Puducherry Technological University
Puducherry –605 014

(A Technological University of Government of Puducherry)

Curriculum and Syllabi
for
M.Tech. (DATA SCIENCE)

(Effective from the Academic Year 2020 – 21)

Submitted for Approval in Board of Studies meeting held on 30.08.2023)

CURRICULUM

The curriculum of M.Tech. (DATA SCIENCE) is designed to fulfill the Programme Educational Objectives (PEO) and Programme Outcomes (PO) listed below:

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1	**Core Competency** To acquire a comprehensive knowledge of data science concepts and apply for investigation of real world problems.
PEO2	**Versatility and Diversification** To garner interdisciplinary knowledge for attaining competitive edge and aligning to industrial needs.
PEO3	**Research, Innovation and Entrepreneurship** To inculcate the sprint of innovation in research and educate the facets of entrepreneurship complemented with ethical attitude, professionalism and modern computing environment.
PEO4	To emphasize the need to pursue life-long learning and to stay relevant in emerging technology trends.

PROGRAMME OUTCOMES (PO)

PO1	An ability to demonstrate expertise in the area of Data analytics and handling huge data for making inferences for complex applications.
PO2	Use research-based knowledge and research methods, tools, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO3	The ability to work both independently and as a team member encompassing time management and organizational skills.
PO4	A commitment for life-long learning with professional and ethical responsibility.
PO5	An ability to independently carryout research/investigation and write a substantial technical report.

Distribution of Credits among the subjects grouped under various categories:

Courses are grouped under various categories and the credits to be earned in each category of courses are as follows:

Sl.No.	Category	Credits	Course Category Code (CCC)
1	Programme Core Course	24	PCC
2	Programme Specific Elective Courses	15	PSE
3	Open Elective Courses	03	OEC
4	Professional Activity Courses (Project Work, Seminar)	28	PAC
5	Mandatory Audit Courses	Non - Credit	MAC
	Total	**70**	

Semester Wise Courses and Credits

Semester I

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CS251	Probability and Statistics for Data Science	PCC	3	0	0	3

CS252	Data Science Essentials	PCC	3	0	0	3
CS253	Machine Learning	PCC	3	0	0	3
CSZNN	Programme Specific Elective - 1	PSE	3	0	0	3
CSZNN	Programme Specific Elective - 2	PSE	3	0	0	3
CS254	Machine Learning Laboratory	PCC	0	0	4	2
CS255	Research Methodology and IPR	PCC	2	0	0	2
AD2NN	Audit Course – I	MAC	2	0	0	0
Total			**23**			**19**

Semester II

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CS256	Next Generation Databases	PCC	3	0	0	3
CS257	Big Data Mining and Analytics	PCC	3	0	0	3
CS258	Deep Learning	PCC	3	0	0	3
CSZNN	Programme Specific Elective - 3	PSE	3	0	0	3
CSZNN	Programme Specific Elective - 4	PSE	3	0	0	3
CS259	Data Analytics and Deep learning Laboratory	PCC	0	0	4	2
CS260	Mini Project and Seminar	PAC	0	0	4	2
AD2NN	Audit Course – II	MAC	2	0	0	0
Total			**25**			**19**

Semester III

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CSZNN	Programme Specific Elective - 5	PSE	3	0	0	3
OE2NN	Open Elective	OEC	3	0	0	3
CS261	Dissertation – Phase I	PAC	0	0	20	10
Total			**26**			**16**

Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CS262	Dissertation – Phase II	PAC	0	0	32	16
Total			**32**			**16**

Audit Courses (MAC)

AD201	English for Research Paper Writing
AD202	Disaster Management
AD203	Value Education
AD204	Constitution of India
AD205	Pedagogy Studies
AD206	Stress Management by Yoga

Open Elective Courses (OEC)

OE201	Business Analytics
OE202	Industrial Safety
OE203	Operation Research
OE204	Cost Management and Engineering
OE205	Composite Materials
OE206	Waste to Energy

Programme Specific Electives (PSE):

PSE - 1, PSE - 2	**CSZ01**	Advanced Data Structures and Algorithms
	CSZ02	Computing Systems for Data Science
	CSZ03	Artificial intelligence and intelligent systems
	CSZ04	Python for Data Science
	CSZ05	Data Warehouse and Data Mining
	CSZ06	Distributed Databases
PSE - 3, PSE - 4	**CSZ07**	Parallel and GPU Computing
	CSZ08	Statistical Modeling with R
	CSZ09	Recommender Systems
	CSZ10	Natural language processing
	CSZ11	Data Visualization
	CSZ12	Data Security and Access Control
PSE - 5	**CSZ13**	Computational Models of Social Mining
	CSZ14	Web Analytics
	CSZ15	Health care Data Analytics

PROGRAMME CORE COURSES

Department: Computer Science and Engineering			Programme:M.Tech. (Data Science)						
Semester: 1			Course Category Code: PCC						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CS251	Probability and Statistics for Data Science		3	-	-	3	40	60	100
Prerequisite:	-								
Course Outcome	CO1	Understand the basic probability models and statistical methods with classical and practical examples	Understanding						
	CO2	Evaluate and apply characteristic functions to understand the concept of inequalities and probabilistic limits.	Evaluating						
	CO3	Analyze the principal components with models and fit models to real data	Analyzing						
	CO4	Investigation of sampling distributions with statistical methods	Analyzing						
	CO5	Model real-world problems using probability.	Applying						
UNIT-I	**Probability Models**		Periods: 9						
Basic Probability Models: Examples – Baye's Rule, Random Graph Models, Combinatorics-basedComputation. Monte Carlo Simulation. Discrete Random Variables: Expected Value: Random Variables, Discrete Random Variables, Independent Random Variables, Expected Value, Properties of Expected Value, Expected Value via Simulation. Discrete Random Variables: Variance, Covariance, Skewness.			CO1						
UNIT-II	**Discrete and Continuous Probability Models**		Periods: 9						
Discrete Parametric Distribution Families: Distributions, Parametric Families of Distributions, Distributions Based on Bernoulli Trials, Two Major Non-Bernoulli Models and examples. Continuous Probability Models: Individual Values with Probability Zero, Cumulative Distribution Functions, Density Functions, Parametric Families of Continuous Distributions, Hazard Functions and Duality of the Exponential Family with the Poisson Family, R's integrate() Function, Inverse Method for Sampling from a Density.			CO1 CO2						
UNIT-III	**Fundamentals of Statistics**		Periods: 9						
Statistics: Sampling Distributions, Sample Mean, Sample Variance, Divide by n – 1, Standard Error, Pima Diabetes Study Example, Simulation Issues, *apply() Functions. Fitting Continuous Models: Model-Free Estimation of a Density from Sample Data, Advanced Methods for Model-Free Density Estimation, Parameter Estimation, MM vs. MLE, Goodness of Fit – The Bayesian Philosophy, Kernel Density Estimators, Generic Functions, the gmm Package. Introduction to Statistical Inference.			CO1 CO3						
UNIT-IV	**Multivariate Analysis**		Periods: 9						
Multivariate Analysis: Multivariate Distributions: Discrete and Continuous, Measuring Co-variance, Correlation, Sets of Independence Random Variables, Matrix Formulations, Estimate of Covariance Matrix, Convolution, Transform Methods. The Multivariate Normal Family of Distributions. Mixture Distributions. Multivariate Description and Dimension			CO2 CO4						

Reduction: Over fitting, Principal Components Analysis, The Linear Model, Some details of Log-Linear Models.			
UNIT-V	**Predictive Modeling**		Periods: 9
Example and Goals of Predictive Modelling, Estimation in Linear Parametric Regression Models, Base Ball Data, Interaction Terms, Parametric Estimation, Dummy Variables, Classification, Machine Learning: Neural Networks. Model Parsimony and Overfitting: Examples of Histogram and Polynomial Regression, Cross-validation, Predictor Subset Selection. Introduction to Discrete Time Markov Chains.			CO1 CO5
Lecture Periods: 45	Tutorial Periods: -	Practical Periods: -	Total Periods: 45

Reference Books:

1. Norman Matloff, Probability and Statistics for Data Science - Math + R + Data, CRC Press, 2020.
2. PrasannaSahoo, Probability and Mathematical Statistics, University of Louisville, KY 40292USA, 2013.
3. Morris H. DeGroot and Mark J. Schervish, Probability and Statistics, Fourth Edition, Addison-Wesley,2012.
4. Jay L. Devore, Probability and Statistics for Engineers and the Sciences, Ninth Edn., CENGAGE Learning,2016.
5. Carlos Fernandez-Granda, Probability and Statistics for Data Science, 2017.

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	3
CO2	3	3	2	2	3
CO3	3	2	3	3	2
CO4	3	2	3	3	2
CO5	2	2	2	2	2
Average	2.6	2.2	2.4	2.6	2.4

Score:3–High;2–Medium;1–Low

Department: **Computer Science and Engineering**		Programme: **M.Tech.(Data Science)**						
Semester: **I**		Course Category Code:**PCC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
CS252	**Data Science Essentials**	3	-	-	3	40	60	100
Prerequisite	-							

Course Outcome	**CO1**	Outline the Data science process, classification and its application	Understanding
	CO2	Classify and formulate the data science problems and manage large dataset	Applying
	CO3	Choose appropriate machine learning model for performing data analysis	Applying
	CO4	Create effective visualization of data and work with data science projects.	Analyzing
	CO5	Use the data science toolkit and develop awareness of ethical dimensions of data science.	Applying

UNIT I	**Introduction**	**Periods : 9**
Introduction: Data Science - Key Features - Motivations - Relationship between Artificial Intelligence, Machine Learning, and Data Science - History and Current Landscape - Data science in a big data world: Big Data and Data Science hype - Datafication - Benefits and uses of data science and big data - Facets of data - Data Science Process: A Data Scientist's Role - Overview of the data science process - Data Science Classification - Data Science Applications.		**CO1**

UNIT II	**Data Management**	**Periods : 9**
Data Exploration: Objectives - Datasets - Descriptive Statistics - Data Visualization – Data Collection: Data Sources - Reading Files - Scraping the Web - Using APIs – Working with Data: Exploring Your Data - Cleaning and Munging - Manipulating Data – Rescaling - Dimensionality Reduction – Data Handling: The problems of handling large data – Techniques and Programming tips for handling large volumes of data - Distributing data storage and processing with frameworks.		**CO2**

UNIT III	**Data Modeling and Algorithm**	**Periods : 9**
The Modeling Process - Machine learning in Data Science - Overfitting and Underfitting - Correctness – Basic Machine Learning Algorithms: Classification: k-Nearest Neighbors - Naïve Bayes - Support Vector Machines– Regression Methods: Linear Regression - Logistic Regression – Clustering: K-means Clustering – Model Evaluation: Confusion matrix - ROC/AUC- and lift Curves.		**CO2, CO3**

UNIT IV	**Data Visualization and Text Analysis**	**Periods : 9**
Define: Data Visualization - Data Visualization History - Types of Data Visualization: Exploratory - Explanatory - Data for Visualization - Data Types - Data Encodings - Retinal variables - Mapping variables to Encodings - Visual encodings - Technologies for Visualization - Bokeh (Python) – Text mining and Text Analytics: Text mining in the real world -Text mining techniques - Case study: Classifying Reddit posts.		**CO3, CO4**

UNIT V	**Data Science Tools and Ethics**	**Periods : 9**
Data Engineering: MapReduce, Pregel, and Hadoop – RapidMiner: User Interface and Terminology - Data Importing and Exporting Tools - Data Visualization Tools - Data Transformation Tools - Sampling and Missing Value Tools - Optimization Tools - Integration with R – Next-Generation Data Scientists, Hubris, and Ethics.		**CO3, CO4**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Vijay Kotu and Bala Deshpande, Data Science, Concepts and Practice, Second Edition, Morgan Kaufmann, 2019.
2. Davy Cielen, Arno D. B. Meysman and Mohamed Ali, Introducing Data Science: Big Data, Machine Learning, and more, using Python Tools, Manning, 2016.

3. Cathy O"Neil and Rachel Schutt, Doing Data Science, Straight Talk from The Frontline, O"Reilly, 2013.

4. Joel Grus, Data Science from Scratch, Second Edition, O"Reilly, 2019.
5. Skiena, Steven S.. The Data Science Design Manual. , Springer, 2017.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	2	1	1	1
CO3	3	2	1	1	2
CO4	2	3	1	1	2
CO5	3	3	1	3	2
Avg.	2.8	2.4	1	1.4	1.6

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Computer Science and Engineering**			Programme: **M.Tech.(Data Science)**						
Semester: **I**			Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week		Credit		Maximum Marks		
			L	T	P		CA	SE	TM
CS253	Machine Learning		**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite									
Course Outcomes	**CO1**	Outline the machine learning fundamentals for supervised learning	Understanding						
	CO2	Demonstrate the machine learning models for clustering and non-parametric methods.	Understanding						
	CO3	Choose appropriate machine learning model for real-life problems	Applying						
	CO4	Analyze the performances of machine learning models created for variety of applications	Analyzing						

UNIT I	**Introduction to Machine Learning, Supervised Learning**	
Introduction: Define Machine Learning, Applications, Supervised Learning: Vapnik-Chervonekis (VC)Dimension, Probably Approximately Correct (PAC)Learning, Regression, Model selection andGeneralization, Dimensions of a Supervised Machine Learning Algorithm		**CO1**
UNIT II	**Bayesian Decision Theory, Dimensionality Reduction**	**Periods** : **9**
Bayesian Decision Theory – Classification – Losses and Risks – Discriminant Functions, AssociationRules. Introduction to Parametric methods and Multivariate methods. Dimensionality reduction:Subset selection – Principal component analysis –Factor analysis – Multidimensional scaling – Lineardiscriminate analysis.		**CO2,CO3**
UNIT III	**Clustering ,Non-Parametric Methods and Reinforcement learning**	**Periods** : **9**
Clustering – Mixture densities – k-Means clustering – Expectation-Maximization algorithm – SpectralClustering-Hierarchical clustering. Non-parametric methods – Nonparametric Density Estimation-Nonparametric Regression smoothing Model. Reinforcement learning: Temporal Difference Learning,Q Learning		**CO2,CO3**
UNIT IV	**Design and Analysis of Machine Learning Experiments, Case Study**	**Periods** : **9**
Multilayer Perceptrons: perceptron – Training a perceptron-. Support Vector Machine, Random Forestclassifiers, Optimal separation, Kernels, learning with trees, Using Decision Trees, Implementation ofdecision trees, Classification and Regression trees CART, Decision by committee: Ensemble Learning.Explore the regression examples in machine learning – Case Study. Assessing a ClassificationAlgorithm's Performance, Comparing Classification Algorithms		**CO3, CO4**
UNIT V	**Design and Analysis of Machine Learning Experiments, Case Study**	**Periods** : **9**
Design and Analysis of Machine Learning Experiments: Cross Validation and Resampling Methods-Measuring classifier Performance-Interval Estimation-Hypothesis Testing-Assessing classificationalgorithm performance-Comparing two Classification Algorithms-Case Study		**CO3, CO4**
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. EthemAlpaydin, Introduction to Machine Learning , MIT Press, 4th Edition,2020
2. Kevin P.Murphy, "Machine Learning – A Probabilistic Perspective", MIT Press, 2nd Edition, 2020.
3. T. Mitchell, Machine Learning, McGraw-Hill, 1997.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	1
CO2	3	3	-	-	2
CO3	3	3	-	-	2
CO4	2	3	-	-	2
Ave	2.25	2.5	-	-	1.75

Score: 3 – High; 2 – Medium; 1 – Low

Department:Computer Science and Engineering		Programme:**M.Tech.Data Science**						
Semester: I		Course Category Code: PCC						
Course Code	Course	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CS254	Machine Learning Laboratory			4	2	40	60	100
Prerequisite	-							

	CO1	Apply appropriate datasets to the Machine Learning Algorithms	Applying
	CO2	Design Java/Python programs for various Learning algorithms	Creating
	CO3	Identify and apply Machine Learning algorithms to solve real world problems	Applying

1. The programs can be implemented in either JAVA or Python.
2. Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.

List of Experiments :	
1. Write a program to implement the Naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets. Calculate the accuracy, precision, and recall for your data set 2. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API 3. Face recognition with PCA.	CO1
4. Image segmentation using K-Means Clustering. 5. Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem. 6. Apply Expectation-Maximization (EM) algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.	CO2
7. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs. 8. Image dimensionality reduction using Reinforcement learning' 9. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the face recognition using appropriate data sets. 10. Handwritten digits recognition using deep learning.	CO3

LecturePeriods:	**Tutorial Periods:**	**Practical Periods: 60**	**Total Periods: 60**

Reference Books

1. Randal S, "Python Machine Learning, PACKT Publishing, 2016.
2. Sebastian Raschka, VahidMirjalili, "Python Machine Learning", PACKT Publishing, 3rd Edition, 2019.
3. Carol Quadros,"Machine Learning with python, scikit-learn and Tensorflow", PacketPublishing,

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	3	3
CO2	3	2	2	2	3
CO3	2	3	3	2	2
AVG	2.7	2.7	2.3	2.3	2.7

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Computer Science and Engineering**		Programme: **M.Tech. (Data Science)**						
Semester: **I**		Course Category Code: **PCC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
CS255	Research Methodology and IPR	**2**	**-**	**-**	**2**	**40**	**60**	**100**
Prerequisite	NIL							
Course Outcomes	**CO1**	Formulate a research problem through literature survey adhering to ethics for a specific research area of interest			Analysing			
	CO2	Draft a research proposal for a specific problem for publishing in reputed journals			Applying			
	CO3	Acquire knowledge of intellectual property rights for patent filing of novel ideas inferred through the investigations carried out			Understanding			

UNIT I	**Introduction**	**Periods** : **6**
Definition of research problem, sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation,Necessary instrumentations.		**CO1**
UNIT II	**Literature Review**	**Periods** : **6**
Effective literature review approaches, literature analysis, avoiding plagiarism, ethics in research, data collection, analysis, interpretation. Tools-Refworks, Endnote, Zotero.		**CO1,CO2**
UNIT III	Technical Writing and Presentation	**Periods** : **6**
Effective technical writing, how to write report, paper developing a research proposal, format of research proposal, a presentation and assessment by a review committee.		**CO2**
UNIT IV	**Introduction & Justification of Intellectual Property Rights**	**Periods** : **6**
Introduction: Protection for ideas, means for protecting ideas, sources of intellectual property law, basic format to intellectual property issues. Justifications: objections to exclusive rights, justifications,justifications for patents, justifications for copyright, trade marks.		**CO3**
UNIT V	**Patent & Inventions**	**Periods** : **6**
Patent: The structure of patent law, patent terminology, patents act 1977, application for a patent, ownership of the patent, the proprietary right, patent licenses. Patentable inventions: inventions,excluded categories, industrial application, novelty, inventive step, disclosure, genetic engineering and patentability.		**CO3**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Reference Books

1. C.R.Kothari, 'Research Methodology Methods & Techniques', 4th Edn., New Age International Publishers, 2019.
2. Catherine Colston, "Principles of Intellectual Property Law", Cavendish Publishing Ltd, 1999.
3. Sreenivasulu, Law Relating to Intellectual Property, Universal Law Publishing, 2nd edition, 2018.
4. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners", Pearson, 5th

Edition 2019.
5. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K, An introduction to Research Methodology, RBSA
Publishers,2002.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	-
CO2	2	2	2	2	3
CO3	-	2	2	2	2
Ave	2	2	2	2	2.5

Score: 3 – High; 2 – Medium; 1 – Low

Semester:**II**			Course Category Code: **PCC**						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CS256	**Next Generation Databases**		3	-	-	3	40	60	100
Prerequisite:	-								
Course Outcome	**CO1**	Outline the market and technology forces leading to today's next generation databases.					Understanding		
	CO2	Illustrate the Hadoop architecture with querying in various Hadoop components.					Understanding		
	CO3	Discuss the working of XML and JSON Document Databases.					Creating		
	CO4	Examine the database applications oriented to Graph and Column databases.					Analyzing		
	CO5	Identify the Distributed Database patterns and consistency models in MongoDB, HBase and Cassandra.					Applying		
UNIT-I	**Database Revolution**								**Periods: 9**
First Database Revolution – Second Database Revolution: Relational Theory – Transaction Models – First Relational Databases – Database Wars - Client-server Computing – Object Oriented Programming and OODBMS – Third Database Revolution: Google and Hadoop – Cloud Computing – Document Databases – NEWSQL.									**CO1**
UNIT-II	**Hadoop: Open-Source Google Stack**								**Periods: 9**
Hadoop's Origin – Power of Hadoop – Hadoop's Architecture – Working with Hadoop: Loading Data – Handling Files – Getting Data. Hadoop's Ecosystem – MapReduce – Hbase – Pig - Hive: Querying Big Data with Hive – Using Hive to query Hadoop files.									**CO2**
UNIT-III	**Document Databases**								**Periods: 9**
XML Databases: XML Tools and Standards – XML support in Relational Systems – JSON Document Databases – JSON and AJAX – Data Models in Document Databases – Early JSON Databases – MemBase and CouchBase – MongoDB									**CO3**
UNIT-IV	**Graph and Column Databases**								**Periods: 9**
Graph Database: RDBMS Pattern for Graphs – RDF and SPARQL – Property Graphs and Neo4j – Gremlin – Graph Database Internals – Graph Compute Engines. Column Databases: Data Warehouse Schema – Columnar Alternative (Columnar Compression, Columnar Write Penalty) – Sybase IQ, C-Store and Vertica – Column Database Architectures.									**CO4**
UNIT-V	**Distributed Database Patterns and Consistency Models**								**Periods: 9**
Distributed Database Patterns: Distributed Relational Databases – Non-relational Distributed Databases – MongoDB Sharding and Replication - HBase – Cassandra. Consistency Models: Types of Consistency – Consistency in MongoDB – Hbase Consistency – Cassandra Consistency									**CO5**
Lecture Periods: 45	**Tutorial Periods: -**		**Practical Periods: -**						**Total Periods: 45**
Reference Books:									
6. Guy Harrison, "Next Generation Databases: NoSQL, NewSQL, and Big Data", Apress Publisher, 2016									

7. Chanchal Singh and Manish Kumar, “Mastering Hadoop Big data processing at scale to unlock unique business insights”, Packt Publishing, 2019.
8. SubhashiniChellappan, DharanitharanGanesan, “MongoDB Recipes: With Data Modeling and Query Building Strategies”, Apress Publisher, 2019.
9. Jeff Friesen, “Java XML and JSON: Document Processing for Java SE”, Apress Publisher, 2019.

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	2
CO2	3	3	2	3	3
CO3	3	3	2	3	2
CO4	2	3	3	2	2
CO5	3	2	2	3	2
Average	2.8	2.8	2.2	2.6	2.2

Score:3–High;2–Medium;1–Low

Department: Computer Science and Engineering	Programme:**M.Tech(Data Science)**
Semester: II	Course Category Code: PCC

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CS257	Big Data Mining and Analytics	3	-	-	3	40	60	100

Prerequisite:			
Course Outcome	**CO1**	Interpret big data analytics platforms,sources, practices for specific applications	Understanding
	CO2	Develop applications using mapreduce model for running in hadoop platforms	Applying
	CO3	Applying similarity computing methods ,stream processing algorithms for big data mining	Applying
	CO4	Appraise regression models ,visualization techniques for predictive analytics	Evaluating

UNIT-I	Introduction To Big Data And Analytics	**Periods: 9**	
Introduction to Big Data Platform – Importance of Big data – Big data sources – Acquisition, Big data Business Analytics - State of the practice in analytics role of data scientists - Key roles for successful analytic project - Main phases of life cycle - Best Practices for Big data Analytics- Big Data Analytics applications			CO1
UNIT-II	HADOOP	**Periods: 9**	
History of Hadoop - Hadoop Distributed File System – Components of Hadoop - Analyzing the Data with Hadoop - Scaling Out - Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics - Developing a Map Reduce Application- How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features- Hadoop environment			CO2
UNIT-III	Similar Items Search	**Periods: 9**	
Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities			CO3
UNIT-IV	Mining Data Streams	**Periods: 9**	
Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows			CO3
UNIT-V	Predictive Analytics	**Periods: 9**	
Predictive Analytics- Simple linear regression- Multiple linear regressions - interpretation of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications			CO4

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods:-**	**Total Periods: 45**

Reference Books:

1. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.

2. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, Second Edition, 2014.
3. Jiawei Han, MichelineKamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
4. Ian H.Witten, Eibe Frank “Data Mining – Practical Machine Learning Tools and Techniques”, Morgan Kaufman Publications, 4th Edition, 2016.
5. Arshdeep Bahga, Vijay Madisetti, “Big Data Science & Analytics: A Hands-On Approach “, VPT, 1st Edition,2018.
6. Michael Minelli, Michehe Chambers, “Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today’s Business”, 1st Edition, Ambiga Dhiraj, Wiely CIO Series, 2013.

CO–PO Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	-
CO2	2	-	2	1	-
CO3	2	2	2	-	2
CO4	2	2	2	-	1
Avg	2	2	2	1	1.5

Score:3–High;2–Medium;1–Low

Department: Computer Science and Engineering			Programme: M.Tech.(Data Science)						
Semester: II			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	SE	TM
CS258	Deep Learning		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	CO1	Examine structure of neural networks with application in optimization-centric methods of machine learning					Analyzing		
	CO2	Analyse backpropagation issues and regulation					Analyzing		
	CO3	Perceive RBF and Restricted Boltzmann Machines					Evaluating		
	CO4	Design models for data that possess sequential dependencies among the attributes and Images					Creating		
	CO5	Develop reward driven trial-and-error process models					Creating		

UNIT I	Introduction to Neural Networks	Periods : 9
Basic Architecture, Training a Neural Network with Backpropagation, Issues, Gradient Problem, function composition, Common Neural Architectures, Benchmarks Machine Learning with Shallow Neural Networks-Binary Classification Models, Multiclass Models, Matrix Factorization with Autoencoders, Application- Word2vec		CO1
UNIT II	Training Deep Neural Networks	Periods : 9
Backpropagation, Setup and Initialization Issues, The Vanishing and Exploding Gradient Problems, Gradient-Descent Strategies, Batch Normalization, Deep Learners to Generalization, Model Tuning and Evaluation, Penalty-Based Regularization, Ensemble Methods, Unsupervised Pretraining, Parameter Sharing, Regularization		CO2
UNIT III	Radial Basis Function Networks and Restricted Boltzmann Machines	Periods : 9
RBF- Training, Variations and Special Cases, Relationship with Kernel Methods Restricted Boltzmann Machines- Hopfield Networks, The Boltzmann Machine, Restricted Boltzmann Machines- applications		CO3
UNIT IV	Recurrent Neural Networks and Convolutional Neural Networks	Periods : 9
The Architecture of Recurrent Neural Networks, challenges, Echo-state networks, LSTM, GRUs, Applications, Basic structure, Training CNN, case studies, visualization, Applications		CO4
UNIT V	Deep Reinforcement Learning	Periods : 9
Stateless Algorithms, basic framework, boostrapping, Policy Gradient Methods, Monte Carlo Tree Search, Case Studies		CO5

Lecture Periods: 45	Tutorial Periods: -	Practical Periods: -	Total Periods: 45

Reference Books:

1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing AG, part of Springer Nature 2018
2. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016, http://www.deeplearningbook.org.
3. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2nd Edition, 2011.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	2	2
CO2	2	3	1	2	3
CO3	3	2	1	1	1
CO4	3	3	2	2	3
CO5	3	3	2	3	3
Avg	2.8	2.8	1.4	2	2.4

Score:3–High;2–Medium;1–Low

Department: Computer Science and Engineering			Programme: M.Tech.(Data Science)						
Semester: II			Course Category Code: PCC			Semester Exam Type: LB			
Course Code	Course Name		Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	SE	TM
CS259	Data Analytics and Deep learning Laboratory		-	-	4	2	40	60	100
Prerequisite	Java and Python Programming								
Course Outcome	CO1	Develop applications using Hadoop and Map Reduce Frameworks				Creating			
	CO2	Design applications using Artificial Neural Networks models				Creating			
	CO3	Apply RNN and CNN for real world applications				Applying			

List of Experiments :

1. Perform setting up and Installing Hadoop in its two operating modes: Pseudo distributed, Fully distributed. 2. Implement the following file management tasks in Hadoop: Adding files and directories Retrieving files Deleting files Benchmark and stress test an Apache Hadoop cluster 3. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. Find the number of occurrence of each word appearing in the input file(s) Performing a MapReduce Job for word search count (look for specific keywords in a file) 4. Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented. Data available at: dataset repositories Find average, max and min temperature for each year in NCDC data set? Filter the readings of a set based on value of the measurement, Output the line of input files associated with a temperature value greater than 30.0 and store it in a separate file. 5. Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data. 6. Write a Pig Latin scripts for finding TF-IDF value for book dataset (A corpus of eBooks available at: Project Gutenberg) 7. Implementation of a feed-forward Neural Network	CO1

1. Training a Neural Network with Backpropagation 2. Machine Learning with Shallow Neural Networks I. Models II. Multiclass Models 3. Creating Word2vec application with neural networks 4. Radial Basis Function Networks	Binary Classification	CO2

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	2
CO2	3	3	2	1	2
CO3	3	3	2	1	1
Ave	3	3	2	1	1.6

Score: 3 – High; 2 – Medium; 1 – Low

PROFESSIONAL ACTIVITY COURSES (PROJECT WORK, SEMINAR)

<table>
<tr><td colspan="3">Department: Computer Science and Engineering</td><td colspan="7">Programme: M.Tech.(Data Science)</td></tr>
<tr><td colspan="3">Semester: II</td><td colspan="4">Course Category Code: PAC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="2">Periods/Week</td><td colspan="2">Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td></td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CS260</td><td colspan="2">Mini Project Work and Seminar</td><td>-</td><td>-</td><td>4</td><td>2</td><td>100</td><td>-</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="9"></td></tr>
<tr><td rowspan="4">Course Outcomes</td><td>CO1</td><td colspan="5">Demonstrate project development skills using machine learning models</td><td colspan="3">Understanding</td></tr>
<tr><td>CO2</td><td colspan="5">Apply theoretical knowledge and practical tools learnt to solve real life problems</td><td colspan="3">Applying</td></tr>
<tr><td>CO3</td><td colspan="5">Analyze the performances of machine learning models created for variety of applications</td><td colspan="3">Analyzing</td></tr>
<tr><td>CO4</td><td colspan="5">Compile the experiences of the project into a structured document as project report</td><td colspan="3">Creating</td></tr>
<tr><td colspan="2">UNIT I</td><td colspan="6">Introduction to Machine Learning, Supervised Learning</td><td colspan="2"></td></tr>
<tr><td colspan="8">I. Significance of various analytical tools and techniques are explored to solve real world problems.
II. The students are expected to develop application oriented small scale projects, through which studentsexplore their technical skills.
III. The students are expected to implement the analytical concepts using analytical tools.
IV. Demonstrate the developed analysis system and applied to real life problem.
V. The students shall carry out the project assigned to them and submit a report at the end of the semester forcontinuous assessment.</td><td colspan="2">CO1, CO2, CO3, CO4</td></tr>
<tr><td colspan="3">Lecture Periods: -</td><td colspan="3">Tutorial Periods: -</td><td colspan="2">Practical Periods: 60</td><td colspan="2">Total Periods: 60</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	-	2
CO2	2	3	2	-	3
CO3	2	3	2	-	3
CO4	1	3	2	-	2
Ave	1.5	2.75	2	-	2.5

Score: 3 – High; 2 – Medium; 1 – Low

<table>
<tr><td colspan="4">Department: Computer Science and Engineering</td><td colspan="4">Programme: M.Tech.(Data Science)</td></tr>
<tr><td colspan="4">Semester: III</td><td colspan="3">Course Category Code: PAC</td><td>Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td colspan="3" rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td></td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CS261</td><td colspan="3">Dissertation – Phase I</td><td>-</td><td>-</td><td>20</td><td>10</td><td>250</td><td>250</td><td>500</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Research Methodology and IPR</td></tr>
<tr><td rowspan="5">Course Outcome</td><td>CO1</td><td colspan="5">Survey literature references in the field of Data Science.</td><td colspan="2">Analyzing</td></tr>
<tr><td>CO2</td><td colspan="5">Build problem analysis skills and generate innovative solutions</td><td colspan="2">Applying</td></tr>
<tr><td>CO3</td><td colspan="5">Apply necessary tools for the development of components.</td><td colspan="2">Applying</td></tr>
<tr><td>CO4</td><td colspan="5">Demonstrate the capability to implement Intelligent Techniques</td><td colspan="2">Understanding</td></tr>
<tr><td>CO5</td><td colspan="5">Develop effective technical writing, communication and presentation skills.</td><td colspan="2">Creating</td></tr>
<tr><td colspan="7">I. Students will work on a dissertation to apply the knowledge of data science for solving a wide variety of real-world problems.
II. Problems and concepts may be defined based on extensive literature survey by standard research articles.
III. Significance of proposed problem and the state of the art to be explored.
IV. Students may implement existing research work in Phase 1.
V. Industry relevant tools may be used for demonstrating the results</td><td colspan="2">CO1, CO2, CO3, CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods:-</td><td colspan="2">Tutorial Periods: -</td><td colspan="2">Practical Periods: 300</td><td colspan="3">Total Periods: 300</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	-	2
CO2	2	3	3	1	2
CO3	2	3	1	1	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Ave	2.2	2.8	2.4	2	2.6

Score: 3 – High; 2 – Medium; 1 – Low

<table>
<tr><td colspan="3">Department: Computer Science and Engineering</td><td colspan="4">Programme: M.Tech.(Data Science)</td></tr>
<tr><td colspan="3">Semester: IV</td><td colspan="2">Course Category Code: PAC</td><td colspan="2">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td></td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CS262</td><td>Dissertation – Phase II</td><td>-</td><td>-</td><td>32</td><td>16</td><td>250</td><td>250</td><td>500</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Research Methodology and IPR</td></tr>
<tr><td rowspan="5">Course Outcome</td><td>CO1</td><td colspan="5">Survey literature references in the field of Data Science.</td><td colspan="2">Analyzing</td></tr>
<tr><td>CO2</td><td colspan="5">l Build problem analysis skills and generate innovative solutions.</td><td colspan="2">Creating</td></tr>
<tr><td>CO3</td><td colspan="5">luate the performance of the work with existing methodologies.</td><td colspan="2">Evaluating</td></tr>
<tr><td>CO4</td><td colspan="5">velop effective technical writing, communication and presentation skills.</td><td colspan="2">Creating</td></tr>
<tr><td>CO5</td><td colspan="5">praise the work for publication.</td><td colspan="2">Evaluating</td></tr>
<tr><td colspan="7">I. Students will continue work on the dissertation from Phase1.
II. New Methodology may be proposed to overcome existing problems.
III. Significance and state of the art of proposed technique to be explored.
IV. Industry relevant tools may be used for demonstrating the results.
V. Publications in reputed journals and conferences may be considered for authenticating the results.</td><td>CO1, CO2, CO3, CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods:-</td><td colspan="2">Tutorial Periods: -</td><td colspan="2">Practical Periods: 480</td><td colspan="2">Total Periods: 480</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	2	3
CO3	3	3	2	3	3
CO4	3	3	3	3	3
CO5	3	2	2	3	3
Ave	3	2.8	2.4	2.6	3

Score: 3 – High; 2 – Medium; 1 – Low

PROGRAM SPECIFIC ELECTIVE 1 and 2

Department: Computer Science and Engineering			Programme:**M.Tech (Data Science)**						
Semester: I			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSZ01	**Advanced Data Structures and Algorithms**		3	-	-	3	40	60	100
Prerequisite :									
Course Outcome	**CO1**	Explain the basic data structures and search trees using appropriate examples	Understanding						
	CO2	Demonstrate problems on priority queue, heaps, hash tables, set operations, searching /indexing techniques	Understanding						
	CO3	Applying appropriate basic algorithmic techniques in solving problems	Applying						
	CO4	Model the problem using appropriate data structures and algorithmic techniques	Applying						
	CO5	Explain algorithms using computational geometry, Np completeness, approximation algorithms, Cryptographic operations, Fast Fourier transform, Linear Programming using appropriate algorithmic techniques	Evaluating						

UNIT-I	**Basic Data Structures and Search Trees**	**Periods: 9**
Algorithm analysis – A mathematical review, case study, Amortized analysis; Basic Data structures– Stacks, Queues, lists, Trees; Binary search trees –Searches and updates, range queries, index based searching-Balanced binary search trees–Ranks and rotations, AVL trees, Red black trees		**CO1 CO3**
UNIT-II	**Queues, Heaps, Hash Tables and Union-Find Structures**	**Periods: 9**
Priority queues and heaps – Priority queues, Heaps, Heap sort, Hash tables – Maps, Hash functions, collisions and rehashing, Cuckoo hashing, Universal hashing. Union-Find structures–Union-Find its applications. Multidimensional searching–Range trees, Priority search trees, Quad trees and *k*-d Trees.		**CO2 CO3**
UNIT-III	**Fundamental Algorithmic Techniques**	**Periods: 9**
Algorithmic techniques–The greedy method, Divide and conquer, Dynamic Programming, graphs and traversal. Graph algorithms – Single source shortest paths, Dijkstra's algorithm, Bellman-Ford algorithm, Shortest paths in directed acyclic graphs, all pairs shortest path, Minimum spanning trees–Properties, Kruskal algorithm, and Prim-Jarnik algorithm. Backtracking and branch and bound techniques.		**CO3 CO4**
UNIT-IV	**Computational Geometry and Computational Intractability**	**Periods: 9**
Computational geometry – Operations on Geometric objects, Convex Hulls, Segment Interaction, Finding a Closest Pairs of Points. Computer Intractability-NPcompleteness – P and NP, NP-Completeness, CNF-SAT and 3SAT, Vertex Cover, Clique, Set cover, Subset sum and knapsack, Hamiltonian cycle and TSP. Approximation algorithms– Themetric Traveling salesman problem, Approximations for covering problems.		**CO3 CO4 CO5**

UNIT-V	Fast Fourier Transform and Linear Programming	Periods: 9	
The Fast Fourier Transform–Convolution, Primitive roots of unity, The Discrete Fourier Transform, The Fast Fourier Transform Algorithm Linear Programming -Formulating the Problem, The Simplex method, Duality, Application of Linear Programming.			**CO3 CO4 CO5**
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books:

1. Michael T.Good rich and Roberto Tamassia, Algorithm Design and Applications, John Wiley& Sons,Inc.,USA, 2015
2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson,2004.
3. Thomas H.Coreman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms,PHI, 3rd Edition,2010.
4. G.Brassard and P.Bratley, Algorithmics:Theory and Practice,Prentice-Hall,1997
5. E. Horowitz, S.Sahni and Dinesh Mehta, Fundamentals of Data structures in C++, University Press, 2007.
6. E.Horowitz, S.SahniandS.Rajasekaran,ComputerAlgorithms/C++,2ndEdition,UniversityPress, 2007.
7. Alfred V.Aho, Jeffrey D. Ullman, John E. Hopcroft, Data Structures and Algorithms, Addison

Wesley,2002.

CO–PO Mapping

	PO1	PO 2	PO 3	PO 4	PO 5
CO1	2	3	3	3	3
CO2	2	3	3	3	3
CO3	3	3	3	3	2
CO4	2	2	2	2	2
CO5	2	2	2	2	2
Avg	2.2	2.6	2.6	2.6	2.4

Score:3–High;2–Medium;1–Low

Department: Computer Science and Engineering			Programme: M.Tech.(Data Science)						
Semester: I			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	SE	TM
CSZ02	Computing Systems for Data Science		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	CO1	Appraise the features of Real time OS and the issues related to the design and analysis of systems with real-time constraints				Evaluating			
	CO2	Classify and Compare various Uniprocessor and Multiprocessor scheduling mechanisms				Understanding			
	CO3	Categorize the difference between traditional and real time databases				Analyzing			
	CO4	Acquire knowledge about Data Storage and Management Technologies				Understanding			
	CO5	Perceive information about Storage Area Networks characteristics and components				Evaluating			

UNIT I	**Introduction**	**Periods : 9**
Introduction to real time computing - Concepts; Example of real-time applications – Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Microarchitecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems		CO1
UNIT II	**Real time OS**	**Periods : 9**
Real time OS – Threads and Tasks – Structure of Microkernel – Time services – Scheduling mechanisms Communication and Synchronization – Event Notification and Software interrupt Task assignment and Scheduling - Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms Fault tolerant scheduling		CO2
UNIT III	**Real time Databases**	**Periods : 9**
Real time Databases – Transaction priorities – Concurrency control issues – Disk scheduling algorithms – Two phase approach to improve predictability		CO3
UNIT IV	**Large Data Storage**	**Periods : 9**
Hard Disks- Networked Attached Storage-Scalability issues- Networking issues. Storage Architecture - Storage Partitioning- Storage System Design- Caching-Legacy Systems.		CO4
UNIT V	**Storage Area Networks**	**Periods : 9**
Storage Area Networks – Hardware and Software Components, Storage-Clusters/Grids. Storage QoS– Performance, Reliability, and Security issues. Recent Trends related to Copy data managementErasure coding-and Software defined storage appliances.		CO5

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. C.M. Krishna, Kang G. Shin – Real Time Systems, McGraw Hill Education; 1 Edition, 2017. 2. Jane W.S. Liu, Real-Time Systems", Pearson Education India, 2002. 3. Sanjoy Baruah, Marko Bertogna, Giorgio Buttazzo, Multiprocessor Scheduling for Real-Time Systems, Springer International Publishing, 2015. 4. Franklyn E. Dailey Jr. , The Complete Guide to Data Storage Technologies for Network-centric Computing Paperback–Import, Computer Technology Research Corporation, 1998 5. Nigel Poulton , Data Storage Networking: Real-World Skills for The Comptia Storage, Wiley,2015. 6. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill, 2017

CO–PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	1	-	-
CO2	2	2	-	1	**2**
CO3	3	3	-	1	-
CO4	3	2	-	2	-
CO5	3	2	-	1	-
Avg	2.6	2.2	1	1.3	2

Score:3–High;2–Medium;1–Low

Department: Computer Science and Engineering			Programme: **M.Tech.(Data Science)**						
Semester: I			Course Category Code: PSE			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
CSZ03	**Artificial Intelligence and Intelligent Systems**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	Analyze the different search techniques to solve real world problems for which solutions are difficult to express using the traditional algorithmic approaches.							Analyzing
	CO2	Develop knowledge representation and reasoning systems that demonstrate intelligent behavior.							Applying
	CO3	Design intelligent computing models to solve real world problems and evaluate them.							Applying
	CO4	Implement new hybrid algorithms and validate their results.							Creating

UNIT I	**Introduction and Search Techniques**	**Periods** : **9**	
History of AI, Problem-solving through search, state-space, blind search techniques: BFS, DFS, UCS, Heuristic search techniques - Best-first search, Greedy search, A* search, AO* search, Adversarial search: Mini-max search, alpha-beta cut off, Problem reduction – AND/OR Graphs, Constraint satisfaction problem, Means Ends Analysis.			**CO1**
UNIT II	**Knowledge Representation Techniques and Reasoning under uncertainty**	**Periods** : **9**	
Approaches for knowledge representation, Propositional Logic, Predicate Logic, Rule based knowledge representation, Conflict Resolution, Semantic networks, Forward Chaining, Backward Chaining, Unification an, Resolution, Managing Uncertainty– Probability Theory, Bayes Rule, Bayesian Belief Networks.			**CO2**
UNIT III	**Planning and Learning**	**Periods** : **9**	
State space planning, partial order planning, Planning graphs, Planning under uncertainty, Learning Types- Rote Learning, Learning by taking advice, Explanation based learning, Supervised and Unsupervised learning, Decision trees based learning, Reinforcement Learning.			**CO2**
UNIT IV	**Intelligent Computing Models**	**Periods** : **9**	
Introduction to Intelligent Systems, Knowing when to use Intelligent Systems, Modes of intelligent interaction, Artificial Neural Networks- Types, Activation functions, Learning algorithms, Fuzzy Logic- Fuzzy sets and operations, Fuzzy Rules, Fuzzy Inference, Evolutionary Algorithms- Genetic Algorithm, Swarm intelligence- Particle Swarm Optimization Algorithm.			**CO3**
UNIT V	**Hybrid Intelligent Systems**	**Periods** : **9**	
Need for hybridization, Types of hybrid intelligent systems – Neuro-Fuzzy Systems, Evolutionary Fuzzy Systems, Evolutionary Neural Networks, Case studies on the applications of hybrid Intelligence techniques.			**CO4**
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1.Stuart J Russell, Peter Norvig, "Artificial Intelligence- A Modern Approach", 4th Edition, Pearson Education, 2020.

2. Geoff Hulten, "Building Intelligent Systems - A Guide to Machine Learning Engineering", Apress, 1st edition, 2018.
3. CrinaGrosan and Ajith Abraham, "Intelligent Systems- A Modern Approach", Springer Intelligent Systems Reference Library Book 17, 2011.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	-
CO2	2	2	2	-	-
CO3	3	2	2	1	2
CO4	3	3	2	2	2
Avg	2.5	2.5	2.0	1.5	2.0

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Computer Science and Engineering**			Programme: **M.Tech.(Data Science)**						
Semester: **I**			Course Category Code:**PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
CSZ04	**Python for Data Science**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	Demonstrate python programming statements using an IDE					Understanding		
	CO2	Apply python libraries for data representation and visualization					Applying		
	CO3	Choose appropriate machine learning model for performing data analysis					Applying		
	CO4	Analyze the performance of various machine learning model using python functions					Analyzing		

UNIT I	**Python Basic Programming**	**Periods : 9**
Introduction to data science - Python Basics – Types - Expressions and Variables - String Operations - Python Data Structures – Lists, List Comprehension - Tuples – Sets – Dictionaries - Python Programming Fundamentals - Conditions and Branching – Loops – Functions: Defining Functions, Calling Functions, Passing Arguments, Scope of the Variables in a Function - Lambda function - Objects and Classes - Modules: Creating modules, import statement, from import statement, Name spacing, Exception handling, File Handling, GUI.		**CO1**
UNIT II	**Data Munging with NumPy and Pandas**	**Periods : 9**
Introducing NumPy : Basics of NumPy Arrays, Universal Functions, Aggregations, Broadcasting, Comparisons, Masks, Indexing, Sorting Arrays, Structured Arrays. Introducing Pandas: Objects - Data Indexing and Selection -Operating on Data -Handling Missing Data - Hierarchical Indexing - Combining Datasets - Aggregation and Grouping - Pivot Tables - Vectorized String Operations.		**CO2**
UNIT III	**Data Visualization with Matplotlib**	**Periods : 9**
Introducing the basics of matplotlib - Simple Line Plots - Simple Scatter Plots - Visualizing Errors - Density and Contour Plots - Histograms, Binnings, and Density Two-Dimensional Histograms and Binnings -Customizing Plot Legends- Customizing Colorbars -Multiple Subplots -Text and Annotation -Customizing Ticks – Visualization with Seaborn .		**CO2, CO3**
UNIT IV	**Working on Data and Models using Scikit-learn**	**Periods : 9**
Introduction to Scikit-Learn- Working with Scikit-Learn Toy Datasets - Data Preprocessing -Data Representation in Scikit-Learn- Scikit-Learn's Estimator API -Hyperparameters and Model Validation: Thinking About Model Validation, Model validation via cross-validation- Model Selection: The bias–variance trade-of, Validation curves in Scikit-Learn, - Learning curves in Scikit-Learn- Feature Engineering with Scikit-Learn -Techniques-Feature Pipelines.		**CO3, CO4**
UNIT V	**Machine Learning using Scikit-learn**	**Periods : 9**
Scikit-learn for Supervised and Unsupervised Learning Algorithms : Linear Regression, Support Vector Machines, Decision Trees and Random Forests, Principal Component Analysis, k-Means Clustering, Gaussian Mixture Models- Case Study : A Face Detection Pipeline.		**CO3, CO4**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. VanderPlas, Jake. Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.", 2016.
2. Boschetti, Alberto, and Luca Massaron. Python Data Science Essentials: A practitioner's guide covering essential data science principles, tools, and techniques. Packt Publishing Ltd, 2018.
3. Grus, Joel. Data science from scratch: first principles with python. O'Reilly Media, 2019.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	1
CO2	3	3	1	1	1
CO3	3	2	1	1	2
CO4	2	3	1	1	2
Avg.	2.5	2.5	1	1	1.5

Department: **Computer Science and Engineering**		Programme: **M.Tech.(Data Science)**						
Semester: **II**		Course Category Code: **PSE**		Semester Exam Type: **TY**				
Course Code	Course Name	Periods / Week	Credit	Maximum Marks				
		L	T	P		CA	SE	TM
CSZ05	**DATA WAREHOUSING AND DATA MINING**	3	-	-	3	40	60	100
Prerequisite	-							

Course Outcome	**CO1**	Explore Data warehousing methods and device efficient and cost effective methods for maintaining Data warehousing	Analyzing
	CO2	Explore the Technique of mapping data warehouse to a Multiprocessor Architecture	Analyzing
	CO3	Discover interesting patterns from large amount data to analyze and extract patterns to solve problems, make predictions of outcomes	Analyzing
	CO4	Select and apply proper data mining algorithm to build analytical applications	Applying
	CO5	Determine the proper Prediction Algorithm to build proper prediction model	Creating

UNIT I	**Data Warehousing**	**Periods** : **9**
Data warehousing Components –Building a Data warehouse –- Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata.		**CO1**
UNIT II	**Business Analysis**	**Periods** : **9**
Reporting and Query tools and Applications – Tool Categories – The Need for Applications – Cognos Impromptu – Online Analytical Processing (OLAP) – Need – Multidimensional Data Model – OLAP Guidelines – Multidimensional versus Multirelational OLAP – Categories of Tools – OLAP Tools and the Internet – pattern and Models		**CO2**
UNIT III	**Data Mining**	**Periods** : **9**
Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation. Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining		**CO3**
UNIT IV	**Classification and Prediction**	**Periods** : **9**
Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier		

or Predictor – Ensemble Methods – Model Section.			**CO4**
UNIT V	**Cluster Analysis**		**Periods** : **9**
Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High- Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis. **Case Studies:** Data Mining Techniques for Optimizing Inventories for Electronic Commerce, Crime Data Mining, Retailing Bank Customer Attrition Analysis			**CO5**
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Alex Berson and Stephen J. Smith, Data Warehousing, Data mining and OLAP , Tata McGraw-Hill, 2016.
2. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2017.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	2
CO2	3	2	2	2	3
CO3	3	3	3	2	2
CO4	3	3	2	3	3
CO5	3	3	3	2	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Computer Science and Engineering**		Programme: **M.Tech.(Data Science)**						
Semester: **I**		Course Category Code: **PSE**		Semester Exam Type: **TY**				
Course Code	Course Name	Periods / Week	Credit	Maximum Marks				
		L	T	P		CA	SE	TM
CSZ06	**Distributed Databases**	3	-	-	3	40	60	100
Prerequisite	-							

Course Outcome	**CO1**	Understand distributed database design issues and distributed database architecture	Understanding
	CO2	Design distributed databases using fragmentation concepts and decide allocation of fragments	Evaluating
	CO3	Analyze query processing, Query optimization and transaction types/concepts	Analyzing
	CO4	Appraise concurrency control mechanisms and reliability protocols	Evaluating
	CO5	Compare parallel database system architectures and appraise current trends	Creating

UNIT I	**Periods** : **9**
Introduction: Distributed Data processing, Distributed database system (DDBMS),Promises of DDBMSs, Complicating factors and Problem areas in DDBMSs, Overview Of Relational DBMS Relational Database concepts, Normalization, Integrity rules, Relational Data Languages, Relational DBMS. Distributed DBMS Architecture: DBMS Standardization, Architectural models for Distributed DBMS, Distributed DBMS Architecture.	**CO1**
UNIT II	**Periods** : **9**
Distributed Database Design: Alternative design Strategies, Distribution design issues. Fragmentation, Allocation. Data and Access Control-View Management, Data security, Semantic Integrity Control.	**CO2**
UNIT III	**Periods** : **9**
Overview of Query Processing: Query processing problem, Objectives of QueryProcessing, Complexity of Relational Algebra operations, characterization of Query processors, Layers of Query Processing. Query Decomposition and data localization Introduction to Transaction Management: Definition of Transaction, Properties of transaction, Types of transactions	**CO3**
UNIT IV	**Periods** : **9**
Distributed Concurrency Control: Serializability, theory, Taxonomy of concurrency control mechanisms, locking based concurrency control algorithms.	**CO4**

Distributed DBMS Reliability – Reliability concepts and Measures – Failures in Distributed DBMS – Local Reliability Protocols – Distributed Reliability Protocols			
UNIT V			**Periods** : **9**
Parallel Database System Architectures – Parallel Data Placement – Parallel Query Processing-load balancing Web Data Management – Web Graph Management - Web Search - Web Querying – Distributed XML Processing. Current Issues-Streaming Data and cloud computing			**CO5**
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. M.Tamer Ozsu, Patrick Valduriez, Principles of Distributed Database Systems , Springer, 2011.
2. Chhandra Ray, Distributed Database Systems , Pearson Education India, 2012
3. Stefano Ceri ,Giuseppe Pelagatti , Distributed Databases: Principles and Systems , McGraw Hill Education,
   2008

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	-
CO2	2	2	2	-	-
CO3	2	2	2	-	-
CO4	2	2	2	2	2
Avg	2	2	1.8	1.5	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: Computer Science and Engineering			Programme:**M.Tech. (Data Science)**						
Semester:			Course Category Code:						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSZ07	Parallel and GPU Computing		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome	**CO1**	Explain the basic concepts in parallel programming, cores, memory and GPU parallelism	Understanding						
	CO2	Solve problems using CUDA programming concepts	Applying						
	CO3	Analyze the GPU architectures, multiprocessors and GPU memory	Analyzing						
	CO4	Explain about CUDA streaming and image processing concepts and CUDA libraries	Understanding						
	CO5	Model problems in GPU programming and deep learning using OpenGL, Python and CUDNN libraries	Applying						

UNIT-I	**Periods: 9**
Introduction: CPU parallel programming – Evolution of parallel programming, more cores more parallelism, Cores Versus threads, developing serial and parallel programs in various platforms and debugging Parallel programs – working with BMP files, task execution by threads. Improving parallel CPU programs – effect of OS on performance – performance improvement of IMFLIPP – process memory map Understanding the cores and memory- DRAM versus SRAM memory – study on IMROTATE.C – The architecture of computer	**CO1**
UNIT-II	**Periods: 9**
Thread management and synchronization : edge detection and study on IMEDGE.C – synchronizing threads – study on IMEDGEMCT Introduction to GPU parallelism and CUDA : Understanding GPU parallelism – CUDA version of the IMFLIPG.CU – study on CUDA programming development in various platforms CUDA Host/Device programming model : designing program parallelism – kernel launch components – studying the kernel details – CUDA debugging	**CO1** **CO2**
UNIT-III	**Periods: 9**
GPU hardware architecture – components – NVIDIA GPU architectures – CUDA edge detection – Kernels – GPU code compilation and execution GPU architecture families – Streaming multiprocessors(SM) – Building blocks – Parallel thread execution (PTX) data types- core friendly IMFLIPG, IMEDGEG	**CO3**
UNIT-IV	**Periods: 9**
Understanding GPU memory – global memory – L2 Cache – texture/L1 cache – shared memory – instruction cache – constant memory – IMFLIPGCM.CU – Core & memory friendly IMEDGEG CUDA streams – pipelining, memory allocation – Fast CPU<->GPU data transfers – study on CUDA streaming – streaming image processing, horizontal flip kernel, edge detection – NVIDIA visual profiler	**CO3** **CO4** **CO5**
UNIT-V	**Periods: 9**
Study on CUDA libraries – cuBLAS, CUFFT, NVIDIA performance primitives, thrust library Introduction to OpenCL – Image flip, Kernel in OpenCL, Edge detection in	**CO4** **CO5**

OpenCL GPU programming with Python, OpenGL Deep learning using CUDA- Artificial Neural NetworkS(ANNS)- Fully connected neural networks – Deep networks/Convolution Neural Networks – training a network – CUDNN library for Deep learning			
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods:-**	**Total Periods:45**
Reference Books:			
1. Tolga Soyata, "GPU Parallel program development using CUDA, CRC Press Taylor & Francis Group, USA, 2018 2. David Kirk, Wen-meiHwu, Morgan Kaufman, " Programming Massively Parallel Processors: A Hands-on Approach", Morgan Kaufmann - Elsevier Publishers, USA, 2010 3. Shane Cook, Morgan Kaufman, "CUDA Programming: A Developer's guide to parallel computing with GPUs", Morgan Kaufmann, 2012.			

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	1
CO2	2	2	2	2	1
CO3	2	2	2	2	1
CO4	2	2	2	2	1
CO5	2	2	2	2	2

Score:3–High;2–Medium;1–Low

Department: Computer Science and Engineering			Programme:M.Tech. (Data Science)						
Semester:2			Course Category Code: PSE						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSZ08	Statistical Modelling with R		3	-	-	3	40	60	100
Prerequisite:	Probability and Statistics								
Course Outcome	CO1	Understand the Statistical and Probability functions to solve practical problems using R	Understanding						
	CO2	Demonstrate the use of R for classification on variety of data	Understanding						
	CO3	Implement Statistical models on higher dimensional data and visualize the outcome	Applying						
	CO4	Explore the reachability of beyond the linearity by experimental analysis and decision trees	Evaluating						
	CO5	Apply Support Vector Machine and clustering techniques for prediction on real-time data	Applying						
UNIT-I	**Introduction to Statistical Learning**		Periods: 9						
Introduction-Assessing Model Accuracy -Introduction to R-Linear Regression-Simple Linear Regression - Multiple Linear Regression-Other Considerations in the Regression Model-The Marketing Plan - Comparison of Linear Regression with K-Nearest Neighbours, Linear Regression using R.			CO1						
UNIT-II	**An Overview of Classification**		Periods: 9						
Introduction- Linear Regression - Logistic Regression-Linear Discriminant Analysis-A Comparison of Classification Methods-Logistic Regression, LDA, QDA, and KNN using R- Resampling Methods-Cross-Validation-The Bootstrap-Cross-Validation and the Bootstrap using R.			CO1 CO2						
UNIT-III	**Linear Model Selection and Regularization**		Periods: 9						
Introduction-Subset Selection-Shrinkage Methods-Dimension Reduction Methods-Subset Selection Methods using R - Ridge Regression and the Lasso using R - Considerations in High Dimensions-PCR and PLS Regression using R.			CO1 CO3						
UNIT-IV	**Moving Beyond Linearity**		Periods: 9						
Introduction-Polynomial Regression-Step Functions-Basis Functions-Regression Splines-Smoothing Splines- Local Regression- Generalized Additive Models- Non-linear Modelling - Tree-Based Methods - The Basics of Decision Trees - Bagging, Random Forests, Boosting- Decision Trees using R.			CO2 CO4						
UNIT-V	**Support Vector Machines and Clustering**		Periods: 9						
Introduction-Maximal Margin Classifier- Support Vector Classifiers- Support Vector Machines- SVMs with More than Two Classes- SVMs with More than Two Classes-Relationship to Logistic Regression- Support Vector Machines using R- Unsupervised Learning- The Challenge of Unsupervised Learning- Principal Components Analysis-Clustering Methods- Principal Components Analysis using R- Clustering using R - Case study : NCI60 Data Example using R.			CO1 CO5						
Lecture Periods: 45	Tutorial Periods: -	Practical Periods: -	Total Periods: 45						
Reference Books:									

1. Trevor Hastie, Robert Tibshirani, Gareth James, Daniela Witten, An Introduction to Statistical Learning with Applications in R. Springer, 1st Edition 2013; eBook (Corrected 8th printing 2017 edition)
2. Dalgaard, Peter, "Introductory statistics with R", Springer Science & Business Media, 2008.
3. Brain S. Everitt, "A Handbook of Statistical Analysis Using R", Second Edition, 4 LLC, 2014.
4. P.M.E.Altham, Introduction To Statistical Modelling in R, Statistical Laboratory, University of Cambridge., January 7, 2015
5. AedinCulhane, Introduction to Programming and Statistical Modelling in R, Harvard School of Public Health, Bio503.

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	2	2
CO3	3	3	3	2	3
CO4	2	2	2	2	3
CO5	3	2	2	2	2
Avg	2.8	2.6	2.6	2.2	2.6

Score:3–High;2–Medium;1–Low

Department: **Computer Science and Engineering**			Programme: **M.Tech.(Data Science)**						
Semester: II			Course Category Code:PSE			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
CSZ09	**Recommender Systems**		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	**CO1**	Explain the needs and challenges in recommender system					Understanding		
	CO2	Apply filtering based recommendation techniques for a particular application domain					Applying		
	CO3	Compare different filtering techniques used in recommendation system					Analyzing		
	CO4	Evaluate the filtering techniques using appropriate metrics					Evaluating		

UNIT I	**Introduction (1)**	**Periods** : **9**
Introduction, Recommender Systems Function, Data and Knowledge Sources, Recommendation Techniques, Application and Evaluation, Recommender Systems and Human Computer Interaction, Recommender Systems as a Multi-Disciplinary Field, Recommender Systems Challenges.		**CO1**
UNIT II	**Content-based Filtering (1)**	**Periods** : **9**
High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.		**CO2, CO3**
UNIT III	**Collaborative Filtering (2)**	**Periods** : **9**
User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on Collaborative recommender systems.		**CO2, CO3**
UNIT IV	**Hybrid approaches (2)**	**Periods** : **9**
Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies		**CO2, CO3**
UNIT V	**Evaluating Recommender System (3)**	**Periods** : **9**
Recommendation System Properties: Accuracy, Coverage, confidence, Trust, novelty, serendipity, diversity, Experimental Settings: Offline Experiments and Online Evaluation. Case Studies: Recommender systems in personalized web search and knowledge-based recommender system.		**CO4, CO2**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed.
2. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
3. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1st ed.
4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st ed.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	-	-
CO2	2	3	1	1	-
CO3	2	3	1	1	2
CO4	3	3	1	1	2
Avg.	2	2.75	1	0.75	1

Score: **3** – High; **2** – Medium; **1** – Low

Department: Computer Science and Engineering			Programme:**M.Tech.**						
Semester:II			Course Category Code: PSE						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSZ10	Natural language processing		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome	**CO1**	Illustrate the normalization of Text and identify the tags of Text for Language Processing				Understanding			
	CO2	Analyse and design applications using NLP components				Creating			
	CO3	Formulate rule based systems to tackle morphology/syntax of a language				Applying			
	CO4	Design a tag set to be used for statistical processing for real-time applications				Creating			
	CO5	Compare and contrast the use of different statistical approaches for different types ofNLP applications.				Understanding			

UNIT-I	**Introduction**	**Periods: 9**
Regular Expressions, Words- Corpora-Text Normalization- Minimum Edit Distance- N-gram Language Models -N-Grams- Evaluating Language Models-Generalization and Zeros- Smoothing- Kneser-Ney Smoothing - The Web and Stupid Backoff-Advanced: Perplexity's Relation to Entropy.		CO1

UNIT-II	Word Level Analysis	**Periods: 9**
Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.		CO2

UNIT-III	Syntactic Analysis	**Periods: 9**
Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.		CO3

UNIT-IV	Computational Semantics and Semantic Parsing	**Periods: 9**
Semantic Roles-Diathesis Alternations -Semantic Roles: Problems with Thematic Roles -The Proposition Bank - FrameNet - Semantic Role Labeling-Selectional Restrictions -Primitive Decomposition of Predicates .		**CO4**

UNIT-V	Discourse Analysis and Lexical Resources	**Periods: 9**
Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brills Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).		**CO5**

Lecture Periods: 45	Tutorial Periods: -	Practical Periods:-	Total Periods: 45

Reference Books:

1. Daniel Jurafsky, James H. MartinSpeech and Language Processing: An Introduction to Natural Language
Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Pythonll, First Edition,
OReilly Media, 2009.
3. Breck Baldwin, Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.
4. Richard M Reese, Natural Language Processing with Javall, OReilly Media, 2015.
5. Tanveer Siddiqui, U.S. Tiwary, Natural Language Processing and Information Retrieval, Oxford University
Press, 2008.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**
CO3	**3**	**3**	**2**	**2**	**2**
CO4	**2**	**2**	**3**	**3**	**2**
CO5	**3**	**3**	**2**	**2**	**3**
AVG	**2.8**	**2.8**	**2.4**	**2.4**	**2.2**

Score: **3** – High; **2** – Medium; **1** – Low

Department: Computer Science and Engineering			Programme:**M.Tech. Data science**						
Semester:			Course Category Code: PSE						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSZ11	Data Visualization		3	-	-	3	40	60	100
Prerequisite:	-								
	CO1	**Analyse datasets to infer the attribute types,semantics for data abstraction for visualization design framworks**							
	CO2	**Analysing the visual encoding principles for effective data visualizations using tools**							
	CO3	Analyse techniques to maniplulate views through navigation of data using visualization tools							
	CO4	**Interpret tabular/spatial data through data visualization techniques**							

UNIT-I	Introduction	**Periods: 9**	
Visualization Definition and Implications .Visualization Design Framework - Four Levels of Design- Threats and Validation- Example Gallery- Problem-Driven vs. Technique-Driven Work.			CO1
UNIT-II	Abstractions	**Periods: 9**	
Data Abstractions -Semantics vs. Types - Attribute Types – Dataset Types- Attribute Semantics - Dataset Semantics-Derived and Transformed Data- Data Abstraction.			CO1
UNIT-III	Principles	**Periods: 9**	
Visual Encoding Principles- Relative vs. Absolute Judgements -Marks and Channels –Channel Effectiveness - Channel Characteristics. Interaction Principles - Classes of Change- Latency and Feedback - Interactivity Costs -Spatial Cognition .Principles: Slogans and Guidelines - No Unjustified 3D – Eyes Over Memory - Resolution Over Immersion-Function First, Form Next-Get It Right In Black And White .			CO2
UNIT-IV	Methods	**Periods: 9**	
Making Views - Using Space - Link Marks - Using Color - Combining Views -Coordinating Views . Superimposing Layers. Reducting Items and Attributes - Filtering -Aggregation - Navigation - Camera-Oriented Attribute Reduction -Focus+Context Methods: Slogans and Guidelines-Overview First, Detail on Demand, Zoom and Filter-Search, Show Context, Expand on Demand-Distortion Costs and Benefits -Networks: Connection vs. Containment vs. Matrix Views - Displaying Dimensionally Reduced Data.			CO3
UNIT-V	Analysis	**Periods: 9**	
Tabular Data- Networks and Trees - Spatial Data - Text/Logs - Complex Combinations.			CO4

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods:-**	**Total Periods:45**

Reference Books:

1. Tamara Munzner, Visualization Analysis & Design, A K Peters/CRC Press, 1st edition, 2014.
2. Scott Murray, Interactive Data Visualization for the Web, O'Reilly Media, Inc., 2nd Edition, 2017.
3. Elijah Meeks, D3.js in Action, Manning Publications, 2nd edition, 2017.
4. Jacques Bertin, Semiology of Graphics, ESRI Press, 1st edition 2011.
5. Leland Wilkinson, The Grammar of Graphics, Springer 2nd edition. 2005

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	2
CO2	2	2	2	-	-
CO3	2	2	2	1	-
CO4	2	2	2	-	2
Avg	2	2	2	1	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Computer Science and Engineering**		Programme: **M.Tech.(Data Science)**						
Semester: **I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods/Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
CSZ12	**Data Security and Access Control**	**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite								

Course Outcome	**CO**	**CO Statement**	
	CO1	Interpret the various access control mechanisms with their design.	Evaluating
	CO2	Analyze the different RBAC models and apply them in MLS systems.	Analyzing
	CO3	Interpret the privacy and regulatory issues, standards, and models concerns of the RBAC.	Evaluating
	CO4	Assess the role engineering plays and use it in enterprises and healthcare applications.	Evaluating
	CO5	Justify the RBAC in the supporting environment.	Evaluating

UNIT I	**Introduction**	**Periods**:**9**
Introduction: Purpose and fundamentals of access control - Brief history – RBAC and the enterprise. Properties, Policies and Models of Access Control: Reference Monitor and Security Kernel – Access control Matrix and Data structure - Discretionary Access Control(DAC)-Non-Discretionary Access Control, Mandatory Access Control(MAC),MAC Policies and models.		**CO1**
UNIT II	**Role Based Access Control**	**Periods**:**9**
CoreRBAC–Role Hierarchies: Inheritance Scheme–Hierarchy structure, SoD and Constraints in RBAS Systems: Types of SoD– SoD in real systems – Temporal Constraints in RBAC-Comparing RBAC to DAC and MAC: Enforcing DAC/MAC using RBAC Implementing RBAC in MLS Systems.		**CO2**
UNIT III	**Privacy and Regulatory Issues**	**Periods**:**9**
Privacy Requirement and Access control Framework – Integrate Privacy Policy support –RBAC and regulatory compliance. RBAC Standards and Profiles: The ANSI/INCITS RBAC Standard – Role Based Administration of RBAC: Crampton-Loizou Administrative model-Role control center		**CO3**
UNIT IV	**Role Engineering**	**Periods**:**9**
Scenario-driven role-engineering approach-Goal driven/hybrid role engineering approach - Tools for role discovery and role management - Role engineering: health care example-Enterprise Access Control Frameworks Using RBAC and XML Technologies		**CO4**
UNITV	**Integrating RBAC with Enterprise IT Infrastructures**	**Periods**:**9**
RBAC for WFMSs-RBAC integration in Web environments-RBAC for UNIX environments -RBAC in Java-RBAC for FDBSs-RBAC Features in Commercial Products.		**CO5**

Lecture Periods: 45	Tutorial Periods:-	Practical Periods:-	Total Periods:45

Reference Books

1. David F. Ferraiolo, D. RichardKuhn, Ramaswamy Chandramouli, Role Based Access Control, Second Edition, Artech House, 2007.
2. Messaoud Benantar, Access Control Systems: Security, Identity Management and Trust Models, Springer, 2006.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	2
CO2	3	3	-	-	1
CO3	3	3	-	2	3
CO4	3	3	2	1	3
CO5	3	3	2	-	3
Ave	3	2.8	0.8	0.6	2.4

***Score*:** 3 – High; 2 – Medium; 1 – Low

PROGRAMME SPECIFIC ELECTIVE – 5

Department: Computer Science and Engineering			Programme:M.Tech (Data Science)						
Semester: III			Course Category Code: PSE						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSZ13	**Computational Models of SocialMining**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome	**CO1**	Outline a broad range of social network concepts and theories.					Understanding		
	CO2	Examine the ways in which links can contribute towards interactions incommunities and Web					Analyzing		
	CO3	Apply social network solutions to real time applications					Applying		
	CO4	Collect network data from different sources while adhering to legal standards and ethics standards					Evluating		

UNIT-I	**Essentials**	**Periods: 9**
Essentials- Graph Basics -Graph Representation - Types of Graphs - Connectivity in Graphs – SpecialGraphs - Graph Algorithms- Network Measures- Centrality - Transitivity and Reciprocity - Balance andStatus - Similarity - Network Models- Properties of Real-World Networks - Random Graphs – SmallWorld Model - Preferential Attachment Model - Data Mining Essentials- Data Preprocessing – DataMining Algorithms - Supervised Learning - Unsupervised Learning		**CO1**
UNIT-II	**Communities and Interactions**	**Periods: 9**
Community Analysis - Community Detection - Community Evolution - Community Evaluation-Information Diffusion in Social Media - Herd Behavior - Information Cascades - Diffusion of Innovations– Epidemics		**CO2**
UNIT-III	**Information Networks and the World Wide Web**	**Periods: 9**
The Structure of the Web - The World Wide Web - Information Networks, Hypertext, and AssociativeMemory - The Web as a Directed Graph - The Bow-Tie Structure of the Web - The Emergence of Web -Link Analysis and Web Search - Searching the Web: The Problem of Ranking - Link Analysis using Hubsand Authorities - PageRank - Applying Link Analysis in Modern Web Search - Applications beyond theWeb - Advanced Material: Spectral Analysis, Random Walks, and Web Search		**CO2**
UNIT-IV	**Applications**	**Periods:9**
Influence and Homophily - Measuring Assortativity - Influence – Homophily- Distinguishing Influenceand Homophily- Recommendation in Social Media - Challenges – Classical Recommendation Algorithms- Recommendation Using Social Context - Evaluating Recommendations - Behavior Analytics – IndividualBehavior - Collective Behavior		**CO3**
UNIT-V	**Case Study**	**Periods: 9**
Mining Twitter: Exploring Trending Topics, Discovering What People Are Talking About, and More – WhyIs Twitter All the Rage?- Exploring Twitter's API - Analyzing the 140 (or More) Characters – MiningFacebook: Analyzing Fan Pages, Examining Friendships, and More - Exploring Facebook's Graph API -Analyzing Social Graph Connections		**CO4**

Lecture Periods: 45	Tutorial Periods: -	Practical Periods:-	Total Periods:45

Reference Books:

1) Abbasi, Mohammad Ali, Zafarani, Reza, Social Media Mining: An Introduction, Cambridge UniversityPress,2014
2) Matthew A. Russell, Mikhail Klassen , Mining the Social Web, 3rd Edition, O'Reilly Media Publisher,2019
3) David Easley , Jon Kleinberg , Networks, Crowds, and Markets: Reasoning about a Highly Connected WorldCambridge University Press, 2010
4) Stanley Wasserman and Katherine Faust, Social Network Analysis – Methods and Applications, CambridgeUniversity Press, 1994.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	1			
CO2	3	3			
CO3	3	3	2	3	3
CO4	2	3	2	3	3
Avg	2.3	2.5	2	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department: Computer Science and Engineering			Programme:**M.Tech**						
Semester: III			Course Category Code: PSE						
Course Code **CSZ14**	Course Name **Web Analytics**		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
			3			3	40	60	100
Prerequisite:									
Course Outcome	**CO1**	Adapt the process of collection, reporting, and analysis of website datato understand and optimize web usage.	Creating						
	CO2	Identify the sources of valuable data, as well as how to automatically collect and manage the information for analytics tasks	Applying						
	CO3	Analyse various mechanism to expose wide range of both quantitative and qualitative analytics techniques with applications across multiple business domains.	Analyzing						
	CO4	Assess various web metrics to optimize the web resources in order to achieve better quality of experience	Evaluating						
	CO5	Apply suitable web analytics model to meet the organizational goal	Applying						

UNIT-I	**Periods:**
Introduction: Definition, Process, Key terms: Site references, Keywords and Key phrases- building blockterms, Visit characterization terms, Content characterization terms, Conversion metrics; Categories:Offsite web, On site web analytics. Web analytics platform, Web analytics evolution, Need for webanalytics, Advantages, Limitations.	CO1
UNIT-II	**Periods:**
Data Collection: Web Analytics Data Source, Click stream Data: Web logs, Web Beacons, JavaScript tags,Packet Sniffing. Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support. Researchdata: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISPbased measurement, Search Engine data.	CO2
UNIT-III	**Periods:**
Qualitative Analysis: Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristicevaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visitsurveys, creating and running a survey, Benefits of surveys. Web Analytic fundamentals: Capturing data: Web logs or JavaScript's tags, Separate data serving anddata capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool,Understanding click stream data quality, Identifying unique page definition, Using cookies, Link codingissues.	CO3
UNIT-IV	**Periods:**
Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce,Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non-e-commercesites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report,Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI,characteristics, Need for KPI, Perspective of KPI, and Uses of KPI. Relevant Technologies: Internet &TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, WebBugs.	CO4

UNIT-V		Periods:		
Web Analytics 2.0:Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0,Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search enginedata, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitivesite overlap and opportunities. - Web 3.0:Google Analytics: Brief introduction and working, Adwords, Benchmarking, and Categories of traffic:Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations,Performance concerns, Privacy issues.				CO5
Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods:45**	
Reference Books:				
1.Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc., 2nd edition, 2012. 2. Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc, 1st edition, 2009. 3. Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons, 2002. 4. https://analytics.google.com/analytics/academy/				

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	2	2	3	3
CO3	3	3	2	3	2
CO4	3	3	2	3	2
CO5	3	3	3	3	3
Ave	3	2.8	2.4	3	2.6

Score: 3 – High; 2 – Medium; 1 – Low

Department:**Computer Science and Engineering**			Programme:**M.Tech. (Data Science)**						
Semester:**III**			Course Category Code: **PSE**						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSZ15	**Health Care Data Analytics**		3	-	-	3	40	60	100
Prerequisite:	1. An Basic knowledge in the field of Data Science is required 2. Basic knowledge of statistics and linear algebra is vital 3. Good mathematical background is necessary								
Course Outcome	**CO1**	Demonstrate the basic concepts in the field of Data Science.					Understanding		
	CO2	Identify the application of data science in the field of Health Care.					Applying		
	CO3	Analyse classification Algorithms and examine the significance of Deep learning in Health care.					Analyzing		
	CO4	Examine the significance of Robots in the field of Data Science and various process involved in data linking.					Analyzing		
	CO5	Interpret the importance of process Analytics and how it improves the health care process.					Understanding		
UNIT-I	**Delineate on Data Science**								**Periods: 9**
Paraphrasing Data Science- Classifying on Applying Fields- Interpolating Data Science and Information Science- Computational Thinking – Skills for Data Science. Data: Types-collections- preprocessing - Mapping Data Analysis and Analytics- Subsuming Analytics – Data Exploration- Understanding Data Classification Algorithms.									**CO1**
UNIT-II	**Data Science in Health Care**								**Periods: 9**
Recognizing Health Care opportunities- Benefits of Data science in Health Care - Healthcare Data Stewardship Challenges- Technology Landscape - Interview on Platforms, Services and InfrastructuresInference on Data Analytics Case study: Interpret on European Medical Information FrameworkCriticize/ Appraise on Philips Health Suite digital platform.									**CO2**
UNIT-III	**Health Science Classification Algorithm and Importance of Deep Learning**								**Periods: 9**
Analyzing Classification Algorithms in Health Science: Naive Bayesian Classification- Examining performance of Classification Algorithm. Deep Learning : Classification methods – Strategies based on Deep Learning- Application of Deep learning in Health Care on : Spatial Data – Text Data Case Study: Challenges faced by deep learning to get approved by regulatory bodies (Food and Drug Administration in the United States/ the European Medicines Agency in the EU/ or the China Food and Drug Administration)									**CO3**
UNIT-IV	**Robots in filed of Data Science & Data Linking**								**Periods: 9**
Overview - Process Mining: ProM: The Open-Source Process Mining Framework - Event Logs - Analysis - Process Models - Process Model Discovery- Process Model Quality- Process Conformance CheckingPerformance Analysis- Process Mining in Healthcare. Case Study: Sepsis Protocol Analysis									**CO4**
UNIT-V	**Process Analytics to Improve Healthcare Processes**								**Periods: 9**

Distributed Database Patterns: Distributed Relational Databases – Non-relational Distributed Databases – MongoDB Sharding and Replication - HBase – Cassandra. Consistency Models: Types of Consistency – Consistency in MongoDB – Hbase Consistency – Cassandra Consistency	**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books:

1. Vijay Kotu, Bala Deshpande, "Data Science: Concepts and Practice", MK Publication, 2nd edition,2018.
2. Chirag Shah, "A Hands-On Introduction to Data Science", Cambridge University Press, 2020.
3. Sergio Consoli, Diego ReforgiatoRecupero, Milan Petković, "Data Science for Healthcare: Methodologies and Applications", Springer Natural, 2019.

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	3	3	3	2	3
CO4	2	2	2	3	2
CO5	3	3	2	2	2
Average	2.8	2.8	2.4	2.6	2.2

Score: 3 – High; 2 – Medium; 1 – Low

OPEN ELECTIVES

Department: IT			Programme: **M.Tech.( )**						
Semester: **III**			Course Category Code: **OEC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
OE201	**Business Analytics**		**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite	-								
Course Outcome	**CO1**	Students will demonstrate knowledge of data analytics.							
	CO2	Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.							
	CO3	Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.							
	CO4	Students will demonstrate the ability to translate data into clear, actionable insights.							

UNIT I	**Periods** : **9**
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	**CO1**
UNIT II	**Periods** : **8**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	**CO2**
UNIT III	**Periods** : **9**
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	**CO3**
UNIT IV	**Periods** : **10**
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	**CO3**
UNIT V	**Periods** : **8**
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	**CO4**
UNIT VI	**Periods** : **4**
Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	**CO4**

Lecture Periods: 48	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 48**

Reference Books

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business Analytics Principles, Concepts, and Applications, Pearson FT Press, 2014.
2. James Evans, Business Analytics, persons Education, 2nd edition,2016.

Department: ME			Programme: **M.Tech.**						
Semester: **III**			Course Category Code: **OEC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
OE202	**Industrial Safety and Maintenance**		**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite	-								
Course Outcome	**CO1**	Can appreciate the need of industrial safety requirements and can implement general guidelines of safety.							
	CO2	Can understand fundamentals and principles of maintenance engineering.							
	CO3	Can acquire the knowledge about conventional maintenance techniquesadopted to reduce/prevent wear and corrosion.							
	CO4	Can able to adoptFault tracingtechniques for general machines and equipments used in industries.							
	CO5	Can apply periodic and preventive maintenancetechniques used for general electrical and mechanical machines and equipments used in industries.							

UNIT I	**Periods** : **9**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	**CO1**
UNIT II	**Periods** : **9**
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	**CO2**
UNIT III	**Periods** : **9**
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	**CO3**
UNIT IV	**Periods** : **9**
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	**CO4**
UNIT V	**Periods** : **9**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.	**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. L M Deshmukh, “Industrial safety management”, TATA McGraw Hill, 2010
2. Lindley R. Higgins. R.Keith Mobley and Darrin Wikoff, “Maintenance Engineering Handbook.”, 7th edition , Mcgraw Hill publication, 2008.
3. GargH. P, “Maintenance Engineering”, , S. Chand and Company, 2010.
4. Audels, “Pump-hydraulic Compressors”, Mcgrew Hill Publication, 1978.
5. Hans F. Winterkorn , “Foundation Engineering Handbook”, Chapman & Hall London,2013.

Department: ME			Programme: **M.Tech.**						
Semester: **III**			Course Category Code: **OEC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
OE203	**Operations Research**		**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite	-								
Course Outcome	**CO1**	Students should able to apply the linear programming to solve problems of discreet and continuous variables.							
	CO2	Students should able to apply the concept of non-linear programming.							
	CO3	Students should able to carry out sensitivity analysis.							
	CO4	Student should able to model the real world problem and simulate it.							

UNIT I	**Periods** : **9**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.	**CO1**
UNIT II	**Periods** : **9**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.	**CO1**
UNIT III	**Periods** : **9**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	**CO2**
UNIT IV	**Periods** : **9**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	**CO3**
UNIT V	**Periods** : **9**
Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.	**CO4**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Department: CE			Programme: **M.Tech.**						
Semester: **III**			Course Category Code: **OEC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
OE204	**Cost Management of Engineering Projects**		**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite	-								
Course Outcome	**CO1**	Understanding the cost controls, data inventory and decision making							
	CO2	Understanding the project documentation from conception to commissioning							
	CO3	Understanding the project cost and profit analysis during the commissioning							
	CO4	Understanding the project resource planning and activity based cost management							
	CO5	Understanding the project budgeting and quantitative techniques for cost management							

UNIT I	Project Cost Management	**Periods** : **9**
Introduction and Overview of the Strategic Cost Management Process. Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.		**CO1**
UNIT II	Project Execution	**Periods** : **9**
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram.		**CO2**
UNIT III	Project Commissioning	**Periods** : **9**
Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.		**CO3**
UNIT IV	Pricing Strategies	**Periods** : **9**
Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.		**CO4**
UNIT V	Project Budgets	**Periods** : **9**
Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting.
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, Pearson Education, 1994.
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, PHI publisher, 2012.
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd., 2000.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	1	3	3	3
CO2		2	1	3	3	3
CO3		2	1	3	3	3
CO4		2	1	3	3	3
CO5		2	1	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: PH		Programme: **M.Tech.( )**						
Semester: **III**		Course Category Code: **OEC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
OE205	**Composite Materials**	**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite	-							

Course Outcome	**CO1**	Able to understand and describe the basic concept and classification of composite.
	CO2	To Learn the concepts of reinforcements and its mechanical behaviour.
	CO3	To acquire the knowledge in metal matrix, ceramic matrix and carbon composites and its applications.
	CO4	To acquire the knowledge in polymer matrix composites and its processing methods.
	CO5	to understand the behavior of strength of Laminates

UNIT I	**INTRODUCTION TO COMPOSITE MATERIALS**	**Periods** : **9**
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.		**CO1**
UNIT II	**REINFORCEMENTS**	**Periods** : **9**
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.		**CO2**
UNIT III	**MANUFACTURING OF COMPOSITES**	**Periods** : **9**
Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.		**CO3**
UNIT IV	**FABRICATION OF POLYMER MATRIX COMPOSITES**	**Periods** : **9**
Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.		**CO4**
UNIT V	**LAMINAR STRENGTH ANALYSIS**	**Periods** : **9**
Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. R.W.Cahn, Material Science and Technology, VCH, West Germany.
2. WD Callister, Jr., R. Balasubramaniam, Materials Science and Engineering, An introduction. John Wiley & Sons, NY, Indian edition, 2007.
3. Lubin, Hand Book of Composite Materials, Springer, 2nd edition,1982.
4. K.K.Chawla, Composite Materials, Springer, 2012.
5. Deborah D.L. Chung, Composite Materials Science and Applications, Springer, 2nd edition, 2010.
6. Danial Gay, Suong V. Hoa, and Stephen W. Tasi, Composite Materials Design and Applications, CRC Press, 3rd edition, 2014.

Department: CE		Programme: **M.Tech.**						
Semester: **III**		Course Category Code: **OEC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
OE206	**Waste to Energy**	**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite	-							
Course Outcome	**CO1**	Knowing about the types of sources of wastes and about its conversion techniques						
	CO2	Understanding about the concepts of Pyrolysis and its application						
	CO3	Understanding about the processes involved in gasification of biomass and its operation process						
	CO4	Understanding the process of biomass combustion techniques and its design concepts in operation						
	CO5	Knowing about the Biogas production techniques and about the status of production in India.						

UNIT I	WASTE & CONVERSION TECHNIQUES	**Periods** : **9**	
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digesters			**CO1**
UNIT II	BIOMASS PYROLYSIS	**Periods** : **9**	
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.			**CO2**
UNIT III	BIOMASS GASIFICATION	**Periods** : **9**	
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.			**CO3**
UNIT IV	BIOMASS COMBUSTION	**Periods** : **9**	
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.			**CO4**
UNIT V	BIOGAS	**Periods** : **9**	
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion -biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion -Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.			**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	1	3	3	3
CO2		2	1	3	3	3
CO3		2	1	3	3	3
CO4		2	1	3	3	3
CO5		2	1	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

MANDATORY AUDIT COURSES

Department: HS			Programme: **M.Tech.( )**						
Semester: I/II			Course Category Code:**MAC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
AD201	**English for Academic Writing**		**2**	**-**	**-**	**-**	**-**	**-**	**-**
Prerequisite									
Course Outcome	**CO1**	Understand principles of academic writing							
	CO2	Understand the importance of proper literature review							
	CO3	Develop critical perspective and analytical skills							
	CO4	Overcome challenges faced in the process of academic writing							
	CO5	Present research in the most effective way							
UNIT I						**Periods** : **6**			
Academic writing: what,why, how - Word Order – organizing and structuring sentences and paragraphs – grammar and punctuation – accuracy, brevity and clarity Planning and Preparation						**CO1**			
UNIT II						**Periods** : **6**			
Literature review : methods - reading techniques – Note taking , Hedging and Criticising, Paraphrasing and annotation						**CO2**			
UNIT III						**Periods** :**6**			
Critical analysis and evaluation – academic tone and language - presenting results and discussion - preparation of outline – drafting - editing						**CO3**			
UNIT IV						**Periods** : **6**			
Sections of a Paper – title – abstract – Introduction – conclusion – thesis statement – research proposals – articles – theses						**CO4**			
UNIT V						**Periods** : **6**			
Acknowledgements - referencing - bibliography - research ethics - academic integrity - plagiarism						**CO5**			
Lecture Periods: 30		**Tutorial Periods: -**		**Practical Periods: -**		**Total Periods: 30**			

Reference Books

1. Goldbort R, Writing for Science, Yale University Press (available on Google Books), 2006
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
3. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook ,1998.
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		2	1	3	3	3
CO2		2	1	3	3	3
CO3		2	1	3	3	3
CO4		2	1	3	3	3
CO5		2	1	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: CE			Programme: **M.Tech.**						
Semester: I/II			Course Category Code: **MAC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
AD202	**Disaster Management**		**2**	**-**	**-**	**-**	**-**	**-**	**-**
Prerequisite	-								
Course Outcome	**CO1**	Knowing about the Types of Disasters							
	CO2	Knowing about the economics and life after the different disasters							
	CO3	Knowing the disaster zones in India and its epidemics							
	CO4	Understanding the disaster preparations and disaster managing procedures							
	CO5	Knowing the risk assessment procedure and mitigation techniques							

UNIT I	**Types of Disasters**	**Periods** : **6**
Introduction: Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.		**CO1**
UNIT II	**Repercussions Of Disasters And Hazards**	**Periods** : **6**
Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Manmade disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.		**CO2**
UNIT III	**Disaster Prone Areas In India**	**Periods** : **6**
Disaster Prone Areas In India: Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.		**CO3**
UNIT IV	**Disaster Preparedness And Management Preparedness**	**Periods** : **6**
Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.		**CO4**
UNIT V	**Disaster Risk Assessment & Mitigation**	**Periods** : **6**
Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. **Disaster Mitigation:** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.		**CO5**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Reference Books

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Department:**HS**		Programme: **M.Tech.**						
Semester: **I / II**		Course Category Code: **MAC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
AD203	**Value Education**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
Prerequisite	-							

Course Outcome		
	CO1	To know the classification of education system
	CO2	To understand strength and weakness of self
	CO3	To know the importance of human body and health
	CO4	To understand the truth of human value by knowing the activities of mind
	CO5	To understand the law of nature – reasons for everything

UNIT I	**Introduction to Value Education**	**Periods** : **6**
Purpose of Life – Philosophy of Life – Greatness of Education: Linguistic, Job-oriented, nature and moral value - Relation among body, soul and mind – Relation among Self, Nature and Society – Harmony in life – World peace.		**CO1**
UNIT II	**Personality development**	**Periods** : **6**
Concept of personality – 16 personality factors – Importance of genetic centre – Purification of genetic centre –Relation between genetic centre and brain - Mind - Bio-magnetism - Universal magnetism.		**CO2**
UNIT III	**Human Health and Body**	**Periods** : **6**
Health - Need of Health - Efficiency of Human resources - Structure and function of Human Body – Disease – Reason for diseases – Preventive methods of diseases – Moderation in five aspects of life – Balanced food – Simplified Physical Exercises - Surya namaskar - A review of medical systems.		**CO3**
UNIT IV	**Mental Health and Human Values**	**Periods** : **6**
Role of Mind in Human Life – Mind and Mental health – Factors for Mental health – Promotion of human values – Tolerance – Adjustment – Sacrifice – Five-fold culture.		**CO4**
UNIT V	**Law of Nature**	**Periods** : **6**
Unified Force – Evolution and functioning of Universe - Evolution of non-living and living beings - Duty-consciousness - Concept of action – Role of karma yoga for self management – Cause and effect system - Impact of qualities – Supremacy of love and compassion.		**CO5**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Reference Books

1. G.V. Vethathiri, Karma Yoga, Vethathiri Publications, 2004.
2. G.V. Vethathiri, Unified Force, Vethathiri Publications, 2004.
3. The Mother, Foundations of Education, Sri Aurobindo Ashram, Pondicherry, 2012.
4. The Mother, Guidance on Education, Sri Aurobindo Ashram, Pondicherry, 2015.
5. The Mother, Physical Education and Culture, Sri Aurobindo Ashram, Pondicherry, 2015.
6. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

Department: HS		Programme: **M.Tech.**						
Semester: I/II		Course Category Code: **MAC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
AD204	**Constitution of India**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
Prerequisite	-							

Course Outcome		
	CO1	Understand and Discuss the emergence,evolution and meaning of Indian Constitution
	CO2	Comprehend the significance of constitutional rights and duties
	CO3	Understand and analyse the three organs of government and the system of governance
	CO4	Understand and describe decentralization, power and role
	CO5	Understand the role of constitutional and non-constitutional bodies

UNIT I	**Making of the Indian Constitution: evolution and development**	**Periods** : **6**
Historical background of the constituent Assembly – various committees(Composition & Working). Philosophy of the Indian Constitution: Preamble Salient Features -amendments		**CO1**
UNIT II	**Contours of Constitutional Rights & Duties**	**Periods** : **6**
Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.		**CO2**
UNIT III	**Organs of Governance**	**Periods** : **6**
Parliament – Composition - Qualifications and Disqualifications - Powers and Functions – Executive – President – Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions. – system of government- the union and its territories – emergency provisions		**CO3**
UNIT IV	**Local Administration**	**Periods** : **6**
District Administration : Role and Importance - Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation - Panchayati raj: Introduction, PRI: ZilaPanchayat - Elected officials and their roles, CEO Zila Panchayat: Position and role - Block level: Organizational Hierarchy (Different departments) - Village level: Role of Elected and Appointed officials - Importance of grass root democracy.		**CO4**
UNIT V	**Constitutional and non-constitutional bodies**	**Periods** : **6**
Election Commission: Role and Functioning - Chief Election Commissioner and Election Commissioners- State Election Commission: Role and Functioning - Institute and Bodies for the welfare of SC/ST/OBC and women – Equality and social justice		**CO5**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Reference Books

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Department: HS		Programme: **M.Tech.**						
Semester: I/II		Course Category Code: **MAC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
AD205	**Pedagogy Studies**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
Prerequisite	-							

Course Outcome		
	CO1	Understand the pedagogical practices being used by teachers in formal and informal classrooms
	CO2	Reflect on the different theories of learning
	CO3	Apply appropriate instructional methods
	CO4	Explore pedagogical innovation
	CO5	Identify gaps in research and effectively apply concepts of communication theory

UNIT I	**Periods** : **6**
Introduction and Methodology: Aims and rationale, , Conceptual framework and terminology - Theories of motivation and learning, Curriculum, Teacher education : policies and programmes	**CO1**
UNIT II	**Periods** : **6**
Pedagogical theory and approaches -Thematic overview - historical perspective - teaching practices in formal and informal classrooms in developing countries – teacher education and training – attitudes and beliefs	**CO2**
UNIT III	**Periods** : **6**
Pedagogic strategies - effectiveness of pedagogical practices - - Theory of change – New learning – didactic, authentic, transformative perspectives – teacher competency and accountability – professional ethics	**CO3**
UNIT IV	**Periods** : **6**
Professional development: alignment with classroom practices and follow-up – classroom management - Peer and community support - - Curriculum and assessment – inclusive teaching – evaluation concepts and approaches –digital initiatives - Barriers to learning	**CO4**
UNIT V	**Periods** : **6**
Research gaps and future directions: Maintaining standards - Research design – Contexts – communication - Dissemination and research impact - innovation.	**CO5**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Reference Books

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning ofbasicmaths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Department:**HS**		Programme: **M.Tech.**						
Semester: **I / II**		Course Category Code: **MAC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
AD206	**Stress Management by Yoga**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
Prerequisite	-							

Course Outcome		
	CO1	To know the role of Yoga
	CO2	To understand the importance of mind and meditations
	CO3	To know how to overcome stress.

UNIT I	**Periods** : **10**
Yoga Definition of yoga – Importance of yoga – Basic rules of yoga – Eight stages of yoga: Iyama – Niyama – Aasana – Pranayama – Prathyagara – Dhaarana – Dhyaana – Samaadhi – Asanas - Kayakalpa yoga - Mudras.	**CO1**
UNIT II	**Periods** : **10**
Meditation Definition – Importance of meditation – Mental wave frequency – Benefits of Agna, Shanthi, Thuriyam and Thuriyaadheetham meditations.	**CO2**
UNIT III	**Periods** : **10**
Stress Management Definition of Pain, Pleasure, Peace and Ecstasy – Reasons for Stress – Knowing the relation among self, nature and society - Analysis of Thoughts - Moralisation of Desire - Neutralisation of Anger - Eradication of Worries - Realisation of Self - Harmony in Life - Greatness of Women – Benefits of Blessings.	**CO3**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Reference Books

1. G.V. Vethathiri, Yoga for Modern Age, The World Community Service Centre Publications, 2010.
2. Yoga practices-2, The World Community Service Centre Publications, 2016.
3. The Mother, Foundations of Education, Sri Aurobindo Ashram, Pondicherry, 2012.