SCHEME OF INSTRUCTION AND DETAILED SYLLABI FOR

MASTER OF TECHNOLOGY PROGRAM

IN

DATA ANALYTICS

Department of Information Technology

DR B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY

JALANDHAR, PUNJAB, INDIA-144027

INSTITUTE VISION AND MISSION STATEMENTS

VISION

To build a rich intellectual potential embedded with interdisciplinary knowledge, human values and professional ethics among the youth, aspirant of becoming engineers and technologists, so that they contribute to society and create a niche for a successful career.

MISSION

To become a leading and unique institution of higher learning, offering state-of-the art education, research and training in engineering and technology to students who are able and eager to become change agents for the industrial and economic progress of the nation. To nurture and sustain an academic ambience conducive to the development and growth of committed professionals for sustained development of the nation and to accomplish its integration into the global economy.

Department Vision and Mission Statements

VISION

- To be in the frontier of Information Technology and to produce globally competent graduates with high moral values committed to build a vibrant nation.
- To be recognised nationally and internationally for delivering outstanding computer science education and conducting research of high distinction, both of value and relevance to the communities we serve.

MISSION

- A strong theoretical excellence and competence in the fundamental areas of Information Technology to nurture students for utilizing high creativity, innovation and out-of-the-box thinking.
- A breadth of knowledge in a variety of application areas pertaining to the field of Information Technology so that students can maximize on their career options.
- Preparation for contemporary research and development in Information Technology applicable to industry or academia.
- The awareness of professional, social and ethical responsibilities through curricular, co-curricular and extracurricular activities.

Introduction

Information Technology helps to build and grow the commerce and business sector and generate maximum possible output. It allows organizations to work more efficiently and maximize productivity and so on. It creates electronic storage systems to protect users' valuable records. The use of IT specifies to computers to store, retrieve, share, and manipulate data or information. It plays the main role in students being able to keep their jobs and go to recognized designations. With the introduction of computers, the business world was changed and by using computers and software, businesses use information technology to ensure that their departments run smoothly. Technology is being leveraged in different sectors and there is the role of IT in other domains like Education, Finance, Healthcare, Security, Communications and many more. Information Technology has also helped other areas to grow. Since the use of technology has increased, the need to manage that has also increased which demands the introduction of this program leveraging the national growth in IT sector.

Big data analytics is offering advanced analytic techniques against large, complex and diverse data sets that include structured, semi-structured and unstructured data, from different sources. The data analytics techniques are used for faster decision-making, modelling and predicting of future outcomes and enhanced business intelligence. Using statistical approaches to access large volume of data and analyses a large variety source of data to gain new insights and take action intelligently will definitely improve in other related fields like machine learning, artificial intelligence, data mining etc.

Flexible data processing and storage tools can help organizations save costs in storing and analyzing large amounts of data. Discover patterns and insights that help you identify to learn more efficiently. It is analytics for improved data-driven. Analyzing data from sensors, devices, video, logs, transactional applications, web and social media empowers an organization to be data-driven.

ANNEXURE-I

SCHEME FOR M. TECH. (DATA ANALYTICS) IN INFORMATION TECHNOLOGY

SEMESTER – I

S. No.	Course Code	Subjects	L	T	P	Credit
1.	IT-501	Statistical Computing	3	0	0	3
2.	IT-503	Big Data Analytics	3	0	0	3
3.	IT-505	Introduction to Artificial Intelligence	3	0	0	3
4.	IT-507	Next Generation Databases	3	0	0	3
5.	IT-5xx	Elective-I	3	0	0	3
6.	IT-5xx	Elective-II	3	0	0	3
7.	IT-513	Big Data Analytics Lab	0	0	3	2
8.	IT-515	Artificial Intelligence lab	0	0	3	2
		Total	**18**	**0**	**6**	**22**

SEMESTER – II

S. No.	Course Code	Subjects	L	T	P	Credit
1.	IT-502	Machine Learning Techniques	3	0	0	3
2.	IT-504	Natural Language Processing	3	0	0	3
3.	IT-506	Social Networking and Mining	3	0	0	3
4.	IT-5xx	Elective-III	3	0	0	3
5.	IT -5xx	Elective-IV	3	0	0	3
6.	IT-5xx	Elective-V	3	0	0	3
7.	IT-512	Machine Learning Lab	0	0	3	2
8.	IT-514	Natural Language Processing Lab	0	0	3	2
		Total	**18**	**0**	**6**	**22**

SEMESTER – III

S. No.	Course Code	Subjects	L	T	P	Credit
1.	IT – 601	M. Tech. Seminar	0	0	6	3
2.	IT – 603	M. Tech. Dissertation Phase-I	0	0	12	6
		Total	**0**	**0**	**18**	**9**

SEMESTER – IV

S. No.	Course Code	Subjects	L	T	P	Credit
1.	IT – 602	M. Tech. Dissertation Phase – II	0	0	24	12
		Total	**0**	**0**	**24**	**12**

GRAND TOTALS OF CREDITS = 65

LIST OF DEPARTMENTAL CORES FOR M.TECH. (DATA ANALYTICS) PROGRAMME IN INFORMATION TECHNOLOGY

Core Courses

S No.	Course Code	Course Title	Hrs / week			Credits
			L	T	P	
1	IT-501	Statistical Computing	3	0	0	3
2	IT-502	Machine Learning Techniques	3	0	0	3
3	IT-503	Big Data Analytics	3	0	0	3
4	IT-504	Natural Language Processing	3	0	0	3
5	IT-505	Introduction to Artificial Intelligence	3	0	0	3
6	IT-506	Social Networking and Mining	3	0	0	3
7	IT-507	Next Generation Databases	3	0	0	3
8	IT-512	Machine Learning Lab	0	0	3	2
9	IT-513	Big Data Analytics Lab	0	0	3	2
10	IT-514	Natural Language Processing Lab	0	0	3	2
11	IT-515	Artificial Intelligence Lab	0	0	3	2
		Total	**18**	**0**	**12**	**26**

LIST OF DEPARTMENTAL ELECTIVES FOR M.TECH. PROGRAMME IN INFORMATION TECHNOLOGY

Department elective courses

S. No.	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1	IT-521	Advanced Data Structure and Algorithm	3	0	0	3
2	IT-522	Data Science Programming	3	0	0	3
3	IT-523	High Performance Computing	3	0	0	3
4	IT-524	Real Time Systems	3	0	0	3
5	IT-525	Massive Graph Analysis	3	0	0	3
6	IT-526	Data Acquisition and Productization	3	0	0	3
7	IT-527	Advanced Optimization Algorithm	3	0	0	3
8	IT-528	Principle of Deep Learning	3	0	0	3
9	IT-529	Image and Video Analysis	3	0	0	3
10	IT-530	Healthcare Data Analytics	3	0	0	3
11	IT-531	Linked Open Data and Semantic Web	3	0	0	3
12	IT-532	Business Intelligence	3	0	0	3
13	IT-533	Fundamentals of Blockchain Technology	3	0	0	3
14	IT-534	Web Intelligence	3	0	0	3
15	IT-535	Introduction to Internet of Things (IoT)	3	0	0	3
16	IT-536	Cryptography & Data Security	3	0	0	3
17	IT-537	Advanced Data Analytics	3	0	0	3

LIST OF OTHER DEPARTMENT ELECTIVES

Other Department elective courses

S. No.	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1	IT-538	Customer Relationship and Management	3	0	0	3
2	IT-539	Financial Risk Analytics and Management	3	0	0	3
3	IT-540	Supply Chain Management	3	0	0	3

SEMESTER - I

STATISTICAL COMPUTING (IT-501)

Objectives:

- To learn the probability distributions and density estimations for various kinds of data.
- To explore statistical analysis techniques using programming languages.
- To expand the knowledge in statistical computing for further research.

Probability Theory: Sample Spaces- Events - Axioms – Counting - Conditional Probability and Bayes' Theorem – The Binomial Theorem – Random variable and distributions: Mean and Variance of a Random Variable-Binomial-Poisson-Exponential and Normal distributions. Curve Fitting and Principles of Least Squares- Regression and correlation.

Sampling Distributions & Descriptive Statistics: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Sampling distributions (Chi-Square, t, F, z). Test of Hypothesis- Testing for Attributes – Mean of Normal Population – One-tailed and two-tailed tests, F-test and Chi-Square test Analysis of variance ANOVA – One way and two-way classifications.

Tabular data- Power and the computation of sample size- Advanced data handling Multiple regression- Linear models- Logistic regression- Rates and Poisson regression Nonlinear curve fitting.

Density Estimation- Recursive Partitioning- Smoothers and Generalized Additive Models - Survivals Analysis- Analyzing Longitudinal Data- Simultaneous Inference and Multiple Comparisons- Meta-Analysis- Principal Component Analysis- Multidimensional Scaling Cluster Analysis.

Introduction to R- Packages- Scientific Calculator- Inspecting Variables- Vectors Matrices and Arrays- Lists and Data Frames- Functions- Strings and Factors- Flow Control and Loops- Advanced Looping- Date and Times. Introduction to Python Packages- Fundamentals of Python- Inserting and Exporting Data- Data Cleansing Checking and Filling Missing Data- Merging Data- Operations- Joins.

References:

1. Richard Cotton, "Learning R", O'Reilly, 2013.
2. Dalgaard, Peter, "Introductory statistics with R", Springer Science & Business Media, Second Edition 2008.
3. Brain S. Everitt, "A Handbook of Statistical Analysis Using R", Second Edition, LLC, 2014.
4. Samir Madhavan, "Mastering Python for Data Science", Packt, 2015.
5. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 5th edition, Academic Press; 2014.
6. Paul Teetor, "R Cookbook", O'Reilly, Second Edition, 2019.
7. Mark Lutz, "Learning Python", O'Reilly, 5th Edition, 2013

Outcomes:

Students will be able to:

- Implement statistical analysis techniques for solving practical problems.
- Evaluate statistical operations on a variety of data.
- Apply statistical tests using programming language and visualize the outcome.

BIG DATA ANALYTICS (IT-503)

Objectives:

- To optimize business decisions and create competitive advantage with Big Data analytics
- To explore the fundamental concepts of big data analytics.
- To analyze big data using intelligent techniques.
- To understand the various search methods and visualization techniques.
- To use various techniques forming data streams.
- To introduce programming tools PIG & HIVE in Hadoop echo system.

Introduction to big data: Introduction to Big Data Platform – Challenges of Conventional Systems Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting.

Mining data streams: Introduction to Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.

Hadoop: History of Hadoop- the Hadoop Distributed File System – Components of Hadoop Analysing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features Hadoop environment.

Frameworks: Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphere Big Insights and Streams.

Predictive Analytics- Simple linear regression- Multiple linear regression- Interpretation of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications.

References:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Tom White “Hadoop: The Definitive Guide” Fourth Edition, O’reilly Media, 2015.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill Publishing, 2017.
4. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2nd Edition 2016.
5. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley& sons, 2012.
6. Glenn J. Myatt, “Making Sense of Data”, John Wiley & Sons, 2nd Edition 2014.
7. Pete Warden, “Big Data Glossary”, O’Reilly, 2011.
8. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, 3rd Edition, Elsevier, Reprinted 2011.
9. Da Ruan, Guoquing Chen, Etienne E.Kerre, Geert Wets, “Intelligent Data Mining”, Springer, 2007.
10. Paul Zikopoulos, Dirkde Roos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, “Harness the Power of Big Data The IBM Big Data Platform”, Tata McGraw Hill Publications, 2012.

10. Arshdeep Bahga, Vijay Madisetti, "Big Data Science & Analytics: A HandsOn Approach ",VPT, 2016
11. Bart Baesens "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)", John Wiley & Sons,2014

Outcomes:

Students will be able to:

- Explore the big data analytics techniques business applications.
- Design efficient algorithms for mining the data from large volumes.
- Analyze the HADOOP and Map Reduce technologies associated with big data analytics.
- Formulate Big Data Applications using Pig and Hive.
- Understand the fundamentals of various big data analytics techniques.
- Build a complete business data analytics solution.

INTRODUCTION TO ARTIFICIAL INTELLIGENCE (IT-505)

Objectives:

- To introduce the concept of artificial intelligence, methods, techniques and applications
- To learn the methods of problem solving using artificial intelligence
- To be familiar with the strengths, and weaknesses of the basic knowledge representation, and learning methods in applying real world problems.

Overview of Artificial Intelligence: The concept and importance of AI, Human intelligence vs. Machine intelligence.

Expert Systems: Expert systems: advantages, disadvantages, Expert system architecture, Functions of various parts, Mechanism and role of inference engine, Types of Expert system, Tuning of expert systems, Role of Expert systems in instrumentation and process control.

Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications.

Machine Learning and Knowledge Acquisition: learning from memorization, examples, explanation, and exploration. Learning nearest neighbor, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications.

Fuzzy Logic: Fuzzy sets and systems, Operations on Fuzzy sets, Fuzzy relations, Membership functions, Fuzzy rule generation, De-Fuzzification, Fuzzy controllers.

Genetic Algorithms: Introduction and concept, Coding, Reproduction, Cross-over and mutation scaling, Fitness, Applications, Swarm intelligence, and their applications.

References:

1. Rich E., Artificial Intelligence, Tata McGraw Hills (2010) 3rd ed.
2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving,

Pearson Education Asia (2009) 6th ed.
3. Patterson D.W, Introduction to AI and Expert Systems, Mc GrawHill 1998, 1st ed.
4. Russel S., Norvig P., Artificial intelligence: A Modern approach, prentice Hall 2014, 3rd edition.
5. Yegnanarayana, B., Artificial Neural Networks, Prentice□Hall of India Private Limited (2008).

Outcomes:
Students will be able to:

- Understand applications of artificial intelligence and categorize various problem domains.
- Analyze basic and advanced search techniques including game playing, evolutionary search algorithms, and constraint satisfaction.
- Understand the importance of probability in knowledge representation for reasoning under uncertainty.
- Acquire knowledge about the architecture of an expert system and design new expert systems for real life applications.

NEXT GENERATION DATABASES (IT-507)

Objectives:

- To explore the concepts of NoSQL Databases.
- To understand and use distributed data base patterns.
- To learn various data models for a variety of databases.

Refresher and database and modeling, relational algebra, tuple relational calculus, query planning evaluation and optimisation, OLAP vs OLTP

Database Revolutions- System Architecture- Relational Database- Database Design Data Storage- and indexing, Transaction Management- Data warehouse and Data Mining- Information Retrieval.

Big Data Revolution- CAP Theorem- Birth of NoSQL- Document Database—XML Databases- JSON Document Databases- Graph Databases.

Column Databases— Data Warehousing Schemes- Columnar Alternative- Sybase IQ- CStore and Vertica- Column Database Architectures- SSD and In-Memory Databases— InMemory Databases- Berkeley Analytics Data Stack and Spark.

Distributed Database Patterns— Distributed Relational Databases- Non-relational Distributed Databases- MongoDB - Sharing and Replication- HBase- CassandraConsistency Models— Types of Consistency- Consistency MongoDB- HBase Consistency- Cassandra Consistency.

Introduction to Parallel Databases, special purpose databases like temporal, spatial and multimedia.

Data Models and Storage- SQL- NoSQL APIs- Return SQL- Advance Databases— PostgreSQL- Riak-CouchDB- NEO4J- Redis- Future Databases— Revolution RevisitedCounter revolutionaries- Oracle HQ- Other Convergent Databases- Disruptive Database Technologies.

References:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, “Database System
2. Concepts”, Sixth Edition, McGrawHill, 2013.
3. Guy Harrison, “Next Generation Databases”, Apress, 2015.
4. Eric Redmond, Jim R Wilson, “Seven Databases in Seven Weeks”, LLC. 2nd Edition 2018.

5. Dan Sullivan, "NoSQL for Mere Mortals", Addison-Wesley, 2015.
6. Adam Fowler, "NoSQL for Dummies", John Wiley & Sons, 2015.

Outcomes:
Students will be able to:

- Explore the relationship between Big Data and NoSQL databases
- Analyze the big data for useful business applications on NoSQL databases.
- Apply different data models to suit various data representation and storage needs.

BIG DATA ANALYTICS LAB (IT-513)

Objectives:

- To optimize business decisions and create competitive advantage with Big Data analytics
- To impart the architectural concepts of Hadoop and introducing map reduce paradigm
- To understand Java concepts for developing map reduce programs.
- To explore programming tools PIG & HIVE in the Hadoop ecosystem.
- To develop Big Data applications for streaming data using Apache Spark

Lab Exercises:

1. (i) Perform setting up and Installing Hadoop in its two operating modes:
    a. Pseudo distributed,
    b. Fully distributed.

   (ii) Use web-based tools to monitor your Hadoop setup.
2. (i) Implement the following file management tasks in Hadoop:
    - Adding files and directories
    - Retrieving files
    - Deleting files

   (ii) Benchmark and stress test an Apache Hadoop cluster
3. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
    - Find the number of occurrences of each word appearing in the input file(s)
    - Performing a MapReduce Job for word search count (look for specific keywords in a file)
4. Stop word elimination problem:
    - Input:
        - A large textual file containing one sentence per line o A small file containing a set of stop words (One stop word per line) □ Output:
        - A textual file containing the same sentences of the large input file without the words appearing in the small file.
5. Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented. Data available at: https://github.com/tomwhite/hadoopbook/tree/master/input/ncdc/all.
    - Find average, max and min temperature for each year in NCDC data set?
    - Filter the readings of a set based on the value of the measurement, Output the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.
6. Purchases.txt Dataset

- Instead of breaking the sales down by store, give us a sales breakdown by product category across all of our stores o What is the value of total sales for the following categories?
    - Toys
    - Consumer Electronics
- Find the monetary value for the highest individual sale for each separate store
    - o What are the values for the following stores?
        - Reno
        - Toledo
        - Chandler
- Find the total sales value across all the stores, and the total number of sales.

7. Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.
8. Write a Pig Latin scripts for finding TF-IDF value for book dataset (A corpus of eBooks available at: Project Gutenberg)
9. Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
10. Install, Deploy & configure Apache Spark Cluster. Run apache spark applications using Scala.
11. Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewed together.
    - Write a single Spark application that:
        - o Transposes the original Amazon food dataset, obtaining a PairRDD of the type: <user_id> → <list of the product_ids reviewed by user_id> o Counts the frequencies of all the pairs of products reviewed together; o Writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.
12. Create a donut chart of population data and morph this into a tree chart using Power-BI tools.

Outcomes:

- Demonstrate data summarization and query analysis.
- Apply data modeling techniques to large datasets
- Create applications for Big Data analytics
- Build a complete business data analytic solution

ARTIFICIAL INTELLIGENCE LAB (IT-515)

Objectives:

- To study and design the heuristic algorithms
- To implement heuristic algorithm on real life applications
- To apply the fuzzy logic for designing the system
- To explore neural networks and evolutionary algorithms for complex systems.

1. Sort a given set of elements using the Quick sort method and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the list to be sorted and plot a graph of the time taken versus n. The elements can be read from a ile or can be generated using the random number generator.
2. Using Open MPI, implement a parallelized Merge Sort algorithm to sort a given set of elements and determine the time required to sort the elements. Repeat the experiment for different values of

n, the number of elements in the list to be sorted and plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

3. Implement Binary tree traversal techniques using recursion and without recursion. Identify the best method, Justify your answer.
4. Print all the nodes reachable from a given starting node in a digraph using BFS method. Check whether a given graph is connected or not using the DFS method.
5. Write and implement an algorithm determining articulation points and the biconnected components in the given graph.
6. Implement an algorithm to find the minimum cost spanning tree using i) Prim's algorithm ii) Kruskal's Algorithm.
7. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.
8. Study of Prolog
9. Write simple fact for the statements using prolog
10. Write predicates one convert's centigrade temperature to Fahrenheit, other checks if a temperature is below freezing.
11. Write a program to solve 4-Queen problem.
12. Write a program to solve 8-puzzle problem.
13. Write a program to solve any problem using Breadth First Search.
14. Write a program to solve any problem Depth First Search
15. Write a program to solve Travelling salesman Problem

Outcomes:

Students will be able to:

- Implement the heuristic and meta-heuristic algorithm for multi-objective function.
- Apply fuzzy logic concepts for multistate values.
- Comprehend neural network concepts on complex systems.
- Evaluate the principle of evolutionary algorithms for real-time applications.

SEMESTER - II

MACHINE LEARNING TECHNIQUES (IT-502)

Objectives:

- To introduce the basic concepts of machine learning.
- To solve practical problems using machine learning techniques.
- To demonstrate the well-known supervised, semi-supervised and unsupervised learning algorithms

Introduction- overview of machine learning- Different forms of learning- Generative learning- Gaussian parameter estimation- maximum likelihood estimation- MAP estimation- Bayesian estimation- bias and variance of estimators- missing and noisy features- nonparametric density estimation- applications- software tools.

Classification Methods-Nearest neighbour- Decision trees- Linear Discriminant Analysis - Logistic regression-Perceptrons- large margin classification- Kernel methods- Support Vector Machines. Classification and Regression Trees.

Graphical and sequential models- Bayesian networks- conditional independence Markov random fields- inference in graphical models- Belief propagation- Markov models- Hidden Markov models- decoding states from observations- learning HMM parameters.

Clustering Methods-Partitioned based Clustering - K-means- K-medoids; Hierarchical Clustering - Agglomerative- Divisive- Distance measures; Density based Clustering DBScan; Spectral clustering.

Neural networks- the perceptron algorithm- multilayer perceptron's- back propagation non-linear regression- multiclass discrimination- training procedures- localized network structure- dimensionality reduction interpretation.

References:

1. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer, 2017.
2. E. Alpaydin, "Machine Learning", MIT Press, 3RD Edition,2014.
3. K. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2016.
4. C. Bishop, "Pattern Recognition and Machine Learning, Springer", 2006.
5. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
6. John Mueller and Luca Massaron, "Machine Learning for Dummies", John Wiley & Sons, 2016.

Outcomes:

Students will be able to:

- Formulate real-world problem using machine learning approaches.
- Implement and apply machine learning algorithms on complex dataset.
- Select appropriate algorithms for solving a particular group of real-world problems.

NATURAL LANGUAGE PROCESSING (IT-504)

Objectives:

- To introduce the language processing technologies for processing the text data.
- To understand the role of Information Retrieval and Information Extraction in Text Analytics.
- To acquire knowledge on text data analytics using language models.

Natural Language Processing – Linguistic Background -– Mathematical Foundations Morphological Analysis-Tokenization- Stemming-Lemmatization - Boundary Determination.

Reading unstructured data - Representing text data - Part of speech tagging - Syntactic representation -Text similarity - WordNet based similarity- Shallow parsing -Semantic representation.

Information retrieval and Information extraction - Named Entity Recognition - Relation Identification-Template filling.

Language model - Probabilistic Models - n-gram language models- Hidden Markov Model- Topic Modelling - Graph Models -Feature Selection and classifiers -Rule-based Classifiers - Maximum entropy classifier – Clustering-Word and Phrase-based Clustering.

Tools – Natural Language Tool kit, Apache OpenNLP. Applications of Text Analytics – Applications in Social media - Life science - Legal Text–Visualization -Case studies.

References:

1. Christopher D. Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
2. Steven Struhl, "Practical Text Analytics: Interpreting Text and Unstructured Data for Business Intelligence", Kogan Page, 2015.
3. Matthew A. Russell, "Mining the Social Web", O'Reilly Media, 3rd Edition 2018.
4. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", 1st Edition, O'Reilly Media, 2009.

Outcomes:
Students will be able to:

- Process the text data at syntactic and semantic level.
- Extract the key information from Text data.
- Analyze the text content to provide predictions related to a specific domain using language models.

SOCIAL NETWORKING AND MINING (IT-506)

Objectives:

- To understand the components of the social network.
- To model and visualize the social network.
- To determine category of users in the social network.
- To predict the interest of the user using social networking tools.

Introduction- Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

Modeling And Visualization- Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams -
Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

Mining Communities- Aggregating and reasoning with social network data- Advanced Representations - Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms Node Classification in Social Networks.

Text and Opinion Mining- Text Mining in Social Networks -Opinion extraction – Sentiment classification and clustering - Temporal sentiment analysis - Irony detection in opinion mining - Wish analysis - Product review mining – Review Classification – Tracking sentiments towards topics over time.

Tools for Social Network Analysis- UCINET – PAJEK – ETDRAW – StOCNET – Splus – R – NodeXL – SIENA and RSIENA – Real world Social Networks (Facebook- Twitter etc.)

References:

1. Charu C. Aggarwal, “Social Network Data Analytics”, Springer; 2011.
2. Peter Mika, “Social Networks and the Semantic Web”, 1st edition, Springer, 2007.
3. BorkoFurht, “Handbook of Social Network Technologies and Applications”, 1st edition, Springer, 2010.
4. GuandongXu, Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and applications”, 1st edition, Springer, 2011.
5. Giles, Mark Smith, John Yen, “Advances in Social Network Mining and Analysis”, Springer, 2010.
6. Ajith Abraham, Aboul Ella Hassanien, VáclavSná el, “Computational Social Network Analysis: Trends, Tools and Research Advances”, Springer, 2010.
7. Toby Segaran, “Programming Collective Intelligence”, O’Reilly, 2012.
8. Sule Gündüz-Ogüdücü, A. Şima Etaner-Uyar, “Social Networks: Analysis and Case Studies”, Springer, 2014.

Outcomes:
Students will be able to:

- Illustrate the internal components of the social network.
- Elaborate model and visualize the social network.
- Compute the behavior of the users in the social network.
- Predict the possible next outcome of the social network.

MACHINE LEARNING LAB (IT-512)

Objectives:

- To introduce basic machine learning techniques.
- To develop the skills in using recent machine learning software for solving practical problems in a high-performance computing environment.
- To develop the skills in applying appropriate supervised, semi-supervised or unsupervised learning algorithms for solving practical problems.

1. Exercises to solve the real-world problems using the following machine learning methods:
    - Linear Regression
    - Logistic Regression
    - Multi-Class Classification Neural Networks
    - Support Vector Machines
    - K-Means Clustering & PCA

2. Develop programs to implement Anomaly Detection & Recommendation Systems.
3. Implement GPU computing models to solving some of the problems mentioned in Problem 1.

Outcomes:
Students will be able to:

- Implement and apply machine learning algorithms to solve problems.
- Determine appropriate algorithms for solving a real-world problem.
- Employ machine learning techniques in a high-performance computing environment to solve real-world problems.

NATURAL LANGUAGE PROCESSING LAB (IT-514)

Objectives:

- To introduce basic natural language processing for processing the text data.
- To understand the role of Information Retrieval and Information Extraction in Text Analytics.
- To acquire knowledge on text data analytics using language models.

A subset of the following exercises shall be conducted:

Tokenizing Text and WordNet basics: Tokenizing text into sentences, Tokenizing sentences into words, Tokenizing sentences using regular expressions, Filtering stopwords in a tokenized sentence, Looking up synsets for a word in WordNet, Looking up lemmas and synonyms in WordNet, Calculating WordNet synset similarity Discovering word collocations.

Replacing and correcting words: Stemming words, Lemmatizing words with WordNet, Translating text with Babelfish, Replacing words matching regular expressions, Removing repeating characters, Spelling correction with Enchant, Replacing synonyms, Replacing negations with antonyms.

Creating Custom Corpora: Setting up a custom corpus, Creating a word list corpus, Creating a partof-speech tagged word corpus, Creating a chunked phrase corpus, Creating a categorized text corpus, Creating a categorized chunk corpus reader, Lazy corpus loading, Creating a custom corpus view, Creating a MongoDB backed corpus reader, Corpus editing with file locking

Parts-of -Speech Tagging: Training a unigram part-of-speech tagger, Combining taggers with backoff tagging, Training and combining Ngram taggers, Creating a model of likely word tags, Tagging with regular expressions, Affix tagging, Training a Brill tagger, Training the TnT tagger Using WordNet for tagging, Tagging proper names, Classifier based tagging.

Extracting Chunks: Chunking and chinking with regular expressions, Merging and splitting chunks with regular expressions, Expanding and removing chunks with regular expressions, Partial parsing with regular expressions, Training a tagger-based chunker, Classification-based chunking, extracting named entities, Extracting proper noun chunks, Extracting location chunks, Training a named entity chunker.

Transforming Chunks and Trees: Filtering insignificant words, Correcting verb forms, Swapping verb phrases, Swapping noun cardinals, Swapping infinitive phrases, Singularizing plural nouns, Chaining

chunk transformations, Converting a chunk tree to text, Flattening a deep tree, Creating a shallow tree, Converting tree nodes.

Parsing Specific Data: Parsing dates and times with Dateutil, Time zone lookup and conversion, Tagging temporal expressions with Timex, Extracting URLs from HTML with lxml, Cleaning and stripping HTML, Converting HTML entities with Beautiful Soup.

Outcomes:
Students will be able to:

- Implement the text data processing at syntactic and semantic level.
- Visualize the key information from Text data.
- Analyze the text content to predict related to the specific domain using language models.

DEPARTMENT ELECTIVES

ADVANCED DATA STRUCTURES AND ALGORITHMS (IT-521)

Course Outcomes: At the completion of the course, students will be able to

- Enhance their expertise in algorithmic design techniques.
- Analyze data structures and algorithms to solve engineering problems and evaluate their solutions
- Understand and apply amortized analysis on data structures, including binary search trees, merge able heaps and graphs.
- Apply algorithms in a variety of areas including string matching, and databases.

Course Contents

Elementary Data Structures and Complexity Analysis: Overview of Basic Data Structures: Arrays, Linked List, Stack, Queues. Implementation of Sparse Matrices, Algorithm Complexity: Average, Best and worst case analysis, asymptotic notations, Simple Recurrence Relations and use in algorithm analysis

Search Structures: Binary search trees, AVL trees, 2-3 trees, 2-3-4 trees, Red-black trees, Binary Heap, Binomial Heap, Fibonacci heap.

Greedy Algorithm: General Characteristics, Knapsack Problem, Huffman code, Activity selection problem, Minimum Spanning trees, Prim's algorithm, Kruskal's algorithm with Disjoint sets, Shortest paths: Dijkstra's Algorithm, Graphs Algorithms: Applications of DFS- bi-connectivity, Topology Sort, Articulation point, Connected components, Max-Flow, Min-Cut, Ford-Fulkerson
Dynamic Programming: Introduction, Principle of Optimality, Calculating Binomial Coefficient, 0-1 Knapsack, Matrix chain multiplication, Longest Common Subsequence, All Points Shortest path Floyd Warshall, Largest Divisible Subset.
Backtracking and Branch and Bound: State-Space Search Tree, eight queen's problem, Graph Colouring, Hamiltonian Cycle, Travelling Salesman Problem using Branch and Bound Approach, String Matching Algorithms, Naive string-matching algorithm, Knuth Morris-Pratt algorithm.
Introduction to NP-Completeness: P and NP, NP Complete and NP-Hard, Approximation algorithms, Travelling Salesman problem, Randomized Algorithms: Randomized Quick Sort, Computational Geometry: Convex hull, Online Algorithms: K Server Problem

Text / References:

1. E. Horowitz, S.Sahni and Dinesh Mehta, Fundamentals of Data structures in C++, Galgotia, 2006.
2. Adam Drozdex, Data Structures and algorithms in C++, Second Edition, Thomson learning – vikas publishing house, 4TH Edition 2012.
2. G. Brassard and P. Bratley, Algorithmics: Theory and Practice, Printice –Hall, 1996.
3. Thomas H.Corman, Charles E.Leiserson, Ronald L. Rivest, "Introduction to Algorithms", PHI, 3rd Edition, 2009.

DATA SCIENCE PROGRAMMING (IT-522)

Objectives:

1. To expertise in Python, which are essential for data science programming languages
2. To expose students to touch basics on cloud computing, big data, natural language processing, and data sentiment analysis.
3. To provide the fundamentals and core concepts of data science, which are essential for working in any industry.

Introduction to Data Science: The fundamentals of data science include types of datasets and standard techniques for exploring data. **Programming Language:** Python and R are essential data science programming languages. An overview of their syntax, basic commands, and how to use them in data analysis projects is included.

Query Language: Learn the basics of Structured Query Language (SQL) and how to query data from a relational database. You will also better understand other query languages, such as NoSQL and MongoDB. **Statistical Foundations for Data Science**: Explores basic concepts of statistics and probability to develop an understanding of how to apply them for data analysis projects.

Mathematics: Fundamentals of mathematics and statistics, including linear algebra, calculus, and probability. **Exploratory Data Analysis:** Fundamentals of data exploration and analysis. It covers different techniques for cleaning and preprocessing data and methods for identifying patterns and correlations in datasets.

Data Mining: Introduces the principles of data mining and covers a range of techniques used for extracting patterns from large datasets. It also focuses on developing data analysis strategies, clustering, and reducing dimensionality. **Machine Learning Techniques & AI:** Understand the fundamentals of Artificial Intelligence (AI), machine learning (ML), and deep learning (DL), and how to use them for solving real-world problems.

Data Modeling, Selection, and Evaluation: Learn to select the right data model and evaluate its performance. It includes understanding metrics such as accuracy, precision, and recall, as well as techniques for selecting the most appropriate model based on a given problem. **Data Visualization and Reporting:** Various techniques and tools can be used to visualize data effectively. You will gain insights into visualizing data using R packages, Tableau, and Power BI.

Business Intelligence tools: Different methods of collecting and managing data to gain meaningful insights. Topics include setting up a data warehouse, integrating multiple data sources, and developing reports with drill-down capabilities. **Big Data & Real-Time Analytics:** Explore tools and techniques used to process, store and analyze large amounts of data in real-time, such as Hadoop, Spark, and NoSQL databases. You will learn about distributed computing frameworks, streaming analytics platforms, and other big data technologies.

References:

1. Data Science from Scratch: First principles with Python, Joel Grus 2015.
2. Python Cookbook, Recipes for Mastering Python 3, By David Beazley, Brian K. Jones · 2013

Students will be able to:

4. Analyze large amounts of data quickly and accurately
5. Visualize patterns in data sets, and use predictive analytics to make informed decisions.
6. Determine meaningful insights and develop practical solutions to complex problems.

HIGH PERFORMANCE COMPUTING (IT-523)

Objectives:

- To learn modern high-performance processors with their strengths and weaknesses.
- To study the architecture of parallel systems for complex data.
- To gain knowledge about the analytical parallel algorithms.

HPC Building Blocks: Single Processor Performance, Memory Hierarchy, Pipelining, Multi-core, Multi-threaded, Superscalar Architectures, Vector Computers, Interconnects, Clusters, Distributed Memory Computers, Grid Computing, Cloud Computing, and Petascale Systems.
Accelerators, Parallel I/O, File Systems, and Operating Systems Perspective
Principles of Parallel Algorithms- Asymptotic Analysis of Parallel Programs, Principles of Message Passing, MPI, Shared Memory, Designing Asynchronous Programs, openMP, GPU Programming, NVidia – GPU Computing – CUDA – Case studies, MapReduce. Sequential Search Algorithms.
Parallel Algorithms: Algorithmic Primitives, Decomposition Techniques, Mapping Techniques, Load Balancing, Various Parallel Models and Algorithms. Performance Metrics for Parallel Systems, Effect of Granularity, Data Mapping, Scalability, and Time. Advanced OpenMP-Wavefront parallelization - Efficient OpenMP programming - Profiling OpenMP programs.
Power-Aware Computing: Designing of power-aware processing, memory, and interconnect. Power Management Software.
Advances: Optics in Parallel Computing, Quantum Computing, Application of Nanotechnology.
Hybrid parallelization with MPI and OpenMP- Basic MPI/OpenMP programming models - Vector mode implementation - Task mode implementation - Case study- Hybrid Jacobi solver - MPI taxonomy of thread interoperability - Hybrid decomposition and mapping Potential benefits and drawbacks of hybrid programming.

References:

1. Georg Hager and Gerhard Wellein, “Introduction to High Performance Computing for Scientists and Engineers”, Chapman & Hall, 2010.
2. Ananth Grama and George Karypis, “Introduction to parallel computing”, Addison -Wesley, 2009.
3. John Levesque and Gene Wagenbreth, “High Performance Computing: Programming and Applications”, Chapman & Hall, 2018.
4. John L. Hennessy and David Patterson, “Computer Architecture- A Quantitative Approach”, Elsevier, 6th Edition 2017.
5. Michael Quinn, “Parallel Programming in C with MPI and OpenMP”, Indian edition, McGraw Hill Education, 2017.

Outcomes:
Students will be able to:

- Investigate modern design structures of pipelined and multiprocessors systems.
- Develop algorithms using the parallel programming principle.
- Design the architecture of parallel systems.

REAL TIME SYSTEMS (IT-524)

Objectives:

- To understand the features of Real-time OS.
- To study the various Uniprocessor and Multiprocessor scheduling mechanisms.
- To learn about various real time communication protocols.
- To comprehend the difference between traditional and real-time databases.

Introduction to real time computing - Concepts; Example of real-time applications – Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics Prediction of Execution Time : Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems

Real time OS – Threads and Tasks – Structure of Microkernel – Time services – Scheduling Mechanisms Communication and Synchronization – Event Notification and Software interrupt

Task assignment and Scheduling - Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms Fault tolerant scheduling Real Time Communication -Network topologies and architecture issues – protocols – contention based, token based, polled bus, deadline based protocol, Fault tolerant routing. RTP and RTCP.

Real time Databases – Transaction priorities – Concurrency control issues – Disk scheduling algorithms – Two phase approach to improve predictability.

References:

1. C.M. Krishna, Kang G. Shin – “Real Time Systems”, International Edition, McGrawHill Companies, Inc., New York, 3rd Edition, 2010.
2. Jane W.S. Liu, “Real-Time Systems”, Pearson Education India, 2018.
3. Philip A. Laplante and Seppo J. Ovaska, “Real-Time Systems Design and Analysis: Tools for the Practitioner’’ IV Edition IEEE Press, Wiley, 2013.
4. Sanjoy Baruah, Marko Bertogna, Giorgio Buttazzo, “Multiprocessor Scheduling for Real-Time Systems”, Springer International Publishing, 2015.

Outcomes:
Students will be able to:

- Gain Knowledge about Schedulability analysis.
- Learn about the Real-time programming environments.
- Attain knowledge about real-time communication and databases.
- Develop real-time systems.

MASSIVE GRAPH ANALYSIS (IT-525)

Objectives:

•To explore the concept of Graphs and related algorithms.
•To learn new ways to model, store, retrieve and analyze graph-structured data.
• To be aware of advanced concepts in graph analytic techniques and its applications.

Introduction and Application of Large-scale Graph, Characteristics, Complex Data Sources Social Networks, Simulations, Bioinformatics; Categories- Social, Endorsement, Location, Co-Occurrence graphs; Graph Data structures, Parallel, Multicore, & Multithreaded Architectural Support for Graph Processing, Mapping Graph Algorithms to Architectures.

Basic and Advanced Large-scale Graph Analysis- Parallel Prefix & List Ranking, Link Analysis, Page Ranking Algorithms; Parallel BFS, Spanning Tree, Connected Components, Minimum Spanning Tree Matroid Algorithms, Social Networking Algorithms, Parallel Betweenness Centrality.

Dynamic Parallel Algorithms - Streaming Data Analysis -Data Structures for Streaming Data Tracking Clustering Coefficients - Tracking Connected Components -Anomaly Detection, Massive-Graphs in Computational Biology, Genome Assembly.

Distributed Computation for Massive Data Sets- Spectral, Modularity-based Clustering, Random Walks; Large Graph Representation and Implementation- V-Graph Representation, Map Reduce, Surfer, Graph Lab.

Advanced Topics- Power Law Distribution, Game-Theoretic Approach, Rank Aggregation and Voting Theory, Recommendation Systems, Social network analysis: case study -Facebook, LinkedIn, Google+, and Twitter.

References:

1. Matthew O. Jackson, “Social and Economic Networks”, Princeton University Press, 2010.
2. Stanley Wasserman, Katherine Faust, "Social Network Analysis: Methods and Applications”, (Structural Analysis in the Social Sciences), Cambridge University Press, 2005.
3. Tanja Falkowski, "Community Analysis in Dynamic Social Networks", (Dissertation), University Magdeburg, 2009.
4. Ladislav Novak, Alan Gibbons, "Hybrid Graph Theory and Network Analysis", Cambridge Tracts in Theoretical Computer Science, 2009.
5. Eric D. Ko laczyk, "Statistical Analysis of Network Data Methods and Models", Springer Series in Statistics, 2009.
6. Akihito Hora, Nobuaki Obata, “Quantum Probability and Spectral Analysis of Graphs”, Springer, 2010.
7. Richard Brath, David Jonker, “Graph Analysis and Visualization: Discovering Business Opportunity in Linked Data”, John Wiley & Sons, 2015.

Outcomes:
Students will be able to:

- Explore the graph analytic techniques and its applications.
- Model a problem into a graph database and perform analytical tasks over the graph in a scalable manner.
- Apply Graph theoretical techniques in massive networks.

DATA ACQUISITION AND PRODUCTIZATION (IT-526)

Objectives:

- To explore the fundamental concepts of data pre-processing, extraction, cleaning, annotation, integration.
- To understand the various information visualization techniques.
- To understand data productization using the Internet of things.

Data Acquisition

Introduction to Data Warehouse- OLTP and OLAP concepts- Introduction to Data Mining- Data Objects and Attribute Types-Basic Statistical Descriptions of DataExploratory Data analysis- Measuring Data Similarity and Dissimilarity- Graphical representation of data.

Introduction to Data Acquisition – Applications –Process- Data Extraction- Data Cleaning and Annotation- Data Integration -Data Reduction- Data Transformation –Data Discretization and Concept Hierarchy Generation.

Visualization-Introduction -Terminology- Basic Charts and Plots- Multivariate Data Visualization-Data Visualization Techniques– Pixel-Oriented Visualization
Techniques- Geometric Projection Visualization Techniques- Icon-Based Visualization Techniques-Hierarchical Visualization Techniques- Visualizing Complex Data and Relations- Data Visualization Tools– Rank Analysis Tools- Trend Analysis ToolsMultivariate Analysis Tools- Distribution Analysis Tools- Correlation Analysis ToolsGeographical Analysis Tools.

Data Productization

IoT Overview- IoT Design methodology- Semantic Web Infrastructure, Intelligence Applications-Programming Framework for IoT- Distributed Data Analysis for IoT- Security and Privacy in IoT- Applied IoT- Cloud Based Smart Facilities Management.

Virtualization on Embedded Boards IoT- Stream Processing in IoT-Internet of Vehicles and Applications - Case study on Data Acquisition using Dashboards, Android and iOS apps.

References:

1. Han, Jiawei, Jian Pei, and Micheline Kamber, “Data mining: concepts and techniques”, 3rd Edition, Elsevier, 2011.
2. Margaret H. Dunham, "Data Mining: Introductory and Advanced Topics", Pearson Education, 2012.
3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things -A hands-on approach”, Universities Press, 2015.
4. Manoel Carlos Ramon, “Intel Galileo and Intel Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2015.
5. Karl Pover, “Learning Qlikview Data Visualization”, Packt, 2013.
6. Rajkumar Buyya, Amir Vahid Dastjerdi, “Internet of Things: Principles and Paradigms”, Elsevier, 2016.

Outcomes:
Students will be able to:

- Apply data pre-processing, extraction, cleaning, annotation, integration on data.
- Determine the suitable visualization techniques to output analytical results.
- Explore applications using the Internet of things.

ADVANCED OPTIMIZATION TECHNIQUES (IT-527)

Course Objectives:

1. To understand the fundamental knowledge of Linear Programming and Dynamic Programming problems.
2. To evaluate classical optimization techniques and numerical methods of optimization.
3. To comprehend the basics of different evolutionary algorithms.
4. To apply different optimization techniques to solve various models arising from engineering areas.

Introduction to Linear algebra: Data preprocessing, covariance matrix and linear regression matrix.

Linear Programming: Convex sets, graphical method, simplex method, revised simplex method; Duality theory, dual simplex method; Sensitivity analysis, multi objective and goal programming; Solutions using graphical and simplex methods.

Integer Linear Programming: Cutting plane, branch and bound techniques for all integer and mixed integer programming.

Dynamic Programming: Multistage decision processes, Discrete and Continuous dynamic programming, Concepts of sub optimization, Recursive Relation-calculus method, tabular method, LP as a case of D.P.

Classical Optimization Techniques: Single variable optimization without constraints, Multi variable optimization without constraints, multivariable optimization with constraints method of Lagrange multipliers, Kuhn-Tucker conditions.

Search Techniques: Direct search and gradient methods; Unimodal functions, Fibonacci search, golden section method, Steepest descent method, NewtonRaphson Method, Hookes and Jeeves method; Conjugate gradient method.

Modern methods of optimizations and evolutionary algorithms: Differences and similarities between conventional and evolutionary algorithms, working principle, Genetic Operators- reproduction, crossover, mutation, Particle Swarm Optimization (PSO), Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems.

Applications of Optimization Algorithms: Traveling salesman Problem (TSP), 0/1 Knapsack, Single and multiobjective optimization.

Text books:

1. Engineering Optimization (4th Edition) by S.S.Rao, New Age International,2008
2. Ravindran, A., Phillips, D.T. and Solberg, J.J., Operations Research: Principles and Practice, 2nd Edition, John Wiley and Sons, 2009.
3. Mohan, C. and Deep, Kusum: Optimization Techniques, New Age 2009.

References:

1. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers
2. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers

3. Operations Research by Hillar and Liberman, TMH Publishers
4. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers

Course Outcomes:

1. Explain the fundamental knowledge of Linear Programming and Dynamic Programming problems.
2. Understand classical optimization techniques and numerical methods of optimization.
3. Describe the basics of different evolutionary algorithms.
4. Apply different techniques to solve various optimization problems arising from engineering areas.

PRINCIPLES OF DEEP LEARNING (IT-528)

Objectives:

- To acquire knowledge on the basics of neural networks.
- To implement neural networks using computational tools for a variety of problems.
- To explore various deep learning algorithms.

Basics of Deep leaning- Deep learning architectures: Convolutional Neural Networks : Neurons in Human Vision-The Shortcomings of Feature Selection-Vanilla Deep Neural
Networks Don't Scale-Filters and Feature Maps-Full Description of the Convolutional Layer-Max Pooling-Full Architectural Description of Convolution Networks-Closing the
Loop on MNIST with Convolutional Networks-Image Preprocessing Pipelines Enable More Robust Models-Accelerating Training with Batch Normalization-Building a Convolutional Network for CIFAR-10-Visualizing Learning in Convolutional NetworksLeveraging Convolutional Filters to Replicate Artistic Styles-Learning Convolutional Filters for Other Problem Domains-Training algorithms.

Memory Augmented Neural Networks : Neural Turing Machines-Attention-Based Memory Access-NTM Memory Addressing Mechanisms-Differentiable Neural Computers-Interference-Free Writing in DNCs-DNC Memory Reuse-Temporal Linking of DNC Writes-Understanding the DNC Read Head-The DNC Controller NetworkVisualizing the DNC in Action-Implementing the DNC in TensorFlow-Teaching a DNC to Read and Comprehend.

Deep Reinforcement Learning: Deep Reinforcement Learning Masters Atari GamesWhat Is Reinforcement Learning?-Markov Decision Processes (MDP)-Explore Versus Exploit-Policy versus Value Learning-Pole-Cart with Policy Gradients-Q-Learning and Deep Q-Networks-Improving and Moving Beyond DQN.

Implementing Neural Networks in TensorFlow : What Is TensorFlow?-How Does TensorFlow Compare to Alternatives?-Installing TensorFlow-Creating and Manipulating TensorFlow Variables-TensorFlow Operations-Placeholder Tensors-Sessions in TensorFlow-Navigating Variable Scopes and Sharing Variables-Managing Models over the CPU and GPU-Specifying the Logistic Regression Model in TensorFlow-Logging and Training the Logistic Regression Model-Leveraging TensorBoard to Visualize Computation Graphs and Learning-Building a Multilayer Model for MNIST in TensorFlow.

Applications: Deep learning for computer vision, Deep Learning Applications at the Enterprise Scale, Deep Learning Models for Healthcare Applications.

Reference:

1. Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly Media, 2017.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville,"Deep Learning (Adaptive Computation and Machine Learning series", MIT Press, 2017.

Outcomes:
Students will be able to:

- Develop algorithms simulating human brain.
- Implement Neural Networks in Tensor Flow for solving problems.
- Explore the essentials of Deep Learning and Deep Network architectures.
- Define, train and use a Deep Neural Network for solving real world problems that require artificial Intelligence based solutions.

IMAGE AND VIDEO ANALYTICS (IT-529)

Objectives:

- To learn the fundamentals of digital image processing, image and video analysis.
- To understand the real time use of image and video analytics.
- To demonstrate real-time image and video analytics applications and others.

Digital image representation- Visual Perception- Sampling and Quantization- Basic Relations between Pixels- Mathematical Tools Used in Digital Image Processing: Fundamental Operations –Vector and Matric Operations- Image Transforms (DFT, DCT, DWT, Hadamard).

Fundamentals of spatial filtering: spatial correlation and convolution-smoothing blurring- sharpening- edge detection - Basics of filtering in the frequency domain: smoothing-blurring- sharpening--Histograms and basic statistical models of image.

Colour models and Transformations – Image and Video segmentation-Image and video demonising- Image and Video enhancement- Image and Video compression.

Object detection and recognition in image and video-Texture models Image and Video classification models- Object tracking in Video.

Applications and Case studies- Industrial- Retail- Transportation & Travel- Remote sensing-Video Analytics in WSN: IoT Video Analytics Architectures.

References:

1. R.C. Gonzalez and R.E. Woods." Digital Image Processing". 3rd Edition. Addison Wesley, 2017.
2. W. Härdle, M. Müller, S. Sperlich, A. Werwatz, "Nonparametric and Semi parametric Models", Springer, 2004.
3. Rick Szelisk, "Computer Vision: Algorithms and Applications", Springer 2011.
4. Jean-Yves Dufour, "Intelligent Video Surveillance Systems", Wiley, 2013.
5. Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.

6. AsierPerallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola, "Intelligent Transport Systems: Technologies and Applications", Wiley, 2015.
7. Basudeb Bhatta, "Analysis of Urban Growth and Sprawl from Remote Sensing Data", Springer, 2010.

Outcomes:
Students will be able to:

- Describe the fundamental principles of image and video analysis and have an idea of their application.
- Apply image and video analysis in real-world problems.

HEALTHCARE DATA ANALYTICS (IT-530)

Objectives:

- To explore the various forms of electronic health care information.
- To learn the techniques adopted to analyse health care data. To understand the predictive models for clinical data

Introduction: Introduction to Healthcare Data Analytics- Electronic Health Records– Components of EHR- Coding Systems- Benefits of EHR- Barrier to Adopting EHRChallenges- Phenotyping Algorithms.

Analysis: Biomedical Image Analysis- Mining of Sensor Data in Healthcare- Biomedical Signal Analysis- Genomic Data Analysis for Personalized Medicine.

Analytics: Natural Language Processing and Data Mining for Clinical Text- Mining the Biomedical- Social Media Analytics for Healthcare.

Advanced Data Analytics: Advanced Data Analytics for Healthcare– Review of Clinical Prediction Models- Temporal Data Mining for Healthcare Data- Visual Analytics for Healthcare- Predictive Models for Integrating Clinical and Genomic Data- Information Retrieval for Healthcare- Privacy-Preserving Data Publishing Methods in Healthcare.

Applications: Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health- Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems- Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.

References:

1. Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2020
2. Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

Outcomes:
Students will be able to:

- Analyze health care data using appropriate analytical techniques.
- Apply analytics for decision making in health care services.

- Apply data mining to integrate health data from multiple sources and develop efficient clinical decision support systems.

LINKED OPEN DATA AND SEMANTIC WEB (IT-531)

Objectives:

- To understand the fundamentals of linked open data, its representation and applications.
- To learn the design considerations for linked data and technologies behind in publishing and consuming linked data on applications.
- To apply the fundamental concepts, advantages and limitations of the Semantic Web and its related techniques and tools.
- To evaluate the basics of ontology and use ontology engineering approaches in semantic applications.

Introduction- Introduction to Linked Data (LD) and the Semantic Web- visions and basic concepts- focusing on linked "entities" on the Web - The Rationale for Linked Data Structure Enables Sophisticated Processing - Hyperlinks Connect Distributed Data - From Data Islands to a Global Data Space - Introducing Big Lynx Productions - Principles of Linked Data - The Principles in a Nutshell - Naming Things with URIs URIs de-referencable - Providing Useful RDF Information - The RDF Data Model - RDF Serialization Formats - Including Links to other Things - Relationship Links - Identity Links - Vocabulary Links.

The Web of Data- - Bootstrapping the Web of Data - Topology of the Web of Data – Cross-Domain Data - Geographic Data - Media Data - Government Data - Libraries and Education - Life Sciences Data - Retail and Commerce - User Generated Content and Social Media- Linked Data Design Considerations- Using URIs as Names for Things Describing Things with RDF - Literal Triples and Outgoing Links - Publishing Data about Data - Choosing and Using Vocabularies - Making Links with RDF - Making Links within a Data Set - Making Links with External Data Sources - Setting RDF Links Manually Auto-generating RDF Links.

Publishing Linked Data- Linked Data Publishing Patterns - The Recipes - Serving Linked Data as Static RDF/XML Files - Serving Linked Data as RDF Embedded in HTML Files Serving RDF and HTML with Custom Server-Side Scripts - Serving Linked Data from Relational Databases - Serving Linked Data from RDF Triple Stores - Serving Linked Data by Wrapping Existing Application or Web APIs - Linked Data Publishing Checklist-
Consuming Linked Data- Deployed Linked Data Applications - Generic Applications Domain-specific Applications - Developing a Linked Data Mashup - Architecture of Linked Data Applications - Effort Distribution between Publishers- Consumers and Third Parties.

Semantic Web- Introduction to Semantic Data - Semantic modeling- Modeling for Human Communication- Explanation and Prediction- Mediating Variability- Expressivity in Modeling -RDF The basis of the Semantic Web - Semantic Web application architecture- RDF Parser/Serializer- RDF Store - Querying the Semantic Web-SPARQL SPARQL—Query Language for RDF- Advanced Features of SPARQL - RDF and inferencing.

RDFS and Ontology- RDF schema- The RDF Schema Language - RDFS-Plus - Using RDFS-Plus in the wild - SKOS—managing vocabularies with RDFS-Plus - Introduction to Ontology- OWL-Web Ontology Language- Basic OWL- Examples include BIBO- FOAFGood Relations- CIDOC-CRM- DPLA - Counting and sets in OWL - Ontologies on the Web—putting it all together - Ontology Mapping - Good and bad modeling practices Expert modeling in OWL The future of the Semantic Web.

References:

1. Tom Heath and Christian Bizer, "Linked Data: Evolving the Web into a Global Data Space - Synthesis Lectures on the Semantic Web: Theory and Technology", 1st Edition, Morgan & Claypool, 2011.
2. Dean Allemang and James Hendle, "Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL", Second Edition, Elsevier, 2011.
3. Bob DuCharme, "Learning SPARQL: Querying and Updating SPARQL 1.1", Second Edition, O'Reilly Media, 2013.
4. Grigoris Antoniou, Paul Groth, Frank van Harmelen and Rinke Hoekstra, "Semantic Web Primer, Third Edition, MIT Press, 2012.
5. Rajendra Akerkar, "Foundations of the Semantic Web", Narosa Publishing House, New Delhi and Alpha Science Intern, 2009.
6. Leslie Sikos, "Mastering Structured Data on the Semantic Web: From HTML5 Microdata to Linked Open Data" , Apress, 2015.

Outcomes:
Students will be able to:

- Describe the fundamentals of linked open data, its representation and advantages
- Explain the design considerations for linked data and technologies behind in publishing and consuming linked data on applications.
- Explore fundamental concepts, advantages and limitations of the Semantic Web and its related techniques and use various tools for constricting applications.
- Use ontology engineering approaches in developing semantic applications.

BUSINESS INTELLIGENCE (IT-532)

Course Objective:

1. To have a basic understanding of most recent advancements in Business Intelligence
2. To formulate the Business Intelligence models
3. To visualize techniques for effective application in Business intelligence.

Introduction to Business Intelligence: Business View of IT Applications, Digital Data, OLTP vs. OLAP, Why, What and How BI? BI Framework and components, BI Project Life Cycle, Business Intelligence vs. Business Analytics.

Big Data Analytics: Big Data Analytics, Framework for Big Data Analysis, Approaches for Analysis of Big Data, ETL in Big Data, Introduction to Hadoop Ecosystem, HDFS, MapReduce Programming, Understanding Text Analytics and Big Data, Predictive analysis on Big Data, Role of Data analyst.

Business implementation of Big Data: Big Data Implementation, Big Data workflow, Operational Databases, Graph Databases in a Big Data Environment, Real-Time Data Streams and Complex Event Processing, Applying Big Data in a business scenario, Security and Governance for Big Data, Big Data on Cloud, Best practices in Big Data implementation, Latest trends in Big Data, Latest trends in Big Data, Big Data Computation, More on Big Data Storage, Big Data Computational Limitations.

Recommended books:

1. Michael Minelli, Michele Chambers, Ambiga Dhiraj, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley CIO Series (2013),1st ed.

2. T. white, Hadoop: The Definitive Guide, O' Reilly Media (2012), 3rd ed.

Students will be able to:

- Translate a business challenge into an analytics challenge and deploy a structured lifecycle approach to data science and big data analytics.
- Understand the usage of Big Data in present World.
- Analyze big data, create statistical models, and identify insights that can lead to actionable results.
- Examine the visualization techniques, communicate analytic insights to business sponsors, and others.
- Distinguish a data scientist from a traditional business intelligence analyst.

FUNDAMENTALS OF BLOCKCHAIN TECHNOLOGY (IT-533)

Course Objective: This course is intended to make students:

- Study the basics of Blockchain technology.
- Understand how blockchain systems (mainly Bitcoin and Ethereum) work
- Analyze applications and legislation for blockchain
- Build and deploy smart contracts and distributed applications
- Implementing learner will have idea about private and public Blockchain, and smart contract

Introduction: Overview, Digital Age, Internet of Information, Concept of Trust, Trust protocol, blockchain technology and working principles of Blockchain transaction, Blockchain Challenges, Transactions and Blocks, P2P Systems.

Components of Blockchain: Importance of distributed consensus, Hash Puzzles, Digital Signatures, Hashing, public key cryptosystems, private vs public blockchain and use cases.

Blockchain advantage over conventional distributed databases, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Tree, Transactions and Fee, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Sybil Attack.

Blockchain design principles: Network integrity, Distributed Power, Value as Incentives, Security, Privacy, Rights Preservation, Inclusion, and Guidelines for choosing Blockchain project. Example case studies, Application areas.

Blockchain Implementation Challenges: The Technology challenges, The Energy Consumption, Governments role, Governing the Protocols, Distributed Autonomous Agents, Privacy, Malicious usage

Blockchain Transactions and consensus: The real need for mining – consensus – Byzantine Generals Problem, and Consensus as a distributed coordination problem, Consensus algorithms, RAFT, Paxos, Byzantine fault Tolerance, PBFT, Consensus in Bitcoin, Bitcoin block structure, block creation and storage, and Bitcoin wallets, Proof of Work, Proof of Stake, Proof of Burn.

Introduction to Bitcoin Blockchain: Introduction to digital currency, Crypto currency, Explanation of Bitcoin with concepts of blockchain, Cryptographic methods in Bitcoin, Hashing in Bitcoin, Overview of Hash puzzle in Bitcoin, Consensus in Bitcoin, Bitcoin block structure, block creation and storage, and Bitcoin wallets.

Introduction to Smart Contracts: advantage of smart contracts, Introduction to REMIX IDE, Introduction to Solidity smart contracts, Solidity structure and language syntax, Deploying and interacting with smart contracts via Remix IDE.

Course Outcomes:

After the completion of this course, student will be able to

- Understand and explore the working of Blockchain technology
- Analyze the working of Smart Contracts
- Apply the learning of solidity and de-centralized apps on Ethereum.
- Evaluate security, privacy, and efficiency of a given blockchain system.

References:

1. S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, 'Blockchain Technology: Cryptocurrency and Applications', Oxford University Press, 2019.
2. Josh Thompson, 'Blockchain: The Blockchain for Beginners, Guide to Blockchain Technology and Leveraging Blockchain Programming', Create Space Independent Publishing Platform, 2017.
3. Nansi Shi, Architectures and Frameworks for Developing and Applying Blockchain Technology, IGI Global 2019.
4. S. Asharaf, S. Adarsh, Decentralized Computing Using Blockchain Technologies and Smart Contracts: Emerging Research and Opportunities, IGI Global 2017.

WEB INTELLIGENCE (IT-534)

Objectives:

- To know the importance of qualitative data, get insights and techniques.
- To develop customer-centric approach in dealing with data.
- To understand the principles, tools and methods of web intelligence.
- To apply analytics for business situations.

Web Analytics – Basics – Traditional Ways – Expectations – Data Collection – Clickstream Data –Weblogs – Beacons – JavaScript Tags – Packet Sniffing – Outcomes data – Competitive data – Search Engine Data.

Qualitative Analysis – Customer Centricity – Site Visits – Surveys – Questionnaires – Website Surveys – Post visits – Creating and Running- Benefits of surveys – Critical components of successful strategy.

Web Analytic concepts – URLS – Cookies – Time on site – Page views – Understand standard reports – Website content quality – Navigation reports (top pages, top destinations, site overlay). – Search Analytics – Internal search, SEO and PPC – Measuring Email and Multichannel Marketing - Competitive intelligence and Web 2.0 Analytics – Segmentation – Connectable reports.

Google Analytics: Analytics - Cookies - Accounts vs Property - Tracking Code Tracking Unique Visitors - Demographics - Page Views & Bounce Rate Acquisitions Custom Reporting.

Goals & Funnels – Filters - Ecommerce Tracking - Real Time Reports - Customer Data Alert - Adwords Linking – A dsense Linking -Attribution Modeling - Segmentation Campaign Tracking - Multi-Channel Attribution.

References:

1. Avinash Kaushik, "Web Analytics 2.0: The Art of Online Accountability and Science Of Customer Centricity ", 1st edition, Sybex, 2009.
2. Michael Beasley, "Practical Web Analytics for User Experience: How Analytics can help you Understand your Users", Morgan Kaufmann, 2013.
3. Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, eds., "Game Analytics: Maximizing the Value of Player Data", Springer, 2016.
4. Bing Liu, "Web Data Mining: Exploring Hyperlinks, Content, and Usage Data", 2nd Edition, Springer, 2011.
5. Justin Cutroni, "Google Analytics", O'Reilly, 2010.
6. Eric Fettman, Shiraz Asif, Feras Alhlou , "Google Analytics Breakthrough", John Wiley & sons, 2016.

Outcomes:
Students will be able to:

- Know the concepts and terminologies related to web analytics.
- Explore various parameters used for web analytics and their impact.
- Explore the use of tools and techniques of web analytics.
- Get experience on websites, web data insights and conversions.

INTRODUCTION TO INTERNET OF THINGS (IT-535)

Objectives:

- To understand the fundamentals of the Internet of Things.
- To provide knowledge about IoT devices, applications and examples.
- To acquire skills to program the embedded devices and connect them to the web and cloud.

Internet of things: Overview, technology of the internet of things, enchanted objects, Design principles for connected devices, Privacy, Web thinking for connected devices

Writing Code: building a program and deploying to a device, writing to Actuators, Blinking Led, Reading from Sensors, Light Switch, Voltage Reader, Device as HTTP Client, HTTP, Push Versus Pull Pachube, Netduino, Sending HTTP Requests—the Simple Way, Sending HTTP Requests—the Efficient Way
HTTP: Device as HTTP Server, Relaying Messages to and from the Netduino, Request Handlers, Web Html, Handling Sensor Requests, Handling Actuator Requests
Going Parallel: Multithreading, Parallel Blinker, prototyping online components, using an API, from prototypes to reality, business models, ethics, privacy, disrupting control, crowdsourcing.
Advancement in IoT: SDN for IoT (contd), Data Handling and Analytics, Cloud Computing, Sensor-Cloud Fog Computing, Edge Computing, Connected Vehicles, Smart Grid, Industrial IoT.
Case Study: The Case Study of a Smart Home, Smart city, Smart Transportation System, Agriculture, Healthcare.
References:

1. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley & Sons, 2013.
2. Cuno Pfister, “Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud”, Maker Media, 2011.
3. Rob Barton, Gonzalo Salgueiro, David Hanes, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, 2017.
4. Radomir Mihajlovic, Muthu Ramachandran, Reinhold Behringer, Petar Kocovic “Emerging Trends and Applications of the Internet of Things”, IGI Global, 2017.
5. Hwaiyu Geng, “Internet of Things and Data Analytics Handbook”, John Wiley & Sons, 2017.
6. Marco Schwartz, “Internet of Things with Arduino Cookbook”, Packt Publishing, 2016.

Outcomes:

Students will be able to:

- Devise the program for embedded devices.
- Demonstrate the program for actuators and sensors.
- Build client programs that push sensor readings from a device to a web service.

CRYPTOGRAPHY AND DATA SECURITY (IT-536)

Objectives:

- Introduces basic concepts in cryptography and computer security and discusses both their theoretical foundations and practical applications
- Address Various threats, attacks and countermeasures including cryptosystems, cryptographic protocols and secure systems/networks
- Brief history of cryptography, encryption (conventional and public key), digital signatures, hash functions, message authentication codes, randomness, unconditional and computational security, zero-knowledge protocols, secure e-commerce, group communication security, anonymity, key escrow. A few popular security mechanisms (e.g., Secure IP, SSL, PGP)

History of Cryptography and Simple Encryption Methods: Historical Ciphers, Crypto Terminology, Symmetric/Convential vs. Asymmetric/Public Key Cryptography **Encryption:** Symmetric/Convential vs. Asymmetric/Public Key Cryptography, Block Ciphers, Data Encryption Standard (DES), Block Cipher Modes, Other Symmetric Ciphers, Advcaned Encryption Standard (AES), One Time Padding

Cryptographic Hash Functions: Cryptographic Properties, Simple Hash Functions, MD5, SHA, HMAC **Math Review:** Groups, Rings, Fields, Euclidean Algorithm, Chinese Remainder Theorem **Public Key Cryptography, Encryption and Signatures:** Diffie Hellman Key Exchange, RSA Encryption, Square-and-Multiply, El Gamal Encryption, Digital Signatures (RSA and El Gamal), Digital Signature Standard (DSS), Identification (Fiat-Shamir), Zero-Knowledge Cave

Authentication and Key Distribution: Definitions, Types of Authentication, Biometrics, Authentication elements (nonces, timestamps, sequence numbers), Key Distribution Center (KDC), Certification Authorities (CA) **Protocols:** Needham-Schroeder Protocol (and Attacks), Station-to-Station Protocol, X.509 Auth and Key Distribution, **Public Key Distribution – Certification:** Merkle's Puzzles, Public Key Distribution, Certificates, X.500, LDAP, **Transport Layer Secruity:** Transport Layer Security/Secure Session Layer (TLS/SSL)

Public Key Certification and Revocation: Certification Trees, Hierarchical PKI, Certificate Paths, X.509 Standard
Implicit/Explicit Revocation, Certificate Revocation Lists, Certificate Revocation Tree, Merkle Hash Trees, Online Certificate Status (OCSP), Certificate Revokation System (CRS), One-way Hash Chains

Access Control: Access Control Matrix, Capabilities, Access Control Lists, Role-based Access Control (RBAC). **Privacy and Anonymity, and Anonymity Application Example: E-Cash:** Definitions, Applications, Types of Attacks, Chaum's Mix, Mix Casdade, Onion Routing, Tor, Hidden Servers, Dining Cryptographers, Minting, Counterfeiting, Double-Spending

References:

1. Cryptography and Information Security 2015 by V.K. Pachghare
2. "Handbook of Applied Cryptography" by Alfred J Menezes and Scott A Vanstone

ADVANCED DATA ANALYTICS (IT-537)

Objectives:

1. To identify, analyze, and solve Business Analytics problems by applying knowledge of mathematics, science, and engineering with modern engineering tools.
2. To provide conceptual knowledge in the Business Analytics domain;
3. To comprehend students with advanced tools used in industry;
4. To develop teamwork experience of professional skills for IT Industry

Introduction: Probability and statistics, Machine Learning, Frequents and Bayesian Probability, Probability Distributions, Information Theory, Time series analysis, Spatial time series analysis, Business analytics and optimization.

Graphical models: directed and undirected graphical models, Constraint - based and score -based algorithms, structure learning algorithm, Inference and learning, Parallel programming environment, Graph structure learning, Graph mining,

Model development & techniques: Data Partitioning, Model selection, Model Development Techniques, Neural networks, Decision trees, Logistic regression, Discriminant analysis, Support vector machine, Bayesian Networks, Linear Regression, Cox Regression, Association rules.

Analytics for Big Data at Rest & in Motion: Data Stream overview; Streams Processing Language Basics; Streams Processing Language Development; SPL Programming Introduction; Relational and Utility Operators, Windowing and Joins; Aggregation and Sorting; Timing and Coordination; Lists, Sets, and Maps; Nodes and Partitions; Debugging; Adapters and Toolkits

Massive Data Analytics: Data Understanding and Preparation; Parallel algorithms, Online learning algorithms, locality sensitive hashing.

References:

1. Text Book - Predictive & Advanced Analytics (IBM ICE Publication)

2. Probability and Statistics: Pearson New International Edition, Morris H. DeGroot, Mark J. Schervish Pearson Education, 29-Aug-2013.

Students will be able to:

- Gain relevant theoretical and practical, knowledge to understand Business Analytics solutions and highlight key capabilities of Big data & Business Analytics
- Understand the core technical concepts related to Business Intelligence, Big Data Analytics along with Hadoop Architecture and many more
- Use cutting edge Analytical Tools to Find, Interpret, Analyze Business Data
- Know about aligning Technology to the need of Business and interpreting outcome

OTHER DEPARTMENT ELECTIVES

CUSTOMER RELATIONSHIP AND MANAGEMENT (IT-538)

Objective:

- To train the participants in the concepts of customer relationship management with industry case studies and strategies for implementing them in any organization.
- To better understand customer needs and to maintain long-term customer relationships.
- Be able to pursue a strategy of Relationship Marketing.

Introduction to Customer Relationship Management: Concept- Evolution of Customer Relationships: Customers as strangers- acquaintances- friends and partners.

Objectives- Benefits of CRM to Customers and Organizations- Customer Profitability Segments- Components of CRM: Information- Process- Technology and PeopleBarriers to CRM. Relationship Marketing and CRM: Relationship Development Strategies: Organizational Pervasive Approach- Managing Customer Emotions- Brand Building through Relationship Marketing- Service Level Agreements- Relationship Challenges.

CRM Marketing Initiatives- Customer Service and Data Management :CRM Marketing Initiatives: Cross-Selling and Up-Selling- Customer Retention- Behaviour PredictionCustomer Profitability and Value Modeling- Channel Optimization- Personalization and Event-Based Marketing. CRM and Customer Service: Call Center and Customer Care: Call Routing- Contact Center Sales-Support- Web Based Self Service- Customer Satisfaction Measurement- Call-Scripting- Cyber Agents and Workforce Management. CRM and Data Management:

Types of Data: Reference Data- Transactional DataWarehouse Data and Business View Data- Identifying Data Quality Issues- Planning and Getting Information Quality- Using Tools to Manage Data- Types of Data Analysis: Online Analytical Processing (OLAP) - Clickstream Analysis- Personalization and Collaborative Filtering- Data Reporting.

CRM Strategy- Planning: Understanding Customers: Customer Value- Customer CareCompany Profit Chain: Satisfaction- Loyalty- Retention and Profits. Objectives of CRM Strategy- The CRM Strategy Cycle: Acquisition- Retention and Win Back- Complexities of CRM Strategy.

CRM Implementation and Evaluation: Planning and Implementation of CRM: Business to Business CRM- Sales and CRM- Sales Force Automation- Sales Process/ Activity Management- Sales Territory Management- Contact Management- Lead ManagementConfiguration Support- Knowledge Management CRM Implementation: Steps- Business Planning- Architecture and Design- Technology Selection- Development- Delivery and Measurement.

CRM Evaluation: Basic Measures: Service Quality- Customer Satisfaction and LoyaltyCompany 3E Measures: Efficiency- Effectiveness and Employee Change.

CRM New Horizons: e-CRM: Concept- Different Levels of E- CRM- Privacy in E-CRM Software App for Customer Service:# Activity Management- Agent Management- Case
Assignment- Contract Management- Customer Self Service- Email Response Management- Escalation- Inbound Communication Management- Invoicing- Outbound Communication Management- Queuing and Routing- Scheduling - Social Networking and CRM - Mobile-CRM - CRM Trends- Challenges and

Opportunities - Ethical Issues in CRM.

References:

1. Anderrson Kristin and Carol Kerr,"Customer Relationship Management", Tata McGraw-Hill, 2002.
2. Ed Peelen, "Customer Relationship Management", Prentice Hall, 2005.
3. Bhasin Jaspreet Kaur, "Customer Relationship Management", Dreamtech Press, 2012
4. Valarie A Zeithmal, Mary Jo Bitner, Dwayne D Gremler and Ajay Pandit, "Services Marketing Integrating Customer Focus Across the Firm", Tata McGraw Hill, 2010.
5. Urvashi Makkar and Harinder Kumar Makkar, "CRM Customer Relationship Management", McGraw Hill Education, 2013.

Outcomes:
Students will be able to:

- Explore the concepts of customer relationship management with industry case studies.
- Develop metrics for customer retention.
- Apply data mining concepts to implement CRM in real world applications.
- Devise strategies to implement CRM in any organization.

FINANCIAL RISK ANALYTICS AND MANAGEMENT (IT-539)

Objectives:

- To identify the different risks involved in the Finance arena.
- To understand and solve the different risks pertaining to the stock market and its instruments.
- To analyze the legal issues affecting the business.

Introduction to Risk -Understanding Risk- Nature of Risk, Source of Risk, Need for risk management, Benefits of Risk Management, Risk Management approaches. Risk
Classification- credit risk, market risk, operational risk and other risk

Risk Measurements -Measurement of Risk – credit risk measurement, market risk measurement, interest rate risk measurement, Asset liability management, measurement of operational risk

Risk Management- Risk management- Managing credit risk, managing operational risk, managing market risk, insurance

Risk in Instruments -Tools for risk management – Derivatives, combinations of derivative instruments, Neutral and volatile strategies, credit derivatives, credit ratings, swaps

Regulation and Other Issues: Other issues in risk management – Regulatory framework, Basel committee, legal issues, accounting issues, tax issues, MIS and reporting, integrated risk management

References:

1. Dun, Bradstreet, "Financial Risk Management", TMH, 2007.
2. John C Hull, "Risk management and Financial Institutions", Pearson, 2015.
3. Aswath Damodharan, "Strategic Risk Taking", Pearson, 2008.

Outcomes:

Students will be able to:

- Identify and categorize the various risks faced by an organization.
- Explore the tools and practices needed to assess and evaluate financial risks.
- Determine risk management practices in an industry.
- Solve legal issues that impact financial and other risks affecting business.

SUPPLY CHAIN MANAGEMENT (IT-540)

Objectives

1. To Provide a congenial learning and training careers in Logistics and Supply Chain Management.
2. To Enhance knowledge through innovative teaching and research, relevant to Logistics and Supply Chain Management.
3. To Analyze and organize Global Network Logistics for trade and transport systems, sourcing and procurement and Supply chain management.
4. To elaborate solid arguments to convince and motivate decision makers
5. To Apply the latest developments in information technology to Logistics and supply chain management

Introduction to Supply Chain: Objectives of supply chain, stages of supply chain, supply chain process cycles, customer order cycle, replenishment cycle, manufacturing cycle, procurement cycle, push/pull view of supply chain processes, importance of supply chain flows, and examples of supply chain.
Objectives of Procurement System, Principles of Procurement, History of procurement function: from administrative to strategic, value added role, Supplier appraisal/vendor capability, Bidding process.
Supply Chain Performance: supply chain strategies, achieving strategic fit, product life cycle, the minimize local cost view, the minimize functional cost view, the maximize company profit view, the maximize supply chain surplus view.
Supply Chain Drivers and Obstacles: Four drivers of supply chain – inventory, transportation, facilities, and information, a framework for structuring drivers, role of each driver in supply chain, obstacles to achieve strategic fit.
Information Technology in Supply chain: Enabling supply chain through IT, ERP vendor platform, service oriented architecture (SOA), RFID.
Introduction to Warehousing Concepts: Role of warehouse-types of warehouse- warehouse location- Need for warehousing- Supply chain trends affecting warehouse –Warehouse functions- Role of warehouse manager-Warehouse process: e-commerce warehouse- Receiving and put away- Warehouse process – pick up preparation-Receiving - Pre-receipt In- handling - Preparation - offloading - Checking - Cross-docking - Quality control - Put-away - Pick preparation - Pick area layout – Picking strategies and equipment -order picking methods - Warehouse processes Replenishment to dispatch- Value adding services - Indirect activities Stock management - Stock or Inventory counting - Perpetual inventory counts - Security - Returns processing – Dispatch.

References:

1. Hugos, Michael H. Essentials of supply chain management. John Wiley & Sons, 2018.

2. Hofmann, Erik. "Supply Chain Management: Strategy, Planning and Operation, S. Chopra, P. Meindl." (2013): 212-213.
3. Vandeput, Nicolas. Inventory optimization: Models and simulations. Walter de Gruyter GmbH & Co KG, 2020.
4. Silver, Edward A., David F. Pyke, and Douglas J. Thomas. Inventory and production management in supply chains. CRC Press, 2016.

Outcomes:

1. Recognize the principles of warehouse or stores location and layout whilst applying proper stock flow, rotation and recording
2. Appreciate the role of procurement plays in an organization

M. TECH. DISSERTATION –Phase I (IT-601)

Dissertation work of 6 Months duration to be extended in phase II.

M. TECH. SEMINAR (IT-603)

The seminar will be conducted in the third semester, where students will choose the topic from any thrust area of Information Technology and present the idea.

M. TECH. DISSERTATION –Phase II (IT-602)

Dissertation work of 6 Months duration with submission of thesis and viva voce examination