DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)
Shahbad Daulatpur, Bawana Road Delhi – 110042

SCHEME OF TEACHING AND EVALUATION FOR M.TECH. BY RESEARCH IN INFORMATION TECHNOLOGY WITH SPECIALIZATION IN DATA SCIENCE AND ENGINEERING

Semester - I														
Group	**S.No.**	**Course Code**	**Course Name**	**Type/ Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**	**Total Credits**
Group A	1	RUCC501	Research and Publication Ethics (RPE)	UCC	2	2	0	0	-	-	25	50	0	**18**
	2	RUCC503	Research Methodology	UCC	4	4	0	0	25	-	25	50	0	
	3	RITR501	Advance Data Structures and Algorithms	DCC	4	4/3	0	0/2	25/15	-/25	25 / 20	50 / 40	0	
	4	RITR505	Fundamentals of Data Science and Machine Learning	DCC	4	4/3	0	0/2	25/15	-/25	25 / 20	50 / 40	0	
	5	RITR507	Report 1	DCC	4	0	0	6	-	40/50	-	-	60 / 50	
Semester - II														
Group	**S.No.**	**Course Code**	**Course Name**	**Type/ Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**	**Total Credits**
Group B	1	RITR502	Data Engineering and Analytics	DCC	4	4 / 3	0	0 / 2	25 / 15	- / 25	25 / 20	50 / 40	0	**22**
	2	RITR504	Deep Learning and Applications	DCC	4	4 / 3	0	0 / 2	25 / 15	- / 25	25 / 20	50 / 40	0	
	3	RITR508	Report 2	DCC	6	0	0	6	-	40 / 50	-	-	60 / 50	
Gro	4	RITR532	Elective 1	DEC/ GEC	4	4 / 3	0	0 / 2	25 / 15	- / 25	25 / 20	50 / 40	0	

	5	RITR534	M.Tech(R) Project -1	DEC/ GEC	4	4 / 3	0	0 / 2	25 / 15	- / 25	25 / 20	50 / 40	0	

Semester - III

Group	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Grou	1	RITR631	M.Tech(R) Project -2	DEC/ GEC	4	4 / 3	0	0 / 2	25 / 15	- / 25	25 / 20	50 / 40	0	**16**
Gro	2	RITR601	Report 3	DCC	12	0	0	12	-	40 / 50	-	-	60 / 50	

Semester - IV

Group	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group	1	RITR602	Final Report	DCC	24	0	0	24	-	-	-	-	100	**24**

List of Elective Courses

	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	1	-	Financial Data Analytics	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	2	-	Quantum Computing	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	3	-	Advanced Computer Vision	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	4	-	Genrative AI	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	5	-	Image Analysis	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	6	-	Artificial Intelligence	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	7	-	Business Intelligence and data warehousing	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	8	-	Information Integration and Data Analytics	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	9	-	Distributed Cloud Computing	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	

	10	-	Natural Language Processing	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	11	-	Ethical AI	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	12	-	Big Data Analytics	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	
	13	-	GPU computing	DEC	4	4/3	0	0/2	25/15	25	25/20	50/40	-	

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
RITR501: Advanced Data Structures	3	0	2	C/C++ Programming, Foundations of Algorithms and Data Structures

Course Objective: To provide in-depth knowledge and understanding of advanced data structures, their design, analysis, implementation, and to prepare students to tackle complex computational problems efficiently.

S. NO	Course Outcomes (CO)
CO1	Understand and implement various advanced tree structures
CO2	Utilize skip lists for randomized data structure operations and implement advanced heap structures
CO3	Apply union-find algorithms for disjoint sets and solving problems related to graph representation
CO4	Implement network flow algorithms as well as graph coloring techniques
CO5	Design and analyze approximation algorithms for NP-hard problems and geometric algorithms
CO6	Implement dictionary abstract data types and applying various hashing techniques

S. NO	Contents	Contact Hours
UNIT 1	Advanced Tree Structures:- : Binary Search Trees, Balanced Multi-way Trees, Segment Tree AVL Trees, Red-Black Trees, 2-3 Trees, B-Trees, Splay Trees: Concept, Properties, Operations	6
UNIT 2	Skip Lists and Advanced Heaps Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations, Probabilistic Analysis, Deterministic Skip Lists Binomial Heaps: Structure, Basic Operations, Union, Insertion, Deletion Fibonacci Heaps: Structure, Insertion, Union, Decrease Key, Delete Node Pairing Heaps: Structure, Operations, and Analysis	8
UNIT 3	Disjoint Sets and Advanced Graph Algorithms I Disjoint Sets: Union-Find Algorithms, Union by Rank, Path Compression, Applications Graph Representation: Types of Graphs, Paths, and Circuits, Euler Graphs: Concept and Properties Hamiltonian Paths & Circuits: Concept and Properties, Cut-sets: Definition and Applications Connectivity and Separability: Definitions and Applications, Planar Graphs: Concept and Properties Isomorphism: Concept and Applications	8
UNIT 4	Advanced Graph Algorithms II and Network Flow Algorithms Network Flow Algorithms: Ford-Fulkerson Method, Edmonds-Karp Algorithm, Max-Flow Min-Cut Theorem Graph Coloring: Techniques, Algorithms, and Applications	7
UNIT 5	Approximation Algorithms and Geometric Algorithms Approximation Algorithms: Set Cover, Max-SAT, Knapsack, Bin Packing, Scheduling, Traveling Salesman Tour Geometric Algorithms: Convex Hull Algorithms, Lower Bound of Convex Hull, Line Segment Intersection, Closest Pair Points	7
UNIT 6	Dictionaries, Hashing Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	6
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein	3rd Edition, 2009
2	Algorithms" by Robert Sedgewick and Kevin Wayne	4th Edition, 2011
3	Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and D.Mount, Seventh Edition Wiley student edition, John Wiley and Sons.	1st Edition, 2008
4	Algorithm Design" by Jon Kleinberg and Éva Tardos	1st Edition, 2005
5	Advanced Data Structures" by Peter Brass	1st Edition, 2008

Course Title	Course Structure			Pre-Requisite
	L	T	P	
RITR505: Fundamentals of Data Science and Machine Learning	3	0	2	Probability, Statistics, Linear Algebra

Course Objective: 1. To familiarize with different types of data and its visualization.
2.To understand and practice data pre-processing, data modeling and data exploration.
3. To solve real-world analytical problems in data science.

S. NO.	Course Outcomes (CO)
CO1	Ability to identify different types of data and data distributions.
CO2	Ability to understand and apply different data cleaning and data transformation techniques.
CO3	Ability to understand and implement different data visualization techniques and data exploration techniques
CO4	Analyse and implement supervised learning algorithms like SVM, decision trees, neural networks for problem solving
CO5	Abiltiy to understand genetic algorithm and fuzzy sets.

S. NO.	Contents	Contact Hours
UNIT 1	**Introduction to data science:** Basics of Probability & Statistics (Random Variables, Bayes's Theorem, Normal distribution, Central Limit Theorem). Defining data science, Recognizing different types of data, Data distributions. Data acquisition and data storage. Data pre-processing: Missing data problem, Outlier definition. Data cleaning, Data transformation or data wrangling procedures such as merging, ordering and aggregating.	10
UNIT 2	Data visualization: Introduction to data visualization, Challenges of data visualization. Definition of Dashboard, Dashboard design and principles. Basic charts and plots, Box plots, Histogram, Graphs, Networks, Hierarchies, Reports.	6
UNIT 3	Exploratory Data Analysis: Data exploration for univariate data. Outlier detection techniques. Descriptive statistics (mean, standard deviation etc.) for data exploration. Correlation statistics for data exploration. Data exploration for multivariate data. Use of multivariate visualization tools such as bar charts, bar plots, heat maps, bubble charts, run charts, and scatter plots.	10
UNIT 4	Supervised Learning: Linear Regression models, classification, Linear discriminant analysis, Probably Approximately Correct (PAC) Learning, Learning Multiple Classes, Model Selection and Generalization, Support vector machine, Decision trees, Nearest neighbors, neural networks.	8
UNIT 5	Unsupervised Learning: Clustering, Mixture Models, Latent Variables, Expectation-Maximization, Feature selection, Dimensionality Reduction, Factor/Component Analysis, Linear Discriminant Analysis.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei, 3rd ed., *Morgan Kaufmann*	2022
2	Data science from scratch, Joel Grus, 2nd ed., *O'Reilly Media.*	2019
3	Python data science handbook, Jake VanderPlas, 2nd ed., O'Reilly Media.	2016
4	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, 2nd ed., O'Reilly Media.	2019
5	Alpaydin, E, Introduction to Machine Learning, MIT Press, 2004	2004
6	David Barber, Machine Learning: A probabilistic approach, 2006.	2006
7	Charlie Kaufman, Radia Perlman and Mike Spencer, "Network Security: Private Communication in a Public World", Prentice Hall.	2002
8	Tom Mitchell , Machine Learning, McGraw Hill, 1997	1997

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
RITR502:Data engineering and analytics	3	0	2	Probability, Statistics, Linear Algebra

Course Objective: 1. To familiarize with the concepts of data mining, data storage, data pipeline and data integration.
2.To analyze data using classification, clustering, feature selection, association rule mining and itemset mining.
3. To understand and explore data warehousing architectures and data lakes.

S. NO.	Course Outcomes (CO)
CO1	Ability to understand and describe data mining, data storage, data pipeline and data integration concepts.
CO2	Ability to understand and implement classification and clustering algorithms for analyzing linearly and non-linearly separable data.
CO3	Ability to understand and implement feature selection algorithms for data reduction.
CO4	Ability to understand and explore patterns and dependencies in data using association-rule mining and itemset-mining.
CO5	Ability to understand, explore and describe data warehousing architectures and data lakes.

S. NO.	Contents	Contact Hours
UNIT 1	**Introduction to data engineering:** Storing data, Data loading, Data transformation, Data structures, SQL and NoSQL databases, Database normalization, Data cubes, Snowflake scheme, Data warehouses, Data lakes, Data Marts, Metadata in Data Warehouse, Data pipeline, Data integration- Extract, Transform, and Load (ETL) processes for integrating data from multiple sources.	10
UNIT 2	**Advanced data analytics and machine learning:** Cluster Analysis, Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods. Classification techniques for linearly separable and non-linearly separable data- Linear Discriminant Analysis and Support Vector Machine. Feature Ranking and Feature Selection Algorithms. Associations and correlations- basic concepts, efficient and scalable frequent item sets mining methods, mining various kinds of association rules, constraint-based association mining.	12
UNIT 3	**Data warehousing**: Planning Your Data Warehouse, The Data Warehouse Project, Architectural Components: Understanding Data Warehouse Architecture, Infrastructure Supporting Architecture, Collection of Tools. Indexing the data warehouse, performance enhancement techniques.	10
UNIT 4	**Data design and data preparation**: From Requirements to Data Design, The STAR Schema, STAR Schema Keys, Advantages of the STAR Schema. Data modeling for data warehouses. Scalable data engineering solutions - handling massive datasets. Online Analytical Processing models, Online Transaction Processing models. .	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei, 3rd ed., *Morgan Kaufmann*	2022
2	Mining Introductory and Advanced Topics, M.H. Dunham, Pearson Education.	2002
3	Data mining, Pieter Adriaans, Pearson Education.	1996
4	Data warehousing in the real world for building decision support systems, Sam Anahory, Pearson Education.	1997
5	The Data Warehouse Lifecycle toolkit, Ralph Kimball, John Wiley.	1996
6	Fundamentals of database systems, Ramez Elmasri, Pearson Education.	2000
7	Oracle8 data warehousing, Michael Corey, Tata McGraw Hill.	1998
8	Data Warehousing Fundamentals, Paulraj Ponniah, John Wiley.	2001

Course code: Course Title	Course Structure			Pre-Requisite
Generative AI	L	T	P	Artifical Intelligence
	4	0	2	

Course Objective: To learn the fundamental concepts of Blockchain technologies for various applications

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of transformers, diffusion models, and their applications in vision and language tasks
CO2	Analyze and differentiate between various transformer architectures used in language and vision, including GPT, BERT, ViT, and CLIP.
CO3	Implement and fine-tune multi-modal and generative foundation models using efficient training and inference techniques
CO4	Evaluate foundation models using standard benchmarks and address issues related to hallucinations, bias, fairness, privacy, and prompt

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Foundation Models:Transformers & Attention : Introduction to Transformers, Self-Attention, Cross-Attention, Perceiver: Arbitrary IO with transformers, Self Attention & Non-Parametric Transformers Diffusion : Sampling, Diffusion Models, Latent Diffusion Models (LDM) Applications : LLMs, LVMs and Applications in Vision	14
UNIT 2	Foundation Model Architectures:Foundation Model Architectures: Transformers in Language including GPT, BERT, RetNet, State Space ModelsTransformers in Vision: ViT, MLP-Mixer, Conformer, Vision-Language(VL) models, CLIP Architectures: Dual-Encoder, Fusion, Encoder-Decoder, Adapted LLM, Unified Architectures	14
UNIT 3	Multi-Modal & Generative Foundation Models:Training & Inference : Training Objectives , Contrastive Learning, Efficient Inference Techniques, Pre-training, Fine-tuning & Parameter Efficient Fine-tuning (LoRA, QLoRa), Flash Attention, Retrieval Augmented Generation (RAG)	8
UNIT 4	Evaluation & Benchmarking: Evaluation Protocols and Standard Benchmarks, Hallucinations, Bias & Fairness, Privacy, Memorization, Machine Unlearning, Prompt Engineering	6
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models" Joseph Babcock and Raghav Bali, packt Publishing	2021
2	"Learn Python Generative AI: Journey from autoencoders to transformers to large language models", Zonunfeli Ralte and Indrajit Kar, Bpb Publication.	2024
3	"Generative Deep Learning" By David Foster & Karl Friston, O'Reilly.	2023

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Business Intelligence and Data Warehousing	4	0	0	DBMS

Course Objective: Give students the understanding on the role and operation of data warehouses, business intelligence. Equip students with skills of developing data warehouses. Equip students with skills of maintaining existing data warehouses. Equip students with skills of manipulating data warehouses to generate information for business decision making.

S. NO	Course Outcomes (CO)
CO1	To understand business intelligence, DE normalizations and relational database review.
CO2	To understand data warehouse, objetcs and various data sources
CO3	To Understand data mining, various analytics algorithms and mobile analytics.
CO4	To Understand business intelligence, various query designer and keys.
CO5	To understand query properties, designing reports, visualization of business intelligence

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Business Intelligence, Data Warehouses, Data mining, Pivot Tables, Relational Database review, Database Normalization, normal forms, DE normalization of tables, SQL, Data Warehousing fundamentals	8
UNIT 2	Modelling the data warehouse: Data sources, operational data store, data marts, Characteristics and key figures , Creating InfoObjects, Building InfoCubes	6
UNIT 3	Data Mining : Statistical techniques in data mining , Preparing data for mining, Association analysis, market basket analysis, Clustering , Classification, Regression, Decisions Trees, Building analytics applications, Mobile analytics. Data Extraction, Transformation and Loading (ETL) in SAP BW Extraction from data sources such as SAP ERP, Flat file extraction, Defining and using Persistent staging areas PSA.	11
UNIT 4	Introduction to Business Intelligence with Business Objects Analysis: Navigating in reports, Designing queries in the Query Designer, Using InfoProviders and InfoObjects for queries, Calculated and restricted key,	9
UNIT 5	Query properties and navigation, Exceptions and Conditions, Front end visualization of business intelligence, Designing Dashboards, Designing reports, Business Objects Web Intelligence, Crystal Reports.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	R. and Ross, The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling Kimball, M.Second Edition. John Wiley & Sons	2006
2	Richard O. Duda, Peter E. Hart, David G. Stork , “Pattern Classification”, IInd edition, Wiley, 1973 Christopher M. Bishop, “Pattern Recognition and Machine Learning”,	2002

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Image Analysis	3	0	2	-

Course Objective: The course aims to provide students with comprehensive knowledge and practical skills in image analysis, including techniques for image enhancement, restoration, segmentation, and the application of various algorithms to effectively interpret and process digital images.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of a digital image processing system.
CO2	Analyze images in the frequency domain using various transforms.
CO3	Evaluate techniques for image enhancement in the spatial and frequency domain.
CO4	Elucidate the mathematical modelling of image restoration.
CO5	Interpret image segmentation and representation techniques.

S. NO	Contents	Contact Hours
UNIT 1	Fundamental steps in DIP, concept of visual information, image formation model, image sampling and quantization, digital image representation, spatial and gray level resolution, relationship between pixels, application of image processing system.	8

UNIT 2	Introduction to Multidimensional signals and systems, 2D-Signals, 2D systems, classification of 2D system, 2D convolution, 2D Z-transform, Image Transform: 2DDFT, discrete cosine, discrete sine, Haar, Walsh, Hadamard, Slant, KL, SVD, Hough,Radon, Ridgelet.	**10**
UNIT 3	Image enhancement; Spatial domain: linear transformation, image negative, grey level shifting, non-linear transformation, logarithmic transformation, exponential transformation, grey level slicing, bit plane slicing, image averaging, mask processing, histogram manipulations.	**8**
UNIT 4	Image Restoration :Image Restoration – degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering	**8**
UNIT 5	Image Segmentation :Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Rafael C. Gonzalez, Richard Eugene Woods "Digital Image Processing" 3rd Edition.	2008
2	Anil K. Jain, Fundamentals of Digital Image Processing Pearson.	2002
3	Kenneth R. Castleman, Digital Image Processing Pearson.	2006
4	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc.	2011

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Artificial intelligence	**4**	**0**	**0**	**Basic course on probability and statistics**

Course Objective: To familiarize the student with the foundations of Artificial Intelligence (AI) and to trace the evolution of AI from knowledge and reasoning based techniques to contemporary AI technologies.

S. NO	Course Outcomes (CO)
CO1	To analyze different types of agents and environments.
CO2	To design and analyze various intelligent search techniques.
CO3	To represent knowledge using Predicate logic.
CO4	To solve rule-based systems, Resolution, and semantic nets and frames.
CO5	To implement probabilistic reasoning and inferencing systems.
CO6	To understand the design of real-world intelligent systems and applications.

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Foundations of AI, AI Problems, Task Domains of AI, Introduction to Intelligent program and Intelligent agents, types of agents and environments. Problem Solving: Basic Problem-solving Method: state space search, problem formulation, uninformed and informed search.	**8**
UNIT 2	Heuristic search Techniques: Hill climbing techniques, Best First search, A* Search, Problem Reduction: AO* Search, Constraint Satisfaction. Evolutionary and metaheuristic algorithms- genetic algorithm, simulated annealing. Game Playing: Game Tree, Searching procedure Minimax, alpha-beta pruning	**10**
UNIT 3	Knowledge Representation: Knowledge Representation issues. Knowledge Representation using Predicate Logic: Unification, resolution. Rule based Systems: Forward versus backward reasoning, conflict resolution. Structured Knowledge Representation: Semantic Nets, Frames, conceptual dependency, scripts.	**10**
UNIT 4	Reasoning: Handling uncertainty Non-Monotonic Reasoning, Probabilistic reasoning, Belief networks, fuzzy logic, neural nets.	**8**
UNIT 5	Applications: Expert Systems: Architecture, Domain Knowledge, Knowledge Acquisition, Case Studies: Computer Vision, Natural language Processing, Speech recognition, Information retrieval, Robotics etc.	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint

1	1. S.Russel, P.Norvig, Artificial Intelligence – A Modern Approach. Second Edition, PHI/ Pearson Education.	2011
2	2. E. Rich and K. Knight, Artificial Intelligence, E. Rich and K. Knight, TMH, 2nd ed.(ISBN- 978-0070522633)	2018
3	3. N.J. Nilsson, Principles of AI, Narosa Publ. House, (ISBN: 978-81-85198-29-3).	1980
4	4. E. Charniak, D. McDermott, Introduction to Artificial Intelligence, Addison Wesley (ISBN: 0201119455)	1985
5	5. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving (5th Edition), 2005. Addison-Wesley. (ISBN: 978-8131723272)	1994

Course code: Course Title	**Course Structure**			**Pre-Requisite**
RITR504: Deep Learning and Applications	**L**	**T**	**P**	
	3	**0**	**2**	

Course Objective: To provide students with an in-depth understanding of deep learning concepts and architectures, including neural networks, convolutional networks, recurrent networks, and their applications.

S. NO	**Course Outcomes (CO)**
CO1	Understand the foundation and scope of Deep Neural networks
CO2	To Explore predicate logic and its applications to understand knowledge representation.
CO3	To solve rule-based systems, Resolution, and semantic nets and frames
CO4	To implement probabilistic reasoning and inferencing systems
CO5	To Study AI-based expert systems, including architecture, domain knowledge, and knowledge acquisition.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Basics of deep learning, Importance of deep learning, Feature engineering, Overview of deep learning framework.	**6**
UNIT 2	Machine Learning Basics: Supervised learning algorithms, Hyper parameters and validation sets, overfitting, under fitting, Unsupervised learning algorithms, Stochastic Gradient Descent, Challenges motivating Deep Learning.	**9**
UNIT 3	Deep feed forward network: Artificial Neural Network, activation function, multi-layer neural network, Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization, Data Augmentation, Dropout.	**9**
UNIT 4	Convolutional Networks (CNN): Motivation, The Convolution Operation, Pooling, Structured outputs, Kernels. Recurrent and Recursive Nets: Recurrent Neural Networks (RNN), Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, Long-Term Dependencies, Long-Short Term Memory, Gated RNNs.	**9**
UNIT 5	Applications: Large scale deep learning, Computer vision, Speech Recognition, Natural Language Processing, Other applications, Deep Learning Tools and Libraries: Caffe, Theano, Keras.	**9**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press.	2006
2	Python Deep Learning, by Valentino Zocca, GianmarioSpacagna, Daniel Slater, and Peter Roelants, Packt Publishing Ltd.	2017
3	Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education.	2004

Course code: Course Title	**Course Structure**			**Pre-Requisite**
Natural language processing	**L**	**T**	**P**	**Basic course on probability and statistics**
	4	**0**	**0**	

Course Objective: To explore and design computer systems that are able to process and understand spoken or written text in natural languages like English, and generate their outputs in a natural language.

S. NO	**Course Outcomes (CO)**

CO1	To understand and implement text pre-processing techniques and pattern matching using regular expressions.
CO2	To execute syntactic parsing of sentences for a given grammar and probabilistic inferencing.
CO3	To implement Bag-of-Words models for feature extraction and machine learning for text classification.
CO4	To analyze the use of word embeddings and sequence learning using LSTM or transformer.
CO5	To examine text generation models using Language modelling and encoder-decoder models.
CO6	To explore real-world applications of Natural Language Processing and Natural Language Generation.

S. NO	**Contents**	**Contact Hours**
UNIT 1	The study of Language, Introduction to NLP and various terms related to NLP- morphology, syntax, semantics, pragmatics, discourse, ambiguity. Regular Expression, Finite State Automata.	**6**
UNIT 2	Pre-processing: Tokenization, Lemmatization, Stemming. Frequency Based Methods: Count Vectorizer, Bag of Words, 1-hot encoding, TF, TF-IDF, Machine learning classifiers. Prediction Based Methods: Word Embeddings, LSTM/Transformer.	**10**
UNIT 3	Word Senses, WordNet, Synsets, Hypernyms, Hyponyms, Meronyms, Holonyms, Word Sense Disambiguation, Word Similarity, Semantic Role Labelling.	**8**
UNIT 4	Probabilistic Context-Free Grammars, Syntactic Parsing, Part-of-speech-tagging, Probabilistic Language Processing, N-gram language modelling. Encoder-decoder model for sequence-to-sequence learning, Attention mechanism.	**10**
UNIT 5	Intelligent Work Processors, Machine Translation, User Interfaces, Man-Machine Interfaces, Natural language Question-Answering Systems, Speech Recognition, Commercial use of NLP, Semantic Interpretation, Information Retrieval.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	D. Jurafsky, J. H. Martin, Speech and Language Processing, Pearson Education,(ISBN-13: 978-8131716724)	2008
2	James Allen, Natural Language Understanding, 2/e, Pearson Education (ISBN 13: 9788131708958)	2003
3	Manning and Schutze, Foundation of Statistical Natural Language Processing, (ISBN-13: 978-0262133609)	1998
4	Bharati, Chaitanya and Sangal: Natural Language Processing- a Paninian perspective(ISBN-13: 978-8120309210)	1995
5	Leonard Bolc. (Ed.): Natural Language Parsing Systems, Springer Verlag, (ISBN-13: 978-0387175379)	1986

Course code: Course Title	**Course Structure**			**Pre-Requisite**
	L	**T**	**P**	
GPU Computing	3	0	2	

Course Objective: The course aims to provide students with a comprehensive understanding of GPU architecture and parallel computing principles,

S. NO	**Course Outcomes (CO)**
CO1	To import basic knowledge of GPU architecture and usage, features and security aspects.
CO2	To learn the languages, compilers, and data management required for GPU computing.
CO3	To learn how to preserve a data's availability, integrity, and confidentiality.
CO4	To recognize various network security procedures in order to defend against threats in networks.
CO5	To be able to assess system security in relation to the proper application of security services and methods.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: History, GPU Architecture, Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel Programming, CUDA OpenCL / OpenACC, Kernels Launch parameters, Thread hierarchy, Warps/Wavefronts, Threadblocks/Workgroups, Streaming multiprocessors, 1D/2D/3D thread mapping, Device properties, Simple Programs	**8**

UNIT 2	Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories	**9**
UNIT 3	Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.	**9**
UNIT 4	Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based- Synchronization - Overlapping data transfer and kernel execution, pitfalls.	**8**
UNIT 5	Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	K R. Fernando and M. Kilgard, "The Cg Tutorial: The Definitive Guide to Programmable Real-Time.	2003
2	E. Kandrot and J. Sanders, Cuda by Example: an Introduction to General-Purpose Gpu Programming, Addison Wesley	2010
3	David B. Kirk, Wen-mei W. Hwu, Morgan Kaufmann, Programming Massively Parallel Processors: A Hands-on App	2010
4	Wen-Mei w. Hwu, Morgan Kaufmann, GPU Computing GEMS Emerald Edition.	2011

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Financial Data Analytics	**3**	**0**	**2**	**Python, Excel**

Course Objective: Equip students with the knowledge and skills to analyze financial data using statistical and computational techniques, enabling them to make informed decisions, detect patterns, and predict trends in financial markets.

S. NO	Course Outcomes (CO)
CO1	Use spreadsheets to perform Extracting, Transforming and Loading (ETL) from different financial data sources
CO2	Understand financial analytics major tools and techniques
CO3	Understand data modeling and create relational database
CO4	Understand data visualization theories and techniques and use visualization techniques to visualize real-time and off-line financial data
CO5	Learn how to create written reports and present analysis results to different financial and non-financial audiences

S. NO	Contents	Contact Hours
UNIT 1	**Useful Excel Functions in Finance** Essential Excel Functions for Analyzing Financial Data • Basic data manipulation - searching, sorting, filtering, and basic statistics. • Descriptive analytics • Data aggregation techniques for single and multiple financial data • Advanced functions	**8**
UNIT 2	**ETL and Power Queries** Connecting Excel to Financial & Non-Financial Data Sources, and ETL (Extracting, Transforming and Loading) (3 week) • ETL techniques • Connecting Excel to popular financial data sources using vendor provided Excel Add-ins (such as Bloomberg Excel Add-in) • Connecting Excel to cloud and web data sources • Using Power Query to perform ETL in Excel • Creating and editing queries in Power Query	**8**

UNIT 3	**Relational Database, Data Models and Power Pivots** Databases, Data Model and Power Pivots (2 week) • Introduction to Relational Databases • Excel's data models and how they can empower financial data analysis • Representation of financial data in data models, data relationships and joins • Basing pivot tables on a data model • Calculated columns, measures, and the DAX language	**8**
UNIT 4	**Big Data, Cloud-based Analytics and Analytics Automation** Cloud-based and Automated Analytics (1 week) • Cloud storage for financial data and analytics findings • Financial analytics in the cloud • Automated analytics • Crowd analytics (or wisdom of the crowd)	**10**
UNIT 5	**Introduction to predictive analytics** • Types of analytics • Supervised versus unsupervised learning for financial and non-financial data • Model performance evaluation • Case studies on business problems, analytical techniques and tools (e.g., Excel macros & VBA, machine learning/data mining, and artificial intelligence)	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Data Analytics Made Easy: Analyze and present data to make informed decisions without writing any code By Andrea De Mauro Publication date :Aug 30, 2021 1st Edition ISBN-13 :9781801074155	2021
2	Financial Data Analytics with Machine Learning, Optimization and Statistics (Wiley Finance) 1st Edition by Yongzhao Chen, Ka Chun Cheung, Kaiser Fan, Phillip Yam	
3	Financial Data Analytics: Theory and Application by Sinem Derindere Köseoğlu Springer Nature, 25 Apr 2022	2022
4	Machine Learning in Finance: From Theory to Practice 1st ed. 2020 Edition by Matthew F. Dixon (Author), Igor Halperin (Author), Paul Bilokon (Author) Format: Kindle Edition	2020

Course code: Course Title	Course Structure			Pre-Requisite
Big Data Analytics	**L**	**T**	**P**	**Database Management system**
	3	**0**	**2**	

Course Objective: Mastering the process of mapping and knowlegde extraction from huge volumes of data.

S. NO	Course Outcomes (CO)
CO1	To learn about distributed file system.
CO2	To understand the working of Apache Hadoop ecosystem.
CO3	To underatand working and commands of Hdoop.
CO4	To study usgaes and design og Hbase concepts.
CO5	To apply big data analytics in real life problem solving .

S. NO	Contents	Contact Hours
UNIT 1	Introduction – distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce.	**8**
UNIT 2	Big Data – Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.	**8**
UNIT 3	Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands , Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering –Monitoring & Maintenance.	**9**
UNIT 4	HBase concepts- Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper	**9**
UNIT 5	Data Analytics with R: Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	C. J. Date Addison-Wesley, Introduction to Database Systems . 8th Ed. Publisher: Addison-Wesley; 8 edition (August 1, 2003) ISBN-10: 0321197844/ ISBN-13: 978-0321197849.	2003
2	R. A. Mata-Toledo and P. Cushman, Fundamentals of SQL Programming. Schaum's Outline Series. McGraw-Hill (2000).	2000
3	H. Garcia-Molina and et al. Prentice Hall, Database Systems the Complete Book; 2ndEdition (June 15, 2008). ISBN-10: 0131873253 / ISBN-13: 978- 013187325	2008
4	R. Elmasri and S. Navathe . Addison-Wesley, Fundamentals of Database Systems Addison-Wesley; 6 edition (April 9, 2010) ISBN-10: 0136086209 / ISBN-13: 978-0136086208	2010

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Information Integration and Data Analytics	3	0	2	Artificial Intelligence, Statistics

Course Objective: To have an expertise in analysing big data volumes using statistical methods for decision making.

S. NO	Course Outcomes (CO)
CO1	To learn basic statistical models for data anlysis.
CO2	To learn supervised learning methods.
CO3	To implement unsupervised learning models.
CO4	To experiment with different information integration and dat models.
CO5	To implement data analytics in real life applications.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to data analytics, Probability distributions, Model fitting, Descriptive statistics, Inferential Statistics through hypothesis tests	8
UNIT 2	Supervised learning: Linear and logistic Regression, Lasso regression, ANNOVA, Linear and quadratic discriminant analysis, K-nearest neighbors, neural networks, deep learning, support vector machines, decision trees, random forest	8
UNIT 3	Unsupervised learning: Introduction to Clustering mechanisms, K-means clustering, Hierarchical clustering, Unsupervised model fitting, Associative rule mining, Anomaly detection	8
UNIT 4	Overview of information integration, integrated views and schema mapping, impact of increasing the number of data sources, data compression, record linking, data exchange, data fusion, data cleaning, source modeling, and information extraction	9
UNIT 5	Retrieving data from Big data management systems, processing on Hadoop and Spark, Integration for Multi-channel customer analytics, Case studies, Data integration tools-Splunk and Datameer, Semantic web (RDF, OWL, SPARQL), linked data and services, mash-ups	9
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009.	2009
2	Doan, AnHai, Alon Halevy, and Zachary Ives. Principles of data integration. Elsevier, 2012 Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons.	2010
3	C. J. Date Addison-Wesley, Introduction to Database Systems . 8th Ed. Publisher: Addison-Wesley; 8 edition (August 1, 2003) ISBN-10: 0321197844/ ISBN-13: 978-0321197849.	2003

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Advanced Computer Vision	3	0	2	

Course Objective: To gain a profound understanding of the theories, algorithms of the state-of-the-art of computer vision, various mathematical approaches, and the applications to video processing and vision-based modeling and interaction. This is a research-orientated course.

S. NO	Course Outcomes (CO)
CO1	Understand master image representation, feature extraction, and other image processing techniques to tackle real-world issues in many disciplines like.

CO2	Implement and understand the benefits of the advanced Deep learning concept of Fine-tuning on pre-trained models such as YOLO
CO3	Understand and implement the Image Classification using Computer vision and Deep learning techniques like Convolutional Neural Networks
CO4	Perform the domain anomaly detection and adaptation using Transfer learning & the pre-trained models, Fine Tuning of the pre-trained models
CO5	Understand domain adaptation and anomaly detection by fine-tuning pre-trained models like YOLO for enhanced object detection and applying transfer learning algorithms for anomaly detection.

S. NO	Contents	Contact Hours
UNIT 1	Image Processing: Image representation, feature extraction and matching, Image filters, Edge detection, Image texture analysis, Clustering, Model Fitting.	**8**
UNIT 2	Image classification: Implementation of Image Classification using Computer vision and Deep learning techniques like Convolutional Neural Networks and segmentation, Applications: Traffic Flow Analysis, 3D model Building.	**11**
UNIT 3	Object Segmentation and Detection: Object Segmentation and detection using Python deep learning libraries like PyTorch Object detection and tracking: Tracking with linear dynamical models, Optical flow estimation, Object tracking using deep neural networks. Applications: Defect detection, OCR detection, Cancer Detection	**11**
UNIT 4	Introduction to Transfer Learning: What is Transfer Learning, How Transfer Works, and Why Should You Use Transfer Learning? Steps to Use Transfer Learning, Model Building in Transfer Learning, Code Implementation of Transfer Learning	**6**
UNIT 5	Fine-tuning pre-trained models: Implement the advanced Deep learning concept of Fine-tuning on pre-trained models such as YOLO. Domain adaptation & anomaly detection: Perform the anomaly detection using Transfer learning algorithms	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	D. Forsyth and J. Ponce ,Computer Vision - A modern approach, Prentice Hall	2013
2	Linda Shapiro and George Stockman, Computer Vision, Prentice-Hall, 2001.	2001
3	Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Media, 2010.	2010
4	Deep Learning by I. Goodfellow, Y. Bengio, A. Courville, MIT Press 2016.	2016
5	E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Publisher: PHI COMPUTER SECURITY.	1994

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Quantum Computing	**3**	**1**	**0**	**Linear Algebra & Probability**

Course Objective: This module aims to provide a self-contained, comprehensive introduction to quantum computing, focusing on the design and analysis of quantum algorithms, as well as covering topics in quantum information and quantum cryptography, such as: quantum teleportation, quantum money, and post-quantum cryptography.

S. NO	Course Outcomes (CO)
CO1	Understand the quantum computing paradigm.
CO2	State the four postulates of quantum mechanics and their application to computation:- Design and analyse quantum algorithms.- Grasp the notions of quantum states, unitary evolution, measurements, andcomposite systems.
CO3	Understand the implications of quantum computing on cryptography and security.
CO4	Analyse fundamental quantum algorithms:- Shor's algorithm.- Grover's search.- The Berstein-Vazirani algorithm.- Simon's problem.- The Deutsch-Jozsa paradigm.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Quantum computing: motivation, foundations, and prominent applications. Review of linear algebra in the context of quantum information, Dirac's bracket notation, limitation of classical algorithms. The four postulates of quantum mechanics, qubits, quantum gates and circuits.	**9**
UNIT 2	Basic quantum algorithms: I — Deutsch's algorithm, analysing quantum algorithms, and implementing quantum circuits via QISKIT.	**6**
UNIT 3	Basic quantum algorithms II — Simon's problem and the Bernstein -V-azirani algorithm. Grover's quantum search algorithm, the BBBV Theorem, and applications of Grover's algorithm. RSA, and Shor's integer factorisation algorithm.	**12**

UNIT 4	Introduction to quantum cryptography (post-quantum security, quantum key distribution).	**7**
UNIT 5	Introduction to quantum information (superdense coding, nocloning theorem, quantum teleportation) Applications (quantum money, the Elitzur-Vaidman bomb).	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Nielse ,"Quantum Computation And Quantum Information" , Cambridge University Press	2013
2	Chuck Easttom, "QUANTUM COMPUTING FUNDAMENTALS", Pearson Education.	2022
3	Parag K. Lala, "QUANTUM COMPUTING", McGraw Hill	2020
4	Daniel J. Bernstein (Editor), Erik Dahmen (Editor), Johannes Buchmann (Editor), "Post-Quantum Cryptography", Springer-Verlag Berlin and Heidelberg Gmb	2010
5	Thomas Vidick, StephanieWehner, Thomas, Stephanie Wehner , Thomas Vidick, "Introduction to Quantum Cryptography" Cambridge University Press	2023

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Ethical AI	**4**	**0**	**0**	**Artifical Intelligence**

Course Objective: The objective of the course is to know about the responsibility of artificial intelligence (AI) to make AI more useful for society and humanity. The course will also teach principles and practices to perform responsible AI.

S. NO	Course Outcomes (CO)
CO1	To be able to state aspects of responsible AI such as fairness, accountability, bias, privacy etc.
CO2	To be able to assess the fairness and ethics of AI modules.
CO3	To be able to enforce fairness in models and remove bias in data.
CO4	To be able to preserve the privacy of individuals while learning from them.
CO5	To be able to develop responsible AI modules for given practical problems and estimate the tradeoff with accuracy.

S. NO	Contents	Contact Hours
UNIT 1	Artificial Intelligence Fundamentals, Introduction to responsible AI, Need for ethics in AI. AI for Society and Humanity	**7**
UNIT 2	Fairness and Bias: Sources of Biases, Exploratory data analysis, limitation of a dataset, Preprocessing, inprocessing and postprocessing to remove bias, Group fairness and Individual fairness, Counterfactual fairness	**9**
UNIT 3	Interpretability and explainability: Interpretability through simplification and visualization, Intrinsic interpretable methods, Post Hoc interpretability, Explainability through causality, Model agnostic Interpretation	**10**
UNIT 4	Ethics and Accountability: Auditing AI models, fairness assessment, Principles for ethical practices Privacy preservation: Attack models, Privacy-preserving Learning, Differential privacy, Federated learning	**10**
UNIT 5	Case study: Recommendation systems, Medical diagnosis, Computer Vision, Natural Language Processing	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Virginia Dignum, "Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way" Springer	2003
2	Christoph Molnar "Interpretable Machine Learning".Lulu, 1st edition, March 24, 2019; eBook. ISBN-10 :	2002

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Business Intelligence and Data Warehousing	**4**	**0**	**0**	**DBMS**

Course Objective: Give students the understanding on the role and operation of data warehouses, business intelligence. Equip students with skills of developing data warehouses. Equip students with skills of maintaining existing data warehouses. Equip students with skills of manipulating data warehouses to generate information for business decision making.

S. NO	Course Outcomes (CO)
CO1	To understand business intelligence, DE normalizations and relational database review.
CO2	To understand data warehouse, objetcs and various data sources
CO3	To Understand data mining, various analytics algorithms and mobile analytics.
CO4	To Understand business intelligence, various query designer and keys.
CO5	To understand query properties, designing reports, visualization of business intelligence

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Business Intelligence, Data Warehouses, Data mining, Pivot Tables, Relational Database review, Database Normalization, normal forms, DE normalization of tables, SQL, Data Warehousing fundamentals	8
UNIT 2	Modelling the data warehouse: Data sources, operational data store, data marts, Characteristics and key figures , Creating InfoObjects, Building InfoCubes	6
UNIT 3	Data Mining : Statistical techniques in data mining , Preparing data for mining, Association analysis, market basket analysis, Clustering , Classification, Regression, Decisions Trees, Building analytics applications, Mobile analytics. Data Extraction, Transformation and Loading (ETL) in SAP BW Extraction from data sources such as SAP ERP, Flat file extraction, Defining and using Persistent staging areas PSA.	11
UNIT 4	Introduction to Business Intelligence with Business Objects Analysis: Navigating in reports, Designing queries in the Query Designer, Using InfoProviders and InfoObjects for queries, Calculated and restricted key,	9
UNIT 5	Query properties and navigation, Exceptions and Conditions, Front end visualization of business intelligence, Designing Dashboards, Designing reports, Business Objects Web Intelligence, Crystal Reports.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	R. and Ross, The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling Kimball, M.Second Edition. John Wiley & Sons	2006
2	Richard O. Duda, Peter E. Hart, David G. Stork , "Pattern Classification", IInd edition, Wiley, 1973 Christopher M. Bishop, "Pattern Recognition and Machine Learning",	2002

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
Distribued Cloud Computing	4	0	0	DBMS

Course Objective: To Understand the Fundamentals of Distributed Computing, Master Cloud Computing Technologies, Implement Distributed Applications on the Cloud, Manage Data in Distributed Cloud Systems

S. NO	Course Outcomes (CO)
CO1	Describe system models for distributed and cloud computing.
CO2	Describe the design principles of computer clusters and data centers.
CO3	Describe and distinguish different virtualization techniques.
CO4	Explain cloud enabling technologies, cloud mechanisms, and cloud architectures.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Clouds, Virtualization and Virtual Machine: Introduction to Cloud Computing:,Cloud computing vs. Distributed computing, Utility computing, Features of today's Clouds: Massive scale, AAS Classification: HaaS, IaaS, PaaS, SaaS, Data-intensive Computing, New Cloud Paradigms, Categories of Clouds: Private clouds, Public clouds, Virtualization: What's virtualization, Benefits of Virtualization, Virtualization Models: Bare metal, Hosted hypervisor, Types of Virtualization: Processor virtualization, Memory virtualization, Full virtualization, Para virtualization, Device virtualization, Hotspot Mitigation for Virtual Machine Migration: Enterprise Data Centers, Data Center Workloads, Provisioning methods, Sandipiper Architecture, Resource provisioning, Black-box approach, Gray-box approach, Live VM Migration Stages, Hotspot Mitigation	8
UNIT 2	Network Virtualization and Geo-distributed Clouds Server Virtualization: Methods of virtualization: Using Docker,Using Linux containers, Approaches for Networking of VMs: Hardware approach: Single-root I/O virtualization (SR-IOV), Software approach: Open vSwitch, Mininet and its applications Software Defined Network: Key ideas of SDN, Evolution of SDN,SDN challenges, Multi-tenant Data Centers: The challenges, Network virtualization, Case Study: VL2, NVP Geo-distributed Cloud Data Centers: Inter-Data Center Networking, Data center interconnection techniques: MPLS, Google's B4 and Microsoft's Swan Leader Election in Cloud, Distributed Systems and Industry Systems Leader Election in Rings (Classical Distributed Algorithms): LeLann-Chang-Roberts (LCR) algorithm, The Hirschberg and Sinclair (HS) algorithm Leader Election (Ring LE & Bully LE Algorithm): Leader Election Problem, Ring based leader election, Bully based leader election, Leader Election in Industry Systems: Google's Chubby and Apache Zookeeper, Design of Zookeeper: Race condition, Deadlock, Coordination, Zookeeper design goals, Data model, Zookeeper architecture, Sessions, States, Usecases, Operations, Access Control List (ACL), Zookeeper applications: Katta, Yahoo! Message Broker	6

UNIT 3	Classical Distributed Algorithms and the Industry Systems: Time and Clock Synchronization in Cloud Data Centers: Synchronization in the cloud, Key challenges, Clock Skew, Clock Drift, External and Internal clock synchronization, Christians algorithm, Error bounds, Network time protocol (NTP), Berkley's algorithm, Datacenter time protocol (DTP), Logical (or Lamport) ordering, Lamport timestamps, Vector timestamps Global State and Snapshot Recording Algorithms: Global state, Issues in Recording a Global State, Model of Communication, Snapshot algorithm: Chandy-Lamport Algorithm Distributed Mutual Exclusion: Mutual Exclusion in Cloud, Central algorithm, Ring-based Mutual Exclusion, Lamport's algorithm, Ricart-Agrawala's algorithm, Quorum-based Mutual Exclusion, Maekawa's algorithm, Problem of Deadlocks, Handling Deadlocks, Industry Mutual Exclusion : Chubby Failures & Recovery Approaches in Distributed Systems: Local checkpoint, Consistent states, Interaction with outside world, Messages, Domino effect, Problem of Livelock, Rollback recovery schemes, Checkpointing and Recovery Algorithms: Koo-Toueg Coordinated Checkpointing Algorithm	**11**
UNIT 4	Cloud Storage: Key-value stores/NoSQL : Design of Key-Value Stores: Key-value Abstraction, Key-value/NoSQL Data Model, Design of Apache Cassandra, Data Placement Strategies, Snitches, Writes, Bloom Filter, Compaction, Deletes, Read, Membership, CAP Theorem, Eventual Consistency, Consistency levels in Cassandra, Consistency Solutions, Design of HBase: What is HBase, HBase Architecture, Components, Data model, Storage Hierarchy, Cross-Datacenter Replication, Auto Sharding and Distribution, Bloom Filter, Fold, Store, and Shift	**9**
UNIT 5	Cloud Applications: MapReduce, Spark and Apache Kafka MapReduce: Paradigm, Programming Model, Applications, Scheduling, Fault-Tolerance, Implementation Overview, Examples, Introduction to Spark: Resilient Distributed Datasets (RDDs), RDD Operations, Spark applications: Page Rank Algorithm, GraphX, GraphX API, GraphX working, Introduction to Kafka: What is Kafka, Use cases for	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Distributed and Cloud Computing by Kai Hwang, Jack Dongarra, Geoffrey C. Fox Released December 2013	2013
2	Scalable Parallel Computing: Technology, Architecture, Programming Hardcover – Import, 16 September 1997 by	1997
3	CLOUD COMPUTING A PRACTICAL APPROACH Paperback – 1 July 2017 by Toby Velte (Author), Anthony	2017