CENTRAL UNIVERSITY OF ANDHRA PRADESH
ANANTHAPURAMU

Vidya Dadati Vinayam
(Education Gives Humility)

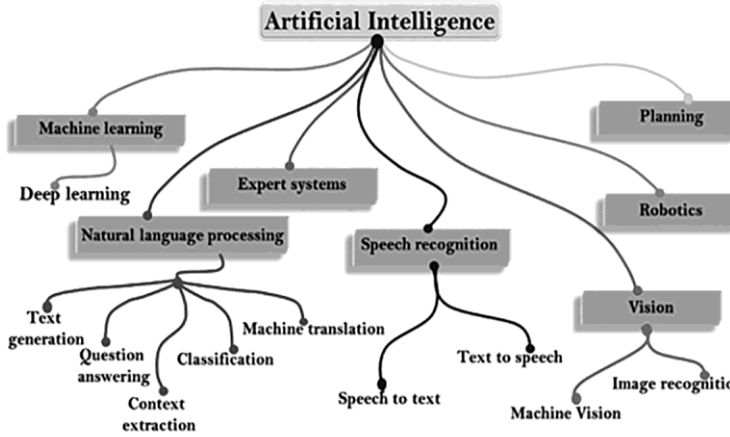
M.Sc.
Artificial Intelligence and Data Science

"Today's AI is about new ways of connecting people to computers, people to knowledge, people to the physical world, and people to people."

- Patrick Winston

Structure and Syllabus
(2023-2024 Batch)

CONTENTS



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CENTRAL UNIVERSITY OF ANDHRA PRADESH

M.Sc. Artificial Intelligence and Data Science

Important Information to Students

I. Programme: M. Sc. in Artificial Intelligence and Data Science.

II. Eligibility: Bachelor's Degree with at least 50% marks or Equivalent Grade in B.E. / B.TECH. in Computer Engineering or Computer Science Engineering or Information Technology or Information & Communication Technology or Electronics Engineering or Electronics & Communication Engineering or Electrical Engineering or Instrumentation or equivalent Qualification or Bachelor of Computer Application (BCA) or B.Sc. in Computer Science or Information Technology or equivalent in the relevant field as recognized by the University.

III. The minimum duration for completion of any PG Programme is four semesters (two academic years) and the maximum duration is eight semesters (four academic years) or as per amendments made by the regulatory bodies from time to time.

IV. A student should attend at least 75% of the classes, seminars, practicals/ lab in each course of study.

V. All theory courses in the programme carry a Continuous Internal Assessment (CIA) component to a maximum of 40 marks and End Semester Examination (ESE) for a maximum of 60 marks. The minimum pass marks for a course is 40%.

All lab components carry a Continuous Internal Assessment (CIA) component to a maximum of 60 marks and End Semester Practical Examination (ESE) for maximum of 40 marks. The minimum pass marks for a course in 40%

VI. A student should pass separately in both CIA and the ESE, i.e., a student should secure 16 (40% of 40) out of 40 marks for theory and 24 (40% of 60) out of 60 marks for lab components in the CIA. Therefore, a student should secure 24 (40% of 60) out of 60 marks for theory and 16 (40% of 40) out of 40 marks for lab components in the end semester examination (ESE).

VII. A student failing to secure the minimum pass marks in the CIA is not allowed to take the end semester examination of that course. She/he has toredo the course by attending special classes for that course and get the pass percentage in the internal tests to become eligible to take the end semester examination.

VIII. Students failing a course due to lack of attendance should redo the course.

IX. Re-evaluation is applicable only for theory papers and shall not be entertained for other components such as practical/ thesis/ dissertation/ internship etc.

X. An on- campus elective course is offered only if a minimum of ten or 40% of the students registered, whichever is higher, exercise their option for that course.

Introduction to the Programme

Introduction:

M.Sc. Artificial Intelligence and Data Science is one of the new postgraduate programmes being offered by CUAP from 2023-24 academic year. Artificial Intelligence (AI) and Data Science are very close and fastest growing fields in contemporary scenario. AI is a branch of computer science that aims to create intelligence showcased by machines (computers and automation systems) in distinction to the natural intelligence of humans. The major goals of AI and Data Science are to attain success in knowledge reasoning, planning, machine learning, natural language processing, computer vision, data analytics and data engineering.

With a vision to impart knowledge of Artificial Intelligence and Data Science, the program focuses on training students to become analytical experts and critical thinkers in research and industry. The course is designed to encourage students to reason with data and build models which can predict future outcomes.

In this program, we aim to prepare students to work in various fields ranging from Artificial Intelligence, Data Science, Data Engineering and Data Analytics.

Programme Objectives:

- To impart knowledge of both fundamental and technical skills on various aspects of Artificial Intelligence and Data Science.
- To expose students to the developments in the area of Data Visualization, Data Cleaning, Machine Learning Models, Artificial Intelligence and their utilization in industry and research.
- To expose to techniques and developments in various domains where AI can be applied.

A Student completing this programme will be capable of taking a career path in the domain of Artificial Intelligence and Data Science.

Programme Outcomes:

On successful completion of the programme student should be able to:

- Understand the fundamentals of Artificial Intelligence, Machine Learning, Inference Engines, Speech, Vision, Natural Language Understanding, Robotics, and Human Computer Interaction.
- Unify the knowledge of Human Cognition, AI, Machine Learning and Data Engineering for designing systems.
- Apply ideas and intuition behind modern machine learning methods as well as a more formal understanding of how, why, and when they work.
- Develop real-time and robust AI-based systems with specific software, hardware and data requirements.
- Upgrade knowledge and undertake further study and research in Artificial Intelligence according to the need of society.

CENTRAL UNIVERSITY OF ANDHRA PRADESH

M.Sc. Artificial Intelligence and Data Science
Semester and Course wise Credits

Semester	Discipline Specific Core (DSC) (L+T+P)	Discipline Elective (DSE) / Elective (EL)	Project Work / Dissertation	Lab	Total Credits
I	DSC 1 (4) DSC 2 (4) DSC 3 (4) DSC 4 (4)	EL1 by MOOC (2) EL-2 (4)	-	System Building Lab- I (3) (DSC 2+ DSC 3+ DSC 4)	25
II	DSC 5 (4) DSC 6 (4) DSC 7 (4) DSC 8 (4)	EL-3 by MOOC (2) EL-4 (4)	-	System Building Lab- II (3) (DSC 5 + DSC 6+ DSC 8)	25
III	DSC 9 (4) DSC 10 (4) DSC 11 (4)	EL-5 by MOOC (2) EL-6 (4)	-	System Building Lab- III (2) (DSC 9 + DSC 10)	20
IV	-	-	Project Work/ Dissertation (12)	-	12
Total	44	18	12	8	82
Percentage	53.65	21.95	14.63	9.75	-

CENTRAL UNIVERSITY OF ANDHRA PRADESH

M. Sc. Artificial Intelligence and Data Science

Programme Structure

S. No	Course Code	Title of the Course	Credits	Contact Hours		
				L	T/L	P/S
Semester – I						
1.	MAI101	Mathematics for Data Science	4	40	10	10
2.	MAI102	Introduction to Artificial Intelligence	4	40	10	10
3.	MAI103	Advanced Data Structures and Algorithms	4	40	10	10
4.	MAI104	Fundamentals of Data Science with Python Programming	4	40	10	10
5.	MAI105	MOOC / Online/ Elective – **I**	2	-	-	-
	Any one of the following electives (Elective-II):		4	40	10	10
6.	MAI115	Computer Networks				
	MAI116	Recommender Systems				
	MAI117	Operating Systems				
	MAI118	Cyber Security				
7.	MAI125	System Building Labs -I: (Based on MAI 102,103,104 carrying 1 credit for each)	3	-	90	-
Total			**25**	**200**	**140**	**50**
S. No	**Course Code**	**Title of the Course**	**Credits**	**Contact Hours**		
				L	**T/L**	**P/S**
Semester – II						
1.	MAI201	Artificial Neural Networks	4	40	10	10
2.	MAI202	Big Data Analytics	4	40	10	10
3.	MAI203	Natural Language Processing	4	40	10	10
4.	MAI204	Machine Learning	4	40	10	10
5.	MAI205	MOOC / Online/ Elective **III**	2	-	-	-
	Any one of the following electives: (**Elective-IV)**		4	40	10	10
6.	MAI215	Blockchain & Cryptocurrency Fundamentals				

	MAI216	Computer Architecture				
	MAI217	Data Preprocessing				
	MAI218	Digital Forensics				
7.	MAI225	System Building Labs -II (Based on MAI 201,202,204 carrying 1 credit for each)	3	-	90	-
Total			**25**	**200**	**140**	**50**

S. No	Course Code	Title of the Course	Credits	Contact Hours		
				L	T/L	P/S
Semester – III						
1.	MAI301	Introduction to Deep Learning	4	40	10	10
2.	MAI302	Scalable Systems for Data Science	4	40	10	10
3.	MAI303	Data Mining & Data Warehousing	4	40	10	10
4.	MAI304	MOOC / Online/ Elective –**V**	2	-	-	-
	Any one of the following electives: **Elective- VI**		4	40	10	10
5.	MAI315	Research Methodology & IPR				
	MAI316	Health Care Data Analytics				
	MAI317	Theory of Computation				
	MAI318	Digital Image Processing				
6.	MAI325	System Building Labs-III (Based on MAI 301,302 carrying 1 credit for each)	2	-	60	-
Total			**20**	**160**	**100**	**40**
Semester – IV						
1.	MAI401	Dissertation	12	0	0	0
Total			**12**	**0**	**0**	**0**

L – Lectures **T/L – Tutorials/Lab** **S/P– Seminar/Presentation**

Note 1: Project Dissertation Phase-I shall be identified and students have to Compulsorily make a presentation at the end of III Semester.

Note 2: One more MOOC course can be done by student to score additional credits. Any course that taken by student can be approved by the competent authority of the University.

Credit Distribution

Semester	Total Credits	Cumulative Credit at the end of the Semester
Semester-I	25	25
Semester-II	25	50
Semester-III	20	70
Semester-IV	12	82

Assessment Pattern: 40% of internal [formative evaluation – two best out of three tests (for a maximum of 15 marks each = 30 marks) and seminar/ assignments/attendance (10 marks)] and 60% (summative evaluation – end of the semester examination)

End Semester Examination

Maximum Marks: 60 Time: 3 Hours

Dissertation / Project Report:

Dissertation Evaluation - 60 Marks

Seminar and Viva-Voce- 40 Marks

SEMESTER-WISE DETAILED SYLLABUS

SEMESTER-I

Course Code : **MAI101** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Mathematics for Data Science**

Course Objectives:

- To enable the understanding of the mathematical and logical basis to many modern techniques in the technology like Data Science, Artificial Intelligence, Machine Learning and Programming Language Design etc.
- To understand important characteristics of Matrices, Eigen values, Eigen vectors and vector spaces etc.
- To learn how to analyze and solve a linear system of equations.

Learning Outcomes:

After completion of the course student will be able to:

- Understand the basic concepts of sets, vector space, subspace, basis and dimension
- Check linear dependency of vectors and identify Eigen values and Eigen vectors derivative of matrix, which will form the basis for Principal Component Analysis.

Course Outline:

Unit-I

Set Theory: Binary Operations, Functions and Relations, Recurrence relations and Generating Functions, Permutations and Combinations: Pigeon Hole Principle, Probability Theory, Prepositional calculus, Tautology & Contradiction, Boolean Algebra.

Unit-II

Differentiation: Logarithmic differentiation, Partial differentiation, Euler's Theorem for Homogenous Functions, Maxima and Minima. Integration: Double Integration, Range of Order of Integration, Find Ideas; Vectors: dot product, cross product, Divergence and convergence of a vector.

Unit-III

Matrices & Determinants: Matrix, Def., types, Addition, Subtraction, Multiplication of Matrices, Singular and Non-Singular Matrices, Rank of a Matrix, Solution of Simultaneous Equations, Cayle Hamilton Theorem, Eigen Values & Eigen Vectors.

Unit-IV

Matrix Algebra and Linear Algebra**:** Introduction of groups, rings and Vector Spaces. Linear Independence and Dependence of Vectors, Linear Combination. Basis and Dimension of Vector space.

References:

Seymour Lipschutz, Marc Lipson, "*Linear Algebra*", 6th Edition, Schaum Series, 2018.

Seymour Lipschutz, Marc Lipson, H. Patil, "*Discrete Mathematics*", 3rd Edition, Schaum Series, 2017.

Elliott Mendelson, Frank Ayres, "*Calculus*", 6th Edition, Schaum Series, 2012.

Philip N. Klein, "*Coding the Matrix: Linear Algebra Through Applications to Computer Science*", Newtonian Press, 2013.

Sheldon Axler, "*Linear Algebra Done Right*", 3rd Edition, Springer, 2015.

Course Code : **MAI102** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Introduction to Artificial Intelligence**

Course Objectives:

- To learn the differences between optimal reasoning vs human like reasoning.
- To understand basic principles of AI towards problem solving, inference perception, knowledge representation and learning.
- To understand the notions of state space representation, heuristic search, time and space complexities.
- To understand the applications of AI namely Intelligent Agents, Game Play, Expert Systems, Machine Learning and NLP.

Learning Outcomes:

After completion of the course student will be able to:

- Able to demonstrate knowledge of building blocks of AI as presented in terms of Intelligent Agents.
- Attain the capability to represent various real-life problem domains using logic-based techniques and use this to perform inference and planning.

Course Outline:

Unit-I

Introduction: What is AI? Foundations of AI, History of AI, Agents and environments, the nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies

Unit -II

Knowledge and Reasoning: Knowledge-based Agents, Representation, Reasoning and Logic, Prepositional logic, First-order logic, Using First-order logic, Inference in First-order logic, forward and Backward Chaining

Unit - III

Learning: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Why Learning Works, Learning in Neural and Belief networks.

Unit -IV

Practical Natural Language Processing: Practical applications, Efficient parsing, scaling up the lexicon, Scaling up the Grammar, Ambiguity, Perception, Image formation, Image processing operations for Early vision, Speech recognition and Speech Synthesis

References:

Stuart Russell, Peter Norvig, "*Artificial Intelligence: A Modern Approach*", 2nd Edition, Pearson Education, 2007.

B. Yagna Narayana, "*Artificial Neural Networks*", PHI, 2005.

E. Rich and K. Knight, "*Artificial Intelligence*", 3rd Edition, TMH, 2017.

Dan W. Patterson, "*Artificial Intelligence and Expert Systems*", PHI, 2015.

Giarrantana, Riley, "*Expert Systems: Principles and Programming*", 4th Edition, Course Technology Inc, 2004.

Ivan Bratka, "*PROLOG Programming for Artificial Intelligence*", Pearson Education, 3rd Edition, 2012.

Course Code : **MAI103** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Advanced Data Structures &Algorithms**

Course Objectives:

- To provide an overview of Data Structures and Algorithms commonly used in Computer Science.
- To solve complex problems by applying appropriate Data Structures and Algorithms.
- To critically analyze the complexity of various algorithms and to select appropriate design strategy to solve real world problems.

Learning Outcomes:

After completion of the course student will be able to:

- Identify and apply appropriate data structures to solve problems and improve their efficiency.
- Analyze and understand the complexity of data structures and associated methods.

Course Outline:

Unit – I

Linear Data Structures: Introduction - Abstract Data Types (ADT) – Stack – Queue – Circular Queue - Double Ended Queue - Applications of stack – Evaluating Arithmetic Expressions - Other Applications - Applications of Queue - Linked Lists - Singly Linked List - Circularly Linked List - Doubly Linked lists – Applications of linked list.

Unit - II

Non-Linear Data Structures: Binary Tree – expression trees – Binary tree traversals – applications of trees – Huffman Algorithm - Binary search tree - Balanced Trees - AVL Tree - B-Tree - Splay Trees – Heap- Heap operations- - Binomial Heaps - Fibonacci Heaps- Hash set.

Unit -III

Graphs: Graphs terminology, Graph ADT, representations, graph search methods DFS and BFS, Applications of Graphs-Minimum cost spanning tree

using Kruskal's algorithm, Dijkstra's algorithm for Single Source Shortest Path Problem.

Unit - IV

Algorithm Analysis – Asymptotic Notations - Divide and Conquer – Merge Sort – Quick Sort - Binary Search - Greedy Algorithms – Knapsack Problem – Dynamic Programming – Optimal Binary Search Tree - Back Tracking- N Queen's Problem.

References:

Mark Allen Weiss, "*Data Structures and Algorithm Analysis in C++",* 2nd Edition, Pearson, 2004.

M T Goodrich, Roberto Tamassia, "*Data Structures and Algorithms in Java*", 6th Edition, Wiley, 2014.

Sartaj Sahni, "*Data Structures, Algorithms and Applications in Java*", 2nd Edition, Universities Press, 2005.

M T Goodrich, Roberto Tamassia, "*Algorithm Design*", John Wiley, 2002.

Course Code : **MAI104** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Fundamentals of Data Science with Python Programming**

Course Objectives:

- To obtain a comprehensive knowledge of various tools and techniques for data transformation and visualization.
- To learn how to describe the data for the data science process
- To learn and utilize Python libraries for data wrangling.

Learning Outcomes:

After completion of the course student will be able to:

- Apply preprocessing techniques to convert raw data to enable further analysis.
- Apply exploratory data analysis and create visualizations to identify patterns.

Course Outline:

Unit-I

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data.

Unit -II

Describing Data: Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores

Unit-III

Describing Relationships: Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression – regression line –least squares regression line.

Unit-IV

Python Libraries for Data Wrangling: Basics of Numpy arrays –aggregations – computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – combining datasets – aggregation and grouping.

Data Visualization: Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation

References:

David Cielen, Arno D. B. Meysman, and Mohamed Ali, "*Introducing Data Science*", Manning Publications, 2016.

Robert S. Witte and John S. Witte, "*Statistics*", Eleventh Edition, Wiley Publications, 2017.

Jake VanderPlas, "*Python Data Science Handbook*", O'Reilly, 2016.

Adi Adhikari and John De Nero, "*Computational and Inferential Thinking: The Foundations of Data Science*", 1st edition, 2019.

Jiawei Han, Micheline Kamber, Jian Pei, "*Data Mining Concepts and Techniques*", 3rd Edition, Elsevier, 2006.

Course Code : **MAI115** Core/ Elective : **Elective** No. of Credits : 4	Course Title **Computer Networks**

Course Objectives:

- To understand the layers of computer network architecture of TCP/IP and OSI model with their applications.
- To understand the performance and characteristics of basic protocols involved in wired/wireless communication process.

Learning Outcomes:

After completion of the course student will be able to:

- Have the knowledge of various functions of each layer of OSI, TCP/IP model and administrate the network and flow of information

Course Outline:

Unit-I

Introduction: Network-Uses of Networks- Types of Networks- Reference Models: TCP/IP Model- The OSI Model- Comparison of the OSI and TCP/IP reference model- Architecture of Internet. Physical Layer: Guided transmission media- Wireless transmission media, Switching.

Unit-II

Data Link Layer - Design issues, Error Detection & Correction, Elementary Data Link Layer Protocols, Sliding window protocols-Multiple Access Protocols - ALOHA, CSMA- Collision free protocols- Ethernet- Physical Layer, Ethernet Mac Sub layer- Data link layer switching: Use of bridges- learning bridges - spanning tree bridges- repeaters, hubs, bridges, switches, routers and gateways.

Unit-III

Network Layer: Network Layer Design issues, store and forward packet switching connection less and connection-oriented networks-routing algorithms-optimality principle, shortest path, flooding, Distance Vector Routing, Count to Infinity Problem, Link State Routing, Path Vector Routing, Hierarchical Routing; Congestion control algorithms, IP addresses, CIDR, Subnetting, SuperNetting, IPv4, Packet Fragmentation, IPv6 Protocol, Transition from IPv4 to IPv6, ARP, RARP.

Unit-IV

Transport Layer: Services provided to the upper layers elements of transport protocol addressing connection establishment, Connection release, Error Control & Flow Control, Crash Recovery.

The Internet Transport Protocols: UDP, Introduction to TCP, The TCP Service Model, The TCP Segment Header, The Connection Establishment, The TCP Connection Release, The TCP Sliding Window, The TCP Congestion Control Algorithm.

Application Layer- Introduction, providing services, Applications layer paradigms: Client server model, HTTP, E-mail, WWW, TELNET, DNS; RSA algorithm,

References:

Andrew S Tanenbaum, "*Computer Networks"*,6th Edition, Pearson,2020.

Behrouz A.Forouzan,"*Data Communications and Networking*",5th Edition TMH, 2013.

James F. Kurose, K. W. Ross "Computer Networking: A Top-Down Approach Featuring the Internet", 6th Edition, Pearson Education, 2017.

Course Code : **MAI116** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Recommender Systems**

Course Objectives:

- To learn techniques for making recommendations, including non-personalized, content-based, and collaborative filtering.
- To automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations.

Learning Outcomes:

After completion of the course student will be able to:

- Design recommendation system for a particular application domain.
- Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity

Course Outline:

Unit-I

Introduction: Overview of Information Retrieval, Retrieval Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

Unit-II

Content-based Filtering: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

Unit-III

Collaborative Filtering: User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.

Unit-IV

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.

References:

Jannach D., Zanker M., Fel Fering A., "*Recommender Systems: An Introduction*", 1st Edition, Cambridge University Press, 2011.

Charu C. Aggarwal, "*Recommender Systems: The Textbook*", 1st Edition, Springer, (2016).

Ricci F., Rokach L., Shapira D., Kantor B.P., "*Recommender Systems Handbook*", Springer, 2011.

Manouselis N., Drachsler H., Verbert K., Duval E., "*Recommender Systems for Learning*", Springer, 2013.

Course Code : **MAI117** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Operating Systems**

Course Objectives:

- To make aware of different types of Operating System and their services.
- To learn different process scheduling algorithms and synchronization techniques to achieve better performance of a computer system.
- Understand issues related to Process Synchronization and focus on principles of Deadlock and related problems.

Learning Outcomes:

After completion of the course student will be able to:

- Understands the different services provided by Operating System at different level and they learn real life applications of Operating System in every field.
- Understands the use of different process scheduling algorithm and synchronization techniques to avoid deadlock.

Course Outline:

Unit-I

Evolution of Operating Systems: Types of operating systems - Different views of the operating systems – Principles of Design and Implementation. The process concept – system programmer's view of processes – operating system's views of processes – operating system services for process management. Process scheduling – Schedulers – Scheduling Algorithms.

Unit-II

Structural overview, Concept of process and Process synchronization, Process Management and Scheduling, Hardware requirements: protection, context switching, privileged mode; Threads and their Management; Tools and Constructs for Concurrency, Detection and Prevention of deadlocks, Mutual Exclusion: Algorithms, semaphores.

Unit-III

Memory Management paging, virtual memory management, Contiguous allocation – static, dynamic partitioned memory allocation – segmentation. Non-contiguous allocation – paging –Virtual Memory, Dynamic Resource Allocation.

Unit-IV

File Systems: A Simple file system – General model of a file system – Symbolic file system –Access control verification – Logical file system – Physical file system — Disk scheduling, Design of IO systems, File Management.

References:

Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "*Operating System Concepts",* 10th edition, Wiley-India, 2018.

Andrew S. Tanenbaum, "*Modern Operating Systems"* 5th Edition, PHI, 2022.

Elmasri, Carrick, Levine, "*Operating Systems: A Spiral Approach*", TMH Edition

Course Code : **MAI318** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Cyber Security**

Course Objectives:

- To understand the concept of security, types of attack experienced, encryption and authentication for deal with attacks
- To understand the concepts of Intrusion prevention, detection and firewall and attack detection and prevention.

Learning Outcomes:

After completion of the course student will be able to:

- Have the knowledge of plaintext, cipher text, RSA and other cryptographic algorithm, Key Distribution, Intrusion detection, Attacks and their prevention.

Course Outline:

Unit-I

Critical characteristics of Information - NSTISSC Security Model - Components of information System - SDLC - Information assurance - Security Threats and vulnerabilities - Overview of Security threats - Security Standards.

Unit-II

Classical Cryptography - Symmetric Cryptography- Asymmetric Cryptography - Modern Cryptography - Access Control - DRM - Steganography - Biometrics.

Unit-III

Network Security - Intrusion Prevention, detection and Management - Firewall - Ecommerce Security - Computer Forensics - Security for VPN and Next Generation Networks.

Unit-IV

Host and Application security -Control hijacking, Software architecture and a simple buffer overflow - Common exploitable application bugs, shellcode - Buffer Overflow - Side-channel attacks - Timing attacks, power analysis, cold-boot attacks, defenses - Malware - Viruses and worms, spyware, key loggers, and botnets; defenses auditing, policy - Defending weak applications - Isolation, sandboxing, virtual machines.

References:

William Stallings, "*Cryptography and Network Security: Principles and Practice*", 6th Edition, PHI,2014.

Michael E. Whitman and Herbert J Mattord, "*Principles of Information Security*", 6th Edition, Vikas Publishing House, 2017.

Bill Nelson, Amelia Phillips, F. Enfinger and Christopher Stuart, "*Guide to Computer Forensics and Investigations*", 4th Edition, Thomson Course Technology, 2010.

Matt Bishop, "*Computer Security: Art and Science*", 1st Edition, Addison-Wesley Professional, 2015.

SEMESTER-II

Course Code :**MAI201** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Artificial Neural Networks (ANN)**

Course Objectives:

- To understand fundamentals of neural networks.
- To understand algorithms and models.
- To design the required and related systems.

Learning Outcomes:

After completion of the course student will be able to:

- Demonstrate ANN structure and activation Functions.
- Define foundations, learning mechanisms and state-space concepts.
- Identify structure and learning of perceptions, Explain Feed forward, multi-layer feed forward networks and Back propagation algorithms

Course Outline:

Unit-I

Introduction: History of Neural Networks, Structure and Functions of Biological And Artificial Neuron, Neural Network Architectures, Characteristics of ANN, Basic Learning Laws and Methods.

Unit-II

SUPERVISED LEARNING: Single Layer Neural Network and architecture, McCulloch-Pitts Neuron Model, Learning Rules, Perceptron Model, Perceptron Convergence Theorem, Delta learning rule, ADALINE, Multi-Layer Neural Network and architecture, MADALINE, Back Propagation learning, Back Propagation Algorithm.

Unit-III

UNSUPERVISED LEARNING-1: Outstar Learning, Kohenen Self Organization Networks, Hamming Network And MAXNET, Learning Vector Quantization, Mexican hat.

Unit-IV

UNSUPERVISED LEARNING-2: Counter Propagation Network -Full Counter Propagation network, Forward Only Counter Propagation Network, Adaptive Resonance Theory (ART) - Architecture, Algorithms.

References:

B.Yegnanarayana, "*Artificial Neural Networks*" PHI, 2006.

S.N.Sivanandam, S.N.Deepa, "*Introduction to Neural Networks using MATLAB 6.0*", 2nd Reprint, TATA MCGraw- Hill, 2006.

J .M. Zurada , "*Introduction to Artificial Neural Systems*" -Jaico publishing,1994.

S.Rajasekaran and G.A.Vijayalakshmi Pai, "*Neural Networks, Fuzzy Logic and Genetic Algorithms*", PHI, 2013.

James A Freeman and Davis Skapura, "*Neural Networks Algorithm, Applications and Programming Techniques*", Pearson Education, 2002.

Simon Hakins, "*Neural Networks*", 3rd Edition, Pearson Education, 2009.

Course Code :**MAI202** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Big Data Analytics**

- Understand big data for business intelligence and learn business case studies for big data analytics.
- Understand nosql big data management.
- Perform map-reduce analytics using Hadoop and related tools.

Learning Outcomes:

After completion of the course student will be able to:

- Describe big data and use cases from selected business domains.
- Explain NoSQL big data management.
- Perform map-reduce analytics using Hadoop and use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

Course Outline:

Unit-I

Introduction-What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open-source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

Unit-II

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, consistency, relaxing consistency,

version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.

Unit-III

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures.

Course Objectives:

Unit-IV

MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.

References:

Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "*Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses*", 1st Edition, Wiley, 2013.

P. J. Sadalage, M. Fowler, "*NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*", Addison-Wesley Professional, 2012.

Tom White, "*Hadoop: The Definitive Guide*", 3rd Edition, O'Reilly, 2012.

Course Code :**MAI203** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Natural Language Processing (NLP)**

- To acquire basic understanding of linguistic concepts and natural language complexity, variability.
- To acquire basic understanding of machine learning techniques as applied to language.
- To implement N-grams Models.

Learning Outcomes:

After completion of the course student will be able to:

- Able to understand Natural Language Processing.
- Applying Hidden Markov model and Speech Recognition.
- Able to implement probabilistic and language parsing.

Course Outline:

Unit-I

Introduction: Natural Language Processing, hands-on demonstrations. Ambiguity and uncertainty in language. The Turing test. Regular Expressions, Chomsky hierarchy, regular languages, and their limitations. Finite-state automata, Practical regular expressions for finding and counting language phenomena, Exploring a large corpus with regex tools. An introduction to programming in Python- Variables, numbers, strings, arrays, dictionaries, conditionals, iteration. The NLTK (Natural Language Toolkit) String Edit Distance and Alignment Key algorithmic tool: dynamic programming, a simple example, use in optimal alignment of sequences. String edit operations, edit distance, and examples of use in spelling correction, and machine translation.

Unit-II

Context Free Grammars Constituency, CFG definition, use and limitations. Chomsky Normal Form, Top-down parsing, bottom-up parsing, Non-

probabilistic Parsing Efficient CFG parsing with CYK, another dynamic programming algorithms. Early parser. Designing a little grammar, and parsing with it on some test data- Examples of applications in natural language. Information Theory The "Shannon game"- motivated by language! Entropy, cross entropy, information gain. Its applicationto some language phenomena.

Unit-III

Language modelling and Naive Bayes Probabilistic language modeling and its applications. Markov models. N-grams. Estimating the probability of a word, and smoothing. Generative models of language. Part of Speech Tagging and Hidden Markov Models, Viterbi Algorithm for Finding Most Likely HMM Path Dynamic programming with Hidden Markov Models, and its use for part-of-speech tagging, Chinese word segmentation, prosody, information extraction, etc.

Unit-IV

Probabilistic Context Free Grammars, Weighted context free grammars, Weighted CYK. Pruning and beam search, Parsing with PCFGs, A tree bank, the probabilistic version of CYK, how do humans parse, Experiments with eye-tracking, Modern parsers, Maximum Entropy Classifiers, The maximum entropy principle and its relation to maximum likelihood, Maximum entropy classifiers and their application to document classification, sentence segmentation, and other language tasks. Maximum Entropy Markov Models & Conditional Random Fields Part-of- speech tagging.

References:

Jurafsky and Martin, "*Speech and Language Processing*", 2nd Edition, Prentice Hall, 2008.

Manning and Schutze, "*Statistical Natural Language Processing*", MIT Press, 2001.

James Allen, "*Natural Language Understanding*", The Benajmins/Cummings Publishing Company,1998.

Cover, T. M. and J. A. Thomas, "*Elements of Information Theory*", 2nd Edition, Wiley, 2006.

Charniak, E., "*Statistical Language Learning*", The MIT Press,1994.

Jelinek, F, "*Statistical Methods for Speech Recognition*", 4th Edition, The MIT Press,1998.

Course Code :**MAI204** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Machine Learning**

Course Objectives:

- To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IoT nodes.
- To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.
- To explore Deep learning technique and various feature extraction strategies.

Learning Outcomes:

After completion of the course student will be able to:

- Extract features that can be used for a particular machine learning approach in various IoT applications.
- Compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
- Mathematically analyse various machine learning approaches and paradigms.

Course Outline:

Unit-I

Supervised Learning (Regression/Classification): Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes, Linear models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond Binary Classification: Multi- class/Structured Outputs, Ranking

Unit-II

Unsupervised Learning: Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models)

Unit-III

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Unit-IV

Sparse Modelling and Estimation, Modelling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

References:

Kevin Murphy, "*Machine Learning: A Probabilistic Perspective*", MIT Press, 2012.

Trevor Hastie, Robert Tibshirani, Jerome Friedman, "*The Elements of Statistical Learning*", Springer, 2009.

Christopher Bishop, "*Pattern Recognition and Machine Learning*", Springer, 2007.

Course Code : **MAI215** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Blockchain and Cryptocurrency Fundamentals**

Course Objectives:

- To understand Blockchain and its main application cryptocurrency.
- To explore various aspects of Blockchain technology like application in various domains.
- To provide the skills and knowledge necessary to implement private, public block chain and smart contract.

Learning Outcomes:

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

- Understand and explore the working of Blockchain technology.
- Analyze the working of smart contracts.
- Understand how to store and use Bitcoins.

Course Outline:

Unit-I

Blockchain definition: Bitcoin & Blockchain, Blockchain Structure, Basic Operations. Ethereum Blockchain: Smart Contracts, Ethereum Structure, Ethereum Operations.

Unit-II

Integrity of transactions and blocks in blockchain: Algorithms & Techniques: Public-Key Cryptography, Hashing, Transaction Integrity.

Unit-III

Introduction to Crypto and Cryptocurrencies: Cryptographic Hash Functions, Hash Pointers and Data Structures, Digital Signatures, Public Keys as Identities.

Unit-IV

Mechanics of Bitcoin: components of the Bitcoin protocol, Bitcoin Transactions, Bitcoin Scripts, Applications of Bitcoin Scripts, Bitcoin Blocks, The Bitcoin Network. How to Store and Use Bitcoins/

References:

Andreas Antonopoulos (2014), "*Mastering Bitcoin: Unlocking Digital Cryptocurrencies*", O'Reilly, 1st Edition, 2014.

Melanie Swa, "*Blockchain*", 1st Edition, O'Reilly, 2015.

Bob Dill, David Smits, "*Zero to Blockchain - An IBM Redbooks course*".

Course Code : **MAI216** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Computer Architecture**

- To understand the design of various functional units and components of computers.
- To understand the function of each element of a memory hierarchy.
- To understand digital logic design and their use in combinational and sequential logic circuit design.

Learning Outcomes:

After completion of the course student will be able to:

- Understand and apply computer architecture concepts related to design pf modern processors.

Course Outline:

Unit-I

Basic Structure of a Computer System: Functional Units — Basic Operational Concepts — Performance — Instructions: Language of the Computer — Operations, Operands — Instruction representation — Logical operations — decision making — MIPS Addressing.

Unit-II

Arithmetic for Computers: Addition and Subtraction — Multiplication — Division — Floating Point Representation — Floating Point Operations — Subword Parallelism

Unit-III

Processor and Control Unit: A Basic MIPS implementation — Building a Datapath — Control Implementation Scheme — Pipelining — Pipelined datapath and control — Handling Data Hazards & Control Hazards — Exceptions.

Unit-IV

Parallel processing challenges — Flynn's classification — SISD, MIMD, SIMD, SPMD, and Vector Architectures — Hardware multithreading — multi-core processors and other Shared Memory Multiprocessors - MEMORY & I/O SYSTEMS Memory Hierarchy — memory technologies — cache memory — measuring and improving cache performance — virtual memory, TLB's — Accessing I/O Devices — Interrupts — Direct Memory Access — Bus structure — Bus operation — Arbitration — Interface circuits — USB.

References:

M. Morris Mano, "*Computer System Architecture*" , Pearson , 3rd edition , 2019 .

William Stallings, "*Computer Organization and Architecture*", Pearson, 11th edition, 2022

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Course Code : **MAI217** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Data Preparation and Analysis**

Course Objective:

- To prepare the data for analysis and develop meaningful data Visualization using latest technologies.

Learning Outcomes:

After completion of the course student will be able to:

- Extract the data for performing the Analysis.

Course Outline

Unit-I

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.

Unit-II

Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.

Unit-III

Exploratory Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation.

Unit-IV

Visualization: Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity.

Visualizations using R or Python.

Reference:

Glenn J. Myatt, "*Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining*", 2nd Edition, John Wiley Publishers, 2014.

Course Code : **MAI218** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Digital Forensics**

Course Objectives:

- To provide an in-depth study of the rapidly changing and fascinating field of computer forensics.
- To combine both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
- To provide Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools.
- To understand E-evidence collection and preservation, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics.

Learning Outcomes:

After completion of the course student will be able to:

- Understand relevant legislation and codes of ethics., Computer forensics and digital detective and various processes, policies and procedures.
- Understand E-discovery, guidelines and standards, E-evidence, tools and environment, Email and web forensics and network forensics.

Course Outline:

Unit-I

Computer forensics fundamentals**,** Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.

Unit-II

Understanding Computing Investigations - Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

Unit-III

Data acquisition - Understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisition tools. Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.

Unit-IV

Current computer forensics tools - software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations.

References:

Warren G. Kruse II and Jay G. Heiser, "*Computer Forensics: Incident Response Essentials*", Addison Wesley, 2002.

Bill Nelson, Amelia Phillips, F.Enfinger and Christopher Stuart, "*Guide to Computer Forensics and Investigations*", 2nd Edition. Thomson Course Technology, 2006.

John R. Vacca, "*Computer Forensics: Computer Crime Scene Investigation*", 2nd Edition, Charles River Media, 2005.

Bill Nelson, Amelia Phillips, F.Enfinger and Christopher Stuart, "*Guide to Computer Forensics and Investigations*", 4th Edition., Thomson Course Technology, 2010.

Anthony T. S. Ho and Shujun Li, "*Handbook of Digital Forensics of Multimedia Data and Devices*", IEEE Press, John Wiley & Sons, 2015.

SEMESTER-III

Course Code :**MAI301** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Introduction to Deep Learning**

Course Objectives:

- To understand the theoretical foundations, algorithms and methodologies of Neural Network.
- To design and develop an application using specific deep learning models.
- To provide the practical knowledge in handling and analysing real world applications.

Learning Outcomes:

After completion of the course student will be able to:

- Recognize the characteristics of deep learning models that are useful to solve real-world problems.
- Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.
- Implement different deep learning algorithms.

Course Outline:

Unit-I

Introduction to Deep Learning: Definition, Applications, Neural Networks, Machine Learning vs Deep Learning, Deep Learning Libraries (Tensorflow, Keras, PyTorch), Types (Supervised Learning, Unsupervised Learning, Reinforcement Learning) and their Comparison. Datasets: Numerical Data, Categorical Data, Data Quality, Data Remediation, Data Preprocessing (Dimensionality Reduction, Feature Transformation, Feature Subset Selection).

Unit-II

Neural Networks: Basics, Types, Intuitions, Neurons, Kernels, Biases, Weights, Initialization, Gradient Descent, Heuristics, Training (Holdout Method, K-Fold Cross-Validation Method, Bootstrap Sampling, Lazy vs Eager Learner), Evaluation (Regression, Classification and Clustering), Perceptrons, Derivatives, Computation graph, Vectorization, Broadcasting, Propagation (Forward and Back), Parameters vs Hyperparameters.

Unit-III

Deep Feedforward Network: Feed-forward Networks, Gradient-based Learning, Hidden Units, Architecture Design, Computational Graphs, Back-Propagation, Regularization, Parameter Penalties, Data Augmentation, Multi-task Learning, Bagging, Dropout and Adversarial Training and Optimization.

Unit-IV

Convolution Networks: Convolution Operation, Pooling, Basic Convolution Function, Convolution Algorithm, Unsupervised Features and Neuroscientific for convolution Network.

Sequence Modelling: Recurrent Neural Networks (RNNs), Bidirectional RNNs, Encoder Decoder Sequence-to-Sequence Architectures, Deep Recurrent Network, Recursive Neural Networks and Echo State networks.

References:

Goodfellow L., Bengio Y. and Courville A., "*Deep Learning*", MIT Press, 2016.

Patterson J. and Gibson A., "*Deep Learning: A Practitioner's Approach*", O'Reilly 1st Edition, 2017.

Haykin S., "*Neural Network and Machine Learning*", Prentice Hall Pearson 3rd Edition, 2009.

Geron A., "*Hands-on Machine Learning with Sci-kit and TensorFlow*", O'Reilly Media, 2017.

Course Code :**MAI302** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Scalable Systems for Data Science**

Course Objectives:

- To introduce systems and approaches for large scale data science problems.
- To understand handling large data sets.
- To learn how large-scale machine learning and distributed machine learning approaches work

Learning Outcomes:

After completion of the course student will be able to:

- Understand handling large data sets
- Learn approaches for solving large scale data science problems link analysis and finding similar items
- Understand real-world problems which need scalable systems for large scale data science such as web advertising and recommendation systems
- Learn the basic principles of large-scale machine learning and distributed machine learning
- Implement models using programming languages to solve large scale data science projects

Course Outline:

Unit-I

Overview of Data Mining and map-reduce, Hash Functions - Indexes, Shingling LSH, Mining Data Streams - Finding similar items near-neighbor search, shingling of documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures, Link-analysis Page Rank, Link spam, Hubs and authorities.

Unit-II

Frequent Item sets Market based model, A-Priori Algorithm, Handling larger data sets in memory, Limited-pass algorithms.

Unit-III

Clustering Hierarchical clustering, k-means, CURE, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism.

Unit-IV

Advertising on the web Matching problem, ad-words problem, Recommendation systems - Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction.

References:

Jure Leskovec, Anand Rajaraman, Jerey David Ullman, "*Mining of Massive Datasets*", Cambridge University Press, 2014.

Jimmy Lin and Chris Dyer, "*Data-Intensive Text Processing with MapReduce*", 1st Edition, Morgan and Claypool Publishers, 2010.

Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, "*Advanced Analytics with Spark: Patterns for Learning from Data at Scale*", Oreilly, 2015.

Ankit Jain, "*Mastering Apache Storm: Processing big data streaming in real time*", Packt Publishing, 2017.

Course Code :**MAI303** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Data Mining &Data Ware Housing**

Course Objectives

- Identify the scope and necessity of Data Mining & warehousing for the society
- Describe various Data models and design Methodlogies of Data Warehousing destined to solve the root problems
- To understand various tools of Data mining and their Techniques to solve the real time problems.

Learning Outcomes:

After completion of the course student will be able to:

- analyze the data, identify the problems, and choose the relevant algorithms to apply.
- Understand To assess the Pros and cons of various algorithms and analyze their behavior on real datasets.
- Understand the consequence of applying various Data Mining tools.
- Create and understand about the way the Data mining tools are used and the domainof application.

Course Outline:

Unit - I

Introduction – Steps in KDD – System Architecture – Types of Data- Data Mining functionalities- Classification of Data mining systems –Integration of data mining system with a data warehouse – Issues- Data Processing –Data Mining Application.

Unit-II

Data warehousing components- Building a data warehouse- Multi Dimensional Data Model –OLAP Operation in the Multi-Dimenstional Model

– Three Tier Data Warehouse Architecture – Schemas for Multidimensional data Model – Online Analytical Processing(OLAP) –OLAP vs OLTP integrated OLAM and OLAP Architecture.

Unit-III

Mining frequent patterns – Associations and correlations – Mining methods – Finding Frequent itemset using Candidate Generation – Generating Association rules from Frequent Item sets – Mining Frequent itemset without candidate Generation- Mining various kinds of association Rules – Mining Multi level Association rule- Mining Multi Dimensional Association Rule- Mining Correlation analysis- Constraint based association mining.

Unit-IV

CLASSIFICATION AND CLUSTERING AND TRENDS IN DATA MINING.

Mining Classification and prediction – Issues regarding Classification and Predection – Classification by Decision Tree Induction –Bayesian classification- Naïve Bayesian Classification - Linear Regression frequent patterns – Associations and correlations-Cluster analysis – Types of data in Cluster Analysis- Social Impacts of Data Mining-Recent trends in Data Mining.

References:

Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, "*Advanced Analytics with Spark: Patterns for Learning from Data at Scale*", Oreilly, 2015.

Ankit Jain, "*Mastering Apache Storm: Processing big data streaming in real time*", Packt Publishing, 2017.

Course Code :**MAI315** Core/ Elective : **Core** No. of Credits : **4**	Course Title **Research Methodology and IPR**

Course Objectives

- To understand the research problem and to know the literature studies, plagiarism and ethics.
- To get the knowledge about technical writing.
- To analyze the nature of intellectual property rights and new developments.

Learning Outcomes:

After completion of the course student will be able to:

- Understand research problem formulation, Analyze research related information and follow research ethics.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasize the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

Course Outline:

Unit-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit-II

Effective literature studies approach, analysis Plagiarism and Research ethics.

Unit-III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Unit-IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

References:

Stuart Melville and Wayne Goddard, "*Research methodology: An Introduction for Science and Engineering Students*", Tata Mc Graw Hill India, 2013.

Ranjit Kumar, "*Research Methodology: A Step by Step Guide for beginners*", 2/e, Prentice Hall of India, 2013.

Halbert, "*Resisting Intellectual Property*", Taylor and Francis Limited, 2007.

Robert P. Merges, Peter S. Menell (2016), Mark A. Lemley, "*Intellectual Property in New Technological Age*", 2016.

T. Ramappa, "*Intellectual Property Rights Under WTO*", S. Chand Publishers, 2008.

Course Code : **MAI316** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Health Care Data Analysis**

Course 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.

Learning Outcomes:

After completion of the course student will be able to:

- Analyze health care data using appropriate analytical techniques.
- Apply analytics for decision making in healthcare services.
- Apply data mining to integrate health data from multiple sources and develop efficient clinical decision support systems.

Course Outline

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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 and Practical Systems for Healthcare.

References:

Chandan K. Reddy and Charu C Aggarwal, "*Healthcare data analytics*", 1st Edition, Taylor & Francis, 2015

Hui Yang and Eva K. Lee, "*Healthcare Analytics: From Data to Knowledge to Healthcare Improvement*", 1st Edition, Wiley, 2016.

Course Code : **MAI317** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Digital Image Processing**

Course Objectives:

- To describe and explain basic principles of digital image processing.
- To design and implement algorithms that perform basic image processing (e.g. noise removal and image enhancement).
- To design and implement algorithms for advanced image analysis (e.g. image compression, image segmentation).

Learning Outcomes:

After completion of the course student will be able to:

- Demonstrate the components of image processing, Explain various filtration techniques.
- Apply image compression techniques.
- Discuss the concepts of wavelet transforms and analyze the concept of morphological image processing.

Course Outline:

Unit-I

Digital Image Processing: Definition, Examples of Fields that use Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System.

Digital Image Fundamentals: Image Sensing, and Acquisition, Image Sampling and Quantization, Basic Relationship between Pixels, Distance Measures, Linear and Non-linear Operations.

Unit-II

Intensity Transformations and Spatial Filtering: Basic Gray Level Transformations, Histogram Processing, Enhancements using Arithmetic/ Logic Operations, Basics of Spatial Filtering, Smoothing, Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Unit-III

Filtering in the Frequency Domain: Fourier Series, Fourier transform of Functions of One Continuous Variable, Discrete Fourier Transform (DFT) of one variable and Its Inverse, 2-D Discrete Fourier Transform and Its inverse, Properties of 2-D DFT, Image Smoothing using Frequency Domain Filters, Image Sharpening Using Frequency Domain Filters, Laplacian in Frequency Domain, Homomorphic Filtering, Band reject and Bandpass Filters, Notch Filters, The Fast Fourier Transform in 1-D .

Unit-IV

Image Restoration: Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter, Geometric Transformations. Colour Image Processing: Colour Models, Pseudo colour Image Processing, Basics of Full Colour Image Processing. Colour Transformations, Smoothing and Sharpening. Colour Segmentation.

References:

R. C. Gonzalez, R. E. Woods, "*Digital Image Processing*", 4th Edition, PHI, 2018.

A. K. Jain, "*Fundamentals of Digital Image Processing*", PHI, 1988.

Course Code : **MSAI318** Core/ Elective : **Elective** No. of Credits : **4**	Course Title **Theory of Computation**

Course Objectives:

- To give an overview of the theoretical foundations of computer science from the perspective of formal languages.
- To illustrate finite state machines to solve problems in computing.
- To familiarize Regular grammars, context frees grammar.

Learning Outcomes:

After completion of the course student will be able to:

- Use basic concepts of formal languages of finite automata techniques.
- Design Finite Automata's for different Regular Expressions and Languages.
- Construct context free grammar for various languages.
- Solve various problems of applying normal form techniques, push down automata and Turing Machines.

Course Outline:

Unit-I

Finite Automata: Deterministic finite Automata, Non deterministic finite Automata, Equivalence of NFA and DFA, Finite Automata with Epsilon-moves. 2-Way Finite Automata, Crossing sequences, Moore and Mealy Machine, Application of finite automata i.e. Lexical Analyzers, text editors.

Unit-II

Regular Expression and Languages: Regular expression, Equivalence of finite Automata and Regular expressions, Conversion between regular expressions and finite automata: Application of Regular Expressions: Regular Expression in UNIX, Lexical analysis, Finding pattern in text.

Unit-III

Regular Languages and Regular sets: Pumping lemma for regular sets, Applications of pumping lemma. Minimization of finite Automata.

Context free Grammar and Languages: Context Free Grammars: Derivation Trees, Leftmost and rightmost derivations, Ambiguity. Normal forms for context free grammars.

Unit-IV

Pushdown Automata: Deterministic Push Down Automata; Equivalence of Push Down Automata and Context free grammar. Turning Machine (TM).

References:

J.E. Hopcroft, R. Motwani and J.D. Ullamn, "*Introduction to Automata Theory, Languages and Computation*", 3rd Edition, Pearson Education Asia, 2007.

Daniel I.A. Cohen, "*Introduction to Computer Theory*", 2nd Edition, Wiley, 1996.

B. M. Moret, "*The Theory of Computation*", 2nd Edition, Pearson Education Asia.

H.R. Lewis and C.H. Papa dimitriou, "*Elements of the theory of Computation*", 2nd Edition, Pearson Education Asia,1998.

SEMESTER-IV

Course Code : **MAI401** Core/ Elective : **Elective (Compulsory)** No. of Credits : **4**	Course Title **Dissertation**

Objective:

Implement some of the existing techniques and develop some new algorithm/ tool and produce meaningful research outputs.

Each student will work on a dissertation to apply the knowledge of Artificial Intelligence and Data science for solving a wide variety of real-world problems. Problems may be decided based on literature survey by standard research articles. Significance of proposed problem and the state-of the art to be explored. Relevant tools may be used for demonstrating the results with physical meaning and create necessary research components

Student is required to submit a detailed project report on the selected topic for their project as per the guidelines decided by the department. The project work is to be evaluated through presentations and viva-voce during the semester and final evaluation will be done at the end of the semester as per the guidelines decided by the department from time to time. The candidate shall present/ publish one paper in national/international conference/seminar/journal of repute.

However, candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.