R23-COURSE STRUCTURE
(M.TECH. DATA SCIENCE)

I SEMESTER

S.No.	Course code	Course Title	Contact hours/week			Credits	Scheme of Valuation		
			L	T	P		CIE	SEE	Total
TheoryCourses									
1	23DS01	Statistical Foundations for Data Science	3	0	0	3	40	60	100
2	23DS02	Machine Learning	3	0	0	3	40	60	100
	PROGRAMELECTIVE–I								
3	23DS03	Cloud Computing and Virtualization	3	0	0	3	40	60	100
	23DS04	Advanced Databases							
	23DS05	Soft Computing							
	PROGRAMELECTIVE–II								
4	23DS06	Web and Database Security	3	0	0	3	40	60	100
	23DS07	Social Media Analytics							
	23DS08	Advanced Data Structures							
5	23RM01	Research Methodology and IPR	2	0	0	2	40	60	100
6	AC	Audit Course-I	2	0	0	0	100	-	-
LaboratoryCourses									
7	23DS61	Machine Learning lab	0	0	4	2	40	60	100
8	23DS62	Python for Data Science Lab	0	0	4	2	40	60	100
Total			**16**	**0**	**8**	**18**	**380**	**420**	**800**

II SEMESTER

S.No.	Course code	Course Title	Contact hours/week			Credits	Scheme of Valuation		
			L	T	P		CIE	SEE	Total
Theory Courses									
1	23DS09	Big Data Analytics	3	0	0	3	40	60	100
2	23DS10	Deep Learning	3	0	0	3	40	60	100
	PROGRAM ELECTIVE–III								
3	23DS11	Computer Vision	3	0	0	3	40	60	100
	23DS12	Natural Language Processing							
	23DS13	Block Chain Technology							
	PROGRAM ELECTIVE–IV								
4	23DS14	Predictive Analytics	3	0	0	3	40	60	100
	23DS15	Reinforcement Learning							
	23DS16	Digital Forensics							
5	AC	Audit course-II	2	0	0	0	100	-	-
LaboratoryCourses									
6	23PI01	Mini Project	0	0	4	2	100	-	100
7	23DS63	Deep Learning Lab	0	0	4	2	40	60	100
8	23DS64	Data Analytics and Visualization Lab	0	0	4	2	40	60	100
Total			**14**	**0**	**12**	**18**	**440**	**360**	**800**

III SEMESTER

S.No	Course code	Course Title	Contact hours/week			Credits	Scheme of Valuation		
			L	T	P		CIE	SEE	Total
TheoryCourses									
1	**PROGRAM ELECTIVE-III**								
	23DS17	Optimization Techniques for Data Analysis	3	0	0	3	40	60	100
	23DS18	Nature Inspired Computing							
	23DS19	Cyber Security							
2	**OPEN ELECTIVE/MOOCS**		3	0	0	3	40	60	100
LaboratoryCourses									
3	23PI02	Industrial/Research Internship	0	0	4	2	100	-	100
4	23PI03	Project Work & Dissertation (Phase-I)	0	0	16	8	40	60	100
Total			**6**	**0**	**20**	**16**	**220**	**180**	**400**

IVSEMESTER

S.No	Course code	Course Title	Contact hours/week			Credits	Scheme of Valuation		
			L	T	P		CIE	SEE	Total
1	23PI04	Project Work & Dissertation (Phase-II)	0	0	32	16	40	60	100
Total			0	0	32	16	40	60	100

Total Credits: 18+18+16+16= 68

OPEN ELECTIVES OFFERED BY CSE DEPARTMENT

SNO	OPEN ELECTIVENAME
23DS81	Introduction to Artificial Intelligence
23DS82	Introduction to Machine Learning
23DS83	Introduction to Data Science

LIST OF COURSES OFFERED UNDER AUDIT COURSE

Code	Name of the course
23AC01	English for research paper writing
23AC02	Disaster Management
23AC03	Sanskrit for Technical Knowledge
23AC04	Value Education
23AC05	Constitution of India
23AC06	Pedagogy Methods
23AC07	Stress Management by Yoga
23AC08	Personality Development through Life Enlightenment Skills

M.Tech. (I Sem.)	23DS01-STATISTICAL FOUNDATIONS FOR DATA SCIENCE	L	T	P	Cr.
		3	0	0	3

Prerequisites: Mathematics courses of first year of study.

Course Objectives:

1. The Number Theory basic concepts useful for cryptography etc
2. The theory of Probability, and probability distributions of single and multiple random variables
3. The sampling theory and testing of hypothesis and making inferences
4. Stochastic process and Markov chains.

Course Outcomes: After learning the contents of this course, the student must be able to

CO1. Apply the number theory concepts to cryptography domain **(Apply-L3)**

CO2. Apply the concepts of probability and distributions to some case studies **(Apply-L3)**

CO3. Correlate the material of one unit to the material in other units **(Apply-L3)**

CO4. Resolve the potential misconceptions and hazards in each topic of study. **(Apply-L3)**

UNIT - I

Greatest Common Divisors and Prime Factorization: Greatest common divisors, The Euclidean algorithm, The fundamental theorem of arithmetic, Factorization of integers and the Fermat numbers Congruences: Introduction to congruences, Linear congruences, The Chinese remainder theorem, Systems of linear congruences

UNIT - II

Simple Linear Regression and Correlation: Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators, Inferences Concerning the Regression Coefficients, Prediction, Simple Linear Regression Case Study Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Statistical Independence. Discrete Probability Distributions: Binomial Distribution, Poisson distribution.

UNIT - III

Continuous Probability Distributions: Normal Distribution, Areas under the NormalCurve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Fundamental Sampling Distributions: Random Sampling, Sampling Distributions, Sampling, Distribution of Means and the Central Limit Theorem, Sampling Distribution of S2, t–Distribution, F Distribution.

UNIT – IV

Estimation & Tests of Hypotheses: Introduction, Statistical Inference, Classical Methods of Estimation. Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Tolerance Limits, Estimating the Variance, Estimating a Proportion for single mean, Difference between Two Means, between Two Proportions for Two Samples and Maximum Likelihood Estimation.

UNIT - V

Stochastic Processes and Markov Chains: Introduction to Stochastic processes- Markov process. Transition Probability, Transition Probability Matrix, First order and Higher order

Markov process, n step transition probabilities, Markov chain, Steady state condition, Markov analysis.

TEXT BOOKS:

1. Kenneth H. Rosen, Elementary number theory & its applications, sixth edition, Addison Wesley, ISBN 978 0-321-50031-1
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Ed. Pearson Publishers.
3. S. D. Sharma, Operations Research, Kedarnath and Ramnath Publishers, Meerut, Delhi

REFERENCE BOOKS:

1. S C Gupta and V K Kapoor, Fundamentals of Mathematical statistics, Khanna publications
2. T.T. Soong, Fundamentals of Probability And Statistics For Engineers, John Wiley & Sons Ltd 2004.
3. Sheldon M Ross, Probability and statistics for Engineers and scientists, Academic Press

M. Tech. (I Sem.) **23DS02-MACHINE LEARNING**

L	T	P	Cr.
3	0	0	3

Pre-requisites: Probability and Statistics, Data Warehousing and Data Mining

Course Educational Objective: The objective of the course provides the basic concepts and techniques of Machine Learning and helps to use recent machine learning software for solving practical problems. It enables students to gain experience by doing independent study and research.

Course Outcomes: At the end of this course, the student will be able to

CO1: Apply predictive algorithms for real-world Problems. (**Apply – L3**).

CO2: Apply unsupervised learning algorithms for real; world problems (**Apply-L3**).

CO3: Familiarize with functions of several variables which is useful in optimization (**Apply– L3**).

CO4: Analyze Ensemble Model building and evaluation approaches (**Analyze – L4**).

CO5: Learn advanced learning techniques to deal with complex data (**Apply – L3**).

UNIT –I

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

UNIT –II

Unsupervised Learning: Clustering: K-means, Dimensionality Reduction: PCA and kernel PCA, Generative Models (Gaussian Mixture Models and Hidden Markov Models)

UNIT – III

Evaluating Machine Learning algorithms, Model Selection, Ensemble Methods (Boosting, Bagging, Random Forests)

UNIT –IV

Modeling Sequence/Time-Series Data, Deep Learning (Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks) and Feature Representation Learning

UNIT – V

Scalable Machine Learning (Online and Distributed Learning) Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

TEXTBOOKS:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2017(corrected copy)
3. Jiawei Han, Micheline Kamber, Jian Pei , Data Mining: Concepts and Techniques, 3/e, Morgan Kaufmann, 2011.(2016 modified copy)
4. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.(2016)

Reference Books:

1. Shai Shalev-Shwartz, ShaiBen David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge.
2. Peter Harington, "Machine Learning in Action" , Cengage, 1st edition, 2012.
3. Peter Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge university press,2012.
4. Jason Brownlee, "Machine Learning Mastery with Python Understand Your Data, Create Accurate Models and Work Projects End-To-End", Edition: v1.4, 2011.

M. Tech. (I Sem.)

23DS03-CLOUD COMPUTING AND VIRTUALIZATION

L	T	P	Cr.
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the basics of cloud computing and its services **(Understand-L2)**

CO2: Analyze the cloud architecture and the technologies driving virtualization **(Analyze-L4)**

CO3: Explore the functioning of different cloud platforms and their applications **(Apply-L3)**

CO4: Identify the need of security in cloud and its mechanisms to manage the cloud environment **(Understand-L2)**

CO5: Assess control storage systems and cloud security, the risks involved its impact and develop cloud application **(Analyze – L4)**

UNIT I: Fundamental Cloud Computing and Models Understanding Cloud Computing: Origin and influences, Basic concepts and terminology, Goals and benefits, Risks and challenges. Fundamental concepts and Models: Roles and boundaries, Cloud characteristics, Cloud Delivery models, Cloud deployment models.

UNIT-II: Cloud Computing Architecture and Virtualization Cloud Computing Architecture: Introduction, The cloud reference model: Architecture, Infrastructure-and hardware-as-a-service, Platform as a service, Software as a service. Virtualization: Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques -Execution Virtualization, Other types of Virtualization, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology examples – VMware, Microsoft Hyper-V.

UNIT III: Cloud Technologies and Eco-Systems Building Cloud Computing Environments: Application development, Infrastructure and system development, Computing platforms and technologies. Working with Clouds: Cloud delivery Models: The cloud provider perspective: Building IaaS Environments, Equipping PaaS Environments, Optimizing SaaS Environments, Cloud Consumer perspective: Working with IaaS Environments, working with PaaS Environments, Working with SaaS Environments

UNIT-IV: Cloud Management and Security Mechanisms Cloud Management Mechanisms: Remote Administration System, Resource Management System and SLA Management System. Fundamental Cloud Security: Basic Terms and Concepts, Threat Agents, Cloud Security Threats, Cloud Security Mechanisms - Encryption, Hashing, Digital Signature, IAM, SSO.

UNIT-V:

Storage Systems:

Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system. Case studies : Amazon web services - Compute services, Storage services. Google AppEngine - Architecture and core concepts.

TEXTBOOKS:

1. Thomas Erl and RicardoPuttini Cloud Computing-Concepts, Technology and Architecture, Pearson, 2013.
2. Rajkumar Buyya, Christian Vecchiola, S Tamarai Selvi "Mastering Cloud Computing Foundations And Applications Programming" , McGraw Hill Education, 2016.

Reference Books :

1. Ivanka Menken and Gerard Blokdijk, Cloud Computing Virtualization Specialist Complete Certification Kit-Study GuideBook, Lightning Source, 2009
2. Barrie Sosinsky, "Cloud Computing Bible", Wiley Publishers, 2012
3. John W. Rittenhouse and James F. Ransome, Cloud Computing Implementation, Management and Security,CRC Press, Taylor& Francis Group, 2010.

M.Tech. (I Sem.) **23DS04-ADVANCED DATABASES**

L	T	P	Cr.
3	0	0	3

Course Objectives: Knowledge on concepts of Distributed Databases, Object-Based Databases, advanced database models

Course Outcomes:

CO1: Understand Database System Architectures and parallel databases. **(Understand-L2)**
CO2: Analyze transactions, Concurrency Control in Distributed Databases. **(Apply-L3)**
CO3: Understand the importance of Data Warehousing and Mining. **(Understand-L2)**
CO4: Illustrate concepts of object-based databases. **(Apply-L3)**

UNIT - I

Database System Architectures: Centralized and Client –Server Architectures, Server System Architectures, Parallel Systems, Distributed Systems, Network Types.
Parallel Databases: Introduction, I/O Parallelism, Inter query Parallelism, Intra Query Parallelism, Intra operation Parallelism, Interoperation Parallelism, Query Optimization, Design of Parallel Systems, Parallelism on Multicore Processors.

UNIT - II

Distributed Databases: Homogeneous and Heterogeneous Databases, Distributed Data Storage, Distributed Transactions, Commit Protocols, Concurrency Control in Distributed Databases, Availability, Distributed Query Processing, Heterogeneous Distributed Databases, Cloud-Based Databases, Directory Systems.

UNIT - III

Data Warehousing and Mining: Decision-Support Systems, Data Warehousing, Data Mining, Classification, Association Rules, Other Types of Associations, Clustering, Other Forms of Data Mining

UNIT - IV

Object-Based Databases: Introduction, Complex Data Types, Structured Types and Inheritance in SQL, Table Inheritance, Array and Multiset Types in SQL, Object-Identity and Reference Types in SQL, Implementing O-R Features, Persistent Programming Languages, Object-Relational Mapping, Object Oriented versus Object-Relational

UNIT - V

XML: Motivation, Structure of XML Data, XML Document Schema, Querying and Transformation, Application Program Interfaces to XML, Storage of XML Data, XML Applications Advanced database models and applications: Active Database Concepts and Triggers, Temporal database concepts, Spatial database concepts, Multimedia database concepts, Deductive databases

TEXT BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan Database System Concepts, Sixth Edition
2. Ramez Elmasri, Shamkant B. Navathe, Database systems- Models, Languages, Design and Application Programming

M.Tech. (I Sem.) **23DS05-SOFT COMPUTING**

L	T	P	C
3	0	0	3

Pre-requisites : Nil

Course Educational Objective: This course gives an introduction to some fields in soft computing with its principal components of Fuzzy logic, Neural Networks and Genetic Algorithms. It also focuses on simple implementation of neural networks and fuzzy logic using Matlab/Python. This course would be quite useful to study the fundamental concepts of soft computing for the pursuit of allied research also

Course Outcomes: At the end of this course, the student will be able to

CO1: Illustrate the evolution and basics of soft computing and machine learning. **(Understand-L2)**

CO2: Experiment with fuzzy sets, operations, fuzzy inference and expert systems. (**Apply–L3).**

CO3: List various forms of neural networks and their learning. **(Understand-L2).**

CO4: Illustrate genetic algorithms and their applications. **(Understand-L2).**

CO5 Experiment with Matlab /Python to understand the implementation of artificial neural network and fuzzy logic. **(Apply-L3)**

Unit I :

Introduction to Soft Computing and Neural Networks: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics

Unit II

Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making

Unit III

Neural Networks: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks

Unit IV

Genetic Algorithms: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition

ICS Lab: Practice - Speaking: Role – plays – formal & informal – asking for and giving information / directions / instructions / suggestions

Unit V

Matlab/Python Lib: Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic

Text Book(s):

1. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro:Fuzzy and Soft Computing®, Prentice:Hall of India, 2003.

2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic:Theory and Applications®, PrenticeHall, 1995.

3. MATLAB Tool kit Manual.

4. Saroj Kaushik, Sunita Tiwari, Soft computing: Fundamentals, Techniques and applications, Mc Graw Hill Education, 2018.

Reference Book(s)

1. Snehashish Chakraverty, Deepti Moyi Sahoo, Nisha Rani Mahato, Concepts of Soft Computing: Fuzzy and ANN with Programming, Springer, 2019.

2. Samir Roy, Udit Chakraborty, Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms, Pearson, 2013

M.Tech. (I Sem.) **23DS06-WEB AND DATABASE SECURITY**

L	T	P	Cr.
3	0	0	3

Course Objectives: Give an Overview of information security and give an overview of Access control of relational databases

Course Outcomes: Students should be able to

CO1. Understand the Web architecture and applications **(Understand-L2)**

CO2. Understand client side and service side programming **(Understand- L2)**

CO3. Understand how common mistakes can be bypassed and exploit the application **(Understand-L2)**

CO4. Identify common application vulnerabilities **(Apply-L3)**

UNIT - I

The Web Security, The Web Security Problem ,Risk Analysis and Best Practices, Cryptography and the Web : Cryptography and Web Security, Working Cryptographic Systems and Protocols , Legal Restrictions on Cryptography ,Digital Identification

UNIT - II

The Web's War on Your Privacy, Privacy-Protecting Techniques , Backups and Antitheft, Web Server Security, Physical Security for Servers, Host Security for Servers, Securing Web Applications

UNIT - III

Database Security : Recent Advances in Access Control, Access Control Models for XML, Database Issues in Trust Management and Trust Negotiation, Security in Data Warehouses and OLAP Systems

UNIT - IV

Security Re-engineering for Databases: Concepts and Techniques , Database Watermarking for Copyright Protection , Trustworthy Records Retention , Damage Quarantine and Recovery in Data Processing Systems , Hippocratic Databases: Current Capabilities

UNIT - V

Future Trends Privacy in Database Publishing: A Bayesian Perspective, Privacy-enhanced Location-based Access Control , Efficiently Enforcing the Security and Privacy Policies in a Mobile Environment.

Textbook

1.Web Security ,Privacy and Commerce Simson GArfinkel, Gene Spafford,O'Reilly .

2.Handbook on Database security applications and trends Michael Gertz, Sushil Jajodia

M.Tech. (I Sem.) **23DS07-SOCIAL MEDIA AND ANALYTICS**

L	T	P	Cr.
3	0	0	3

Course Objectives: Knowledge on social media and its analytics

Course Outcomes:

CO1. Understanding characteristics and types of social media **(Understand-L2)**

CO2. Knowledge on layers of social media analytics **(Understand-L2)**

CO3. Apply text analysis tools on social media data **(Apply-L3)**

CO4. Understand the significance of action analytics **(Understand-L2)**

CO5. Detect viral topics on social media (YouTube) **(Apply-L3)**

UNIT - I:

Introduction To Social Media: World Wide Web, Web 1.0, Web 2.0, Web 3.0, Social Media, Core Characteristics Of Social Media, Types Of Social Media, Social Networking Sites, Using Facebook For Business Purposes, Content Communities

UNIT - II:

Social Media Analytics Overview: Purpose of Social Media Analytics, Social Media Vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types Of Social Media Analytics, Social Media Analytics Cycle, Challenges To Social Media Analytics, Social Media Analytics Tools.

Case Study: The Underground Campaign That Scored Big

UNIT - III:

Social Media Text Analytics: Types of Social Media Text, Purpose of Text Analytics, Steps In Text Analytics, Social Media Text Analysis Tools.

Case Study: Tapping Into Online Customer Opinions

UNIT - IV:

Social Media Actions Analytics: Introduction To Actions Analytics, Common Social Media Actions, Actions Analytics Tools.

Case Study: Cover-More Group

UNIT - V:

Social Media Hyperlink Analytics: Types Of Hyperlinks, Hyperlink Analytics, Types Of Hyperlink Analytics, Hyperlink Analytics Tools.

Case Study: Hyperlinks And Viral YouTube Videos

TEXT BOOKS:

1. Seven Layers of Social Media Analytics Mining Business Insights From Social Media Text,Actions, Networks, Hyperlinks, Apps, Search Engine, And Location Data By Gohar F. Khan

Isbn: 1507823207, Isbn-13: 9781507823200

REFERENCES:

1. Social Media Analytics: Techniques And Insights For Extracting Business Value Out Of Social Media By Matthew Ganis, Avinash Kohirkar, Pearson Education.

2. Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, Marshall Sponder, MGH.

3. Big Data And Analytics,Seema Acharya, Subhasinin Chellappan, Wiley Publications.

4. Big Data, Black Booktm , Dreamtech Press, 2015 Edition.

M. Tech (I Sem) **23DS08-ADVANCED DATA STRUCTURES**

L	T	P	Cr.
3	0	0	3

Pre-Requisites: UG level course in Data Structures

Course Objectives: This course will enable students to implement Object Oriented Programming concepts in Python. Understand Lists, Dictionaries and Regular expressions in Python. Understanding how searching and sorting is performed in Python. Understanding how linear and non-linear data structures works.

Course Outcomes: The students should be able to:

CO1. Examine Python syntax and semantics and apply Python flow control and functions. **(Apply-L2)**

CO2. Create, run and manipulate Python Programs using core data structures like Lists. **(Apply-L3)**

CO3. Apply Dictionaries and use Regular Expressions. **(Apply-L3)**

CO4. Interpret the concepts of Object-Oriented Programming as used in Python. **(Apply-L3)**

CO5. Master object-oriented programming to create an entire python project using objects and classes **(Apply-L3)**

UNIT - I

Oops Concepts- class, object, constructors, types of variables, types of methods. Inheritance: single, multiple, multi-level, hierarchical, hybrid, Polymorphism: with functions and objects, with class methods, with inheritance, Abstraction: abstract classes.

UNIT - II

Data Structures – Definition, Linear Data Structures, Non-Linear Data Structures, Python Specific Data Structures: List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings, slicing.

UNIT - III

Arrays - Overview, Types of Arrays, Operations on Arrays, Arrays vs List. Searching -Linear Search and Binary Search.

Sorting - Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort.

UNIT - IV

Linked Lists – Implementation of Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists. Stacks - Overview of Stack, Implementation of Stack (List & Linked list), Applications of Stack Queues: Overview of Queue, Implementation of Queue (List & Linked list), Applications of Queues, Priority Queues.

UNIT - V

Graphs -Introduction, Directed vs Undirected Graphs, Weighted vs Unweighted Graphs, Representations, Breadth First Search, Depth First Search.

Trees - Overview of Trees, Tree Terminology, Binary Trees: Introduction, Implementation, Applications. Tree Traversals, Binary Search Trees: Introduction, Implementation, AVL Trees: Introduction, Rotations, Implementation.

TEXT BOOKS:

1. Data structures and algorithms in python by Michael T. Goodrich
2. Data Structures and Algorithmic Thinking with Python by Narasimha Karumanchi

REFERENCE BOOKS:

1. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition by Dr. Basant Agarwal, Benjamin Baka.
2. Data Structures and Algorithms with Python by Kent D. Lee and Steve Hubbard.
3. Problem Solving with Algorithms and Data Structures Using Python by Bradley N Miller and David L.Ranum.
4. Core Python Programming -Second Edition,R. Nageswara Rao, Dreamtech Press.

M.Tech. (I Sem.) 23RM01-RESEARCH METHODOLOGY AND IPR	L	T	P	Cr.
	2	0	0	2

Pre-Requisites: Knowledge in Engineering, English

COURSE EDUCATIONAL OBJECTIVES:

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

COURSE OUTCOMES: At the end of this course student will be able to

CO1: Analyze the research problem and its formulation.

CO2: Analyze the significance of research ethics.

CO3: Apply the information technology for better tomorrow and to develop creativity.

CO4: Identify the importance of intellectual property rights to be promoted among students in general and Engineering in particular.

CO5: Describe the IPR protection for new and better products, and in turn brings about, economic growth and social benefits.

UNIT I- RESEARCH PROBLEM AND SCOPE FOR SOLUTION

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 instrumentation's.

UNIT II- FORMAT

Effective literature studies approaches, analysis, Plagiarism, Research ethics. 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 III- PROCESS AND DEVELOPMENT

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.

UNIT IV- PATENT RIGHTS

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V- NEW DEVELOPMENTS IN IPR

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

REFERENCES:

1. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.

2. Mayall, “Industrial Design”, McGraw Hill, 1992.

3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “Introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

M.Tech. (I Sem.) **23DS61-MACHINE LEARNING LAB**

L	T	P	Cr.
0	0	4	2

Pre-requisites: Probability and Statistics, Programming Knowledge

Course Educational Objectives: The objective of this lab is to Make use of Data sets in implementing the machine learning algorithms in any suitable language of choice.

Course Outcomes: At the end of the course, the student shall be able to

CO1: Apply the appropriate pre-processing techniques on data set **(Apply – L3)**

CO2: Implement supervised and unsupervised Machine Learning algorithms. (**Apply – L3)**

CO3: Implement unsupervised Machine Learning algorithms. **(Apply – L3)**

CO4: Improve individual / teamwork skills, communication & report writing skills with ethical values

List of Experiments

1. Introduction to Python Libraries- Numpy, Pandas, Matplotlib, Scikit
2. Perform Data exploration and preprocessing in Python
3. Implement regularized Linear regression
4. Implement Naive Bayes classifier for dataset stored as CSV file.
5. Implement regularized logistic regression 6. Build models using different Ensembling techniques
7. Build models using Decision trees
8. Build model using SVM with different kernels
9. Implement K-NN algorithm to classify a dataset.
10. Build model to perform Clustering using K-means after applying PCA and determining the value of K using Elbow method
11. Develop Model on any real world dataset with preprocessing, feature selection, model and evaluation and analyze the results

REFERENCES

Lab Manual

M. Tech. (I Sem.) **23DS62- PYTHON FOR DATA SCIENCE LAB**

L	T	P	Cr.
0	0	4	2

Course Outcomes: Upon successful completion of the course, the student will be able to:

CO1 Implement python programming constructs to build small to large scale applications **(Apply-L3)**
CO2 Manipulate one-dimensional and multi -dimensional numpy arrays, and pandas series and data frames **(Apply-L3)**
CO3 Perform data loading, cleaning, transformation and merging **(Apply-L3)**
CO4 Create different plots for basic exploratory data analysis **(Apply-L3)**

Week1:
1. Creation of Python scripts that uses Operators, Control flow statements
2. Create Python Script that uses functions with various types of arguments such as default arguments, keyword argument and variable length arguments

Week2:
1. Create python script to implement fruitful functions and void functions
2. Simulate the calculator application to perform all the operation to be implemented on it.
3. Write a function that takes an ordered list of numbers (a list where the elements are in order from smallest to largest) and another number. The function decides whether or not the given number is inside the list and returns (then prints) an appropriate boolean

Week3:
1. Creation of python programs on the modules Numpy
2. Analyse the given series of data using pandas
3. Python programs that uses the dictionaries, tuples and other data structures

Week4:
1. Python Program on Text Files reading, handling and manipulation on these files
2. Creation of python programs to handle missing data and hierarchical indexing, data aggregation on multi indexes

Week5:
1. Python scripts that access the data from a given database

Week6:
1. Creation of Python forms for the department library/Lab/attendance etc., by entering student details of each student. Validate the form using Python validators and display error message

Week7:
1. Python programs on data transformation and string manipulation
2. Python Programs to simulate Queue Operations
3. Implement the data structure of binary search trees, using classes, with operations for inserting and finding an element

Week8:
1. Python programs on Scatter plots with histograms and a Scatter plot matrix for a given data
2. Find the root words of the given list of words using Porter and snowball Stemming

3. Perform tokenization and parts of speech tagging for the given sentence

Week 9 & 10:

1. Malicious URL is one of the dangerous threats to the web users in today‟s world and cyber security. These URL‟s are mainly used by the attackers and hackers to steal our valuable information like monetary loss, stealing of private information, and installation of malware. As a python data analyst, develop a suitable algorithm to detect malicious URL from a given set of URL‟s.
2. Implement depth first search traversal for a graph which contains 6 vertices. Keep the elements in the stack, the lower order number first. Also check the traversal if you keep the higher order number first.

Text Book(s):

1. Jeffrey Stanton, Syracuse University , An Introduction to Data Science
2. VamsiKurama, "Python Programming: A Modern Approach", Pearson India, 2017
3. Wes McKinney , “Python for Data Analysis” ,OReilly Media Inc. 2013
4. Samir Madhavan, “Mastering Python for Data Science”, PACKT publishing, 2015

M.Tech. (II Sem.) **23DS09-BIG DATA ANALYTICS**

L	T	P	Cr.
3	0	0	3

Pre-requisites: Fundamentals of Data Mining

Course Educational Objectives: To familiarize students with the stages of the visualization pipeline, including data modeling, mapping data attributes to graphical attributes, perceptual issues, existing visualization paradigms, techniques, and tools, and evaluating the effectiveness of visualizations for specific data, task, and user types.

Course Outcomes: At the end of the course, the student will be able to

CO1 Understand The Fundamental Concepts of Big Data and HDFS. **(Understand-L2)**
CO2 Solve Big Data Problems Using Map reduce. **(Apply-L3)**
CO3 Implement various problems using Pig and Hive.**(Apply-L3)**
CO4 Use NoSQL Databases To Process Different Varieties of Data.**(Apply-L3)**
CO5 Perform In Memory Data Analytics With Spark and Spark Streaming.**(Apply-L3)**

UNIT – I

Introduction to big data: Data, Types of digital data, Evolution and Definition of big data, Challenges of big data, Characteristics and Need of big data.

Introduction to Hadoop: Introducing Hadoop, need of Hadoop, limitations of RDBMS, RDBMS versus Hadoop, Distributed Computing Challenges, History of Hadoop, Hadoop Overview, Hadoop Distributors.

HDFS (Hadoop Distributed File System): HDFS Daemons, Anatomy of file read, Anatomy of file write, working with HDFS commands.

UNIT – II:

Introduction to MAPREDUCE Programming: Processing Data with Hadoop, Managing Resources and Applications with Hadoop YARN (Yet another Resource Negotiator), Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression, Hadoop Ecosystem.

UNIT – III

Introduction to Pig: Key Features of pig, The Anatomy of Pig, Pig on Hadoop , Pig Philosophy, Pig Latin Overview, Data Types in Pig, Running Pig, Execution Modes of Pig, Relational Operators.

Introduction to HIVE: HIVE features, HIVE architecture, HIVE datatypes, HIVE File Formats, HIVE Query Language

UNIT – IV

NoSQL: Introduction to NOSQL, Types of NoSQL Databases, and Advantages of NoSQL databases, CAP Theorem, BASE, SQL versus NoSql.

Unit- V

Spark: Introduction to data analytics with Spark, Spark Stack, Programming with RDDS, Working with key/value pairs, Spark SQL, Schema RDD. Sparking Streaming: High level architecture of Spark Streaming, DStreams, Transformations on DStreams, Different Types of Transformations on DStreams.

Text Book(s):

1. SeemaAcharya, SubhashiniChellappan, “Big Data and Analytics”, Wiley Publishers, 2015, First Edition.

2. Holden Karau, Andy Konwinski, Patrick Wendell, MateiZaharia, “Learning Spark: Lightning-Fast Big Data Analysis", O'Reilly Media, Inc, 2015 First Edition.

Reference Books:

1. Tomwhite, Hadoop, “Thedefinitiveguide”, 3rdedition, O’reillypublications, 2012.
2. David Loshin, "BigDataAnalytics: From Strategic Planning to Enterprise IntegrationwithTools,Techniques,NoSQL,andGraph”, MorganKaufmannPublishers, 2013.
3. Hadoop in Practice by AlexHolmes, MANNING.
4. Dirk deRoos, Chris Eaton, George Lapis, Paul Zikopoulos, Tom Deutsch “Understanding Big Data Analytics for Enterprise Class Hadoop and Streaming Data”, 1st Edition, TMH,2012

L	T	P	Cr.

M. Tech. (II Sem.) **23DS10-DEEP LEARNING**

3	0	0	3

Pre-requisites: Foundations Neural Networks

Course Educational Objective:
Used to formalize tasks in terms of computational Complexity via Deep Learning Architectures. Helpful to Build datasets, tune and train deep learning models with advanced deep learning libraries and to understand the inner mechanisms of Deep learning Neural techniques during training

Course Outcomes: At the end of the course, the student will be able to

CO1: Design deep architectures and algorithms for pattern recognition **(Apply-L3)**
CO2: Analyze classification problems probabilistically and estimate classifier performance **(Apply-L3)**
CO3: Explore the essentials of Deep Learning and Deep Network architectures**(Apply-L3)**
CO4: Elaborate different types of deep learning network models**(Apply-L3)**
CO5: Explore the essentials of Optimization for Training Deep Models**(Understand-L2)**

UNIT – I: Introduction: How do we train Deep Architectures, Intermediate Representations: Sharing Features and Abstractions Across Tasks, Computational Complexity, Local vs Non-Local Generalization

UNIT – II: Probability and Information Theory: Why Probability, Random Variables, Probability Distributions, Conditional Probability, Independence and Conditional Independence, Expectation, Variance and Covariance, Information Theory, Common Probability Distributions.

UNIT – III : Neural Networks for Deep Architectures: Learning Algorithms, Generalization, Capacity, over fitting and under fitting, Generalization Error, Estimators, Bias and variance, Maximum Likelihood Estimation. Learning Mechanisms: Supervised Vs Unsupervised Learning.

UNIT – IV: Feed forward Deep Learning Neural Networks: Introduction, Formalizing and Generalizing Neural Networks, Multi-Layer Neural Networks, The Challenge of Training Deep Neural Networks, Unsupervised Learning for Deep Architectures, Deep Generative Architectures, Convolutional Neural Networks, Auto-Encoders.

UNIT – V: Optimization for Training Deep Models: Optimization for Model Training: Empirical Risk minimization, generalization, Data parallelism. Challenges in Optimization: Local Minima, III- Conditions, Plateaus, Saddle Points and Other flat regions. Optimization Algorithms: Gradient Descent, Stochastic Gradient Descent, Momentum

TEXTBOOKS

1 Learning Deep Architectures for AI", Foundations and Trends® in Machine Learning, Yoshua Bengio, 2009, Now Publishers
2 Deep Learning, YoshuaBengio Ian J. Goodfellow Aaron Courville, MIT Press, 2015

REFERENCES

1. Deep Learning in Python Prerequisites The Lazy Programmer (http://lazyprogrammer.me).
2. Deep Learning and Neural Networks, Jeff Heaton, Heaton Research, Inc 2015
Statistical Language Learning, Charniack, Eugene, MIT Press, 1993.

L	T	P	Cr.

M. Tech (II Sem) **23DS11-COMPUTER VISION**

3	0	0	3

Pre-requisites: Nil

Course Educational Objectives: To introduce students the fundamentals of image formation; To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition; To develop an appreciation for various issues in the design of computer vision and object recognition systems; and To provide the student with programming experience from implementing computer vision and object recognition applications.

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

CO1: Identify basic concepts, terminology, theories, models and methods in the field of computer vision. **(Understand-L2)**
CO2: Understand various feature extraction methods and its significance. **(Understand-L2)**
CO3: Describe basic methods of computer vision related to multi-scale representation **(Apply-L3)**
CO4: Describe basic methods of computer vision related to segmentation **(Understand-L2)**
CO5: Understand basic methods of computer vision related to object recognition **(Understand-L2)**

UNIT I

Image Formation Models: Monocular imaging system, Orthographic& Perspective Projection, Camera model and Camera calibration, Binocular imaging systems

UNIT II

Image Processing and Feature Extraction: Image representations (continuous and discrete), Edge detection

UNIT III

Motion Estimation: Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion

UNIT IV

Shape Representation and Segmentation: Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multiresolution analysis

UNIT V

Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal Component analysis, Shape priors for recognition.

TEXT BOOKS:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.

REFERENCE BOOKS:

1. Richard Szeliksy “Computer Vision: Algorithms and Applications” (http://szeliski.org/Book/)
2. Haralick& Shapiro, “Computer and Robot Vision”, Vol II
3. G_erardMedioni and Sing Bing Kang “Emerging topics in computer vision”
4. Emanuele Trucco and AllessandroVerri “Introductory Techniques for 3-D Computer Vision”, Prentice Hall, 1998.
5. Olivier Faugeras, “Three-Dimensional Computer Vision”, The MIT Press, 1993.

M.Tech. (II Sem.) **23DS12-NATURAL LANGUAGE PROCESSING**

L	T	P	Cr.
3	0	0	3

Pre-requisite **:** Machine Learning

Course Educational Objective: Natural language processing (NLP) is one of the most important technologies of the information age. Understanding complex language utterances is also a crucial part of artificial intelligence. Natural language processing (NLP) is the relationship between computers and human language. More specifically, natural language processing is the computer understanding, analysis, manipulation, and/or generation of natural language. This course enables the students to learn the Natural language processing at different levels like Morphological Level, Syntactic Level, Semantic Level, Discourse Level and Pragmatic Level.

Course Outcomes: At the end of this course, the student will be able to

CO1: Understand the Regular expressions and finite state automata. **(Understand-L2)**

CO2: Apply different models of syntax. (**Apply-L3**)

CO3: Understand Sentence – Level Constructions.**(Understand-L2)**

CO4: Apply different machine translation techniques **(Apply-L3)**

CO5: Understand the research trends using Deep Learning **(Understand-L2)**

Unit I

Introduction – Models -and Algorithms - -Regular Expressions, Finite State Automata, Morphology, Morphological Parsing

UNIT – II

N-grams Models of Syntax - Counting Words - Unsmoothed, Smoothing, Entropy, Part of Speech Tagging

UNIT – III

Context Free Grammars for English Syntax, Sentence- Level Constructions, Parsing – Top-down – Early Parsing, feature Structures – Probabilistic Context-Free Grammar

UNIT – IV

Discourse -Reference Resolution - Text Coherence - Discourse Structure – Coherence, Machine Translation -Transfer Metaphor–Interlingua- Statistical Approaches

UNIT – V

Applications of Natural Language Processing- Recent Research in NLP using Deep Learning: Factoid Question Answering, similar question detection, Dialogue topic tracking, Neural Summarization, Smart Reply.

Text Books:

1. Daniel Jurafsky, James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2/e, Prentice Hall, 2008.
2. C. Manning, H. Schutze, "Foundations of Statistical Natural Language Processing",

MIT Press. Cambridge, MA, 1999.

3. Jacob Eisenstein, Introduction to Natural Language Processing, MIT Press, 2019.
4. EBook: Le Deng, Yang Liu, Deep Learning in Natural Language Processing, Springer, 2018.
5. Jalaj Thanaki, Python Natural Language Processing: Explore NLP with machine Learning and deep learning Techniques, Packt, 2017

M.Tech. (II Sem.) **23DS13-BLOCK CHAIN TECHNOLOGY**

L	T	P	Cr.
3	0	0	3

Pre-requisite: Information Security

Course Educational Objective:

To understand block chain technology and Crypto currency works

Course Outcomes:

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

CO1: Demonstrate the block chain basics, Crypto currency **(Understand-L2)**

CO2: Compare and contrast the use of different private vs. public block chain and use cases **(Understand-L2)**

CO3: Design an innovative Bit Coin, Block chain and scripts, Block chain Science on varies coins **(Apply-L3)**

CO4: Classify Permission Block chain and use cases – Hyper ledger, Corda **(Analyze-L4)**

CO5: Use of Block-chain in E-Governance, Land Registration, Medical Information Systems and others **(Apply-L3)**

UNIT I:

Introduction: Introduction, basic ideas behind block chain, how it is changing the landscape of digitalization, introduction to cryptographic concepts required, Block chain or distributed trust, Currency, Cryptocurrency, How a Cryptocurrency works, Financial services, Bitcoin prediction markets.

UNIT II:

Hashing, public key cryptosystems, private vs public block chain and use cases, Hash Puzzles, Extensibility of Block chain concepts, Digital Identity verification, Block chain Neutrality, Digital art, Block chain Environment

UNIT III:

Introduction to Bitcoin : Bitcoin Block chain and scripts, Use cases of Bitcoin Block chain scripting language in micropayment, escrow etc Downside of Bit coin mining, Block chain Science: Grid coin, Folding coin, Block chain Genomics, Bit coin MOOCs.

UNIT IV:

Ethereum continued, IOTA, The real need for mining, consensus, Byzantine Generals Problem, and Consensus as a distributed coordination problem, Coming to private or permissioned block chains, Introduction to Hyper ledger, Currency, Token, Campus coin, Coin drop as a strategy for Public adoption, Currency Multiplicity, Demurrage currency

UNIT V:

Technical challenges, Business model challenges, Scandals and Public perception, Government Regulations, Uses of Block chain in E-Governance, Land Registration, Medical Information Systems.

Text Books:

1. Block chain Blue print for Economy by Melanie Swan

Reference Books:

1. Block chain Basics: A Non-Technical Introduction in 25 Steps 1st Edition, by Daniel Drescher

M.Tech. (II Sem.) **23DS14-PREDICTIVE ANALYTICS**

L	T	P	Cr.
3	0	0	3

Course Objectives: The course serves to advance and refine expertise on theories, approaches and techniques related to prediction and forecasting

Course Outcomes

CO1: Understand prediction-related principles, theories and approaches. **(Understand-L2)**

CO2. Learn model assessment and validation**. (Apply-L3)**

CO3. Understand the basics of predictive techniques and statistical approaches. **(Apply-L3)**

CO4. Analyze supervised and unsupervised algorithms**. (Apply-L3)**

UNIT - I

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection, Ridge regression, Lasso regression, Linear Discriminant Analysis, Logistic regression, Perceptron learning algorithm.

UNIT - II

Model Assessment and Selection: Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate, Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation, Bootstrap methods, conditional or expected test error.

UNIT - III

Additive Models, Trees, and Boosting: Generalized additive models, Regression and classification trees, Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, New Zealand fish, Demographic data)

UNIT - IV

Neural Networks (NN), Support Vector Machines (SVM), and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest – Neighbor classifiers (Image Scene Classification)

UNIT - V

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis.

TEXT BOOK:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning Data Mining, Inference, and Prediction, Second Edition, Springer Verlag, 2009

REFERENCES:

1. C. M. Bishop –Pattern Recognition and Machine Learning, Springer, 2006,L. Wasserman - All of statistics

2. Gareth James. Daniela Witten. Trevor Hastie Robert Tibshirani. An Introduction to Statistical

Learning with Applications in R

M.Tech. (II Sem.) **23DS15-REINFORCEMENT LEARNING**

L	T	P	Cr.
3	0	0	3

Pre-requisite: Basic Machine Learning and Linear Algebra

Course Educational Objective: To understand the foundation of Reinforcement learning is an area of machine learning, where an agent or a system of agents learn to archive a goal by interacting with their environment. RL is often seen as the third area of machine learning, in addition to supervised and unsupervised areas, in which learning of an agent occurs as a result of its own actions and interaction with the environment.

Course Outcomes:

CO1: Understand the Basic concepts of Reinforcement learning **(Understand-L2)**

CO2: Implement tabular methods to solve classical control problems **(Apply-L3)**

CO3: Understand the policy gradient methods from vanilla to more complex cases **(Understand-L2)**

CO4: Understand the importance of model based RL approaches **(Understand-L2)**

CO5: Recognize current advanced techniques and applications in RL **(Understand-L2)**

UNIT-1

Introduction and Basics of RL , Defining RL Framework and Markov Decision Process, Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation, Code Standards and Libraries used in RL (Python/Keras /Tensor flow)

UNIT-2

Tabular methods and Q-networks ,Planning through the use of Dynamic Programming and Monte Carlo, Temporal-Difference learning methods (TD(0), SARSA, Q-Learning) ,Deep Q-networks (DQN, DDQN, Dueling DQN, Prioritized Experience Replay)

UNIT-3

Introduction to policy-based methods: Vanilla Policy Gradient, REINFORCE algorithm and stochastic policy search, Actor-critic methods (A2C, A3C) , Advanced policy gradient (PPO, TRPO, DDPG)

UNIT-4

Model-based RL approach: Analytic gradient computation, Sampling-based planning, Model-based data generation, Value-equivalence prediction, Model-based policy optimization. Model-based RL approach Recent Advances and Applications**.**

UNIT-5

Meta-learning: Multi-Agent Reinforcement Learning. Partially Observable Markov Decision Process. Ethics in RL . Applying RL for real-world problems

TEXT BOOKS

1.Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", Second Edition, MIT Press, 2019

2. Li, Yuxi. "Deep reinforcement learning." arXiv preprint arXiv:1810.06339 (2018).

3.Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning." Adaptation, learning, and optimization 12 (2012): 3

REFERENCE BOOKS

1. Russell, Stuart J., and Peter Norvig. "Artificial intelligence: a modern approach."Pearson Education Limited, 2016.

2. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. "Deep learning." MIT press, 2016. • David Silver's course on Reinforcement Learning (link

M.Tech. (II Sem.)	23DS16-DIGITAL FORENSICS	L	T	P	Cr.
		3	0	0	3

Pre-Requisites: Cybercrime and Information Warfare, Computer Networks

Course Objectives:

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

Course Outcomes: On completion of the course the student should be able to

CO1. Understand relevant legislation and codes of ethics**. (Understand-L2)**

CO2. Computer forensics and digital detective and various processes, policies and procedures. **(Apply-L3)**

CO3. E-discovery, guidelines and standards, E-evidence, tools and environment. **(Apply-L3)**

CO4. Understand Email and web forensics and network forensics. **(Understand-L2)**

UNIT - I

Digital Forensics Science: Forensics science, computer forensics, and digital forensics.

Computer Crime: Criminalistics as it relates to the investigative process, analysis of cyber criminalistics area, holistic approach to cyber-forensics

UNIT - II

Cyber Crime Scene Analysis:

Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.

UNIT - III

Evidence Management & Presentation:

Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, explain what the normal case would look like, define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.

UNIT - IV

Computer Forensics: Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, Complete a case, Critique a case, Network Forensics: open-source security tools for network forensic analysis, requirements for preservation of network data.

UNIT - V

Mobile Forensics: mobile forensics techniques, mobile forensics tools. Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008. Recent trends in mobile forensic technique and methods to search and seizure electronic evidence

TEXT BOOKS:

1. John Sammons, The Basics of Digital Forensics, Elsevier
2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

REFERENCES:

1. William Oettinger, Learn Computer Forensics: A beginner's guide to searching, analyzing, and securing digital evidence, Packt Publishing; 1st edition (30 April 2020), ISBN: 1838648178.
2. Thomas J. Holt, Adam M. Bossler, Kathryn C. Seigfried-Spellar, Cybercrime and Digital Forensics: An Introduction, Routledg

M.Tech. (II Sem.)	23DS63-DEEP LEARNING LAB	L	T	P	Cr.
		0	0	4	2

Pre-requisite: Python

Course Educational Objective: The Objective of the course is to provide practical, foundation level training that enables to handle various high dimensional data sets using various deep learning techniques

Course Outcomes (CO): At the end of this course, the student will be able to:

CO1: Implement deep neural networks to solve real world problems **(Apply-L3)**

CO2: Choose an appropriate pre-trained model to solve real-time problems. (**Analyze – L4)**

CO3: Interpret the results of two different deep learning models. (**Analyze – L4)**

CO4: Improve individual / teamwork skills, communication & report writing skills with ethical values.

Experiments:

1. Numerical Methods to solve matrix problems in Python
2. Eigen Value decomposition techniques
3. Dimensionality Reduction-PCA
4. Fundamentals of Tensor flow
5. Build a Convolution Neural Network for MNIST Handwritten Digit Classification
6. Build a Convolution Neural Network for simple image Classification
7. Implement one hot encoding of words or characters.
8. Word2vec Framework
9. Implement word embedding's for IMDB dataset.
10. Implement a Recurrent Neural Network for IMDB movie review classification problem.

Text Book:

Reza Zadeh and Bharath Ramsundar, "Tensorflow for Deep Learning", O'Reilly publishers, 2018

References:

https://github.com/fchollet/deep-learning-with-python-notebooks

M.Tech. (II Sem.)	23DS64-DATA ANALYTICS AND VISUALIZATION LAB	L	T	P	Cr.
		0	0	4	2

Course Outcomes (CO): At the end of this course, the student will be able to:
CO1: Implement big data analytics using Hadoop Map Reduce, PIG and Spark **(Apply-L3)**
CO2: Process Semi structured and unstructured data using NoSQL databases. **(Apply-L3)**
CO3: Construct visualizations for effective data analysis **(Apply-L3)**
CO4: Improve individual / teamwork skills, communication & report writing skills with ethical Values.

Week 1
Hadoop Installation on
[1] a) Single Node b) Multi Node Cluster
[2] Hadoop Distributed File System Commands for File/folder operations.
[3] Graphical User Interface of HDFS to monitor the health of the HDFS
Week 2
[1] Design a distributed application using MapReduce which processes a log file of a system.
[2] List out the users who have logged for maximum period on the system.
[3] Use simple log file from the Internet and process it using MapReduce.
Week 3:
[1] Design and develop a distributed application to find the coolest/hottest year from the available weather data. Use weather data from the Internet and process it using MapReduce.
[2] Monitor the MapReduce Job Interface.
Week 4:
[1] Install and Run Pig then write Pig Latin scripts to sort, group, join, project and filter the data.
[2] Implement data preprocessing operations using Pig Latin
[3] Implement log file processing using Pig Latin
Week 5:
[1] Implement document processing using MongoDB document oriented database creation and its operations.
[2] Write an application using Graph Database Neo4J to store Facebook data and find the friend of friend, distance between two people.
Week 6:
[1] Implement data processing using Spark RDDS.
[2] Process streaming data using Spark Streaming.
[3] Connect Tableau with Spark cluster
[4] Analyze and visualize with Tableau
Week 7:
[1] Reading different types of data sets (.txt, .csv) from web and disk and writing in file in specific disk location. And Reading Excel, XML data sheets in R.
[2] Using with and without R objects on console, mathematical functions on console create R objects for calculator application and save in a specified location in disk.
[3] Write an R script to find basic descriptive statistics using summary, str, quartile unction on mtcars& cars datasets and to find subset of dataset by using subset (), aggregate () functions on dataset.
Week 8:
Implementing data visualization using R
[1] Find the data distributions using box and scatter plot.
[2] Find the outliers using plot.
[3] Plot the histogram, bar chart and pie chart on sample data.

Week 9:
Implementing basic operations in Tableau to get accustomed to its interface and Emphasizing the Results and Map View
[1] Tableau Workspace, connecting to a Data Source, creating a view and Refining the view
[2] Adding Filters to the view, Adding Colors to the view and Key Findings
[3] Building a Map View, getting into details and Identifying the Key points
Week 10:
Creating a dashboard and building story to showcase stories in presentation mode
[1] Creating a dashboard and Adding Instructiveness
[2] Building a Story and Making a Conclusion
Week 11& 12:
Case study 1:
Implementation of all types of Join operations using MapReduce for the given multiple datasets.
Case Study 2:
Implementation of PageRank algorithm using Apache Spark, the algorithm maintains two datasets: one of (page ID, link List) elements containing the list of neighbors of each page, and it has to find (page ID, rank) elements containing the current rank for each page.

Text Book(s):

[1] Cole Nussbaumer Knaflic, Storytelling With Data: A Data Visualization Guide for Business Professionals,Wiley Publications,2015
[2] Tom Soukup and Ian Davidson, "Visual Data Mining: Techniques and Tools for Data Visualization and Mining", 1st Edition, John Wiley & Sons, 2002
[3] Gauravvaish, "Getting Started with NoSQL"(Kindle Edition),1st edition,2007.
[4] TomWhite, Hadoop,"The Definitive Guide",4th Edition,O'Reilly Publications, 2012.
[5] Holden Karau, Andy Konwinski, Patrick Wendell, MateiZaharia, "Learning Spark: Lightning-Fast Big Data Analysis", O'Reilly Media, Inc.

Reference Books:

[1] Andy Kirk, Data Visualization & M Digitals Pvt Ltd.,2016
[2] Chun-houh ChenWolfgang Härdle Antony Unwin,," Handbook of Data Visualization", Springer-Verlag Berlin Heidelberg,2008.

M.Tech. (III Sem.)	23DS17- OPTIMIZATION TECHNIQUES FOR DATA ANALYSIS	L	T	P	Cr.
		3	0	0	3

Course Outcomes: On completion of the course the student should be able to
CO1. Understand the concept of optimality criteria for various types of optimization problem. **(Understand-L2)**
CO2. Analyze optimization algorithms for Linear Programming (**Analyze-L4)**
CO3. Solve various constrained and unconstrained nonlinear Programming problems. **(Apply-L3)**
CO4. Apply the modern optimization methods to provide optimal solution for a given problem. **(Apply-L3)**

UNIT I:
Introduction to Optimization: Introduction, Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems.
UNIT II:
Classical Optimization Techniques: Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints.
UNIT III:
Linear Programming
Introduction, Applications of Linear Programming, Standard Form of a Linear Programming Problem, Geometry of Linear Programming Problems, Solution of a System of Linear Simultaneous Equations, Pivotal Reduction of a General System of Equations Simplex Method: Motivation of the Simplex Method, Simplex Algorithm, Improving a Nonoptimal Basic Feasible Solution, Two Phases of the Simplex Method.
UNIT IV:
Nonlinear Programming Algorithms: Unconstrained Algorithms – Direct Search Method, Gradient method, Constrained Algorithms - Separable Programming, Quadratic Programming, Chance- Constrained Programming, Linear Combinations method, SUMT Algorithm.
Case Study 1: Chance Constrained Problem
UNIT V:
Modern Methods of Optimization
Introduction, Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, Optimization of Fuzzy Systems, Neural Network-Based Optimization
Case Study 2: Travelling Salesperson Problem

Text books:

1. Singiresu S Rao, “Engineering Optimization Theory and Practice", John Wiley and sons, 4th Edition, 2009.
2. HamdyA.Taha, “OprationResearch : An Introduction”, 8th Edition, Pearson Prentice Hall, 2007.
3. Paulo Cortez, “Modern Optimization with R”, Springer series, 2014.

Reference Books:

1. S.Rao, “Engineering optimization: Theory and practice”, 4th Edition, New Age International, 2009.
2. Edwin K. P. Chong and Stanislaw. Zak “An Introduction to Optimization”, John Wiley and sons, 2nd Edition 2001.

3. Andreas Antoniou, “Practical Optimization Algorithms and Engineering Applications”,
4. An Introduction to Optimization Edwin K., P. Chong & Stanislaw h. Zak.
5. Andreas Antoniou. “Practical Optimization Algorithms and Engineering Applications”, Springer Series, 2007

M.Tech. (III Sem.) **23DS18-NATURE INSPIRED COMPUTING**

L	T	P	Cr.
3	0	0	3

Course Objectives: Knowledge on significance of intelligence, genetic algorithms Ant Colony algorithms

Course Outcomes:

CO1. Familiar with Genetic algorithm and its applications. **(Understand-L2)**

CO2. Compare different Ant Colony Optimization algorithmic models. **(Apply-L3)**

CO3. Compare different Artificial Bee Colony Optimization algorithmic models. **(Apply- L3)**

CO4. Illustrate Particle swam optimization algorithm with an example. **(Apply-L3)**

UNIT - I:

Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-organization, swarm and evolutionary algorithms. Optimization problems – single and multi-objective optimization, heuristic, meta-heuristic and hyper heuristic functions.

UNIT - II:

Genetic algorithms - Mathematical foundation, Genetic problem solving, crossover and mutation. genetic algorithms and Markov process, applications of genetic algorithms

UNIT - III:

Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimization, variations of ACO, case studies.

UNIT - IV:

Particle Swarm algorithms - particles moves, particle swarm optimization, variable length PSO, applications of PSO, case studies. Artificial Bee Colony algorithms - ABC basics, ABC in optimization, multi-dimensional bee colony algorithms, applications of bee algorithms, case studies.

UNIT - V:

Selected nature inspired techniques - Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Firey algorithm, SDA algorithm, bat algorithm, case studies. Other nature inspired techniques - Social spider algorithm, Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm, Artificial immune system, Flower pollination algorithm, case studies.

TEXT BOOKS:

1. Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006

2. Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories, methods, and Technologies" IT Press, 2008

REFERENCES:

1. Leandro Nunes de Castro - " Fundamentals of Natural Computing, Basic Concepts, Algorithms
and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007

2. Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005

3. Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioner's Approach", Prentice Hall of India, New Delhi, 2020.

M.Tech. (III Sem.)	23DS19- CYBER SECURITY	L	T	P	Cr.
		3	0	0	3

Course Outcomes: On completion of the course the student should be able to
CO1 Identify the assets of information and significance of security. **(Understand-L2)**
CO2 Apply data leakage, protection and security policies on digital systems. **(Apply-L3)**
CO3 Analyze log files and backup strategies for securing the data in real time environment. **(Analyze-L4)**
CO4 Implement the issues in handling web vulnerabilities. **(Apply-L3)**

UNIT I: Information Security and Threats
Introduction – Information Security, Information Assets & Threats – Threats to Information Assets, Types of Attacks, Types of Virus, Types of Worms, Types of Trojans, Network Attacks, Common Vulnerabilities and Exposures (CVE).
UNIT II: Fundamentals of Information Security:
Elements of information security –Network Security, Application Security, Communications Security. Principles and concepts – data security – Critical Information Characteristics, Information States, Prevention Vs Detection, Types of controls – Access Control Models.
UNIT III: Data Leakage and Prevention
Introduction to Data Leakage, Organizational Data Classification, Location and Pathways, Content Awareness, Content Analysis Techniques, Data Protection Network Sniffers and Injectors – Sniffers Overview, Tcpdump, Windump, Wireshark, Ettercap, Hping.
UNIT IV: Log Correlation and Management
Event Logs - Concepts, Log Management and its need, Log Management Process, IIS Log Files, Log Analysis and Response. Data Backup: Data Backup -Overview, Types of Backup, Backup Procedures, Types of Storage.
UNIT V:
Web Application Hacking: Scanning for web vulnerabilities : Nikto, HTTP utilities - Curl, OpenSSL, Stunnel, Application Inspection – Zed Attack Proxy, Sqlmap, Password Cracking and Brute-Force Tools

Text Book(s):
1. Student Handbook – Security Analyst, NASSCOM
2. Anti-Hacker Tool Kit (Indian Edition) by Mike Shema, Publication McGraw Hill

Reference Books:
1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Nina Godbole and SunitBelpure, Publication Wiley
2. Nelson Phillips and EnfingerSteuart, “Computer Forensics and Investigations”, Cengage Learning, New Delhi, 2009.
3. Robert M Slade,” Software Forensics”, Tata McGraw - Hill, New Delhi, 2005
4. Kevin Mandia, Chris Prosise, Matt Pepe, “Incident Response and Computer Forensics “, Tata McGraw -Hill, New Delhi, 2006.
5. McClure, Stuart, Saumil Shah, and Shreeraj Shah. Web Hacking:attacks and defense. Addison Wesley. 2003.

M. Tech. (I Sem.)	AUDIT COURSE-I 23AC05 – CONSTITUTION OF INDIA	L	T	P	Cr.
		2	0	0	0

Pre-requisites: Nil

Course Educational Objectives:

- To enable the student to understand the importance of constitution.
- To understand the structure of Executive, Legislature and Judiciary.
- To understand Philosophy of fundamental rights and duties.
- To understand the autonomous nature of constitution bodies like Supreme Court and High Court Controller and Auditor General of India and Election Commission of India.
- To understand the Central and State relation, financial and administrative.

Course Outcomes: At the end of the course, the student shall be able to

CO1: Understand history and philosophy of constitution with reference to Preamble, Fundamental Rights and Duties (Understand – L2).

CO2: Understand the concept of Unitary and Federal Government along with the role of President, Prime Minister and Judicial System (Understand – L2).

CO3: Understand the structure of the state government, Secretariat, Governor and Chief Minister and their functions (Understand – L2).

CO4: Learn local administration viz. Panchayat, Block, Municipality and Corporation (Understand – L2).

CO5: Learn about Election Commission and the process and about SC, ST, OBC and women (Understand – L2).

UNIT – I:

Introduction to Indian Constitution: 'Constitution' meaning of the term, Indian Constitution – Sources and Constitutional History, Features – Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT – II:

Union Government and its Administration Structure of the Indian Union: Federalism Centre – State relationship, President: Role, Power and Position. Prime Minister (PM) and Council of Ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. The Supreme Court and High Court: Powers and Functions.

UNIT – III:

State Government and its Administration Governor – Role and Position – Chief Minister (CM) and Council of Ministers. State Secretariat: Organization, Structure and Functions.

UNIT – IV:

A Local Administration -- Role and Importance, Municipalities – Mayor and Role of Elected Representative, Panchayati Raj: Functions of Panchayati Raj Institution, Zilla Panchayat, Elected Officials and their roles, Village level – Role of Elected and Appointed officials.

UNIT – V:

Election Commission: Election Commission – Role of Chief Election Commissioner and Election Commissionerate State Election Commission: Functions and Commissions for the welfare of SC/ST/OBC and Women.

Reference Books:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd., New Delhi.
2. Subash Kashyap, Indian Constitution, National Book Trust.
3. J. A. Siwach, Dynamics of Indian Government and Politics.
4. D.C. Gupta, Indian Government and Politics.
5. H. M. Sreevai. Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication).
6. J.C. Johari, Indian Government and Politics Hans.
7. J. Raj, Indian Government and Politics.
8. M. V. Pylee, Indian Constitution, Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd., New Delhi.
9. Noorani, A. G. (South Asia Human Rights Documentation Centre), Challenges to Civil Right). Challenges to Civil Rights Guarantees in India, Oxford University Press 2012.

E-Resources:

1. nptel.ac.in/courses/109104074/8.
2. nptel.ac.in/courses/109104045.
3. nptel.ac.in/courses/101104065.
4. www.hss.iitb.ac.in/en/lecture-details.
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indianconstitution.

M. Tech. (II Sem.)	AUDIT COURSE-II 23AC01 – ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	Cr.
		2	0	0	0

Pre-Requisites: Knowledge in English

Course Educational Objective:
This course gives knowledge on research paper writing skills. This course also describes the different sections of the research paper. This course also provides skills that are needed for publication which includes paper preparation, plagiarism check and submission process.

Course Outcomes (COs): At the end of the course, students will be able to
CO1: **Understand** research article readability and writing skills.
CO2: **Identify** essential parameters of each section of research articles.
CO3: **Apply** the knowledge for writing and submit research paper for publication.
CO4: **Develop** skills that are required to maintain quality of research paper.

UNIT-I: Research paper Writing Skills Part-I
Planning and Preparation, Word Order, Breaking up long sentences, Structuring, Paragraphs and Sentences, Being Concise, and Removing Redundancy

UNIT-II: Research paper Writing Skills Part-II
Avoiding Ambiguity and Vagueness, Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism

UNIT-III: Parts of research Paper
Title, Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.

UNIT-IV: Preparation of manuscript
Key skills are needed when writing a Title, an Abstract, an Introduction, a Review of the Literature, the Methods, the Results, the Discussion, Conclusions, preparing the tables and figures

UNIT-V: Publishing the Paper
Rights and Permission, How to Submit the Manuscript, The Review Process (How to Deal with Editors), The Publishing Process (How to Deal with Proofs) and After Publication.

Text Books:
1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day, Robert A., How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.

M.Tech. (III Sem.)

23DS81-INTRODUCTION TO ARTIFICIAL INTELLIGENCE

L	T	P	Cr.
3	0	0	3

Pre-requisite: Basic Engineering Mathematics Knowledge

Course Educational Objective: The objective of the course is to present an overview of artificial intelligence (AI) principles and approaches. Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, reasoning, and learning. Students will implement a small AI system in a team environment. The knowledge of artificial intelligence plays a considerable role in some applications students develop for courses in the program**.**

Course Outcomes: At the end of this course, the student will be able to

CO1: Enumerate the history and foundations of Artificial Intelligence. **(Understand-L2)**

CO2: Apply the basic principles of AI in problem solving**. (Apply-L3).**

CO3: Illustrate the different searching algorithms to find and optimize the solution for the given problem**. (Apply-L3)**

CO4: Illustrate the different gaming algorithms and identify the importance of knowledge representation in Artificial Intelligence. (**Apply- L3)**

CO5: Describe the use of predicate logic to represent the knowledge in AI domain. **(Understand - L2)**

UNIT I

Introduction: What Is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

UNIT II

Problem Solving: Problem-Solving Agents, Example Problems, searching for Solutions, search algorithms terminologies, properties of search algorithms, types of search algorithms. Informed and Uninformed Search Strategies, Informed (Heuristic) Search Algorithms: Best first search, A* Algorithm, AO* Algorithm and Local Search Algorithms. Searching with Non deterministic Actions.

UNIT III

Search Algorithms: Uniformed / Blind Search Algorithms: Breadth- first Search, Depth first Search, Depth-limited Search, Iterative deepening depth-first search, Uniform cost search, Bidirectional Search.

UNIT IV

Adversarial Search/ Game Playing: Introduction, Minimax algorithm, Alpha-Beta pruning. Knowledge-Based Agent: Architecture, Knowledge base Levels, Types , Knowledge Representation mappings, forward and backward chaining/Reasoning techniques of inference engine , Approaches of knowledge representation, issues in knowledge representation.

UNIT V

Knowledge Representation Techniques: Propositional Logic: A Very Simple Logic, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, What is Reasoning? Types of Reasoning and Reasoning Systems for Categories, The Internet Shopping World.

TEXTBOOKS:

1. Stuart Russell, Peter Norvig,"Artificial Intelligence: A Modern Approach", 3 rd edition,
2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India,2011
3. Rich & Knight, Artificial Intelligence, second edition,Tata Mc GrawHill.

REFERENCE BOOKS:

1. Nils Nilsson, "ArtificialIntelligence: A New Synthesis", Morgan Kaufmann, 1998.
2. David Poole, Alan Mackworth, "ArtificialIntelligence: Foundations for Computational

Agents",Cambridge Univ. Press, 2010.
3. Ronald Brachman, "Knowledge Representation and Reasoning", Morgan Kaufmann, 2004.
4. Frank van Harmelen, Vladimir Lifschitz, Bruce Porter (Eds), "Handbookof Knowledgerepresentation", Elsevier, 2008.
5. Ivan Bratko, "Prolog Programming for ArtificialIntelligence", 4thEd., Addison-Wesley, 2011

M.Tech. (III Sem.)

23DS82-INTRODUCTION TO MACHINE LEARNING

L	T	P	Cr.
3	0	0	3

Pre-requisite: Probability and Statistics

Course Educational Objective: The objective of the course is to provide the basic concepts and techniques of Machine Learning and help to use recent machine learning approaches for solving practical problems. It enables students to gain experience to do independent study and research.

Course Outcomes: At the end of this course, the student will be able to

CO1: Identify the characteristics of machine learning. **(Understand- L2)**

CO2: Understand the Model building and evaluation approaches**. (Understand- L2)**

CO3: Apply regression algorithms for real-world Problems. **(Apply- L3)**

CO4: Handle classification problems via supervised learning algorithms. **(Apply-L3)**

CO5: Learn advanced learning techniques to deal with complex data. **(Apply- L3)**

UNIT I

Introduction to Machine Learning - Introduction, Types of Machine Learning, Applications of Machine Learning, Issues in Machine Learning. Preparing to Model Introduction, Machine Learning Activities, Basic Types of Data in Machine Learning,Exploring Structure of Data, Data Quality and Remediation, Data Pre-Processing

UNIT II

Modeling & Evaluation- Introduction, selecting a Model, training a Model (for Supervised Learning), Model Representation and Interpretability, Evaluating Performance of a Model.

Basics of Feature Engineering- Introduction, Feature Transformation – Feature Construction, Feature Extraction, Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Linear Discriminate Analysis (LDA), Feature Subset Selection

UNIT III

Regression: Introduction to regression analysis, Simple linear regression, Multiple linear regression, Assumptions in Regression Analysis, Main Problems in Regression Analysis, Improving Accuracy of the linear regression model, Polynomial Regression Model, Logistic Regression, Regularization, Regularized Linear Regression, Regularized Logistic Regression.

UNIT IV

Supervised Learning: Classification- Introduction, Example of Supervised Learning, Classification Model, and Classification Learning Steps. Common Classification Algorithms - k-Nearest Neighbor (kNN), Support vector Machines (SVM), Random Forest model.

UNIT V

Other Types of Learning : Ensemble Learning- Bagging, Boosting, Stacking and its impact on bias and variance, Ada Boost, Gradient Boosting Machines, XG Boost. Reinforcement Learning - Introduction, Q Learning

TEXTBOOKS

1. Subramanian Chandra mouli, Saikat Dutt, Amit Kumar Das, “Machine Learning”, Pearson Education India ,1st edition,2015.

2. Tom M. Mitchell, “Machine Learning’, MGH, 1997.

REFERENCE BOOKS

1. Shai Shalev-Shwartz, ShaiBen David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge.

2. Peter Harington, “Machine Learning in Action” , Cengage, 1st edition, 2012.

3. Peter Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge university press,2012.

4. Jason Brownlee, “Machine Learning Mastery with Python Understand Your Data, Create Accurate Models and Work Projects End-To-End”, Edition: v1.4, 2011.

M.Tech. (III Sem.) **23DS83-INTRODUCTION TO DATA SCIENCE**

L	T	P	Cr.
3	0	0	3

Pre-requisite : Programming knowledge

Course outcomes:

CO1: Identify basic building blocks of python to solve mathematical problems. **(Understand L2)**

CO2: Describe the key concepts in data science. **(Understand-L2)**

CO3: Enumerate the fundamentals of NumPy. (**Understand L2**)

CO4: Demonstrate the fundamentals of Pandas. (**Understand L2**)

CO5: Demonstrate data analysis, manipulation and visualization of data using Python libraries. (**Apply L-3)**

UNIT I

Introduction to Python: Features of Python, Data types, Operators, Input and output, Control Statements. Strings: Creating strings and basic operations on strings, string testing methods. Lists, Dictionaries, Tuples.

UNIT II

What is Data science? Data Science life cycle ,Datafication, Exploratory Data Analysis, The Data science process, A data scientist role in this process.

UNIT III

NumPy Basics: The NumPy ndarray: A Multidimensional Array Object, Creating ndarrays , Data Types for ndarrays, Basic Indexing and Slicing, Boolean Indexing, Fancy Indexing, Expressing Conditional Logic as Array Operations, Methods for Boolean Arrays Sorting , Unique.

UNIT IV

Getting Started with pandas: Introduction to pandas, Library Architecture, Features, Applications, Data Structures, Series, Data Frame, Index Objects, Essential Functionality Re indexing, Dropping entries from an axis, Indexing & selection, and filtering.

UNIT V

Data Preprocessing: Data Loading, Storage, and File Formats - Reading and Writing data in text format, binary data formats, interacting with html and web apis, interacting with databases; Data Wrangling: Clean, Transform, Merge, Reshape - Combining and Merging Data Sets, Reshaping and Pivoting, Data Transformation. String Manipulation; Data Aggregation.

TEXT BOOKS:

1. Wes McKinney, “Python for Data Analysis”, O’REILLY, ISBN:978-1-449- 31979-3, 1st edition, October 2012.
2. Rachel Schutt & O’neil, “Doing Data Science”, O’REILLY, ISBN:978-1- 449-35865-5, 1st edition, October 2013.
3. Python For Data Analysis (O Reilly, Wes Mckinney)

REFERENCE BOOKS:

1. Python: The Complete Reference, Martin C. Brown, McGraw Hill Education
2. Joel Grus, “Data Science from Scratch: First Principles with Python”, O’Reilly Media, 2015
3. Matt Harrison, “Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, O'Reilly, 2016.