Image smoothing and sharpening using frequency domain filters.

Image Restoration: A model of the image degradation/restoration process, Noise models, Noise filters, Degradation function.

Multiresolution Analysis: Wavelet analysis, Continuous wavelet transform, Discrete wavelet transform, Wavelet decomposition and reconstruction in two dimensions, Wavelet packet analysis, Wavelet based image denoising.

Image Compression: Image compression model, Compression measures, Compression algorithm and its types (Entropy, Predictive, Transform and layered coding), Types of redundancy (Coding, Inter-pixel, Psycho-visual and Chromatic), Lossless compression algorithms – Run-length, Huffman, Bit-plane, Arithmetic, Predictive coding. Lossy compression algorithms – Lossy predictive, Block transform coding.

Morphological Image Processing: Structuring element, Erosion, Dilation, Opening, Closing, Hit-or-Miss transform, Boundary detection, Hole filling, Connected components, Convex hull, Thinning, Thickening, Skeletons, Pruning, Reconstruction by dilation and erosion.

Image Segmentation: Classification of image segmentation algorithms, Point, Line and Edge detection, Hough transforms, Corner detection, Global thresholding, Otsu's method, Multivariable thresholding, Region-based segmentation, Watershed segmentation

Image Features Representation: Characteristics of good features, Boundary representation (Chain code, Polygonal approximations, Signatures, Bending energy, Statistical moments, Region Representation)

Applications of image processing.

Recommended Books:

1. R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, Pearson Education, 2013.
2. S. Sridhar, “Digital Image Processing”, Oxford University Press, 2011.
3. M. Sonka, V. Hlavac and Roger Boyle, “ Image Processing, Analysis and Machine Vision”, Thomas Learning, 2007
4. K. R. Castleman, “Digital Signal Processing”, Pearson Education, 2007.
5. R. Gonzalez and R. Woods, “Digital Image Processing Using MATLAB”, McGraw Hill Education, 2010.

Information Retrieval (MTCS506)

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Prerequisites: Basic knowledge of web search and web metadata.

Syllabus:

Introduction: Information retrieval, Retrieval process, Retrieval models - Set theoretic, Algebraic and probabilistic models, Key word based querying, Structured queries, Query optimization.

Text Encoding: Tokenisation, Stemming, Lemmatisation, Stop words, Phrases, Optimizing indices with skip lists, Proximity and phrase queries, Positional indices.

Dictionaries and Index Construction: Dictionary data structures, Wild-card queries, permuterm indices. Spelling correction and synonyms - Edit distance, Soundex, Language detection. Postings size estimation, Sort-based indexing, Dynamic indexing, Positional indexes, N-gram indexes, Distributed indexing.

Scoring and Search System: Scoring, Term weighting and vector space model, Cosine measure, Scoring documents. Computing scores in complete search system - Components of an IR system. Efficient vector space scoring, Nearest neighbor techniques, Reduced dimensionality approximations, Random projection.

Web Crawling: Web search overview, Web structure, Search engine optimization, Web size measurement, Crawling and web indexes, Near-duplicate detection, Link analysis, Learning to rank, Focused web crawler and its different architectures.

Recommended Books:

1. C. Manning, P. Raghavan, and H. Schütze, “Introduction to Information Retrieval”, Cambridge University Press, 2008.
2. R. B. Yate and B. R. Neto, “Modern Information Retrieval”, Pearson Education, 2007.
3. G. G. Chowdhury, “Introduction to Modern Information Retrieval”, Neal- Schuman Publishers; 2nd edition, 2003.
4. D.Grossman and O.Frieder, “Information Retrieval: Algorithms, and Heuristics”, Academic Press, 2000.

Lab-I (MTCS507)

L	T	P
0	0	4

Software Engineering Methodologies Lab:

1. Study and usage of ERP based system.
2. Preparation of Software Requirement Specification Document, Design Documents for some problems.
3. Study and usage of any Design phase CASE tool.
4. Case study of Six Sigma in any engineering application.
5. Case study for highlighting any applications using UML.

Advanced Data Structures Lab:

Students are required to implement following programs:

1. To implement the Stack ADT and Queue ADT using an array and singly Linked List.
2. To perform various operations on a binary search tree.
3. To traverse the given binary tree in Preorder, Inorder and Postorder.
4. To implement BFS and DFS for a given graph.
5. To implement various sorting methods.
6. To perform various operations on a B-Tree.
7. To perform various operations on an AVL tree.
8. To generate a minimum cost spanning tree using Prim/Kruskal algorithm.
9. To implement Dijkstra algorithm to find the shortest path.
10. To implement various hashing techniques.

Lab-II (MTCS508)

L	T	P
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Digital Image Processing Lab:

- Familiarity with MATLAB image processing commands.
- Implementation of various algorithms related to following topics:
- Generation of lines, array, matrix and image.
- Application of image processing operations.
- Enhancement of images in spatial domain and frequency domain.
- Image restoration techniques.
- Color image processing.
- Wavelet transforms.
- Segmentation of 2-D images.
- Image compression techniques.
- Morphological image processing.
- Texture features
- A minor project based on above taught image processing techniques.

Information Retrieval Lab:

1. Analysis of textual and semi-structured data sets.
2. Write code for text indexing and retrieval.
3. Development of algorithm for summarization of information.
4. Comparative analysis of posting algorithms.
5. Computing similarity between two documents.
6. Ranking and scoring documents in a repository based on certain search criteria.
7. Implementation of Web Crawling Algorithms.
8. Study of existing tools of information retrieval.

Network Security (MTCS601)

L	T	P
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Introduction: Overview of computer networks (OSI reference model, TCP/IP protocol suite), MAC protocols for high speed LANs, MANs and Wireless LANs (FDDI,DQDB, HIPPI, Gigabit Ethernet, Wireless Ethernet), Fast access technologies.

Basics of Network Security: Introduction to security in networks, Characteristics of networks intrusion, Kinds of security breaches, Plan of attack, Points of vulnerability, Methods of defence, Control measures, Effectiveness of controls.

Cryptography: Symmetric Cryptography - Classical techniques, Block ciphers – DES, Triple DES, AES. Stream Ciphers - RC4, Asymmetric cryptography - Public key, RSA, Diffie Hellman. Key management and distribution.

Data Integrity: Hash Functions, Digital signatures, Digital certificates.

Network and Information Security: SSL, HTTPS, SSH, PGP, IPsec, ESP, IDS, Viruses and worms, Attacks and firewalls**.**

Recommended Books:

1. W. Stallings, “Cryptography and Network Security”, Prentice Hall, 2013.
2. J. Meneze, “Handbook of Applied Cryptography”, CRC Press, 1997.
3. W. Stallings, “Network Security Essentials: Applications and standards”, Person Education Asia, 2000.
4. B. A. Forouzan, “Cryptography and Network Security”, Tata McGraw Hill, 2007.

Ad-hoc Networks (MTCS602)

L	T	P
3	0	0

Introduction: Wireless sensor networks, Ad-hoc networks - Characteristics, Features and applications, Characteristics of wireless channel. Ad-hoc Mobility Models - Indoor and outdoor models.

Ad-hoc MAC: MAC Protocols - Design issues, Goals and classification. Multi-channel MAC and Power control MAC protocol. IEEE Standards: 802.11a, 802.11b, 802.11g, 802.15, HIPERLAN.

Ad-hoc Network Routing: Routing Protocols - Design issues, Goals and classification. Proactive, Reactive routing, Unicast routing algorithms, Multicast routing algorithms, Hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.

End-to-End Delivery and Security: Transport layer – Ad-hoc Transport Layer Issues, Transport layer classification, Ad-hoc transport protocols. Security issues and challenges, Network security attacks, Secure routing protocols. TCP Over Ad-hoc - Feedback based, TCP with explicit link, TCP-Bus, Ad-hoc TCP, and Split TCP.

Cross Layer Design and Integration of Ad-hoc for 4G: Cross layer Design - Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary perspective, Integration of Ad-hoc with Mobile IP networks.

Sensor Networks: Sensor network architecture, Data dissemination, Data gathering, MAC protocols for sensor networks, Location discovery, Quality of Sensor Networks, Evolving standards and other issues, Recent trends in infrastructure less networks.

Recommended Books:

1. S. Basagni, M. Conti, S. Giordano and I. Stojmenovic, “Mobile Adhoc Networking”, Wiley-IEEE press, 2004.
2. M. Ilyas, “The Handbook of Adhoc Wireless Networks”, CRC press, 2002.
3. F. Zhao and L. Guibas, “Wireless Sensor Networks”, Morgan Kaufman Publishers, 2004.
4. C. S. Murthy and B. Smanoj, “AdHoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.

Wireless Networks (MTCS603)

L	T	P
3	0	0

Prerequisites: The understanding of computer networks and security.

Syllabus:

Introduction: Wireless networks and its architecture, Wireless components, Wireless Communication, Multiplexing, Modulation, Spread Spectrum, 2G/2.5/3G Networks, Cellular Networks, Polling.

Mobile Communication Systems: GSM mobile services, System architecture, Protocols, Localization, Calling, Handover procedures, Security, Data services, Cordless systems, DECT system and protocol, Architecture, TETRA, UMTS and IMT 2000.

Wireless LAN: Infrared and radio transmission, Ad-hoc networks, Wireless local loop, Wi-Fi and Wi-Max. IEEE 802.11 - System architecture, Services, Medium access control, Standards. Wi-Fi security and protected access, HIPERLAN.IEEE 802.15 – Architecture and services. IEEE 802.16 – Architecture and services.

Mobile Networks and Transport Layer: Mobile IP, Dynamic host configuration protocol, Mobile Ad-hoc routing protocols, Multicast routing, TCP over wireless networks, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmission and recovery, Transmission timeout, Freezing, Selective retransmission, Transaction oriented TCP.

Application Layer: Wireless application protocol and its architecture, Wireless transport layer security, Wireless application environment, WML, WML scripts, Wireless telephony applications.

Recommended Books:

1. W. Stallings, “Wireless Communications and Networks”, Pearson Education, 2005.
2. T. S. Rappaport, “Wireless Communication: Principles and Practices”, Pearson Education, 2001.
3. J. Schiller, “Mobile Communications”, Pearson Education, 2008.
4. S. Kumar, S. Manvi and M.S. Kakkasageri, “Wireless and Mobile Networks: Concepts and Protocols”, Wiley India, 2010.

Parallel Computing (MTCS604)

L	T	P
3	0	0

Introduction: Basic uniprocessor architecture, Multiprogramming and time sharing, Pipeline computers, Multiprocessor systems, Serial versus parallel processing. Parallelism approaches – Data parallelism, Control parallelism. Hardware taxonomy – Flynn's classifications, Handler's classifications, Parallel processing applications.

Performance Metrics: Laws governing performance measurements. Metrics - Speedups, Efficiency, Utilization, Communication overheads, Single/multiple program performances, Bench marks.

Parallel Computer Models: Elements of modern computers, System attributes to performance, Shared memory multiprocessors, Distributed memory multicomputers, Loosely and tightly coupled multiprocessors, Multivector computers, PRAM models, Interconnection networks.

Pipelining and Superscalar Techniques: Linear pipeline processors - Asynchronous and synchronous models, Clocking and timing control, Nonlinear pipeline processors, Reservation and latency analysis, Collision-Free scheduling, Pipeline schedule optimization. Instruction pipeline design - Instruction execution phases, Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch handling techniques, Pipeline hazards.

Basic Parallel Algorithmic Techniques and Programming: Pointer jumping, Divide-and-Conquer, Partitioning, Pipelining, Accelerated cascading, Symmetry breaking, Synchronization (Locked, Lock-free) parallel algorithms. Programming systems - Pthreads, OpenMP, MPI and global address space languages.

Recommended Books:

1. F. A. Briggs, "Computer Architecture and Parallel Processing", McGraw-Hill International Editions, 1984.
2. M. J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill, 2003.
3. J. d. Carpinelli, "Computer Systems Organization and Architecture", Addison Wesley, 2001.
4. A. Grama, G. Karypis, V. Kumar and A. Gupta, "Introduction to Parallel Computing", Addison-Wesley, 2003.

Cloud Computing (MTCS605)

L	T	P
3	0	0

Introduction of Computing Paradigms: Overview of existing computing paradigms, Cluster computing, Grid computing, Utility computing, Autonomic computing, Introduction to cloud computing, Cloud computing history and evolution, Essential characteristics of cloud computing, Cloud benefits, The NIST model of cloud computing.

Cloud Computing Architecture: The cloud reference model architecture, Cloud based services, Infrastructure as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), Cloud deployment scenarios, Public cloud, Private cloud, Hybrid cloud and Community cloud.

Virtualization: Virtualization, Characteristics of virtualization, Virtualization in cloud computing, Types of virtualization- Resource virtualization, Server, Storage and Network virtualization, Hypervisors. Data center- Classic data center, Virtualized data center.

Issues and Security: Cloud computing issues and challenges like security, Elasticity, Service level agreement, Resource management and scheduling, Cloud security, Understanding security risks, Cloud security reference model, Encryption and key management in the cloud, Identity management.

Mobile Cloud Computing: Overview of mobile cloud computing, Advantages, Challenges, using smartphones with the cloud. Offloading techniques - their pros and cons, Mobile cloud security.

Cloud Computing Platforms: Study of recent emerging cloud computing platforms and their comparison.

Recommended Books:

1. R. K. Buyya, J. Broberg and A.M.Goscinski, “Cloud Computing: Principles and Paradigms”, 2011.
2. B. Sosinsky, “Cloud Computing Bible”, Wiley India Pvt. Ltd, 2013.
3. M. Miller, “Cloud Computing”, Que Publishing, 2008.
4. A. Velte, T. Velte and R. Elsenpeter, “Cloud Computing: A practical Approach”, Tata McGrawHill, 2012.
5. J. Rittinghouse and J. F. Ransome, “Cloud Computing: Implementation, Management, and Security”, CRC Press Taylor and Francis Group, 2010.

Big Data Analytics (MTCS606)

L	T	P
3	0	0

Prerequisites: Basic quantitative skills, including elementary statistics, as well as basic programming skills in SQL.

Syllabus:

Introduction: Big Data overview, State of the practice in analytics, When to consider Big Data Solutions, The Data scientist, Big Data Analytics in industry. Verticals - Big Data for web analytics, Big Data in crowd sourcing analytics, Big Data in mobile business intelligence and Big Data in healthcare.

Statistical Modeling for Big Data using R: Introduction to R, Analyzing and exploring the data, Statistics for model building and evaluation. Introduction to Rstudio.

Advanced Analytics: Analytics for unstructured data, Understanding distributed systems and Hadoop, Components and architecture of Hadoop, Hadoop management, Setting up a Hadoop cluster, Difference of HDFS from other DFS, Working with files in HDFS, Anatomy of a mapreduce program.

Big Data Management: In-database Analytics – Introduction to NoSQL- aggregate data models, Graph databases, Graphless databases, Distribution models, Introduction to Hbase, Pig, Hive, MongoDB, Casadenra.

Machine Learning: Introduction to Clustering, Classification, Association rules, Linear regression, Logistic regression, Naïve Bayes, Decision trees.

Case Studies: Social media data management, Anomaly detection, Web search recommendation systems.

Recommended Books:

1. T.D. deRoos, C. Eaton, G. Lapis, P. Zikopoulos and T. Deutsch, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, IBM RedBooks, 2011.
2. C. Lam, “Hadoop in Action”, DreamTech Press, 2011.
3. V. Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publication, 2013.
4. C. Ballard, K. Foster, A. Frenkiel, B. Gedik, M. P. Koranda, S. Nathan, D. Rajan, R. Rea, M. Spicer, B. Williams and V. N. Zoubov, “IBM InfoSphere Streams: Assembling Continuous Insight in the Information Revolution”, IBM Red Books, 2012.
5. J. Dean, “Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners”, Wiley Publication, 2014.

Advanced Operating Systems (MTCS607)

L	T	P
3	0	0

Prerequisites: Basic knowledge of the Operating Systems and Computer Architecture.

Syllabus:

Introduction: Review of Operating Systems, Process synchronization mechanisms, System architecture types, Communication primitives, Operating system services, System calls, Virtual machines.

Multiprocessor Operating Systems: Classification - Tightly coupled, Loosely coupled multiprocessor architecture. Flynn's taxonomy - SISD, SIMD, MISD, MIMD, Design approaches for multiprocessor Operating Systems.

Distributed Operating Systems: Distributed system goals, Types and architecture of Distributed Systems, Threads, Virtualization, Client/server model, Communication and synchronization in distributed systems, Limitations of distributed operating systems.

Real Time Operating Systems: Characteristics, Task operations, Task states and scheduling, Inter task communication and resource sharing, Analysis of real time systems requirement, Hardware and Software tradeoffs, Timer interrupt service routines.

Deadlocks: Deadlock handling strategies, Issues in deadlock detection and revaluation, Distributed deadlock detection. Control organization – Centralized, distributed and hierarchical detection algorithms.

Fault Tolerance: Introduction, Process resilience, Group communication, Distributed commit, Recovery, Secure channels, Access control, Security management.

Case Study: Overview of UNIX, LINUX, WINDOWS NT, Android and IOS Operating systems.

Recommended books:

1. A. Silberschatz, P. B. Galvin and G. Gagne, "Operating System Concepts", Wiley, 2008.
2. A. S. Tanenbaum, "Distributed Operating systems", PHI, 2008.
3. D.M. Dhamdhere, "Operating systems – A concept based approach", TMH, 2008.
4. A. N. Haberman, "Introduction to Operating System Design", Galgotia Publications, 2000.
5. A. C .Shaw, "Logic Design Of operating systems", PHI.
6. M. Singhal and N. G. Shivaratri: Advanced concepts in operating systems, TMH, 1994.

Object Oriented Analysis and Design Using UML (MTCS608)

L	T	P
3	0	0

Prerequisites: Basic knowledge of Object Oriented programming principles and software engineering fundamentals.

Syllabus:

Introduction: Object Oriented analysis and design fundamentals, Principles of modeling, Conceptual model of UML, Software development life cycle, Iterative and evolutionary analysis and design, Agile modeling.

Structural Modeling: Classes, Relationships, Access specification (visibility of attributes and operations) class diagrams, Advanced classes, Advanced relationships, Interfaces types and roles, Packages, Instances and object, Object diagrams.

Behavioral Modeling: Interactions, Use cases and Use case diagrams. Interaction diagrams - Notations, Conditional messaging, Branching, Time constraints, Sequence diagram, Collaboration diagram and Activity diagrams.

Advanced Behavioral Modeling: Events and signals, State machines, Process and threads, Transition and condition, Time and space, State chart diagrams.

Architectural Modeling: Components- Terms and concepts, Component diagrams, Nodes and connections, Deployment diagrams, Modeling a client/server system.

Case Studies: NextGen POS system, Railway reservation, Booking ticket, Library management system, Online mobile recharge.

Recommended Books:

1. G. Booch, J. Rumbough and I. Jacobson, "The Unified Modelling Language User Guide". Pearson Education, 2002.
2. A. Bahrami, "Object Oriented System Development", McGraw-Hill, 1999.
3. C. Larman, "Applying UML and Patterns: An Introduction to object-oriented Analysis and Design and iterative development", Pearson Education, 2005.
4. M. P. Jones, "Fundamentals of Object Oriented Design in UML", Addison Wesley, 2000.
5. M. P. Matha, "Object Oriented Analysis and Design Using UML", PHI Publication, 2008.

Software Testing and Quality Assurance (MTCS609)

L	T	P
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Testing Fundamentals: Principles of testing, Software development life cycle models, Significance and potential of testing. Types of testing - White box testing, Black box testing, Integration testing, System and acceptance testing, Performance testing, Regression testing, Ticking Box testing, Static analysis, Symbolic testing, Program mutation testing, Input space, partitioning, Functional program testing, Data flow guided testing, Internalization testing, Ad-hoc testing, Object Oriented testing strategies and issues, Interface testing and test case design.

Test Management and Automation: Software testing strategies - Approach, Issues, Integration, incremental, system, alpha and beta testing. Test planning - Test management, Testability and features of test cases. Software test automation – Automation tools, Generic requirement for test tool/framework, Selecting a test tool, Dynamic analysis tools, Test data generators, Debuggers, Test drivers.

Software Quality Metrics: Measurement theory, Software quality metrics, Product quality metrics, Software maintenance metrics, Collecting software engineering data.

Software Quality Assurance: Importance and essence, FTR, Structured walk through technique, Software reliability, Validation, Safety and hazards analysis, Features affecting quality of software, Software quality assurance plan. Software quality in business context, Planning for software quality assurance, Product quality and process quality, Quality standards and control.

Software Quality Models: ISO - Capability Maturity Model, CMMI, People CMM, Test maturity model.

Recommended Books:

1. R. Gopalswamy and D. Srinivasan, “Software Testing: Principles and Practices”, Pearson Education, 2006.
2. N. S. Godbole, “Software Quality Assurance: Principles and Practice”, Narosa Publishers, 2004.
3. G. J. Myers, C. Sandler, T. Badgett and T. M Thomas, “The Art of Software Testing”, Wiley, 2004.
4. I. Burnstein, “Practical Software Testing”, Springer – Verlag, 2003.
5. J. D. McGregor and D. A. Sykes, “A Practical Guide to Testing Object-Oriented Software”, Addison-Wesley Professional, 2001.

Compiler Design (MTCS610)

L	T	P
3	0	0

Introduction to Compiler: Compilers, Analysis of the source program. Analysis - Synthesis model of compilation, Phases of compilation, Grouping of phases, Phases of translation, Interpretation, Bootstrapping.

Lexical Analysis: Regular grammar and regular expression for common programming language features, Interface with input, Parser and symbol table, Token, Lexeme and patterns, Problems in lexical analysis, Error reporting, Implementation, Transition diagrams, Study of LEX tool.

Syntax Analysis: Role of the parser. Writing grammars - Context-free grammar, Top down parsing - Backtracking, LL(1), Recursive descent parsing, Predictive parsing, Bottom-up parsing - Shift reduce parsing, Operator precedent parsing, LR parsers, SLR parser, Canonical LR parser, LALR parser, Study of YACC tool.

Symbol Table: Symbol table format, Block structure languages, Hashing, Tree structure representation of scope information. Block structures and non-block structure storage allocation - Static, Runtime stack and heap storage allocation, Storage allocation for arrays, Strings and records.

Semantic Analysis: Abstract syntax tree, Polish notation and three address codes, Attributed grammars, Syntax directed translation. Type checking - Type system, Type expressions, Structural and name equivalence of types, Type conversion, Type checker.

Intermediate Code Generation: Intermediate languages, Declarations, Assignment Statements, Boolean expressions, Case statements, Back patching, Procedure calls.

Code Generation: Issues in the design of code generator, Basic blocks and Flow graphs, DAG representation of Basic blocks, Peephole optimization.

Code Optimization: Principal sources of optimization, Optimization of basic blocks, Global data flow analysis.

Recommended Books:

1. A. Aho, R. Sethi and J. D Ullman, “Compilers: Principles, Techniques and Tools”, Pearson Education Asia, 2003.
2. A. Aho, “Principles of Compiler Design”, Narosa Publishers, 2002.
3. S. S. Muchnick, “Advanced Compiler Design and Implementation", Morgan Kaufmann Publishers, 1997.
4. A.W. Appel, “Modern Compiler Implementation in C: Basic Design”, Cambridge Press, 2004.

Pattern Recognition (MTCS611)

L	T	P
3	0	0

Introduction: Definitions, Data sets for pattern recognition, Different paradigms of pattern recognition, Clustering vs Classification, Supervised vs Un-supervised learning, Representations of patterns and classes, Linearly separable patterns and Non-linearly separable patterns, Applications and examples.

Clustering: Basics of clustering, Sequential algorithm, Similarity and dissimilarity measures, Clustering criteria, Hierarchical algorithms, Functional optimization-based clustering, Graph clustering, Learning clustering, Clustering high dimensional data, Subspace clustering, Cluster validity measures.

Feature Extraction and Selection: Role of feature extraction and selection in pattern recognition, Feature extraction methods, Non-transformed structural characteristics- moments. Transformed signal characteristics- Discrete fourier transform, Discrete cosine and sine transform. Structural descriptors- Graph descriptors. Texture- first-order Statistics features, Second-order statistics features, Laws texture energy measures. Shape based features. Feature selection methods – exhaustive search, Branch and bound algorithm, Max-min feature selection and sequential forward and sequential backward selection.

Classifiers: Role of classifier in pattern recognition, Decision tree, Linear classifier, Quadratic classifier, K-nearest neighbor, Bayesian classifier. Support vector machines (SVMs) – Non-linear SVM classifier, Different kernel functions (Radial Basis function, polynomial). Artificial neural networks (ANNs) for classification and regression, Single layer perceptron, Multi-layer Perceptron, Backpropagation ANN. training set, Test set, Standardization and normalization.

Case Study: Digit recognition, Character recognition, Pattern recognition applications in bioinformatics and medical imaging.

Recommended Books:

1. C. M .Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
2. S. Marsland, “Machine Learning: An Algorithmic Perspective”, CRC Press, 2009.
3. D. Koller and N. Friedman, “Probabilistic Graphical Models”, MIT Press, 2009.
4. S. Theodoridis and K. Koutroumbas “Pattern Recognition”, Academic Press, 2008.

Machine Learning (MTCS 612)

L	T	P
3	0	0

Prerequisites: Knowledge of basic computer science principles and skills, Familiarity with the basis of probability theory and linear algebra.

Syllabus:

Introduction: Definition of learning systems, Goals and applications of machine learning. Aspects of developing a learning system- Training data, Concept representation, Function approximation, Issues in machine learning. Types of machine learning- Learning associations. Supervised learning - Classification and regression trees, Support vector machines. Unsupervised learning - Clustering, Instance-based learning - K-nearest neighbor, Locally weighted regression, Radial basis function, Reinforcement learning.

Clustering: Introduction, Mixture densities, K-means clustering, Expectation-maximization algorithm, Hierarchical clustering, Choosing the number of clusters.

Decision Trees: Introduction, Univariate trees - Classification and regression. Pruning, Rule extraction from Trees, Learning rules from data, Multivariate trees, Basic decision tree learning algorithm, Issues in decision tree learning.

Artificial Neural Networks: Neurons and biological motivation, Linear threshold units, Perceptrons, Training a perceptron. Multilayer networks and back propagation, Training procedures, Tuning the network size, Bayesian view of learning, Dimensionality reduction, Learning time.

Support Vector Machines: Maximum margin linear separators, Quadratic programming solution to finding maximum margin separators, Kernels for learning non-linear functions.

Bayesian Learning and Instance Based Learning: Probability theory and bayes rule, Naive Bayes learning algorithm, Parameter smoothing, Generative vs. discriminative training, Bayes nets and markov nets for representing dependencies, K-Nearest neighbor algorithm, Case-based learning.

Hidden Markov Model: Introduction, Discrete Markov Processes, Three basic problems of HMM, Learning model parameters, Continues observations, The HMM with input, Model selection in HMM.

Recommended Books:

1. E. Alpaydin, “Introduction to Machine Learning”, MIT Press, 2010.
2. T.M. Mitchell, “Machine Learning”, McGraw Hill, 1997.

3. M. Mehryar, R. Afshin and T. Ameet, “Foundations of Machine Learning”, MIT Press, 2012.
4. S.S. Vinod Chandra and S. Anand H, “Artificial Intelligence and Machine Learning”, PHI Learning, 2014.
5. C. Bishop, “Pattern Recognition and Machine Learning”, Springer-Verlag, 2006.

Bioinformatics (MTCS613)

L	T	P
3	0	0

Introduction: Living parts - Tissues, Cells, Compartments and organelles, Molecular biology, Concept of DNA, RNA, Protein and metabolic pathway. Bioinformatics, Role of bioinformatics in biological sciences, Scope and challenges in bioinformatics.

Databases in Bioinformatics: Bioinformatics databases - Genbank, NCBI, EMBL, DDBJ, UniGene, SGD, EMI genomes. Protein databases - PIR, SWISSPROT, TrEMBL, Prosite. Need and challenges of databases.

Proteomics: Classification of proteomics, Proteomic analysis, Protein identification methods, Protein structure prediction, Applications of proteomics.

Genomics: Genomics, its classification, DNA structure prediction, DNA sequencing, genome analysis, applications of genomics, Whole genome comparison.

Sequence Analysis: File formats for biomolecular sequences. Sequence alignment - pairwise alignment, Multiple sequence alignment, Sequence similarity, BLAST and FASTA algorithms.

Applications of Bioinformatics: Phylogenetic analysis, Microarrays, DNA and protein microarrays. Bioinformatics in pharmaceutical industry - Informatics, Drug discovery and designing.

Recommended Books:

1. T. K. Attwood and Parry-Smith, “Introduction to Bioinformatics”, Addison Wesley Longman, 1999.
2. H. Des and W .Taylor, “Bioinformatics Sequence, Structures and Databanks”, Oxford University Press, USA, 2000
3. A . Jagota, “Data Analysis and Classification for Bioinformatics”, Pine Press, 2001.
4. W. M. David, “Bioinformatics: Sequence and Genome Analysis”, CBS Publishers, 2004.

Soft Computing (MTCS614)

L	T	P
3	0	0

Introduction: Introduction to soft computing: Definitions, Goals and importance, applications of soft computing.

Fuzzy Computing: Introduction, Uncertainty, Fuzzy vs crisp, Crisp sets, Operations on crisp sets, Properties of crisp sets, Fuzzy sets, Fuzzy membership functions, Basic fuzzy set operations, Properties of fuzzy sets, Crisp relations, Fuzzy relations, Crisp logic, Predicate Logic, Fuzzy logic, Fuzzy quantifiers, Fuzzy inference, Fuzzy rule based system, De-fuzzification methods, Applications.

Neural Computing: Model of an artificial neuron, Comparison of artificial neural network and biological neural network, Neural network architectures, Learning methods, Activation functions, Perceptron, Hopfield network, Back-propagation network, Function network, Kohonen self-organizing feature maps.

Stochastic and Evolutionary Computing: Introduction to simulated annealing, Swarm intelligence, Ant colony optimization. Genetic algorithms - Working principle, Encoding, Fitness function, Reproduction, Crossover operators and mutation operator.

Recommended Books:

1. V. Kecman, 'Learning and Soft Computing", MIT Press, 2001.
2. G. J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic", Prentice Hall of India, 1997.
3. S. Haykin, "Neural Networks. A comprehensive Foundation", Prentice Hall, 2005.
4. D.E. Goldberg, "Genetic Algorithms in Search and Optimization, and Machine Learning", Addison-Wesley, 1989.
5. S. Rajasekaran and G.A.V. Pai, "Neural Networks, Fuzzy logic and Genetic Algorithms", Prentice Hall of India, 2003.
6. J. Sun and Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice Hall of India, 2003.
7. D. Ruan, "Intelligent Hybrid Systems", Kluwer Academic Publisher, 1997.

Natural Language Processing (MTCS615)

L	T	P
3	0	0

Introduction: Need for processing of natural languages, Language processing levels, Applications of NLP, Introduction to Finite State Automata and Regular expressions, Introduction to Formal languages and Context-free grammars.

Morphological Processing: Inflectional and Derivational morphology, Morphological parsing, Finite state transducers, N-gram language models.

Part-of-Speech Tagging: Word Classes, Part-of-speech tagging, Tagsets, Rule-based, Stochastic and Transformation based POS tagging.

Parsing: Basic parsing strategies, Parsing with context-free grammars, Earley algorithm, Finite-state parsing methods, Unification of feature structures.

Semantic Analysis: Lexical Semantics, Lexemes, Relations among lexemes and their senses, WordNet, Word Sense Disambiguation.

Pragmatics: Discourse, Discourse structure. Dialogue - Acts, structure, conversational agents. Language generation, Architecture for generation.

Recommended Book:

1. D. Jurafsky and J. H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2008.
2. J. Allen , “Natural Language Understanding”, Addison Wesley, 2007.
3. J. Handke, “The Structure of the Lexicon: Human Versus Machine (Natural Language Processing)”, Mouton de Gruyter, 1995.

Speech Processing (MTCS616)

L	T	P
3	0	0

Introduction: Mechanism of speech production, Acoustic phonetics, Digital models for speech signals, Sampling of speech signals, Quantization, Delta modulation, Differential PCM.

Speech Processing in Time Domain: Time domain parameters of Speech signal, Methods for extracting the parameters, Energy, Average magnitude, Zero crossing rate. Silence discrimination using energy and Zero crossings, Short time auto correlation function, Pitch period estimation using auto correlation function.

Speech Processing in Frequency Domain: Fourier transform and Linear filtering interpretations, Sampling rates, Spectrographic displays, Pitch detection, Analysis by synthesis. Analysis synthesis systems – Phase vocoder, Channel vocoder. Homomorphic speech processing – Cepstral analysis of speech, Pitch detection, Formant estimation, Homomorphic vocoders.

Linear Predictive Coding of Speech: Linear predictive analysis, Auto correlation method, Covariance method. Solution of LPC equations – Cholesky solution, Durbin's Recursive solution, Lattice formulation and solution. Application of LPC parameters – Pitch detection, Formant analysis, Vocoders.

Speech Modeling: Hidden Markov Models - Markov processes, Elements of HMM. Probability evaluation - Forward and backward procedures. Viterbi algorithm, Parameter estimation, Baum-Welch algorithm.

Speech Synthesis and Recognition: Voice response systems, Speech synthesis systems, Source-filter theory, Articulatory synthesis, Formant synthesis, Concatenative synthesis. Speech recognition, Feature extraction. Speech recognition systems – Isolated, Continuous and Spontaneous speech recognition. Speaker verification and identification systems.

Recommended Books:

1. L. R. Rabiner and R. W. Schaffer, "Digital Processing of Speech signals", Prentice Hall, 1978.
2. B. Gold, N. Morgan and D. Ellis, "Speech and Audio Signal Processing", John Wiley and Sons, 2011.
3. T. F. Quatieri, "Discrete-time Speech Signal Processing", Pearson Education India, 2002.
4. D. Jurafsky and J. H. Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2000.

Research Methodology (MTCS617)

L	T	P
3	0	0

Introduction: Meaning of research, Objectives of research, Motivation in research, Types of research, Research approaches, Significance of research, Research methods versus Methodology, Research and scientific method, Importance of knowing how research is done, Research process, Criteria of good research.

Defining the Research Problem: Define research problem, Selecting the problem, Necessity of defining the problem, Technique involved in defining a problem.

Research Design: Meaning of research design, Need for research design, Features of a good design, Important concepts relating to research design, Different research designs, Basic principles of experimental designs, Developing a research plan.

Sampling Design: Census and sample survey, Implications of a sample design, Steps in sampling design, Criteria of selecting a sampling procedure, Characteristics of a good sample design, Different types of sample designs, Selecting a random sample, Random sample from an infinite universe, Complex random sampling designs.

Measurement and Scaling Techniques: Measurement in research, Measurement scales, Sources of error in measurement, Tests of sound measurement, Technique of developing measurement tools, Scaling, Meaning of scaling, Scale classification bases, Scaling techniques, Scale construction techniques.

Methods of Data Collection: Collection of primary data ,Observation method, Interview method, Collection of data through questionnaires, Collection of data through schedules, Difference between questionnaires and schedules, Collection of secondary data, Selection of appropriate method for data collection, Guidelines for constructing questionnaire/schedule, Guidelines for successful interviewing, Difference between survey and Experiment.

Processing and Analysis of Data: Processing operations, Problems in processing, Elements/Types of analysis, Statistics in research, Measures of central tendency, Measures of Dispersion, Measures of asymmetry (Skewness), Measures of relationship, Simple regression analysis, Multiple correlation and regression, Partial correlation, Association in case of attributes.

Sampling Fundamentals: Need for sampling, Important sampling distributions, Central limit theorem, Sampling theory, Sandler's A-test, Concept of standard Error, Estimation, Estimating the population mean, Estimating population proportion, Sample size and its determination, Determination of sample size through the approach based on precision rate and confidence level, Determination of sample size through the approach based on Bayesian Statistics.

Interpretation and Report Writing: Meaning of interpretation, Need of interpretation, Technique of interpretation, Precaution in interpretation, Significance of literature survey, Significance of report writing, Different steps in writing report, Layout of the research report, Types of reports, Oral presentation, Mechanics of writing a research report, Precautions for writing research reports .

Recommended Books:

1. C.R. Kothari, "Research Methodology Methods and Techniques", New Age International, 2004.
2. D. R. Cooper and P. S. Schindler, "Business Research Methods", Tata McGraw-Hill Co. Ltd., 2006.
3. N .G. Das, "Statistical Methods Combined Edition (Volumes I and II)", McGraw Hill Education (India) Private Limited, 2008.
4. R. Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", SAGE Publications Ltd; 2014.

Optimization Techniques (MTCS618)

L	T	P
3	0	0

Introduction: Optimization principles, Single-variable and multi-variable functions, Classical and numerical optimization techniques, Formulation of optimization problems.

Unconstrained Single-Variable Optimization Methods: Optimality criteria. Bracketing methods - Exhaustive search method, Bounding phase method. Region elimination methods - Interval halving method, Fibonacci search method, Golden section search method. Gradient based methods - Newton Raphson method, Bisection method, Secant method, Cubic search method.

Unconstrained Multi-Variable Optimization Methods: Optimality criteria, Direct search methods - Evolutionary optimization method, Simplex search method, Hooke-Jaeves pattern search method. Gradient based methods - Steepest descent method, Newton's method, Conjugate gradient method.

Constrained Optimization Methods: Kuhn-Tucker conditions, Penalty function method, Multiplier method, Variable elimination method, Complex search method, Random search method

Advanced Optimization Methods: Linear programming, Geometric programming, Genetic algorithms, Particle swarm optimization, Ant colony optimization, Bee colony optimization.

Recommended Books:

1. K. Deb, "Optimization for Engineering Design – Algorithms and Examples", Prentice Hall India, 2012.
2. D. Belegundu and T. R. Chandrupatla, "Optimization Concepts and Applications in Engineering", Cambridge University Press, 2011.
3. W.Forst and D. Hoffmann, "Optimization—Theory and Practice", Springer Science and Business Media, 2010.
4. D. Simon, "Evolutionary Optimization Algorithms", John Wiley and Sons, 2013.

Modeling and Simulation (MTCS619)

L	T	P
3	0	0

Introduction: Modeling concepts and definitions, System models and role of simulation, Types of models, Discrete-event simulation, Steps in a simulation study, Simulation examples.

Statistical Models in Simulation: Basics of statistical model, Discrete and continuous distribution, Poisson processes and empirical distribution, Elementary queuing theory, Queuing models involving non-exponential distribution, Queuing models involving hyper- exponential distribution, Queuing models without a poisson input, Priority discipline queuing model, Queuing networks, Application of queuing models.

Random Number Generation: Properties of random numbers, Generation of pseudo random numbers, Random variate generation, Techniques for generation of pseudo random numbers - Mid-square random number generator, Residue method, Arithmetic congruential generator, Hypothesis testing and tests for random numbers.

Input Modeling and Output analysis: Data collection, Identifying the distribution of data- histograms and Quantile-Quantile plots. Parameter estimation, Goodness of fit tests applied to simulation inputs, Output analysis and measures of performance and estimation.

Simulation Tools: Basic introduction to simulation tools - Scilab, Tortuga and Extend. Introduction to network simulators - NS2, CloudSim, Wireshark.

Recommended Books:

1. J. Banks, J.S. Carson II, B. L. Nelson and D. M. Nicol, ”Discrete- event system and simulation”, Prentice Hall of India, 2010.
2. A. M. Law, “Simulation Modeling and Analysis”, Tata McGraw Hill India, 2007.
3. G.A. Wainer, “Discrete-event modeling and simulation: a practitioner’s approach”, CRC Press, 2009.
4. B.P. Zeiger, H. Praehofer and T. G. Kim, “Theory of modeling and simulation: integrating discrete event and continuous complex dynamic systems”, Academic Press, 2000.
5. W. J. Karplus, G. A. Bekey and B. YakobKogan, “Modeling and simulation: theory and practice”, Springer, 2003.

Neural Networks and Fuzzy Logic (MTCS620)

L	T	P
3	0	0

Introduction of Neural Networks: Basic concepts of neural networks, Human brain, Biological neuron, Model of an artificial neuron, Analogy between real and artificial neurons, Comparison between artificial neural network and biological neural network, Characteristics of neural networks, Neural network architectures, Learning methods, Activation functions, Application of ANNs.

Perception and Backpropagation: Rosenblatt's perceptron, Perceptron learning rule, Perceptron training algorithm, ADALINE, Delta rule, MADALINE, Concept of backpropagation, Architecture of backpropagation, Method of steepest descent, Backpropagation training algorithm, Learning rate, Selection of learning rate, Momentum factor, Merits and demerits of backpropagation, Applications of backpropagation.

Counter Propagation Networks and Hopfield Nets: Counter propagation algorithm and its applications, Hopfield net algorithm for auto-association, Capacity of hopfield nets, and hopfield net algorithm for optimization, Stability of hopfield nets.

Fuzzy Set: Introduction, Uncertainty, Fuzzy v/s Crisp, Crisp sets, Operations on Crisp sets, Properties of Crisp sets, Fuzzy sets, Fuzzy membership functions, Basic fuzzy set operations, Properties of fuzzy sets, Crisp relations, Fuzzy relations.

Fuzzy Logic: Crisp logic, Predicate logic, Fuzzy logic, Fuzzy quantifiers, Fuzzy inference, Fuzzy rule based System, De-fuzzification methods, Applications.

Fuzzy Model Identification: Structure Specifications, Parameter estimation, Model validation.

Recommended Books:

1. J.S.R. Jang, C.T. Sun and E. Mizutani, "Neuro Fuzzy and Soft Computing: A Computational approach to learning and Machine Intelligence", Pearson Education, 2002.
2. L. M. Fu, "Neural Networks in Computer Intelligence", McGraw-Hill, Inc, 1994.
3. G. J Klir and B. Yuan, "Fuzzy sets and Fuzzy Logic, Theory and Applications", PHI, 1996.
4. I. Cloete and J. M. Zurada, "Knowledge based Neuro Computing", University Press, 2001.

Project Management (MTCS621)

L	T	P
3	0	0

Concept of Project and Project Management: Definition, Characteristics, Importance, Types, Steps in identification of projects, Project life-cycle. Project management-Meaning and scope.

Project Appraisal: Technical appraisal, Environmental appraisal, Economic and market appraisal, Including market survey for forecasting future demand and sales, Managerial appraisal.

Financial Appraisal: Project cost estimation and working capital requirements, Sources of funds, Appropriate composition of funds (capital budgeting).

Preparation of Projected Financial Statements: Projected balance sheet, Projected income statement, Projected funds and cash flow statements, Preparation of detailed project report.

Need and Techniques for Comparison of Investment Proposals: Payback method, Accounting rate of return, Internal rate of return, Net present value method, Net terminal value method, Multiple internal rate of return.

Project Risk Analysis: Management risk, Market risk, Technical risk.

Social Cost Benefit Analysis (SCBA): Meaning, Rationale, Approaches to SCBA - UNIDO approach, L-M approach, Social appraisal of projects in developing countries with special reference to India.

Implementation of Projects: Project scheduling and control, Problems of project implementation, Role of project manager, Project audit.

Case studies relevant to the course should be discussed in the class.

Recommended Books:

1. P. Chandra, “Projects: Planning, Analysis, Selection, Financing, Implementation and Review”, Tata McGraw Hill Education Private Limited, 2009.
2. Y. Y. Chong and E. M. Brown, “Managing Project Risk”, Pearson Education, 1999.
3. Ghattas and McKee, “Practical Project Management”, Pearson, 2000.
4. H. Maylor, “Project Management”, Pearson, 2010.

Human Resources Development and Training Methods (MTCS622)

L	T	P
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Prerequisites: Basics of Human Resource management.

Syllabus:

Human Resource Management: Definition, Objectives, Functions, Scope, Importance of HRM in India, Human resource planning, Job analysis, Job description and Job specification, Performance appraisal methods, Compensation management, Training and development- Concepts and rationale, Need, Requisites of effective training, Policies, Its linkage to company's strategy, Role of external agencies in training and development. Training Needs Assessment (TNA) - Meaning and purpose, TNA at different levels, Approaches, Output and methods used in TNA.

Overview of Training Methodologies: Logic and process of Learning, On the job training, Off the job training, lecture, Field trips, Panel discussion, Behavior modeling, Interactive demonstrations, Brain storming, Case studies, Action mazes, Incident process, Jig saws, In-baskets, Team tasks, Buzz-groups and syndicates, Agenda setting, Use of audio-visual aids in training, Computer aided instructions- Distance learning, Open learning, E-Learning- Choosing optimum training method, Technologies convergence and multimedia environment.

Development Techniques: Need for development - Differences between training and development, Development techniques for enhancing decision–making and interpersonal skills, Case-study, In-basket exercise, Special projects, Role plays, Finding metaphors, Simulations, Business games, Clinics, Critical incidents, Fish bowls, T-groups, Hot role plays, Data gathering, Grouping methods, Transactional analysis, Expectation analysis, Multiple management, Programme learning, Syndicate work, Games, Demonstration and practice monitoring, Coaching, Self diagnostic skills, Experience learning, Discovery learning, Brain storming, Counselling, Position rotation, Team building, and sensitivity training.

Designing Training and Development Programs: Organization of training and development programs, Training design, Kinds of training and development programs-Competence based and role based training, Diversity training, Choice of training and development methods, Preparation of trainers, Developing training materials, E-learning environment, Flexible learning modules, Self-development, Training process outsourcing.

Evaluation of Training and Development: Reasons for evaluating training and development programs, Problems in evaluation, Evaluation planning and data collection, Different evaluation frameworks, Problems of measurement and evaluation, Costing of training, Measuring costs and benefits of training program, Obtaining feedback of trainees, Methods of evaluating effectiveness of training Efforts, Kirkpatrick model of training effectiveness, Training issues resulting from the external environment and

internal needs of the company employee appraisal methods, Competency mapping, Bench marking, Entrepreneurial development, Entrepreneurial development program, Training and development of entrepreneurs.

Emerging Trends in Training and Development: Gamification, Team training and six sigma training, Electronic Enabled Training Systems (EETS)-Concept and types, benefits and challenges in using EETS, Concerns in implementation– Availability, Incorporation, Extension, and Learning renewals for EETS, Use of EETS and its up scalability, Follow up activities, Training and development initiatives of some selected companies from private and public sectors and MNCs, Employee counselling, Competency mapping, PCMM, Balanced score card, Appreciative inquiry, Integrating HRD with technology.

Relevant case studies to be discussed.

Recommended Books:

1. R. A. Noe, "Employee Training and Development", McGraw Hill Publication (International Edition), 2012.
2. D. Mankin, "Human resource development", Oxford University Press India (2009).
3. R. A. Noe, and A. D. Kodwani, "Employee Training and Development", Tata McGrawHill, 2012.
4. Craig and L. Robert, "Training and Development Handbook", McGraw Hill, 1996.
5. J. Prior, "Handbook of Training and Development", Jaico Publishing House, Bombay, 1994.
6. I. Dayal, "Management Training in Organisations", Prentice Hall, 2006.