ISO 9001:2015 AICTE-CII: GOLD Category Institute NAAC-'A' Grade Institute (CGPA: 3.21) NIRF-2020 Rank Band: 201-250

KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE
Opp : Yerragattu Gutta, Hasanparthy (Mandal), WARANGAL - 506 015, Telangana, INDIA.
काकतीय प्रैद्योगिकी एवं विज्ञान संस्थान, वरंगल - ५०६ ०१५ तेलंगाना, भारत
కాకతీయ సాంకేతిక విజ్ఞాన శాస్త్ర విద్యాలయం, వరంగల్ - ౫౦౬ ౦౧౫ తెలంగాణ, భారతదేశము
(An Autonomous Institute under Kakatiya University, Warangal)
(Approved by AICTE, New Delhi; Recognised by UGC under 2(f) & 12(B); Sponsored by EKASILA EDUCATION SOCIETY)
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DEPARTMENT OF INFORMATION TECHNOLOGY

PG – M.Tech. (DATA SCIENCE)

PRR -20

SYYLABI, SCHEME OF INSTRUCTION & EVALUATION

(I Semester to IV Semester)

(Applicable from the Academic Year 2020-21)

DEPARTMENT OF INFORMATION TECHNOLOGY
KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE, WARANGAL – 15
(An Autonomous Institute under Kakatiya University, Warangal)
SCHEME OF INSTRUCTION & EVALUATION FOR TWO YEAR POSTGRADUATE PROGRAMME

PRR-20

M.TECH. (DATA SCIENCE)

SEMESTER-I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits	Evaluation Scheme								
				L	T	P		CIE –TA							ESE	Total Marks
								I²RE				Minor	MSE	Total		
								ATLP	CRP	CP	PPT					
1	**PC**	**P20DS101**	Advanced Data Structures and Algorithms	3	-	-	3	8	8	8	6	10	20	60	40	100
2	**PC**	**P20DS102**	Mathematical Foundations for Data Science	3	-	-	3	8	8	8	6	10	20	60	40	100
3	**PE**	**P20DS103**	Professional Elective-1	3	-	-	3	8	8	8	6	10	20	60	40	100
4	**PE**	**P20DS104**	Professional Elective-2	3	-	-	3	8	8	8	6	10	20	60	40	100
5	**PC**	**P20DS105**	Advanced Data Structures and Algorithms Laboratory	-	-	4	2	-	-	-	-	-	-	60	40	100
6	**PC**	**P20DS106**	Data Science Laboratory	-	-	4	2	-	-	-	-	-	-	60	40	100
7	**MC**	**P20MC107**	Research Methodology and IPR	2	-	-	2	8	8	8	6	10	20	60	40	100
8	**AC**	**P20AC108**	Audit Course - 1	2	-	-	1	8	8	8	6	10	20	60	40	100
			Total:	**16**	**-**	**8**	**19**							**480**	**320**	**800**

[L= Lecture, T = Tutorials, P = Practicals, C = Credits, ATLP = Assignments, CRP = Course Research Paper, CP = Course Patent, PPT = Course Presentation, Minor=Minor Examination, MSE=Mid Semester Examination and ESE=End Semester Examination]

Professional Elective-1	Professional Elective-2	Audit Course-1
P20DS103A: Advanced Data Mining	P20DS104A: Big Data Analytics	P20AC108A: English for Research Paper Writing
P20DS103B: Artificial Intelligence	P20DS104B: Natural Language Processing	P20AC108B: Sanskrit for Technical Knowledge
P20DS103C: Information Retrieval Systems	P20DS104C: Soft Computing	P20AC108C: Constitution of India
P20DS103D: MOOCs	P20DS104D: MOOCs	P20AC108D: Pedagogy Studies

Total Contact Periods/Week: 24 **Total Credits: 19**

Note: Additional Learning: Students are advised to do MOOCs to bridge the gap in the curriculum, as suggested by the Department Academic Advisory Committee (DAAC). The credits earned by the students through MOOCs will be printed in the semester grade sheet.

P20DS101 ADVANCED DATA STRUCTURES AND ALGORITHMS

Class: M.Tech. I-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Exam	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: basic data structures, priority queues, heaps, hash and binary search tree

LO2: balanced binary search tree technique, greedy method and dynamic programming

LO3: concepts of randomized algorithms

LO4: concepts of approximation algorithms

UNIT - I (9)

Basic Data Structures: Stacks and queues, Lists, Trees

Priority Queues and Heaps: Priority queues, Priority queue sort, Selection sort and insertion sort, Heaps, Heap sort

Hash Tables: Maps, Hash functions, Handling collisions and rehashing

Analyzing Algorithms: Pseudo code, Counting primitive operations, Asymptotic notation: The Big-Oh Notation, Little-Oh and Little-Omega

Binary Search Trees: Searches and updates, Range queries, Index–based searching, Randomly constructed search trees

UNIT - II (9)

Balanced Binary Search Trees: Ranks and rotations, AVL trees, Red-Black trees, Weak AVL trees, Splay trees

Greedy Method: The fractional knapsack problem, Task scheduling, Text compression and Huffman coding, Minimum Spanning Trees**:** Kruskal's algorithm, The Prim Jarnik algorithm, Baruvka's algorithm, Shortest Paths: Dijkstra's algorithm, The bellman-ford algorithm

Dynamic Programming: The longest common subsequence problem, The 0-1 knapsack problem

UNIT – III (9)

Randomized Algorithms : A first application: Contention resolution, Finding the global minimum cut, Random variables and their expectations, A randomized approximation algorithm for MAX 3-SAT, Randomized divide and conquer: Median-finding and quicksort, Hashing: A randomized implementation of dictionaries, Finding the closest pair of points: A randomized approach, Randomized caching, Chernoff bounds, Load balancing, Packet routing, Background: Some basic probability definitions

UNIT - IV (9)

Approximation Algorithms: Greedy algorithms and bounds on the optimum: A load balancing problem, The center selection problem, Set cover: A general greedy heuristic, The pricing method: Vertex cover, Maximization via the pricing method: The disjoint paths problem, Linear programming and rounding: An application to vertex cover, Load balancing revisited: A more advanced LP application, Arbitrarily good approximations: The knapsack problem

Text Book(s):

[1] M T Goodrich, Roberto Tamassia, *Algorithm Design and Applications*, 2nd ed. USA: John Wiley& Son, 2015. (Chapters: 1 to 6, 10, 12, 14, 15)

[2] Jon Kleinberg, Eva Tardos, *Algorithm Design*, USA: Pearson Education Ltd, 2005. (Chapters: 11, 13)

Reference Book(s):

[1] Debasis Samantha, *Classic Data Structures*, 2nd ed. New Delhi: PHI Learning Pvt. Ltd., 2009.

[2] Aho, Hopcroft, Ulman, *The Design and Analysis of Computer Algorithms*, New Delhi, Pearson Education Inc., 2009.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: apply data structure concept, priority queues & heaps and binary search tree to solve real time problems

CO2: utilize greedy methods and dynamic programming techniques to find optimal solutions

CO3: use randomized algorithms to employs a degree of randomness

CO4: apply approximation algorithms to finding an optimal solution and near-optimal solution

Course Articulation Matrix (CAM): P20DS101 ADVANCED DATA STRUCTURES AND ALGORITHMS

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS101.1**	2	1	1	2	2
CO2	**P20DS101.2**	2	1	1	2	2
CO3	**P20DS101.3**	1	1	1	1	1
CO4	**P20DS101.4**	1	1	1	2	1
P20DS101		**1.5**	**1.5**	**1**	**1**	**1.75**

P20DS102 MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE

Class: M.Tech. I-Semester **Specialization**: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop student's knowledge on/in

LO1: linear systems and eigen value problems and its applications
LO2: various statistical measures and probability distributions to analyze the data
LO3: applications of exact sampling distributions in testing of hypothesis
LO4: unconstrained and constrained optimization

UNIT - I (9)

Linear Algebra: Matrix transformations, LU-factorization, Vectors in the plane, Linear transformations, Vector spaces, Sub spaces, Linear independence of vectors, Basis and dimension, Rank of a matrix and applications, Eigen values and Eigen vectors of a matrix, Diagonalization, Kernel and range of a linear transformation, Matrix of a linear transformation

UNIT - II (9)

Curve Fitting and Principle of Least Squares: Fitting of a straight line, Fitting second degree parabola, Conversion of data to linear form

Correlation and Regression: Scatter diagram, Karl Pearson's coefficient of correlation, Rank correlation, Lines of regression, Regression coefficients, Properties of regression coefficients, Angle between two lines of regression

Random variables and Distribution functions: Discrete random variable, Probability mass function, Discrete distribution function, Continuous random variable, Probability density function, Continuous distribution function

Probability Distributions: Binomial, Poisson and normal distributions

UNIT - III (9)

Sampling and Large Sample Tests: Types of sampling, Parameter and statistic, Null hypothesis, Alternative hypothesis, Errors in sampling, Critical region and level of significance, One tailed and two tailed tests, Procedure for testing of hypothesis, Test of significance for single Mean, Test of significance for difference of Means, Test of significance for difference of standard deviations

Applications of Exact sampling distributions: Chi-Square test for goodness of fit, Single mean, T-test for difference of means, F-test for equality of population variances, F-test for equality of several means

UNIT - IV (9)

Non-Linear Programming Problem (NLPP): Classification of NLPP, Unconstrained optimization techniques- Iterative methods - Steepest decent method, Conjugate gradient method, Fibonacci method and Golden section method

Constrained Optimization Techniques-- Lagrange's method and Kuhn-Tucker method

Text Book(s):

[1] Bernard Kolman and David R.Hill *Introductory linear algebra an applied first course*, Pearson education, 8th ed., 2009.

[2] S.C. Gupta and V.K. Kapoor, *Fundamentals of Mathematical Statistics*, New Delhi: Sultan Chand & Sons, 10th ed., 2000.

[3] S.S. Rao, *Engineering Optimization theory and practice,* John Wiley & Sons, Inc., Hoboken, New Jersey, 4th ed., 2009.

[4] Kanti Swarup, P.K.Gupta, Man Mohan, *Operations Research*, S. Chand & Sons, New Delhi, 16th ed., 2013.

Reference Book(s):

[1] G. Strang, *Introduction to Linear Algebra*, 5th ed., United States: Wellesley-Cambridge Press,2016

[2] L.S.Prakasa Rao, *A first course in Probability and Statistics*, New Jersey: Cambridge University Press India, 2009.

[3] S.P.Gupta, *Statistical Methods*, New Delhi: Sultan Chand & Sons, 2010.

[4] J.C. Pant, *Introduction to Optimization (Operations Research)* Jain Brothers, 7th ed., 2015.

Course Learning Outcomes (COs):

On completion of this course, student will be able to …

CO1: apply linear algebra concepts to model, solve, and analyze real-world situations

CO2: analyze the data using various statistical measures and probability distributions

CO3: apply exact sampling distributions in testing of hypothesis

CO4: optimize the data using various methods of optimization

Course Articulation Matrix (CAM): P20DS102 MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS102.1**	2	1	1	2	1
CO2	**P20DS102.2**	2	1	1	2	1
CO3	**P20DS102.3**	2	1	1	2	1
CO4	**P20DS102.4**	2	1	1	2	1
P20DS102		**2**	**1**	**1**	**2**	**1**

P20DS103A ADVANCED DATA MINING

Class: M.Tech. I-Semester **Specialization:** Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):
This course will develop students' knowledge in /on
- *LO1: various data mining processes*
- *LO2: association rule mining and fuzzy sets approach*
- *LO3: rough sets, SVM and genetic algorithms*
- *LO4: performance analysis and applications of data mining*

UNIT – I (9)

Introduction: What is data mining, What is needed to do data mining, Business data mining, Data Mining tools

Data Mining Process: CRISP-DM, Business understanding, Data understanding, Data preparation, Modeling, Evaluation, Deployment, SEMMA, Steps in SEMMA process, Example Data Mining process application, Comparison of CRISP & SEMMA, Handling data

UNIT – II (9)

Memory-Based Reasoning Methods: Matching, Weighted matching, Distance minimization, Software

Association Rules in Knowledge Discovery: Market-Basket analysis, Market Basket analysis benefits, Demonstration on small set of data, Real market basket data, The counting method without software

Fuzzy Sets in Data Mining: Fuzzy sets and decision trees, Fuzzy sets and ordinal classification, Fuzzy association rules, Demonstration model, Computational results, Testing, Inferences

UNIT – III (9)

Rough Sets: A brief theory of rough sets, Information system, Decision table, Some exemplary applications of Rough Sets, Rough sets software tools, The process of conducting Rough Sets analysis

Support Vector Machines: Formal explanation of SVM, Non-linear classification, Use of SVM – A process-based approach, Support vector machines versus Artificial neural networks, Disadvantages of support vector machines

Genetic Algorithm Support to Data Mining: Demonstration of genetic algorithm, Application of genetic algorithms in Data Mining

UNIT – IV (9)

Performance Evaluation for Predictive Modeling: Performance metrics for predictive modeling, Estimation methodology for classification models, Simple split (Holdout), The *k*-fold cross validation, Bootstrapping and jackknifing, Area under the ROC curve

Applications: Applications of methods, Memory-based application, Association rule application, Fuzzy data mining, Rough set models, Support vector machine application, Genetic algorithm applications, Predicting the financial success of Hollywood movies

Text Book:

[1] David L, Olson Dursun Delen, *Advanced Data Mining Techniques*, Verlag: Springer, 2008.

Reference Book(s):

[1] Jiawei Han, M Kamber, Jain Pei, *Data Mining Concepts and Techniques*, 3rd ed., Amsterdam: Elsevier Publication, 2011.
[2] Vipin Kumar, Pang-Ning Tan, Michael Steinbach, *Introduction to Data Mining*, South Asia: Pearson Education, 2016.
[3] Ikvinderpal Singh, *Data Mining and Warehousing*, New Delhi: Khanna Publishing, 2014.

Course Learning Outcomes (COs):
On completion of this course, students will be able to ...

CO1: differentiate various data mining processes
CO2: generate association rules from transactional data sets and apply fuzzy logic to classification algorithms
CO3: apply rough sets, SVM and genetic algorithms to improve the classification accuracy
CO4: evaluate various performance measures of classification & prediction and apply data mining to different real world problems

Course Articulation Matrix (CAM): P20DS103A ADVANCED DATA MINING

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS103A.1**	1	1	1	1	2
CO2	**P20DS103A.2**	1	1	1	2	1
CO3	**P20DS103A.3**	1	1	1	2	1
CO4	**P20DS103A.4**	1	1	1	1	1
P20DS103A		**1**	**1**	**1**	**1.5**	**1.25**

P20DS103B ARTIFICIAL INTELLIGENCE

Class: M.Tech. I-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: fundamentals of Artificial Intelligence and problem-solving using search techniques

LO2: local search algorithms, search techniques used in game playing and solving constraint satisfaction problems

LO3: propositional logic, syntax & semantics of first order logic and inferencing methods

LO4: quantifying uncertainty, probabilistic reasoning over time, making simple & complex decisions and robotics applications

UNIT – I (9)

Introduction: Definitions of Artificial Intelligence (AI), Foundations of AI, History of AI

Intelligent Agents: Agents and environments, Nature of environments, Structure of agents

Solving Problems by Searching: Problem solving agents, Example problems, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions

UNIT – II (9)

Beyond Classical Search: Local search algorithms and optimization problems, Local search in continuous spaces, Searching with non-deterministic actions, Searching with partial observations

Adversarial Search: Games, Optimal decisions in games, Alpha-Beta pruning, Imperfect real-time decisions, Stochastic games

Constraints Satisfaction Problems: Defining constraints satisfaction problems (CSP), Constraint propagation, Backtracking search for CSPs

UNIT – III (9)

Logical Agents: Knowledge based agents, Propositional logic, Propositional theorem proving, Agents based on propositional logic

First Order Logic: Syntax and semantics of first order logic, Using first order logic, Knowledge engineering in first order logic

Inference in First Order Logic: Propositional vs. first order inference, Unification and lifting, Forward chaining, Backward chaining, Resolution

UNIT – IV (9)

Quantifying Uncertainty: Acting under uncertainty, Bayes' rule and its use

Probabilistic Reasoning over Time: Time and uncertainty, Inference in temporal models, Hidden markov models

Making Simple and Complex Decisions: Combining beliefs and desires under uncertainty, The basis of utility theory, Utility functions, Sequential decision problems, Value iteration, Policy iteration

Robotics: Robot hardware, Robotic perception, Planning and control, Application domains

Text Book:

[1] Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed. US: Pearson Education, 2010.

Reference Book(s):

[1] Richard E. Neapolitan, Xia Jiang, *The Artificial Intelligence: With an Introduction to Machine Learning*, 2nd ed. New York: CRC Press, 2018.

[2] Elaine Rich, Kevin Knight and Shivashankar B Nair, *Artificial Intelligence*, 3rd ed. New Delhi: Tata McGraw-Hill, 2009.

[3] Vinod Chandra S.S, Anand Hareendran S., *Artificial Intelligence and Machine Learning*, New Delhi:PHI Learning Pvt.Ltd., 2014.

[4] Zsolt Nagy, *Artificial Intelligence and Machine Learning Fundamentals*, UK:Packt Publishing, 2018.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: apply different search techniques in solving engineering problems

CO2: analyze search algorithms, game playing and constraint satisfying problem & solutions

CO3: apply first order logic and use inferencing methods in solving AI problems

CO4: apply decision theory for solving simple & complex problems and illustrate the software & hardware used in robots

Course Articulation Matrix (CAM): P20DS103B ARTIFICIAL INTELLIGENCE

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS103B.1**	1	1	1	1	-
CO2	**P20DS103B.2**	2	1	2	1	-
CO3	**P20DS103B.3**	2	1	2	2	1
CO4	**P20DS103B.4**	2	1	2	2	1
P20DS103B		**1.75**	**1**	**1.75**	**1.5**	**1**

P20DS103C INFORMATION RETRIEVAL SYSTEMS

Class: M.Tech. I-Semester **Specialization**: Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: indexes and queries that deal with Boolean retrieval

LO2: score measure of a document that matches a query

LO3: relevance feedback and probability theory to compute scores for documents on queries

LO4: linear algebraic methods in information retrieval and techniques & challenges in web information retrieval.

UNIT - I (9)

Boolean Retrieval: Information retrieval problem, Building an inverted index, Processing boolean queries, The extended boolean model versus ranked retrieval

The Term Vocabulary and Postings Lists: Document delineation and character sequence decoding, Determining the vocabulary of terms, Faster postings list intersection via skip pointers, Positional postings and phrase queries

Dictionaries and Tolerant Retrieval: Search structures for dictionaries, Wildcard queries, Spelling correction, Phonetic correction

Index Construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes

Index and Compression: Statistical properties of terms in information retrieval, Dictionary compression

UNIT - II (9)

Scoring, Term Weighting and the Vector Space Model: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, Variant tf-idf functions

Computing Scores in a Complete Search System: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction

Evaluation in Information Retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, A broader perspective, System quality and user utility, Results snippets

Text Classification and Naive Bayes: The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, Feature selection, Evaluation of text classification

UNIT – III (9)

Relevance Feedback and Query Expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation

XML retrieval: Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs data-centric XML retrieval

Probabilistic Information Retrieval: Review of basic probability theory, The Probability

ranking principle, The 1/0 loss case, The PRP with retrieval costs, The binary independence model

Language Models for Information Retrieval: Language models, The query likelihood model, Language modeling versus other approaches in IR, Extended language modeling approaches

UNIT – IV (9)

Matrix Decompositions and Latent Semantic Indexing: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing

Web Search Basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, User query needs, Index size and estimation, Near-duplicates, and shingling

Web Crawling and Indexes: Overview, Crawling, Distributing indexes, Connectivity servers

Link Analysis: The Web as a graph, PageRank, Hubs and authorities, Choosing the subset of the Web

Text Book:

[1] Christopher D. Manning and Prabhakar Raghavan and Hinrich Schütze, *Introduction to Information Retrieval*, Cambridge University Press, 2008.

Reference Book(s):

[1] Kowalski, Gerald, Mark T Maybury, *Information Storage and Retrieval Systems: Theory and Implementation*, 2nd ed., New York: Kluwer Academic Publishers, Springer, 2002.

[2] Ricardo Baeza-Yates, *Modern Information Retrieval*, New York: Addison Wesley, ACM Press, 2007.

[3] David A Grossman and Ophir Frieder, *Information Retrieval: Algorithms and Heuristics*, 2nd ed., Norwell: Kluwer Academic Publishers Springer, 2004.

[4] William B Frakes, Ricardo Baeza-Yates, *Information Retrieval Data Structures and Algorithms,* India: Pearson Education, 1992.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: illustrate boolean retrieval process to identify a document which matches a query

CO2: compute scores leading to list the documents in rank-order for a given query

CO3: apply probability theory to compute scores for documents on queries

CO4: explain basic challenges in web search together with techniques that are pervasive in web Information

Course Articulation Matrix (CAM): P20DS103C INFORMATION RETRIEVAL SYSTEMS						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS103C.1**	1	1	1	1	1
CO2	**P20DS103C.2**	2	1	1	1	1
CO3	**P20DS103C.3**	2	1	2	1	1
CO4	**P20DS103C.4**	2	1	2	1	1
P20DS103C		**1.75**	**1**	**1.5**	**1**	**1**

P20DS104A BIG DATA ANALYTICS

Class: M.Tech. I–Semester **Specialization:** Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: different types of digital data, characteristics of big data, typical data warehouse & Hadoop environment, and classification of analytics

LO2: the design of Hadoop distributed file system, I/O structure, and configuring & running the development environment of MapReduce application

LO3: job execution, types, formats, & features of MapReduce

LO4: tools like Pig, Hive, ZooKeeper, which are analytics platform built on Hadoop distributed file system and MapReduce

UNIT – I (9)

Types of Digital Data: Classification of digital data

Introduction to Big Data: Characteristics of data, Evolution of big data, Definition of big data, Challenges with big data, What is big data, Other characteristics of data which are not definitional traits of big data, Why big data, Are we just an information consumer or do we also produce information, Traditional business intelligence versus big data, A typical data warehouse environment, A typical Hadoop environment, What is new today, What is changing in the realms of big data

Big Data Analytics: Where do we begin, What is big data analytics, What big data analytics isn't, Why this sudden hype around big data analytics, Classification of analytics, Greatest challenges that prevent businesses from capitalizing on big data, Top challenges facing big data, Why is big data analytics important, What kind of technologies are we looking toward to help meet the challenges posted by big data, Data science, Data scientist your new best friend, Terminologies used in big data environments, Basically available soft state eventual consistency, Few top analytics tools

UNIT – II (9)

The Hadoop Distributed File system: The design of HDFS, HDFS concepts, The command-line interface, Hadoop file systems, The java interface, Parallel copying with distcp, Hadoop archives

Hadoop I/O: Data integrity, Compression, Serialization, File-based data structures

Developing a MapReduce Application: The configuration API, Configuring the development environment, Writing a unit test, Running locally on test data, Running on a cluster, Tuning a job, MapReduce workflows

UNIT – III (9)

How MapReduce Works: Anatomy of a MapReduce job run, Failures, Job scheduling, Shuffle and sort, Task execution

MapReduce Types and Formats: MapReduce types, Input formats, Output formats

MapReduce Features: Counters, Sorting, Joins, Side data distribution, MapReduce library classes

UNIT – IV (9)

Pig: Installing and running Pig, An example, Comparison with databases, Pig latin, User-defined functions, Data processing operators, Pig in practice

HBase: HBasics, Concepts, Installation, Clients, Example, HBase versus RDBMS, Praxis

ZooKeeper: Installing and running ZooKeeper, An example, The ZooKeeper service, ZooKeeper in production

Text Book(s):

[1] Seema Acharya, Subhashini Chellappan, *Big Data and Analytics*, 2nd ed., New Delhi: Wiley India Pvt. Ltd., 2019. (*Chapters: 1, 2, 3*)

[2] Tom White, *Hadoop: The Definitive Guide*, 4th ed., California: O'Reilly Media, Inc, 2015. (*Chapters: 3 to 8, 11 to 13*).

Reference Book(s):

[1] V.K. Jain, *Big Data and Hadoop*, New Delhi: Khanna Book Publishing Co. (P) Ltd., 2017.

[2] DT Editorial Services, *Big Data (Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization), Black Book*, New Delhi: Dreamtech Press, 2015.

[3] Benjamin Bengfort, Jenny Kim, *Data Analytics with Hadoop: An Introduction for Data Scientists*, California: O'Reilly Media, Inc, 2016.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: classify digital data, address the challenges and understand the realm of Big Data

CO2: make use of HDFS for storing and running large datasets using MapReduce

CO3: understand the anatomy, types, formats and features of MapReduce programming

CO4: make use of Pig for large-scale data processing, HBase for structured and semi-structured data, and ZooKeeper toolkit for building distributed systems

Course Articulation Matrix (CAM): P20DS104A BIG DATA ANALYTICS

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS104A.1**	1	1	-	1	-
CO2	**P20DS104A.2**	2	1	1	1	-
CO3	**P20DS104A.3**	2	1	1	1	1
CO4	**P20DS104A.4**	2	1	1	2	2
P20DS104A		**1.75**	**1**	**1**	**1.25**	**1.5**

P20DS104B NATURAL LANGUAGE PROCESSING

Class: M.Tech. I-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):
This course will develop students' knowledge in /on
LO1: language processing, accessing corpora, lexical resource and processing raw text
LO2: categorizing, tagging words and classification techniques for textual data
LO3: concepts of information extraction, sentence analysis and feature based grammars
LO4: analyzing the meaning of sentences and linguistic data

UNIT – I (9)

Language Processing and Python: Computing with language, Automatic natural language understanding

Accessing Text Corpora and Lexical Resources: Accessing text corpora, Conditional frequency distributions, Lexical resources, Wordnet

Processing Raw Text: Accessing text from the web and from disk, Strings: text processing at the lowest level, Text processing with unicode, Regular expressions for detecting word Patterns, Useful applications of regular expressions, Normalizing text, Regular expressions for tokenizing text, Segmentation, Formatting: from lists to strings

UNIT – II (9)

Categorizing and Tagging Words: Using a tagger, Tagged corpora, Mapping words to properties using python dictionaries, Automatic tagging, N-gram tagging, Transformation-based tagging

Learning to Classify Text: Supervised classification, Evaluation, Decision trees, Naive bayes classifiers, Maximum entropy classifiers, Modeling linguistic patterns

UNIT – III (9)

Extracting Information from Text: Information extraction, Chunking, Developing and evaluating chunkers, Recursion in linguistic structure, Named entity recognition, Relation extraction

Analyzing Sentence Structure: Context-free grammar, Parsing with context-free grammar, Dependencies and dependency grammar, Grammar development

Building Feature-Based Grammars: Grammatical features, Processing feature structures, Extending a feature-based grammar

UNIT – IV (9)

Analyzing the Meaning of Sentences: Natural language understanding, Propositional logic, First-order logic, The semantics of english sentences, Discourse semantics.

Managing Linguistic Data: Corpus structure: a case study, The life cycle of a corpus, Acquiring data, Working with XML, Working with toolbox data, Describing language resources using OLAC metadata

Text Book:

[1] Steven Bird, Ewan Klein, Edward Loper, *Natural Language Processing with Python*, USA: O'Reilly Media, 2009.

Reference Book(s):

[1] Daniel Jurafsky, James H Martin, *Speech and Language Processing*, 2nd ed., India:Pearson Education, 2013.

[2] Bharati A., Sangal R., Chaitanya V., *Natural language processing: a Paninian perspective*, 2nd ed., New Delhi:Prentice Hall Education, 2000.

[3] Uma Shanker Tiwary, Tanveer Siddiqui, *Natural Language Processing and Information Retrieval*, UK:Oxford University Press, 2008.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: use text corpora for processing raw text in lexical analysis

CO2: apply tagging words and classification techniques for given text data

CO3: apply concepts of information extraction and feature based grammars for natural language processing

CO4: analyze the meaning of sentence and linguistic data for natural language processing

Course Articulation Matrix (CAM): P20DS104B NATURAL LANGUAGE PROCESSING

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS104B.1**	1	1	1	1	1
CO2	**P20DS104B.2**	1	1	1	1	1
CO3	**P20DS104B.3**	2	1	1	2	2
CO4	**P20DS104B.4**	2	1	2	1	2
P20DS104B		**1.5**	**1**	**1.25**	**1.25**	**1.5**

P20DS104C SOFT COMPUTING

Class: M.Tech. I–Semester **Specialization**: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: the concepts of artificial intelligence and neural networks

LO2: implementing backpropagation algorithms

LO3: concepts of fuzzy logic and fuzzy systems

LO4: concepts of genetic algorithms and genetic modelling

UNIT – I (9)

Introduction to Artificial Intelligence Systems: Neural networks, Fuzzy logic, Genetic algorithms. Fundamentals of neural networks: Basic concepts of neural networks, Human brain, Model of an artificial neuron, Neural network architectures, Characteristics of neural networks, Learning methods, Taxonomy of neural network architectures, Early neural network architectures: ADA line network, MADA line network

UNIT – II (9)

Backpropagation Networks: Architecture of a backpropagation network, Backpropagation learning, Illustration, Applications, Effect of tuning parameters of the backpropagation neural network, Selection of various parameters in BPN, Variations of standard backpropagation algorithm, Research directions

UNIT – III (9)

Fuzzy Logic: Fuzzy set theory, Fuzzy versus crisp, Crisp sets, Fuzzy sets, Crisp relations, Fuzzy relations

Fuzzy Systems: Crisp logic, Predicate logic, Fuzzy logic, Fuzzy rule-based system

UNIT – IV (9)

Genetic Algorithms: Fundamentals of genetic algorithms, Genetic algorithms history, Basic concepts, Creation of offsprings, Working principle, Encoding, Fitness function, Reproduction

Genetic Modelling: Inheritance operators, Cross over, Inversion and deletion, Mutation operator, Bit-wise operators, Bit-wise operators used in genetic algorithms, Generational cycle, Convergence of genetic algorithm, Applications

Text Book:

[1] R. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications*, New Delhi: Prentice Hall of India, 2003.

Reference Book(s):

[1] S.N. Deepa, S.N. Sivanandam, *Principles of Soft Computing*, 2nd ed., New Delhi: Wiley, 2011.

[2] Sunita Tewari, *Soft Computing fundamentals, Techniques and Applications*, New Delhi :Tata McGraw Hill, 2018.

[3] B. Yegnanarayana, *Artificial Neural Networks*, New Delhi:Prentice Hall of India, 2005.

Course Learning Outcomes (COs):

On completion of this course, students will be able to …

CO1: identify and describe artificial intelligence, neural networks techniques in building intelligent machines

CO2: implement backpropagation algorithms to solve various classification problems

CO3: differentiate fuzzy and crisp sets

CO4: apply genetic algorithms to optimization problems

Course Articulation Matrix (CAM): P20DS104C SOFT COMPUTING

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS104C.1**	2	1	-	2	-
CO2	**P20DS104C.2**	2	1	1	1	2
CO3	**P20DS104C.3**	2	1	1	1	2
CO4	**P20DS104C.4**	2	1	1	1	2
P20DS104C		**2**	**1**	**1**	**1.25**	**2**

P20DS105 ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY

Class: M.Tech. I-Semester **Specialization**: Data Science

Teaching Scheme :

L	T	P	C
-	-	4	2

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: *basic concepts of various data structures*

LO2: *concepts of trees, heaps and hash functions for problem solving*

LO3: *analyzing shortest distance path using Bellman-Ford and Dijkstra's algorithm*

LO4: *implementation of randomized and approximation algorithms*

List of Experiments

Experiment-I

1. Program to create stacks and implement insert, delete and search operations.
2. Program to create queues and implement insert, delete and search operations.

Experiment-II

3. Program to create binary search tree and implement following operations.
    a. Insertion
    b. Deletion
    c. Finding an element
    d. Finding minimum element
    e. Finding maximum element

Experiment-III

4. Program to implement selection sort.
5. Program to implement insertion sort.
6. Program to implement heap sort.

Experiment-IV

7. Program to create linked list and implement insert, delete, replace and search operations.
8. Program to implement different operations in heap for the given data as strings.
9. Program to implement hash function using various data types.

Experiment-V

10. Program to create AVL trees and implement insertion and deletion operations.
11. Program to implement fractional knapsack problem using greedy method.

Experiment-VI

12. Program to implement Huffman coding.
13. Program to implement 0-1 knapsack problem using Dynamic programming.

Experiment-VII

14. Program to implement Kruskal's algorithm and Prim's algorithm.

Experiment-VIII

15. Program to implement longest common subsequence problem using Dynamic programming technique.

Experiment-IX

16. Program to implement Bellman-Ford algorithm and Dijkstra's algorithm for single source shortest path in a weighted directed graph.

Experiment-X

17. Demonstrate the working procedure of the following randomized algorithms.
    a. Randomized divide and conquer
    b. Finding the closest pair of points

Experiment-XI

18. Demonstrate the following approximation algorithm technique.
    a. Load balancing techniques
    b. Vertex cover

Experiment-XII

19. Demonstrate the LP relaxation approximation technique to design approximation algorithms.

Laboratory Manual:

[1] Advanced Data Structures through Python Laboratory Manual, *prepared by the faculty of Dept. of IT.*

Reference Book:

[1] Narasimha Karumanchi, *Data Structures and Algorithmic Thinking with Python*, Mumbai : CareerMonk publications, 2020.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: *experiment with data structure operations and sorting techniques in real time data*

CO2: *examine hash function applications and AVL tree operations.*

CO3: *use greedy methods in network design and apply dynamic programming to find optimal solutions.*

CO4: *apply randomized algorithms and approximation algorithms in real time problems.*

Course Articulation Matrix (CAM) : P20DS105 ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS105.1**	1	2	-	1	2
CO2	**P20DS105.2**	1	2	-	1	2
CO3	**P20DS105.3**	1	2	1	1	2
CO4	**P20DS105.4**	1	2	1	1	2
P20DS105		**1**	**2**	**1**	**1**	**2**

P20DS106 DATA SCIENCE LABORATORY

Class: M.Tech. I-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
-	-	4	2

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: *basic statistics and data manipulation.*

LO2: *concepts of data visualization techniques*

LO3: *regular expression, linear regression and hypothesis testing.*

LO4: *classification techniques and inferential statistics*

List of Experiments

Experiment-I

1. Program to experiment with basic statistics.
   a. Basic statistics using NumPy , Pandas, Matplotlib, Scikit
   b. Using discrete & continuous random variables
   c. Finding mean, mode and median
   d. Calculate variance and standard deviation
   e. Basic statistics using Sk-learn

Experiment-II

2. Program to perform data exploration and preprocessing in Python.

Experiment-III

3. Program to implement data manipulation concepts using Python
   a. Indexing a data frame
   b. Apply function in data frame
   c. Aggregating data
   d. Sorting data frames and merging data frames

Experiment-IV

4. Program to implement data visualization techniques using matplotlib library
   a. Line plot
   b. Area plot
   c. Histogram
   d. Box plot
   e. Scatter plot

Experiment-V

5. Install tableau software for data visualization and perform the following
    f. Create Tableau Workspace
    g. Connecting to a Data Source
    h. Creating a view
    i. Refining the view
    j. Adding Filters to the view
    k. Adding Colors to the view with key findings
    l. Building a map view
    m. Getting into details and identifying the key points
    n. Creating a dashboard and adding interactiveness

Experiment-VI

6. Implement a program to use regular expressions for data science using python
7. Implement Naive Bayes classifier for dataset stored as CSV file.

Experiment-VII

8. Implement a decision tree to classify the data set

Experiment-VIII

9. Implement a program to perform sampling analysis in inferential statistics

Experiment-IX

10. Implement sampling distribution and 1-tail test & 2-tail test

Experiment-X

11. Develop a simple linear regression model in python

Experiment-XI

12. Develop a multiple linear regression model in python

Experiment-XII

13. Implement a program for clustering analysis in data science

Laboratory Manual:

[1] Data Science Laboratory Manual, *prepared by the faculty of Dept. of IT.*

Reference Book:

[1] Chantal D. Larose, Daniel T. Larose, *Data Science using Python and R*, USA: John Wiley& Sons, Inc., 2019.

Course Outcomes (COs):

On completion of this course, students will be able to…

CO1: experiment with basic statistics and data manipulation

CO2: utilize data visualization techniques to visualize the given data set

CO3: choose proper classification techniques to predict the class and apply inferential statistics to analyze the samples

CO4: apply regular expression, linear regression and hypothesis testing for optimal solutions

Course Articulation Matrix (CAM) : P20DS106 DATA SCIENCE LABORATORY						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS106.1**	1	2	1	1	2
CO2	**P20DS106.2**	1	2	1	1	2
CO3	**P20DS106.3**	1	2	1	1	2
CO4	**P20DS106.4**	1	2	1	1	2
P20DS106		**1**	**2**	**1**	**1**	**2**

P20MC107 : RESEARCH METHODOLOGY AND IPR

Class: M. Tech., I-Semester

Specialization(s): SCE, DE, VE, PE, SE DS, DC & CSP

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: research methodology, approaches, principles of experimental design and research plan

LO2: sampling design, data collection, data representation and statistical analysis

LO3: layout of a research report, technical paper writing, oral presentation and intellectual property

LO4: patent rights and developments in IPR.

UNIT - I (6)

Research Methodology: Meaning of research, Objectives, Motivation, Types, Approaches, Research methods Vs methodology, scientific method, Research process, Criteria for good research, Literature review, Research ethics, Plagiarism, Problems encountered by researchers in India

Defining the Research Problem and Research Design: Selecting a research problem, Necessity and techniques in defining research problem, Need for research design, Features of good design, Different research designs, Basic principles of experimental design, Developing a research plan

UNIT – II (6)

Sampling Design: Census and sample survey, Implications, Steps, Criteria of selecting a sampling procedure, Characteristics of a good sample design, Types of sample designs, Complex random sampling designs

Data Collection & Data Analysis: Collection of primary and secondary data, Observation method, Interview method, Collection of data through questionnaires, Schedules, Data organization, Methods of data grouping, Diagrammatic and graphic representation of data, Regression modeling, Direct and interaction effects, ANOVA, F-test, Time series analysis, Autocorrelation and Autoregressive modeling.

UNIT – III (6)

Interpretation and Report Writing: Interpretation Technique, Precaution in interpretation, Significance, steps and layout of report writing, Types of reports, Oral presentation, Mechanics of writing a research report, Precautions, Format of the research report, synopsis, dissertation, thesis, references/bibliography/webliography, Technical paper writing/ journal/ report writing, Making presentation, Use of visual aids.

Nature of Intellectual Property: Patents, Designs, Trade and Copyright.

Process of Patenting and Development: Technological research, innovation, patenting, development.

UNIT – IV (6)

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

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

Text Book(s):

[1] C.R Kothari and Gaurav Garg, *Research Methodology, Methods & Techniques*, 4th ed., New Age International Publishers, 2019 (*Chapters 1, 2, 3, 6, 7, 11, 14*)

[2] Deborah Ebouchoux, *Intellectual Property, The Law of Trademarks, Copyrights, Patents and Secrets*, 4th ed., Delmar, Cengage Learning, 2012 *(Chapter 1, 2, 3, 17, 18)*

[3] ***Anti-plagiarism policy of KITSW*** - A handout prepared by Dean, Research and Development, KITSW, Jan 2020.

[4] Frequently Asked Questions, Office of CGPDTM, INDIA 2020

[5] Patent Office Procedures: http://www.ipindia.nic.in/writereaddata/images/pdf/ patent-office-procedures.pdf

References Book(s):

[1] Stuart Melville and Wayne Goddard, *Research methodology: An Introduction for Science & Engineering Students*, 2nd ed., JUTA, 2007.

[2] Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in New Technological Age - I*, Clause 8, 2016.

[3] Dobera J Halbert, *Resisting Intellectual Property*, Taylor & Francis Ltd., 1st ed., 2005.

[4] Ranjit Kumar, *Research Methodology: A Step by Step Guide for beginners*, 3rd ed., New Delhi : Sage Publications India Pvt. Ltd, 2011.

[5] T. Ramappa, *Intellectual Property Rights Under WTO*, 4th ed., .S. Chand, 2008.

[6] R. Ganesan, *Research Methodology for Engineers*, MJP Publishers, Chennai, 2011.

[7] Patent application procedures: https://patentinindia.com/cost-patent-registration-india/

[8] http://www.ipindia.nic.in/history-of-indian-patent-system.htm

[9] Patent Law India: https://www.mondaq.com/india/patent/656402/patents-law-in-india--everything-you-must-know

[10] How to file patents: https://iptse.com/how-to-file-patents-understanding-the-patent-process-in-india/

[11] How Can I get a patent for my project: https://patentinindia.com/cost-patent-registration-india/

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: develop and formulate research problem using research methodology techniques.

CO2: utilize techniques of data modeling and analysis to solve research problem

CO3: choose an appropriate methodology to write a technical report and present a research paper

CO4: judge patent rights and adapt new developments in IPR for their patent publications

Course Articulation Matrix (CAM): P20MC107 RESEARCH METHODOLOGY & IPR						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20MC107.1**	2	2	1	-	-
CO2	**P20MC107.2**	2	2	1	1	-
CO3	**P20MC107.3**	2	2	1	-	-
CO4	**P20MC107.4**	2	2	-	-	-
P20MC107		**2**	**2**	**1**	**1**	**-**

P20AC108A: ENGLISH FOR RESEARCH PAPER WRITING

Class: M.Tech. I-Semester

Specialization(s): SCE, DE, VE, PE, SE, DS, DC &CSP

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: planning for quality research writing with improved level of readability

LO2: constituents and attributes of a research paper

LO3: specifications for research transcription and pedagogic skills for reporting research

LO4: guidelines for publishing research papers in quality journals

UNIT - I (6)

Skills for Research Writing: Planning and preparation, Word order, Breaking up long sentences, Structuring paragraphs and sentences, Being concise and removing redundancy

Improving Level of Readability: Avoiding ambiguity and vagueness, clarifying who did what, highlighting your findings, hedging and criticizing, paraphrasing and plagiarism

UNIT - II (6)

Constituents of a Research Paper: Abstract, styles of abstract, keywords, characteristics of poor abstract, assessing quality of abstract, introduction- outline in introduction, assessing quality of introduction, review of literature, ways of referring to authors in literature, attributes of a research paper: methodology, use of tenses and articles in methodology, results, styles of reporting results, discussion, styles of writing discussions, conclusions, impact of writing conclusions, assessing quality of conclusions, final check-do's and don'ts

UNIT - III (6)

Specifications for research Transcription: Structuring phrasing and summarizing of title and abstract, Structuring phrasing and summarizing of introduction, critical review of literature, limitations of previous work and demonstration of innovation in proposed research

Pedagogic skills for reporting research: Structuring and justifying the methodology, structuring, reporting, interpreting and summarizing results, structuring, comparing, interpreting and summarizing discussions, styles of writing discussions, structuring, differentiating and summarizing of conclusions

UNIT - IV (6)

Quality Assurance and Corroboration of Research: Indexing and harnessing useful phrases, adapting final check for readability, clarity in logical order of argumentation, checking for journal guidelines, consistency, accuracy, acknowledgements and spell-check

Text Book:

[1] Adrian Wallwork, *English for Writing Research Papers,* 2nd ed., New York, Dordrecht Heidelberg London, Springer books, 2016

Reference Book(s):

[1] Goldbort R, *Writing for Science, London,* 2nd ed., Yale University Press, 2006

[2] Day R, *How to Write and Publish a Scientific Paper,* 8th ed., Cambridge:University Press, 2016

[3] Adrian Wallwork, *English for Academic Research, Grammar, Usage and Style,* 2nd ed., Springer New York Dordrecht Heidelberg London, Springer Books, 2012

Course Learning Outcomes (Cos):

On completion of this course, the student will be able to…

CO1*: develop essential skills for research writing with improved level of readability.*

CO2*: organize the constituents of research paper and derive conclusions with a final check of Do's and Don'ts*

CO3*: justify, interpret, compare and summarize results for proposed methodologies in research paper.*

CO4*: adopt quality assurance methods like final check for readability, consistency and accuracy of a research paper.*

Course Articulation Matrix: P20AC108A ENGLISH FOR RESEARCH PAPER WRITING					
CO Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
P20AC108A.1	1	2	2	-	-
P20AC108A.2	1	2	2	-	-
P20AC108A.3	1	2	2	-	-
P20AC108A.4	1	2	2	-	-
P20AC108A	**1**	**2**	**2**	**-**	**-**

P20AC108B: SANSKRIT FOR TECHNICAL KNOWLEDGE

Class: M.Tech. I – Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: proficiency in illustrious Sanskrit, the scientific language in the world
LO2: the depth of grammar in sanskrit
LO3: deeper insight into tenses used in sanskrit
LO4: concepts related to various technical fields

UNIT – I (6)

Introduction: Alphabets, vowels, consonants, Māheśvara sutras, combined alphabets, verbs, basic words

UNIT –II (6)

Study of grammar I: Singular/dual/plural, nominative case, accusative case, instrumental case, dative case, ablative case, genitive case, locative case

UNIT– III (6)

Study of grammar II: Nouns and adjectives, indeclinable, present tense, past tense, future tense, order and request, prefixes, number word, combinations ablative case, genitive case, locative case and cases**.**

UNIT - IV (6)

Technical concepts related to various fields: Technical concepts of Mathematics, Chemistry, Electrical science, Mechanics & Mechanical Science, Metallurgy, Aeronautics, Marine science, measurement of time, astronomy, architecture, botany, agriculture, hygiene & health

Text Book(s):

[1] Dr.Vishwas, *Abhyaspustakam,* 1st ed. New Delhi: Samskrita-Bharti Publication, 2014

[2] Suresh Soni, *India's Glorious Scientific Tradition,* 1st ed. NewDelhi: Ocean books (P) Ltd, 2008 (*For Unit IV*)

Reference Book:

[1] Vempati Kutumbshastri, *Teach Yourself Sanskrit*, 1st ed. New Delhi: Prathama Deeksha Rashtriya Sanskrit Sansthanam, 2012

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: understand to read and write basic Sanskrit language

CO2: identify the usage of grammar in the ancient Indian language

CO3: make use of tenses in Sanskrit language

CO4: analyze the ancient Sanskrit literature on Science and Technology

Course Articulation Matrix (CAM): P20AC108B SANSKRIT FOR TECHNICAL KNOWLEDGE						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20AC108B.1**	2	1	1	-	-
CO2	**P20AC108B.2**	2	1	1	-	-
CO3	**P20AC108B.3**	2	1	1	-	-
CO4	**P20AC108B.4**	2	1	1	-	-
P20AC108B		**2**	**1**	**1**	**-**	**-**

P20AC108C: CONSTITUTION OF INDIA

Class: M. Tech. I–Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: state policy and parliamentary form of government, council of ministers
LO2: necessity of act of information technology and its powers, cyber security and its laws
LO3: consumer protection act, rights of consumer-deficiency in service
LO4: crimes against women, different legislations, process of investigation and right to information act

UNIT – I (6)

Constitutional Law: Constitution meaning and significance-constitutional history-status of fundamental rights-role of fundamental duties-implementation of the directive principles of the state policy-parliamentary form of government-president-prime minister-council of ministers-federal structure in constitution-relations between central and state-amendment of constitution –procedure and kinds of amendments.

UNIT – II (6)

Law of information technology: Evolution-genesis and necessity of information technology act-features and various authorities under it act-their powers-impact of other related enactments-e-commerce laws in india-digital and electronic signatures in indian laws-e-contracts and its validity in india-cyber tribunals-definition and necessity of cyber security-computer and cyber security-e-mail security-database security-operating system security-advance computers-network and mobile security techniques- sensitive personal data and information in cyber laws-cyber crimes-hacking-phishing –stalking-cyber terrorism.

UNIT – III (6)

Corporate Law: Definition and essentials of valid contract - corporate incorporation and management-directors of company-company secretary-corporate governors-different system of corporate governors-corporate governance and social responsibility-emerging trends-corporate and social environment responsibility-competition law-objectives competition commission of india-consumer protection act-consumerism-rights of consumer-deficiency in service-unfair trade practices-e-contracts etc.

UNIT - IV (6)

Criminal Law: Definition of crime--crimes against women including cyber crimes-criminal justice systems-protection for women for atrocities-different legislations like constitution, indian penalcode, human rights, domestic violence, equality in rights, dowry prohibition,

prevention of child marriage, prevention of sexual harassment against woman at work place, protection of children some sexual harassment – investigation – compliant - process of investigation – fir, panchanama, closure report, charge sheet etc - procedure of search

Right to Information Act: Freedom of information - indian constitution and right to information - legislating the right to information - salient features of the right to information act 2005 - public authority under RTI act - nature of RTI, exemptions and limitations - composition, powers and functions of the information commissions - right to information and implementation issues

Text Book(s):

[1] M.P.Jain, Indian *Constitutional Law*, Vol.1, Wadhwa & Co, Nagpur, 2003

[2] Vakul Sharma, *Information Technology – Law and Practice,* Universal Law Publishing, 3rd Ed. 2011

[3] Gower and Davies, *Principles of Modern Company Law,* Sweet and Maxwell Publishing, 10th Ed.

[4] Ratan Lal and Dhiraj Lal: *Indian Penal Code*, Wadhwa & Co., 36th Ed. 2000

[5] O.P.Srivastava: *Principles of Criminal Law,* Eastern Book Company, 6th Ed. 2016

[6] KM Shrivastava, *The Right to Information: A Global Perspective*, Lancer Publisher, New Delhi (2013)

Reference Book(s):

[1] H.M.Seervai, *Constitutional Law of India, Vol.3,* N.M.Tripathi , 4th Ed., 1997

[2] G.C.V.Subba Rao, *Indian Constitutional Law*, S.Gogia& Co., Hyderabad

[3] Dr.S.R.Myneni, *Information Technology Law (Cyber Laws),* Asia Law House, Hyderabad, 1st Ed. 2018.

[4] J.M. Thomson: *Palmer's Company Law, Vol.4, 21st Ed. Wildy & Sons Ltd.*

[5] P.S.Achutan Pillai: *PSA Pillai's Criminal Law*, Butterworth Co., 2000.

[6] K.D.Gour: *Criminal Law*, *Cases and Materials*, 9th Ed. LexisNexis, 2019.

[7] Sairam Bhat, *Right to Information and Good Governance*, National Law School of India University, 2016.

[8] Dheera Khandelwal and KK Khandelwal , A Commentary and Digest on the *Right to Information Act, 2005,* 2nd Ed., 2014.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: develop the knowledge in state policy and parliamentary form of government
CO2: make use of information technology act and cyber security
CO3: utilize the consumer protection act and rights consumer
CO4: perceive the legislations and understand the process of investigation and right to information act

Course Articulation Matrix (CAM): P20AC108C : CONSTITUTION OF INDIA						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20AC108C.1**	1	1	1	-	-
CO2	**P20AC108C.2**	1	1	1	-	-
CO3	**P20AC108C.3**	1	1	1	-	-
CO4	**P20AC108C.4**	1	1	1	-	-
P20AC108B		**1**	**1**	**1**	**-**	**-**

P20AC108D : PEDAGOGY STUDIES

Class: M. Tech. I–Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop student's knowledge in/on

LO1: terminology of pedagogy studies, role of curriculum, relation between teaching and learning
LO2: effectiveness of pedagogical practices and teaching strategies
LO3: student centered approaches of learning
LO4: factors supporting effective pedagogy, research gaps and future directions of potential areas

UNIT - I (6)

Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning- Behaviourism, Constructivism, Social constructivism, Critical theory, Difference between curriculum and syllabus, Curriculum, Importance of curriculum for students and teachers, Role played by the curriculum

Teaching- Learning Process: Introduction, Concept of pedagogy, Principles of teaching, Maxims of teaching, Phases of learning, Relationship between teaching and learning, Factors of teaching and learning in classroom situation, Difference between teaching and learning

UNIT - II (6)

Overview of pedagogical practices in developing countries: Overview and aims, Pedagogy approaches, Pedagogy as practice, Pedagogy as ideas, Pedagogy and equity, Curriculum, Teacher education - initial teacher education, Continuing professional development, Training unqualified teachers, Effectiveness of pedagogical practices, Pedagogic theory and pedagogical strategies, Teachers' attitudes and beliefs

Strategies of Teaching: Features, Characteristics, Advantages and limitations of lecture method, Demonstration method, Experimental method and Discussion method

UNIT - III (6)

Student Centred Approaches: Features, characteristics, Advantages and limitations of constructivist approach of learning, Discovery method of learning, Enquiry method, Project Based Learning (PBL), Activity Based Learning (ABL)

Practical Approaches: Features of experiential learning and Teacher's role, Peer tutoring, Field visits and process of organizing, E-learning tools, Strengths and weaknesses.

UNIT - IV (6)

Role of Teacher Education, School Curriculum, Guidance Materials in Supporting Effective Pedagogy: Professional development, Alignment with classroom practices and follow-up

support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Research Gaps and Future Directions: Research design, contexts, Pedagogy, Teacher education, curriculum and assessment, Dissemination and research impact

Text Book(s):

[1] Dr. S. K. Bhatia, Dr. Sonia Jindal, *A Textbook of curriculum, pedagogy and evaluation*, 1st ed., New Delhi: Paragon International Publishers, 2016.

[2] Jo Westbrook, Naureen Durrani, Rhona Brown, David Orr, John Pryor, Janet Boddy, Francesca Salvi, *Pedagogy, Curriculum. Teaching Practices and Teacher Education in Developing Countries*, Education Rigorous Literature Review, Center for International Education, University of Sussex, December 2013.

Reference Book(s):

[1] Ackers J, Hardman F, *Classroom interaction in Kenyan primary schools*, Compare, 31 (2): 245-261, 2001.

[2] Agrawal M, *Curricular reform in schools: The importance of evaluation*, Journal of Curriculum Studies, 36 (3): 361-379, 2004.

[3] Akyeampong K, *Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1.* London: DFID, 2003.

[4] Akyeampong K, Lussier K, Pryor J, Westbrook J, *Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?* International Journal Educational Development, 33 (3): 272–282, 2013.

[5] Alexander RJ, *Culture and pedagogy: International comparisons in primary education.* Oxford and Boston: Blackwell, 2001.

[6] Chavan M, *Read India: A mass scale, rapid, 'learning to read' campaign,* 2003.

[7] www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Learning Outcomes (COs):

On completion of this course, the students will be able to…

CO1: describe the significance of curriculum, relationship between teaching and learning

CO2: justify the effectiveness of pedagogical practices of teaching and compare the lecture, demonstration, experimental and discussion methods of teaching strategies

CO3: analyse the role of student centered approaches in learning of a student and identify suitable approaches for the improvement

CO4: exemplify the role of professional development, curriculum, assessment for effective pedagogy and identify the research gaps in allied areas

Course Articulation Matrix: P20AC108D PEDAGOGY STUDIES

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20AC108D.1**	-	1	-	-	-
CO2	**P20AC108D.2**	1	1	1	-	-
CO3	**P20AC108D.3**	1	1	1	-	-
CO4	**P20AC108D.4**	1	1	1	-	-
P20AC108D		**1**	**1**	**1**	**-**	**-**

PRR-20

DEPARTMENT OF INFORMATION TECHNOLOGY
KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE, WARANGAL – 15
(An Autonomous Institute under Kakatiya University, Warangal)
SCHEME OF INSTRUCTION & EVALUATION FOR TWO YEAR POSTGRADUATE PROGRAMME
M.TECH. (DATA SCIENCE)

SEMESTER-II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits	Evaluation Scheme								
								CIE - TA							ESE	Total Marks
								I²RE				Minor	MSE	Total		
				L	T	P		ATLP	CRP	CP	PPT					
1	PC	P20DS201	Advanced Neural Networks	3	-	-	3	8	8	8	6	10	20	60	40	100
2	PC	P20DS202	Machine Learning	3	-	-	3	8	8	8	6	10	20	60	40	100
3	PE	P20DS203	Professional Elective-3	3	-	-	3	8	8	8	6	10	20	60	40	100
4	PE	P20DS204	Professional Elective-4	3	-	-	3	8	8	8	6	10	20	60	40	100
5	PC	P20DS205	Neural Networks Laboratory	-	-	4	2	-	-	-	-	-	-	60	40	100
6	PC	P20DS206	Machine Learning Laboratory	-	-	4	2	-	-	-	-	-	-	60	40	100
7	PROJ	P20DS207	Mini Project with Seminar	-	-	4	2	-	-	-	-	-	-	100	-	100
8	AC	P20AC208	Audit Course - 2	2	-	-	1	8	8	8	6	10	20	60	40	100
			Total:	**14**	**-**	**12**	**19**							**520**	**280**	**800**

[L= Lecture, T = Tutorials, P = Practicals, C = Credits, ATLP = Assignments, CRP = Course Research Paper, CP = Course Patent, PPT = Course Presentation, Minor=Minor Examination, MSE=Mid Semester Examination and ESE=End Semester Examination]

Professional Elective- 3	Professional Elective- 4	Audit Course - 2
P20DS203A: Reinforcement Learning	P20DS204A: Social Data Analytics	P20AC208A: Stress Management by Yoga
P20DS203B: Web Analytics and Development	P20DS204B: Predictive Analytics	P20AC208B: Value Education
P20DS203C: Information and Cyber Security	P20DS204C: Distributed Systems	P20AC208C: Personality Development through Life Enlightenment Skills
P20DS203D: MOOCs	P20DS204D: MOOCs	P20AC208D: Disaster Management

Total Contact Periods/Week: 26 **Total Credits: 19**

Note: The students shall undergo mandatory Industrial training/ Internship for at least 6 to 8 weeks during summer vacation at Industry/R&D organization. Internship evaluation will be done during the III semester.

Note: Additional Learning: Students are advised to do MOOCs to bridge the gap in the curriculum, as suggested by the Department Academic Advisory Committee (DAAC). The credits earned by the students through MOOCs will be printed in the semester grade sheet.

P20DS201 ADVANCED NEURAL NETWORKS

Class: M.Tech. II–Semester

Specialization: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Examination	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: basics of neural networks, deep learning, convolutional neural networks and deep networks

LO2: linear discriminant analysis, perceptron learning algorithm, generative learning algorithm, and deep feedforward networks

LO3: deep reinforcement learning, deep optimization learning, convolutional operations, network architectures, and sequence analysis

LO4: types of neural networks, tools, applications and survey of deep learning

UNIT – I (9)

The Neural Network: Introduction, Neurons, Linear perceptrons as neurons, Neural nets architecture / design, Working of neural nets, Layers of neural networks and deep learning, Activation functions, Feed forward neural networks, Limitations of neurons, Deep belief networks, Large scale DBNs, Large scale convolutional neural networks, Deep learning for big data, Deep learning from high volumes of data, Deep learning from high variety of data, Deep learning from high velocity of data, Local minima in deep networks, Rearranging neurons in a layer of a neural network, Spurious local minima in deep networks

UNIT – II (9)

Machine Learning Retrospective: Introduction, Learning algorithms, Developing a learning system – training experience, concept representation, function approximation, Linear discriminant analysis, Probabilistic models, Curse of dimensionality, Perceptron and perceptron learning algorithm, Exponential family, Generative model and generative learning algorithm, Guassian discriminant analysis

Deep Feedforward Networks: Introduction, Training neurons, Some common terminologies, Flowchart for training a deep learning model, Avoiding overfitting in deep neural networks, Deep reinforcement learning, Explore versus exploit, Policy versus value learning, Q-Learning and deep Q-Networks, POMDPS, Applications of POMDPS

UNIT – III (9)

Deep Learning Optimization: Introduction, Learning versus pure optimization, Challenges in neural network optimization, Basic optimization algorithms, Parameter initializations, Meta-algorithms

Convolutional Neural Networks: Introduction, Convolution, The convolution layer, The convolution operation, Max pooling, Various convolutional network architectures

Sequence Analysis: Introduction, Variable-sized inputs analysis, Beam search, Stateful deep learning models, Recurrent neural networks, Bidirectional RNNs, Deep recurrent networks, Augmenting recurrent networks, Neural turing machines

UNIT – IV (9)

Practical Deep Learning: Introduction, TensorFlow tool, Deep learning with H_2O tool, Installation of tools

Applications of Deep Learning: Introduction, Large scale deep learning, Computer vision, Speech recognition, Natural language processing, Other applications

Deep Learning Survey: Introduction, Representation learning, Transfer learning, Exponential gains from depth, Challenges of unstructured modeling, Using graphs to explain model structure, Sampling, Advantages of structured modeling, Deep learning approach to structured probabilistic models, Deep boltzmann machines, Directed generative nets, Generative stochastic networks

Text Book:

[1] Dr. Rajiv Chopra, *Deep Learning A Practical Approach (Using Python)*, New Delhi: Khanna Book Publishing Co. (P) Ltd., 2nd ed., 2018.

Reference Book(s):

[1] Josh Patterson, Adam Gibson, *Deep Learning: A Practitioners Approach*, California: O'Reilly Media Inc / Shroff Publishers & Distributors, 2017.

[2] Nikhil Buduma, *Fundamentals of Deep Learning*, California: O'Reilly Media Inc / Shroff Publishers & Distributors, 2017.

[3] Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, Cambridge: MIT Press, 2016.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: illustrate basic neural network architecture & its applications and depicts the symbolic association between big data & deep learning

CO2: apply machine learning and deep feedforward neural network algorithms in classification

CO3: design CNN architecture & working models and analyze different types of RNNs

CO4: use TensorFlow, H_2O tools to analyze deep neural networks and deep learning algorithms

Course Articulation Matrix (CAM): P20DS201 ADVANCED NEURAL NETWORKS						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS201.1**	1	1	1	-	1
CO2	**P20DS201.2**	1	1	1	1	1
CO3	**P20DS201.3**	2	1	2	1	1
CO4	**P20DS201.4**	2	1	2	2	2
P20DS301A		**1.5**	**1**	**1.75**	**1.33**	**1.25**

P20DS202 MACHINE LEARNING

Class: M.Tech. II-Semester **Specialization:** Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: basics of machine leaning and decision tree learning

LO2: foundation and representation of artificial neural networks

LO3: computational learning theory, instance based learning and genetic algorithms

LO4: learning sets of rules, combining inductive and analytical learning

UNIT – I (9)

Introduction: Well-posed learning problems, Designing a learning system, Perspectives and issues in machine learning

Concept Learning and General-to-Specific Ordering: Introduction, A concept learning task, Concept learning as search, Find-S, Version spaces and candidate-elimination, Remarks on version spaces and candidate-elimination, Inductive bias

Decision Tree Learning: Introduction, Decision tree representation, Appropriate problems for decision tree learning, Appropriate problems for decision tree learning, The basic decision tree learning, Hypothesis space in decision tree learning., Inductive bias in decision tree learning, Issues in decision tree learning

UNIT – II (9)

Artificial Neural Networks: Introduction, Neural network representations, Appropriate problems for neural networking learning, Perceptrons, Multilayer networks and back propagation algorithm, Remarks on back propagation algorithm

Evaluating Hypotheses: Motivation, Estimating hypothesis accuracy, Basics of sampling theory, A general approach for deriving confidence intervals, General approach for deriving confidence intervals, Difference in error of two hypothesis, Comparing learning algorithms

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, Maximum likelihood and least-squared error hypothes, Minimum description length principles, Bayes optimal classifier, Gibbs algorithm, Navie bayes classifier, Bayseian brief networks, The EM algorithm

UNIT – III (9)

Computational Learning Theory: Introduction**,** Probably learning an approximately correct hypothesis, Sample complexity for finite hypothesis spaces, Sample complexity for infinite hypothesis spaces, The mistake bound model of learning

Instanced Based Learning: Introduction, k-Nearest neighbor learning, Locally weighted regression, Radial basis functions, Case-based reasoning, Remarks on lazy and eager learning

Genetic Algorithms: Motivation, Genetic Algorithms, Genetic programming, Model of evolution and learning, Parallelizing genetic algorithms

UNIT – IV (9)

Learning Sets of Rules: Introduction, Sequential covering algorithms, Learning first-order rules, Learning sets of first-order rules, Induction as inverted deduction, Inverting resolution Analytical Learning: Introduction, Learning and analytical learning problem, Learning with perfect domain theories, Remarks on explanation-based learning

Combining Inductive and Analytical Learning: Motivation, Inductive and analytical approaches to learning, Using prior knowledge to initiative to initialize the hypothesis, Using prior knowledge to alter search objective, Using prior knowledge to augment search.

Text Book:

[1] Tom M. Mitchell, *Machine Learning*, India: Mc GrawHill Education, 2017.

Reference Book(s):

[1] Stuart Russel and Peter Norvig, *Artificial Intelligence – A Modern Approach*, 3rd ed. USA: Prentice Hall, 2010,

[2] Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", United Kingdom: Cambridge University Press, 2012.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: describe the concepts of machine learning and decision tree learning & its issues.

CO2: illustrate neural network representations and bayesian learning algorithm

CO3: design and analyze machine learning approaches using various algorithms using

CO4: experience in learning sets of rules using and inductive & analytical learning

Course Articulation Matrix(CAM): P20DS202 MACHINE LEARNING						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS202.1**	1	1	1	1	-
CO2	**P20DS202.2**	1	1	1	1	1
CO3	**P20DS202.3**	1	1	1	2	1
CO4	**P20DS202.4**	1	1	2	2	2
P20DS202		**1**	**1**	**1.25**	**1.5**	**1.33**

P20DS203A REINFORCEMENT LEARNING

Class: M.Tech. II-Semester **Specialization**: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: basic concepts, examples of reinforcement learning and multi-armed bandits

LO2: finite markov decision processes and dynamic programming

LO3: monte carlo methods and temporal-difference learning

LO4: n-step bootstrapping, planning and learning with tabular methods

UNIT – I (9)

Reinforcement Learning: Introduction, Examples, Elements of reinforcement learning, Limitations and scope, An extended example: Tic-Tac-Toe, Tabular solution methods

Multi-armed Bandits: A k-armed bandit problem, Action-value Methods, The 10-armed testbed, Incremental implementation, Tracking a nonstationary problem, Optimistic initial values, Upper-confidence-bound action selection, Gradient bandit algorithms, Associative search (Contextual Bandits)

UNIT – II (9)

Finite Markov Decision Processes: The Agent–environment interface, Goals and rewards, Returns and episodes, Unified notation for episodic and continuing tasks, Policies and value functions, Optimal policies and optimal value functions, Optimality and approximation

Dynamic Programming: Policy evaluation (Prediction), Policy improvement, Policy iteration, Value iteration, Asynchronous dynamic programming, Generalized policy iteration, Efficiency of dynamic programming

UNIT – III (9)

Monte Carlo Methods: Monte carlo prediction, Monte carlo estimation of action values, Monte carlo control, Monte carlo control without exploring starts, Off-policy prediction via importance sampling, Incremental implementation, Off-policy Monte Carlo control, Discounting-aware importance sampling, Per-decision importance sampling

Temporal-Difference Learning: TD prediction, Advantages of TD prediction methods, Optimality of TD(0), Sarsa: On-policy TD control , Q-learning: off-policy TD control, Expected Sarsa, Maximization bias and double learning, Games, Afterstates, and other special cases

UNIT – IV (9)

n-step Bootstrapping: n-step TD prediction, n-step sarsa, n-step off-policy learning, Per-decision methods with control variates , Off-policy learning without importance sampling: The n-step tree backup algorithm, A unifying algorithm: n-step Q(σ)

Planning and Learning with Tabular Methods : Models and planning, Dyna: Integrated planning, Acting and learning , When the model is wrong , Prioritized sweeping, Expected vs. Sample updates, Trajectory sampling, Real-time dynamic programming, Planning at decision time, Heuristic search, Rollout algorithms, Monte Carlo tree search

Text Book:

[1] Richard S. Sutton and Andrew G. Barto, *Reinforcement Learning*, 2nd ed. United Kingdom: MIT Press,2018(*Chapters 1-8*)

Reference Book(s):

[1] Wiering, Marco, and Martijn Van Otterlo, *Reinforcement learning,* United States: Springer, 2012.

[2] Russell, Stuart J., and Peter Norvig, *Artificial intelligence: a modern approach,* United Kingdom: Pearson Education Limited, 2016.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: understand reinforcement learning algorithms Multi-armed Bandits

CO2: use the formal framework of Markov decision processes to define the interaction between a learning agent and its environment

CO3: apply Monte Carlo Methods to model the probability of different outcomes in a process

CO4: implement planning and learning with tabular methods to provide a bridge from TD to Monte Carlo methods

Course Articulation Matrix(CAM): P20DS203A REINFORCEMENT LEARNING						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS203A.1**	1	1	2	2	1
CO2	**P20DS203A.2**	1	1	2	2	1
CO3	**P20DS203A.3**	1	1	2	2	1
CO4	**P20DS203A.4**	1	1	2	2	1
P20DS203A		**1**	**1**	**2**	**2**	**1**

P20DS203B WEB ANALYTICS AND DEVELOPMENT

Class: M.Tech. II-Semester **Specialization**: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: web analytics 2.0, types of data available to achieve business objectives, analytics tools and negotiate a contract

LO2: critical web metrics and click stream analysis

LO3: NodeXL features and network metrics

LO4: data analysis tasks with NodeXL

UNIT – I (9)

The Bold New World of Web Analytics 2.0: State of the analytics union, Rethinking web analytics, click stream, Multiple outcomes analysis, Experimentation and testing, Voice of customer, Competitive intelligence, The strategic imperative, The tactical shift, Bonus analytics

The Optimal Strategy for Choosing Your Web Analytics Soul Mate: Three critical questions to ask yourself before you seek an analytics soul mate!, Ten questions to ask vendors before you marry them, Comparing web analytics vendors, Identifying your web analytics soul mate, Negotiating the prenuptials

UNIT – II (9)

The Awesome World of Click stream Analysis: Metrics: Eight critical web metrics, Bounce rate, Exit rate, Conversion rate, Engagement, Web metrics demystified, Strategically aligned tactics for impactful web metrics

The Awesome World of Click stream Analysis: Practical Solutions: A web analytics primer, The best web analytics report, Foundational analytical strategies, Everyday click stream analyses made actionable, Reality check perspectives on key web analytics challenges

UNIT – III (9)

NodeXL: Introduction, Layout: Arranging vertices in the graph pane, Visual Design: Making network displays meaningful, Labeling: Adding text labels to vertices and edges

Calculating and Visualizing Network Metrics: Kite network, Computing graph metrics, Less miserable co-appearance network

UNIT – IV (9)

Preparing Data and Filtering: Serious eats network example, Filtering to reduce clutter and reveal important features

Clustering and Grouping: The 2007 senate voting analysis, Less miserable character clusters, Federal Communications Commission (FCC) lobbying coalition network

Text Book(s):

[1] Avinash Kaushik, *Web Analytics 2.0: The Art of Online Accountability*, New York: Wiley Publishing Inc., 2010. (*Chapter 1, 2, 3*)

[2] Hansen, Derek, Ben Sheiderman, Marc Smith, Itai Himelboim, *Analyzing Social Media Networks with NodeXL*, 2nd ed., United States: Morgan Kaufmann Publishers (An Imprint of Elsevier), 2019. (*Chapter 4, 5, 6, 7*)

Reference Book(s):

[1] Easley D, Kleinberg J, *Networks, Crowds, and Markets: Reasoning About a Highly Connected World*, United Kingdom: Cambridge University Press, 2010.

[2] Stanley Wasserman, Katherine Faust, *Social network analysis: Methods and applications*, 2nd ed., United Kingdom: Cambridge University Press, 1999.

Course Learning Outcomes (COs):

On completion of this course, the student will be able to…

CO1: understand analytics vendors and compare analytics tools

CO2: apply critical web metrics for click stream analysis

CO3: use NodeXL to arrange vertices in the graph pane, calculate and visualize network metrics

CO4: create a semantic network by using the text analysis feature of NodeXL

Course Articulation Matrix(CAM): P20DS203B WEB ANALYTICS AND DEVELOPMENT						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS203B.1**	1	1	1	1	1
CO2	**P20DS203B.2**	1	1	1	1	1
CO3	**P20DS203B.3**	2	1	1	2	1
CO4	**P20DS203B.4**	2	1	1	2	1
P20DS203B		**1.5**	**1**	**1**	**1.5**	**1**

P20DS203C INFORMATION AND CYBER SECURITY

Class: M.Tech. II–Semester **Specialization**: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):
This course will develop students' knowledge in /on
LO1: overview of information security and risk analysis
LO2: securing unstructured data, storage security and database security
LO3: attacker techniques and defense & analysis techniques
LO4: foothold techniques in cyber security

UNIT – I (9)

Information Security Overview: The importance of information protection, The evolution of information security, Justifying security investment, Security methodology, How to build a security program, The impossible job, The weakest link, Strategy and tactics, Business processes versus technical controls

Risk Analysis: Threat definition, Threat vectors, Threat sources and targets, Types of attacks, Malicious mobile code, Advanced persistent threats (APTs), Manual attacks

UNIT – II (9)

Securing Unstructured Data: Structured data versus unstructured data, At rest, In transit and in use, Approaches to securing unstructured data, Newer approaches to securing unstructured data

Storage Security: Storage security evolution, Modern storage security, Risk remediation, Best practices

Database Security: General database security concepts, Understanding database security layers, Understanding database-level security, Using application security, Database backup and recovery, Keeping your servers up to date, Database auditing and monitoring

UNIT – III (9)

Attacker Techniques and Motivations: How hackers cover their tracks, Tunneling techniques, Fraud techniques

Defense and Analysis Techniques: Memory forensics, Honeypots, Malicious code naming, Automated malicious code analysis systems, Intrusion detection systems

UNIT – IV (9)

Techniques to Gain a Foothold: Shellcode, Integer overflow vulnerabilities, Stack-based buffer overflows, Format string vulnerabilities, SQL injection, Malicious pdf files, Race conditions, Web exploit tools, DoS conditions, Brute force and dictionary attacks

Text Book(s):

[1] Rhodes-Ousley, Mark., *Information Security The Complete Reference,* 2nd ed., US: McGraw-Hill Osborne Media, 2013. (*Chapters: 1, 2, 8, 11, 12*)

[2] James Graham, Ryan Olson, Rick Howard, *Cyber Security Essentials*, New York:Auerbach Publications, 2010. (*Chapters: 2, 3, 5*)

Reference Book(s):

[1] Gaurav Gupta, Sarika Gupta, *Information Security & Cyber Laws*, New Delhi: Khanna Publishing, 2019.

[2] Pachghare.V.K., *Cryptography and Information Security*, 3rd ed., New Delhi: PHI Learning, 2013.

[3] Nina Godbole, Sunit Belapure, *Cyber Security*, New Delhi:Wiley Publishers, 2011.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: illustrate the overview of information security and risk analysis

CO2: categorise unstructured data approaches for security and analyse storage security & database security

CO3: analyse attacker techniques, defense techniques and analysis techniques

CO4: compare different types of attack techniques in cyber security

Course Articulation Matrix (CAM): P20DS203C INFORMATION AND CYBER SECURITY

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS203C.1**	-	1	-	-	-
CO2	**P20DS203C.2**	2	1	1	1	1
CO3	**P20DS203C.3**	1	1	-	-	1
CO4	**P20DS203C.4**	1	1	-	1	-
P20DS203C		**1.33**	**1**	**1**	**1**	**1**

P20DS204A SOCIAL DATA ANALYTICS

Class: M.Tech. II-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: social analytics in the enterprise

LO2: social business intelligence and four steps to social business intelligence

LO3: valuable data for the enterprise and accessing the data

LO4: social business intelligence and collaboration and social media and network monitoring

UNIT – I (9)

Introduction: A new Universe of data, Understanding social analytic platforms, Platform analytic functions

Social Analytics in the Enterprise: Put employees first, Pilot, Experiment, Learn, Alstom's pillars of collaboration, Governance, How to measure success, Success is more than metrics, What's next

UNIT – II (9)

Social Business Intelligence: Social analytics and business intelligence integration, Case study, Results

Four Steps to Social Business Intelligence: Creating and engaging social media presence, Tie social media monitoring to your business goals, Decide on collaboration, Examine analytics for insights

UNIT – III (9)

Valuable Data for the Enterprise: Understanding social data types, Location/geographic data, Rich media data

Accessing the Data: Acquire, Refine, Classify, Categorize, Discovery, Metricize, Challenges in data quality, Delivering the infrastructure, Delivering access to data, How does the enterprise use this data

UNIT – IV (9)

Social Business Intelligence and Collaboration: Increasing customer focus and transforming to customer-driven enterprise, An integrated approach, Enabling a better cross-sell and up-sell opportunity, Business benefits, Social media and software, Social intelligence, Solution architecture

Social Media and Network Monitoring: Bringing the external to the internal – how to create a platform, Perspective on social media tools

Text Book:

[1] Krish Krishnan, Shawn Rogers, *Social Data Analytics,* US: Elsevier, 2014.

Reference Book(s):

[1] Aggarwal, Charu C, *Social Network Data Analytics*, 2nd ed. New York: Springer, 2011.

[2] Hansen, Derek, Ben Sheiderman, Marc Smith., *Analyzing Social Media Networks with NodeXL: Insights from Connected World*, LoS Angeles: Morgan Kaufmann, 2010.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: identify social analytics in the enterprise

CO2: describe different steps to social business intelligence

CO3: identify valuable data for the enterprise and methods to access the data

CO4: analyse social business intelligence, collaboration and network monitoring

Course Articulation Matrix (CAM): P20DS204A SOCIAL DATA ANALYTICS						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS204A.1**	-	1	1	1	-
CO2	**P20DS204A.2**	1	1	1	-	1
CO3	**P20DS204A.3**	-	1	1	1	1
CO4	**P20DS204A.4**	1	1	1	1	1
P20DS204A		**1**	**1**	**1**	**1**	**1**

P20DS204B PREDICTIVE ANALYTICS

Class: M.Tech. II–Semester **Specialization**: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: the concepts of linear methods for regression and classification

LO2: model assessment and selection

LO3: additive models, trees and related methods and boosting

LO4: concepts of neural networks, support vector machines & k-nearest neighbour and unsupervised learning and random forests

UNIT – I (9)

Linear Methods for Regression: Linear regression models and least squares, Subset selection, Shrinkage methods, Methods using derived input directions, Discussion: A comparison of the selection and shrinkage methods, Multiple outcome shrinkage and selection

Linear Methods for Classification: Linear regression of an indicator matrix, Linear discriminant analysis, Logistic regression, Separating hyper planes

UNIT – II (9)

Model Assessment and Selection: Bias, Variance and model complexity, The bias–variance decomposition, Optimism of the training error rate, Estimates of in-sample prediction error, The effective number of parameters, The bayesian approach and BIC, Minimum description length, Vapnik–Chervonenkis dimension, Cross-Validation, Bootstrap methods, Conditional or expected test error

UNIT – III (9)

Additive Models, Trees and Related Methods: Generalized additive models**,** Tree-based methods, PRIM: Bump hunting, MARS: Multivariate Adaptive Regression Splines, Hierarchical mixtures of experts, Missing data, Computational considerations

Boosting and Additive Trees: Boosting fits an additive model, Forward stagewise additive modeling, Exponential loss and AdaBoost, Why exponential loss?, Loss functions and robustness, "Off-the-Shelf" procedures for Data Mining , Example on spam data, Boosting trees, Numerical optimization via gradient boosting, Right-sized trees for boosting, Regularization

UNIT – IV (9)

Neural Networks (NN), Support Vector Machines (SVM) and K-Nearest Neighbour: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification,

Reproducing kernels, SVM for regression, K-Nearest Neighbour classifiers (Image scene classification)

Unsupervised Learning and Random Forests: Association rules, Cluster analysis, Principal components, Random forests and analysis

Text Book:

[1] Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning-Data Mining, Inference, and Prediction*, 2nd ed., New York : Springer Verlag, 2009.

Reference Book(s):

[1] G. James, D. Witten, T. Hastie, R. Tibshirani, *An introduction to statistical learning with applications in R*, Newyork : Springer, 2013.

[2] C.M. Bishop, *Pattern Recognition and Machine Learning*, NewYork: Springer, 2006.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: identify linear methods for regression and classification

CO2: illustrate model assessment and selection

CO3: analyze additive models, trees and boosting

CO4: evaluate neural networks, support vector machines and k-nearest neighbour

Course Articulation Matrix (CAM): P20DS204B PREDICTIVE ANALYTICS						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS204B.1**	-	1	-	1	1
CO2	**P20DS204B.2**	1	1	-	-	-
CO3	**P20DS204B.3**	1	1	1	-	1
CO4	**P20DS204B.4**	1	1	1	-	1
P20DS204B		**1**	**1**	**1**	**1**	**1**

P20DS204C DISTRIBUTED SYSTEMS

Class: M.Tech. II-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: characterization of distributed systems, system models, interprocess communication

LO2: distributed objects and components, web services, peer-to-peer systems

LO3: distributed file systems, name services, time and global states

LO4: mobile and ubiquitous computing, design and implement distributed file systems

UNIT – I (9)

Characterization of Distributed Systems: Introduction, Examples of distributed systems, Trends in distributed systems, Focus on resource sharing, Challenges

System Models: Introduction, Physical models, Architectural models, Fundamental models

Interprocess Communication: Introduction, The API for the Internet protocols, External data representation and marshalling, Multicast communication, Network virtualization: Overlay networks

UNIT – II (9)

Distributed Objects and Components: Introduction, Distributed objects, From objects to components

Web Services: Introduction, Web services, Service descriptions and IDL for web services, A directory service for use with web services, XML security, Coordination of web services, Applications of web services

Peer-To-Peer Systems: Introduction, Napster and its legacy, Peer-to-peer middleware, Routing overlays, Overlay case studies: Pastry, Tapestry, Application case studies: Squirrel, OceanStore, Ivy

UNIT – III (9)

Distributed File Systems: Introduction, File service architecture – Sun Network file system-The Andrew file system

Name Services: Introduction, Name services and the Domain Name System, Directory services

Time and Global States: Introduction, Clocks, Events and process states, Synchronizing physical clocks, Logical time and logical clocks, Global states, Distributed debugging

UNIT – IV (9)

Mobile and Ubiquitous Computing: Introduction, Association, Interoperation, Sensing and context awareness, Security and privacy, Adaptation

Distributed Multimedia Systems: Characteristics of multimedia data, Quality of service management, Resource management

Designing Distributed Systems Google Case Study: Introducing the case study Google, Overall architecture and design philosophy, Underlying communication paradigms, Data storage and coordination services, Distributed computation services

Text Book:

[1] George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, *Distributed Systems: Concepts and Design*, 5th ed., Boston: Pearson Education, 2011

Reference Book(s):

[1] A S Tanenbaum, M V Steen, *Distributed Systems,* India, Pearson Education, 2008.
[2] S.K.Basu, *Parallel and distributed computing,* India: Prentice Hall, 2016
[3] Sukumar Ghosh, *Distributed Systems: An Algorithmic Approach*, 2nd ed., Florida:CRC Press, 2014
[4] Ajay D. Kshemakalyani, Mukesh Singhal, *Distributed Computing,* New York: Cambridge University Press, 2008

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: illustrate models of distributed systems and interprocess communication
CO2: analyze distributed objects, web services and peer to peer systems
CO3: analyze distributed file systems time and global states
CO4: design and implement distributed file systems and ubiquitous Computing

Course Articulation Matrix (CAM): P20DS204C DISTRIBUTED SYSTEMS

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS204C.1**	1	1	1	1	1
CO2	**P20DS204C.2**	1	1	1	2	1
CO3	**P20DS204C.3**	1	1	1	2	1
CO4	**P20DS204C.4**	2	1	2	1	1
P20DS204C		**1.25**	**1**	**1.25**	**1.5**	**1**

P20DS205 NEURAL NETWORKS LABORATORY

Class: M.Tech. II–Semester **Specialization:** Data Science

Teaching Scheme:

L	T	P	C
-	-	4	2

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: simple neural networks, 2D input space and time series prediction

LO2: multilayer perceptron and crab classification

LO3: implementing different classifications and use various MATLAB scripts

LO4: construction and working of Convolutional Neural Network and Recurrent Neural Network

List of Experiments

Experiment – I:

1. Calculate the output of a simple neuron.
2. Create and view custom neural networks.

Experiment – II:

3. Construct a Perceptron for the classification of linearly separable data with two clusters of data, belonging to two classes, are defined in a 2D input space.
4. Construct a Perceptron network with 2-inputs and 2-outputs is trained to classify input vectors into 4 categories.

Experiment – III:

5. Construct an ADALINE for adaptive prediction of time series based on past time series data.

Experiment – IV:

6. Define a neural network for solving the XOR problem with 4 clusters of data (A, B, C, D) are defined in a 2D input space. (A, C) and (B, D) clusters represent XOR classification problem with a multilayer Perceptron.

Experiment – V:

7. Define a neural network for classification of arbitrary point in the 2D space into one of the classes (A, B, C, D) with 4 clusters of data (A, B, C, D) defined in a 2D input space with a multilayer Perceptron.

Experiment – VI:

8. Write a program to implement AND OR gates using Perceptron.

Experiment – VII:

9. Write a program to implement Crab Classification using pattern net.

Experiment – VIII:

10. Write a program to implement Wine Classification using Back propagation.

Experiment – IX:

11. Write a MATLAB Script containing four functions Addition, Subtraction, Multiply and Divide functions.

Experiment – X:

12. Study Convolutional Neural Network and Recurrent Neural Network.

Experiment – XI:

13. Study ImageNet, GoogleNet, ResNet convolutional Neural Networks.

Experiment – XII:

14. Study Long Short Term Memory for Time Series Prediction.
15. Study the use of Long Short Term Memory / Gated Recurrent Units to predict the stock prices based on historic data.

Laboratory Manual:

1. Neural Networks Laboratory Manual, *prepared by the faculty of Department of Information Technology.*

Reference Book(s):

1. B. Yegnanarayana, "*Artificial Neural Networks*", 9th ed., New Delhi: PHI Learning Pvt. Ltd., 2012.
2. Dr. Rajiv Chopra, "*Deep Learning A Practical Approach (Using Python)*", 2nd ed., New Delhi: Khanna Book Publishing Co. (P) Ltd., 2018.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: construct perceptron defined in 2D space and construct adaline time series based on the data
CO2: define neural networks for solving classification problems using multilayer perceptron
CO3: implement crab & wine classifications using pattern net & back propagation and design MatLab scripts that uses different function calls
CO4: design and implement various CNN and RNN for given applications

Course Articulation Matrix (CAM): P20DS205 NEURAL NETWORKS LABORATORY

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS205.1**	1	2	1	-	1
CO2	**P20DS205.2**	1	2	-	1	1
CO3	**P20DS205.3**	2	2	2	2	1
CO4	**P20DS205.4**	2	2	2	2	2
P20DS205		**1.5**	**2**	**1.66**	**1.66**	**1.25**

P20DS206 MACHINE LEARNING LABORATORY

Class: M.Tech. II-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
-	-	4	2

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: *basics of R-programming and WEKA tool.*

LO2: *machine learning concepts of association rule learning using R, WEKA tool.*

LO3: *unsupervised machine learning algorithms using R, WEKA tool.*

LO4: *supervised machine learning algorithms using R, WEKA tool.*

Note:-

1. The programs can be implemented in either Python, R, WEKA tool.
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

Experiment-I

1. Introduction to R and installation of RStudio, loading tidyverse.
2. Data visualization in R.

Experiment-II

3. Exploratory Data Analysis (EDA) using R.
4. Model building in R.

Experiment-III

5. Introduction to the WEKA machine learning toolkit**.**
6. Introduction to WEKA Explorer.

Experiment-IV

7. Introduction to Data visualization in WEKA.
8. Basics of visualization: Plots, Subplots and their functionalities.

Experiment-V

9. Write a program in any programming language to create a file in ARFF format consisting of at least 10,000 transactions with at least three items.

Experiment-VI

10. Write a program to implement Apriori algorithm.
11. Generate association rules from frequent itemsets.

Experiment-VII

12. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
13. Write a program to demonstrate the working of Random Forest.

14. Write a program to construct a Naïve Bayesian classifier considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart disease data set.

Experiment-VIII

15. Write a program to implement Linear Regression and Logistic Regression.
16. Write a program to implement Support Vector Machine (SVM) for any data set. Also illustrate the confusion matrix and score of model.

Experiment-IX

17. Write a program to implement k-Nearest Neighbor algorithm (k-NN) to classify the iris data set. Print both correct and wrong predictions. Calculate the score also.

Experiment-X

18. Implement k-Means clustering algorithm.

Experiment-XI

19. Implement hierarchical clustering algorithm.

Experiment-XII

20. 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.

Laboratory Manual:

[1] Machine Learning Laboratory Manual, *prepared by the faculty of Dept. of IT.*

Reference Book(s):

[1] Hadley Wickham and Garrett Grolemund, *R for Data Science*, US: O'Reilly Publishing, 2017.
[2] Bostjan Kaluza, *Instant Weka How-to*, UK:Packt Publishing, 2013.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: explore R-programming and Weka tool in machine learning perspective
CO2: design and develop programs for association learning algorithms using python, R or Weka tool
CO3: apply appropriate data sets to implement supervised machine learning algorithms
CO4: implement different unsupervised machine learning algorithms to solve real world problems

Course Articulation Matrix (CAM): P20DS206 MACHINE LEARNING LABORATORY						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS206.1**	1	2	1	1	1
CO2	**P20DS206.2**	2	2	1	2	1
CO3	**P20DS206.3**	2	2	2	2	2
CO4	**P20DS206.4**	2	2	2	2	2
P20DS206		**1.75**	**2**	**1.5**	**1.75**	**1.5**

P20DS207: MINI PROJECT WITH SEMINAR

Class: M.Tech. II-Semester **Specialization:** Data Science

Teaching Scheme:

L	T	P	C
-	-	4	2

Examination Scheme:

Continuous Internal Evaluation	100 marks
End Semester Examination	---

Course Learning Objectives (LOs):

This course will develop students' knowledge on /in…

LO1: implementing a project independently by applying knowledge to practice

LO2: literature review and well-documented report writing

LO3: creating PPTs and effective technical presentation skills

LO4: writing technical paper in scientific journal style & format and creating video pitch

Continuous Internal Evaluation (CIE) for Mini Project with Seminar:

1) The *Post Graduate Mini Project Evaluation Committee (PGMPEC)* shall be constituted with HoD as a Chairman, M.Tech. Coordinator as a Convener and three to five other faculty members representing various specializations in that particular programme as members.
2) Student has to take up independent mini project on innovative ideas, innovative solutions to common problems using their knowledge relevant to courses offered in their program of study, which would supplement and complement the program assigned to each student.
3) *PGMPEC* shall allot a faculty supervisor to each student for guiding on
   (a) Selection of topic
   (b) Literature survey and work to be carried out
   (c) Preparing a report in proper format
   (d) Right conduct of research and academic activity to promote academic integrity
   (e) Use of anti-plagiarism software to detect plagiarism in the report and submission of Mini project report within acceptable plagiarism levels
   (f) Effective mini project oral presentation before the PGMPEC

   There shall be only Continuous Internal Evaluation (CIE) for seminar
4) The CIE for mini project is as follows:

Assessment	Weightage
Mini project Supervisor Assessment	**20**%
PGMPEC Assessment: *(i) Registration presentation* ***(10%)*** *(ii) Working model / process / software package / system developed* ***(20%)*** *(iii) Mini project report* ***(20%)*** *(iv) Mini project paper* ***(10%)*** *(v) Mini project video pitch* ***(10%)*** (vi) *Final presentation (with PPT) and viva-voce* ***(10%)***	**80** %
Total Weightage:	**100**%

Note: It is mandatory for the student to

(i) appear for final presentation (with PPT) and viva-voce to qualify for course evaluation

(ii) write mini project paper in given journal format

(ii) create a good video pitch to present mini project

(a) **Mini Project Topic**: The topic should be interesting and conducive to discussion. Topics may be found by looking through recent issues of peer reviewed Journals/Technical Magazines on the topics of potential interest

(b) **Working Model**: Each student is requested to develop a working model/ process/ software package /system on the chosen work and demonstrate before the *PGMPEC* as per the dates specified by *PGMPEC*

(c) **Mini Project Report:** Each student is required to submit a well-documented mini project report as per the format specified by *PGMPEC*

(d) **Anti-Plagiarism Check:** The mini project report should clear plagiarism check as per the Anti-Plagiarism policy of the institute

(e) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the *PGMPEC* as per the schedule notified by the department

(f) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her mini project. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include key points about his / her business idea / plan (*if any*) and social impact

5) The student has to register for the Mini project as supplementary examination in the following cases:

i) he/she is absent for oral presentation and viva-voce

ii) he/she fails to submit the report in prescribed format

iii) he/she fails to fulfill the requirements of Mini project evaluation as per specified guidelines

6) (a) The CoE shall send a list of students registered for supplementary to the HoD concerned

(b) The PGMPEC, duly constituted by the HoD, shall conduct Mini project evaluation and send the award list to the CoE within the stipulated time

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: apply knowledge to practice to design and conduct experiments and utilize modern tools for developing working models / process / system leading to innovation and entrepreneurship

CO2: demonstrate the competencies to perform literature survey, identify gaps, analyze the problem and prepare a well-documented Mini project report

CO3: make an effective oral presentation through informative PPTs, showing knowledge on the subject and sensitivity towards social impact of the Mini project

CO4: write a "Mini project paper" in scientific journal style and format from the prepared Mini project report and create a video pitch on Mini project

Course Articulation Matrix (CAM): **P20DS207 MINI PROJECT WITH SEMINAR**						
CO		**PO 1**	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO1	**P20DS207.1**	2	-	2	2	2
CO2	**P20DS207.2**	2	-	2	2	2
CO3	**P20DS207.3**	-	2	-	1	1
CO4	**P20DS207.4**	-	2	-	1	1
P20DS207		**2**	**2**	**2**	**1.5**	**1.5**

P20AC208A: STRESS MANAGEMENT BY YOGA

Class: M.Tech. II–Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC &CSP**

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: awareness about different types of stress
LO2: yoga in the management of stress
LO3: positive health and overall wellbeing
LO4: prevention of stress related health problems by yoga practice

UNIT – I (6)

Stress: Definition of Stress, Types of stress - Acute and chronic; Stressors; Definition of Yoga from various sources, Types of yoga – Karma yoga, Gnana yoga, Bhakti yoga and Raja yoga; Concept of Bhagavad Gita; Yoga versus exercise; Basics of Physiology and Psychology; Brain and its parts – central nervous system (CNS), peripheral nervous system (PNS), hypothalamic pituitary adrenal (HPA) axis; Sympathetic and Parasympathetic nervous systems; Fight and Flight mechanism; Relationship between stress and yoga

UNIT – II (6)

Ashtanga Yoga: Do's and Don'ts in life; Yamas – ahimsa, satya, asteya, bramhacharya and aparigraha; Niyama – shaucha, santosha, tapa, svadhyaya, ishvarapranidhana; Asana; Pranayama; Pratyahara; Dharana; Dhyana; Samadhi

UNIT– III (6)

Asana and Stress: Definition of Asana from Patanjali; Origin of various names of asanas; Various yoga poses and their benefits for mind and body; Sequence of performing asanas - standing, sitting, lying down on stomach, lying down on back and inverted postures; Activation of Annamaya kosha; Effect on various chakras, systems and glands thereby controlling the stress levels through the practice of asanas

UNIT - IV (6)

Pranayama: Anulom and Vilom Pranayama, Nadi shudhi Pranayama, Kapalabhati Pranayama, Bhramari Pranayama, Nadanusandhana Pranayama

Meditation Techniques: Om Meditation; Cyclic meditation; Instant Relaxation technique (IRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Text Book(s):

[1] "*Yogic Asanas for Group Training - Part-I*", Nagpur: Janardhan Swami Yogabhyasi Mandal.

[2] Swami Vivekananda, "*Rajayoga or Conquering the Internal Nature*", Kolkata: Advaita Ashrama (Publication Department).

Reference Book:

[1] Nagendra H.R and Nagaratna R, "*Yoga Perspective in Stress Management*", Bangalore : Swami Vivekananda Yoga Prakashan.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: differentiate yoga and exercise

CO2: explain eight steps of Ashtanga yoga

CO3: describe different yogasanas, and their benefits for mind and body

CO4: discuss the benefits of pranayama and meditation as an effective tool for stress management

Course Articulation Matrix (CAM): P20AC208A STRESS MANAGEMENT BY YOGA						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20AC208A.1**	1	1	-	-	-
CO2	**P20AC208A.2**	1	1	-	-	-
CO3	**P20AC208A.3**	1	1	-	-	-
CO4	**P20AC208A.4**	1	1	-	-	-
P20AC208A		**1**	**1**	**-**	**-**	**-**

P20AC208B: VALUE EDUCATION

Class: M.Tech. II–Semester

Specialization(s): SCE, DE, VE, PE, SE, DS & CSP

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):
This course will develop students' knowledge on /in…

LO1: value of education and self-development
LO2: importance of cultivation of values
LO3: personality and behavior development
LO4: character and competence

UNIT – I (6)

Values and self-development: Social values and individual attitudes; Work ethics; Indian vision of humanism; Moral and non-moral valuation; Standards and principles; Value judgments

UNIT – II (6)

Importance of cultivation of values: Sense of duty, devotion, self-reliance, confidence, concentration, truthfulness, cleanliness, honesty, humanity, discipline, power of faith; National Unity, patriotism; Love for nature

UNIT – III (6)

Personality and Behavior Development: Soul and scientific attitude; Positive thinking; Integrity, discipline and punctuality; Love and Kindness; Avoid fault thinking, free from anger; Dignity of labor

Universal brotherhood and religious tolerance: True friendship, love for truth, happiness vs suffering; Aware of self-destructive habits; Association and cooperation; Doing best for saving nature

UNIT – IV (6)

Character and Competence: Holy books vs blind faith; Self-management and good health; Science of reincarnation; Equality, non-violence, humility, role of women; All religions and same message; Mind your mind, self-control, honesty, studying effectively

Text Book:

[1] S. K. Chakroborty, *Values and Ethics for organizations: Theory and practice*, New Delhi: Oxford University Press, 2000.

Reference Book(s):

[1] D. N. Grose, *A text book of Value Education*, New Delhi: Dominant Publishers and Distributors, 2005.

[2] Yogesh Kumar Singh and Ruchika Nath, *Value Education*, New Delhi: A. P. H. Publishing Corporation, 2005.
[3] S. P. Ruhela, *Human Values and Education*, New Delhi: Sterling Publishers Pvt. Ltd., 1986.
[4] V. Narayan Karan Reddy, *Man, Education and Values,* New Delhi: B. R. Publishing Corporation, 1979.
[5] Bharatwaj Tilak Raj, *Education of Human Values,* New Delhi,: 2nd Ed., Mittal Publications, 2001.

Course Learning Outcomes (COs):
On completion of this course, students will be able to…

CO1: illustrate social & moral values and inculcate Indian vision of humanism
CO2: develop sense of duty, national unity and love for nature
CO3: utilize positive thinking and develop universal brotherhood
CO4: build character & competence through holy books

Course Articulation Matrix (CAM): P20AC208B VALUE EDUCATION

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20AC208B.1**	-	1	-	-	-
CO2	**P20AC208B.2**	-	2	-	-	-
CO3	**P20AC208B.3**	-	1	-	-	-
CO4	**P20AC208B.4**	-	2	-	-	-
	P20AC208B	**-**	**1.5**	**-**	**-**	**-**

P20AC208C: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Class: M.Tech. II-Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):
This course will develop students' knowledge on/in…

LO1: holistic development of personality
LO2: accomplishment of day to day responsibilities and to achieve the highest goal
LO3: basic knowledge to maintain a stable mind, pleasing personality and determination
LO4: personality building towards becoming a role model

UNIT – I (6)

Holistic development of personality: Neetisatakam - Verses-19, 20, 21, 22(wisdom), Verses-29, 31, 32 (pride& heroism), Verses-26, 28, 63, 65(virtue), Verses-52, 53, 59(don'ts), Verses-71, 73, 75, 78(do's)

UNIT – II (6)

Approach to day to day work and duties: Shrimad Bhagwad Geeta - Chapter2-Verses 41, 47, 48 chapter3-Verses 13, 21, 27, 35; Shrimad Bhagwad Geeta - Chapter6-Verses 5, 13, 17, 23, 35, chapter18-Verses 45, 46, 48

UNIT – III (6)

Statements of basic Knowledge: Shrimad Bhagwad Geeta - Chapter2-Verses 56, 62, 68 chapter12-Verses 13, 14, 15, 16, 17, 18

UNIT – IV (6)

Personality of Role model: Shrimad Bhagwad Geeta - Chapter2-Verses 17, chapter3-Verses 36,37,42 chapter4-Verses 18,38,39, chapter18-Verses 37,38,63

Text Book:

[1] Swami Swarupananda, *Shrimad Bhagavad Geeta*, Advaita Ashram (Publication Department), Kolkata: Printed in Sharada Press, Car Street, Mangalore.

Reference Book(s):

[1] Prof. Satyavrata Siddhantalankar, *Bhagavad Geeta* , New Delhi: Oriented Publishing
[2] P.Gopinath, *Bhartrihari's Three Satakam (Niti-sringar-vairagya),* New Delhi: Rashtriya Sanskrit Sansthanam
[3] Maharaja Bhadrihari, *Nithishatakam Translated by P.Jwala Dutta Sharma*, Dharm Diwakar Press, Moradabad, 1909, First Edition
[4] *world.com/section_personality_development.html*

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: build an holistic personality

CO2: develop himself to accomplish his responsibilities and achieve his highest goal in life

CO3: perceive basic knowledge to maintain stable mind, pleasing personality and determination

CO4: originate himself to become a role model thus leading mankind to peace and prosperity

Course Articulation Matrix (CAM): P20AC208C PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTEMENT SKILLS						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20AC208C.1**	2	1	1	-	-
CO2	**P20AC208C.2**	2	1	1	-	-
CO3	**P20AC208C.3**	2	1	1	-	-
CO4	**P20AC208C.4**	2	1	1	-	-
P20AC208C		**2**	**1**	**1**	**-**	-

P20AC208D: DISASTER MANAGEMENT

Class: M.Tech. II–Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
2	-	-	1

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: disaster management cycle and relation between disaster & development
LO2: risk / vulnerability assessment and reduction strategies
LO3: management strategies, approaches, frameworks and governance
LO4: disaster mitigation aspects and recovery strategies

UNIT – I (6)

Introduction to Disaster: Concepts of hazard, vulnerability & risks; natural and manmade disasters- earthquake, cyclone, floods , volcanoes; famine, displaced populations, industrial & transport accidents; slow and rapid onset disasters - famine, draught , epidemics , air crash, tidal waves & tsunami

Mitigation and Management techniques of Disaster: Basic principles of disasters management, disaster management cycle, political, social, economic impacts of disasters, gender and social issues during disasters, principles of psychosocial issues and recovery during emergency situations, Impact of disaster on development, different stake holders in disaster relief, refugee operations during disasters, human resettlement and rehabilitation issues during and after disasters, intersectorial coordination during disasters, models in disasters

UNIT – II (6)

Disaster Risk and Vulnerability: Introduction to disaster risk and vulnerability, risk analysis techniques, process of risk assessment, analytical systems for risk assessment, natural hazard/ risk assessment, understanding climate risk, mapping of risk assessment, decision making for risk reduction, problems in risk assessment, strategies for risk reduction, community-based risk reduction; observation and perception of vulnerability, vulnerability identification, vulnerability types and dimensions, vulnerability and social and economic factors

Preparedness and Response: Disaster preparedness significance & measures, institutional mechanism for disaster preparedness, disaster preparedness policy & programmes, concept and significance of disaster preparedness plan, community based disaster preparedness plan, prediction, early warnings and safety measures of disaster, resource mobilization, post disaster reliefs & logistics management, emergency support functions and coordination mechanism

UNIT – III (6)

Disaster Management and Governance: Institutional arrangements, disaster management strategies & approaches, Community Based Disaster Preparedness (CBDP) - components, teams, preparedness, linkages with development programmes

Disaster Response in India: Legal framework, National disaster management Act, 2005, institutions for disaster management – NDMA, NIDM, role of government agencies, NCMC

committee, crisis management group, need, media, community resilience, social & economic problems, funding mechanism

UNIT - IV (6)

Disaster Risk Mitigation: Background, strengthening, Sendai framework and strengthening disaster risk governance, responsibility matrix

Disaster Recovery: Scope, approach, recovery process, steps involved in recovery process, early, mid& long-term recovery, reconstruction; coordination–central, state, & private sectors and voluntary organizations, rehabilitation–economical and psychological

Text Book(s):

[1] Manual on *Natural Disaster Management in India*, M C Gupta, NIDM, New Delhi, 2016*(Chapters 1- 5, 7, 9 &10)*

[2] N. G. Dhawan, A. S. Khan, *Disaster Management and Preparedness*, 1st ed., New Delhi: CBS Publication, 2014 *(Chapters 1, 2, 3, 4, 6, 7, 8 &10)*

Reference Book(s):

[1]Ashok Kumar and Vipul Anekant, *Challenges to internal security of India*, Tata McGraw hill, 2020

[2] Larry R. Collins, *Disaster management and Preparedness*, CRC Press, 2004

[3]Tony Moore and Raj Lanka, *Hand book of Disaster and Emergency Management*, 3rd ed., Elsevier, 2006.

[4]R. K. Dave, *Disaster Management in India: Challenges and Strategies*, Prowess Publishing, 2018

[5] M. M. Sulphey, *Disaster Management*, 1st ed.,Prentice Hall of India, 2016.

[6] M. Pandey, *Disaster Management*, 1st ed., Wiley India, 2014.

[7] R. B. Singh, *Natural Hazards and Disaster Management: Vulnerability and Mitigation*, Noida: Rawat Publications, 2006

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1:categorize disasters, analyse the phases of disaster management cycle and relation between disaster & development

CO2: perform risk / vulnerability assessment and devise response & preparedness strategies for risk / vulnerability reduction

CO3: identify the role of government and private agencies involved in disaster assistance

CO4: analyse the mitigation measures and recovery strategies to inculcate a culture of resilience

Course Articulation Matrix (CAM): P20AC208D DISASTER MANAGEMENT

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20AC208D.1**	2	1	1	-	-
CO2	**P20AC208D.2**	2	1	1	-	-
CO3	**P20AC208D.3**	1	1	-	-	-
CO4	**P20AC208D.4**	2	1	-	-	-
P20AC208D		**1.75**	**1**	**1**	**-**	**-**

PRR-20

DEPARTMENT OF INFORMATION TECHNOLOGY
KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE, WARANGAL – 15
(An Autonomous Institute under Kakatiya University, Warangal)
SCHEME OF INSTRUCTION & EVALUATION FOR TWO YEAR POSTGRADUATE PROGRAMME

M.TECH. (DATA SCIENCE)

SEMESTER-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits	Evaluation Scheme								
								CIE - TA							ESE	Total Marks
								I²RE				Minor	MSE	Total		
				L	T	P		ATLP	CRP	CP	PPT					
1	**PE**	**P20DS301**	Professional Elective-5	3	-	-	3	8	8	8	6	10	20	60	40	100
2	**OE**	**P20OE302**	Open Elective	3	-	-	3	8	8	8	6	10	20	60	40	100
3	**PROJ**	**P20DS303**	**Dissertation Phase – I/Industrial Project** (*to be continued in IV – Semester also as Dissertation Phase – II*)	-	-	18	9	-	-	-	-	-	-	100	-	100
4	**PROJ**	**P20DS304**	**Internship Evaluation**	-	-	2	-	-	-	-	-	-	-	100	-	100
			Total:	**6**	**-**	**20**	**15**							**320**	**80**	**400**

[L= Lecture, T = Tutorials, P = Practicals, C = Credits, ATLP = Assignments, CRP = Course Research Paper, CP = Course Patent, PPT = Course Presentation, Minor=Minor Examination, MSE=Mid Semester Examination and ESE=End Semester Examination]

Professional Elective- 5	Open Elective
P20DS301A: Medical Image Processing	P20OE302A: Business Analytics
P20DS301B: Video Analytics	P20OE302B: Industrial Safety
P20DS301C: Blockchain Technologies	P20OE302C: Operations Research
P20DS301D: MOOCs	P20OE302D: Cost Management of Engineering Projects
	P20OE302E: Composite Materials
	P20OE302F: Waste to Energy
	P20OE302G: Renewable Energy Sources
	P20OE302H: MOOCs

Total Contact Periods/Week: 26 **Total Credits: 15**

Note: Additional Learning: Students are advised to do MOOCs to bridge the gap in the curriculum, as suggested by the Department Academic Advisory Committee (DAAC). The credits earned by the students through MOOCs will be printed in the semester grade sheet.

P20DS301A MEDICAL IMAGE PROCESSING

Class: M.Tech. III-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):
This course will develop students' knowledge in /on
LO1: components of biomedical image processing
LO2: extraction and Statistical Measurement and reduction filters for medical images
LO3: concepts of image restoration and image segmentation
LO4: soft computing techniques, CBIR and CBMIR

UNIT – I (9)

Introduction: What is image, Digital image, Image resolution and aspect ratio, Components of digital image processing, Sampling and quantization, Applications areas, Vision fundamentals, CAD system, Research areas of Digital image processing
Biomedical Image Processing: Various modalities of medical imaging, Problems with medical images, Image enhancement, Other modalities of medical imaging

UNIT – II (9)

Noise Reduction Filters for Medical Images: Sources of noise and filters used for noise reduction, Spatial domain filters, Frequency domain filters, Practical results
Feature Extraction and Statistical Measurement: Selection of features, Shape related features, Fourier descriptors, Texture analysis, Breast tissue detection, Analysis of tissue structure

UNIT – III (9)

Medical Image Restoration: Image restoration, Degradation model, Estimation of degradation function, Blur model, Medical image restoration, Blur identification, Super-resolution method, Applications of image restoration
Biomedical Image Segmentation: Image segmentation: Broad classification and applications, Points detection, Line detection, Edge detection methods, Histogram-based image segmentation, Segmentation using split and merge method, Region growing method, Watershed method, k-means clustering method, Self-similar fractal method, Topological derivative-based segmentation, Comparison of segmentation methods

UNIT – IV (9)

Soft Computing Techniques: Fuzzy-based techniques, Neural network-based techniques, Genetic algorithm-based techniques, Comparison of results of various methods, Neuro fuzzy techniques
Content-Based Medical Image Retrieval: Content-Based Image Retrieval (CBIR), Content-Based Medical Image Retrieval (CBMIR)

Text Book:

[1] G.R. Sinha, Bhagwati Charan Patel, *Medical Image Processing: Concepts and Applications,* New Delhi: Prentice Hall India, 2014.

Reference Book(s):

[1] John C Russ, *The image processing handbook*, 4th ed., Florida: CRC and IEEE press, 2002.

[2] Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image processing, analysis and machine vision*, 2nd ed., Boston: Brooks Cole publishing Co., 1999.

[3] Jayaram, Kudupa and Gabor,T Herman, *3D imaging in medicine*, 2nd ed., Florida: CRC press, 2000.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: illustrate components of biomedical image processing

CO2: apply noise reduction filters and statistical measurement for improvement of images

CO3: analyze image restoration and image segmentation techniques

CO4: apply image retrieval and soft computing techniques

Course Articulation Matrix (CAM): P20DS301A MEDICAL IMAGE PROCESSING

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS301A.1**	1	1	1	2	1
CO2	**P20DS301A.2**	1	1	2	1	2
CO3	**P20DS301A.3**	1	1	1	2	1
CO4	**P20DS301A.4**	1	1	2	1	1
P20DS301A		**1**	**1**	**1.5**	**1.5**	**1.25**

P20DS301B VIDEO ANALYTICS

Class: M.Tech. III-Semester **Specialization:** Data Science

Teaching Scheme :

L	T	P	C
3	-	-	3

Examination Scheme :

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on

LO1: image feature extraction and approximation algorithms

LO2: object detection, tracking and recognition on videos

LO3: human body pose inference and discriminative gaussian process on videos

LO4: human activities and calibration of multi cameras overlapping.

UNIT – I (9)

Fundamentals of Intelligent Video Surveillance: Image feature extraction, Multiple view geometry, Probabilistic inference, Pattern recognition and Machine learning.

Adaptive Background Modeling and Subtraction: A density-based approach with multiple features: Kernel density approximation, Background modeling and subtraction algorithm.

UNIT – II (9)

Pedestrian Detection and Tracking: Introduction, Pedestrian detection by boosting local shape features, Occluded pedestrian detection by part combination, Pedestrian tracking by associating detection responses.

Vehicle Tracking and Recognition: Introduction, Joint tracking and Recognition framework, Joint appearance-motion generative model, Inference algorithm for joint tracking and recognition, Enhanced inference algorithm for joint tracking and recognition.

UNIT – III (9)

Articulated Human Motion Tracking: Introduction, Image feature representation, Dimension reduction and movement dynamics learning, Human body pose inference using Bayesian mixture of experts, Human motion tracking.

Human Action Recognition: Introduction, Discriminative gaussian process dynamic model, Human action recognition using discriminative gaussian process dynamic model.

UNIT-IV (9)

Multi-Level Human Interaction Recognition: Introduction, Generation of virtual view by homography binding, Adaptive selection of the best view, Learning the human activity, Track-body synergy framework.

Multi-Camera Calibration and Global Trajectory Fusion: Introduction, Problem formulation, Non-overlapping cameras, Overlapping cameras.

Text Book:

[1] Yunqian Ma and Gang Qian, *Intelligent Video Surveillance Systems and Technology,* USA: CRC Press, 2009. *(Chapter 2, 4 to 8, 10 and 11)*

Reference Book(s):

[1] Fredrik Nilsson, *Intelligent Network Video understanding Modern Video Surveillance Systems,* 2nd ed. USA: CRC Press, 2017.

[2] Francesco Camastra and Alessandro Vinciarelli, *Machine Learning for Audio, Image and Video Analysis,* 2nd ed., London: Springer Nature, 2015.

[3] Richard Szeliski, *Computer Vision – Algorithms and Applications*, London: Springer, 2011.

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: understand the pattern recognition and machine learning techniques

CO2: apply vehicle tracking and object recognition algorithms

CO3: make us of gaussian mixture model-based silhouette descriptor and nearest neighbor classification in the latent space

CO4: distinguish track-body level analysis and understand the overlapping cameras

Course Articulation Matrix (CAM): P20DS301B VIDEO ANALYTICS

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS301B.1**	1	1	1	1	1
CO2	**P20DS301B.2**	1	1	2	2	1
CO3	**P20DS301B.3**	2	1	2	2	1
CO4	**P20DS301B.4**	1	1	1	1	1
P20DS301B		**1.25**	**1**	**1.5**	**1.5**	**1**

P20DS301C BLOCKCHAIN TECHNOLOGIES

Class: M.Tech. III-Semester

Specialization: Data Science

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on …

LO1: basic concepts of blockchain and its types, consensus theorem , decentralization

LO2: cryptography techniques working in blockchain using different encryption algorithms

LO3: Bitcoins, cryptographic keys, transactions with bitcoin network and payments

LO4: Bitcoin APIs, alternate coins and smart contracts

UNIT – I (9)

Blockchain: The growth of blockchain technology, Distributed systems, The history of blockchain, Types of blockchain

Consensus: Consensus mechanism, Types of consensus mechanisms, Consensus in blockchain

Decentralization: Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Blockchain and full ecosystem decentralization

UNIT – II (9)

Symmetric Cryptography: Working with the openSSL command line, Cryptography, Confidentiality, Integrity, Authentication, Non-repudiation, Accountability

Cryptographic Primitives: Keyless primitives, Symmetric cryptography, Data Encryption Standard(DES), Advanced Encryption Standard(AES).

Public Key Cryptography: Mathematics**,** Asymmetric cryptography, Cryptographic constructs and blockchain technology

UNIT – III (9)

Introducing Bitcoin: Bitcoin-an overview: The beginnings of bitcoin, Egalitarianism versus authorianism, Bitcoin definition, Bitcoin - A users perspective

Cryptographic keys: Private keys in bitcoin, Public keys in bitcoin, Addresses in bitcoin

Transactions: The transaction life cycle, The transaction data structure, Types of scripts, Coinbase transactions, Transaction validation, Transaction bugs, Blockchain, Mining, Mining pools

Bitcoin Network and Payments: The Bitcoin Network, Wallets, Bitcoin Payments, Innovation in Bitcoin, Advanced protocols, Bitcoin investment and buying and selling

UNIT – IV (9)

Bitcoin Clients and APIs: Bitcoin client Installation, Experimenting further with bitcoin-cli, Bitcoin programming

Alternative Coins: Introducing altcoins, Theoritical foundations: Alternatives to proof of work (PoW), Proof of stake (PoS), Proof of activity (PoA), Non-outsourceable puzzles

Smart Contracts: Introduction, History, Ricardian contracts, Smart contract templates, Deploying smart contracts

Ethereum: Introduction, The ethereum network, Components of the ethereum ecosystem Transactions and messages, Ether cryptocurrency / tokens (ETC and ETH), The Ethereum Virtual Machine (EVM)

Text Book:

[1] Imran Bashir, *Mastering Blockchain: Distributed ledger technology, decentralization, and smart contracts explained*, 2nd ed. United Kingdom: Packt Publishing Limited, 2018.

Reference Book(s):

[1] Narayanan A, Bonneau J, Felten E, Miller A, and Goldfeder S, *Bitcoin and Cryptocurrency Technologies – A Comprehensive Introduction*, 2nd ed., United States: Princeton University Press, 2016.

[2] Andreas M. Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain*, 2nd ed., United States: O'Reilly Media, Inc., 2018.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: illustrate the concepts of blockchain with its types, consensus theorem and decentralization

CO2: apply cryptography techniques in blockchain to ensure security of blockchain

CO3: develop the bitcoin in blockchain technology and experiment with transactions

CO4: analyse the smart contracts to identify best contract and examine the ethereum development Processes

Course Articulation Matrix(CAM): P20DS301C BLOCKCHAIN TECHNOLOGIES						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS301C.1**	1	1	1	1	1
CO2	**P20DS301C.2**	1	1	1	1	1
CO3	**P20DS301C.3**	1	1	1	1	1
CO4	**P20DS301C.4**	1	1	1	1	1
P20DS301C		**1**	**1**	**1**	**1**	**1**

P20OE302A : BUSINESS ANALYTICS

Class: M. Tech. III–Semester

Specialization: **SCE, DE, VE, PE, SE DS, DC & CSP**

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop student's knowledge in/on

LO1: fundamental concepts of business analytics and descriptive analytics
LO2: data collection and data visualization methods
LO3: text analysis and simulation methods in business analytics
LO4: social media, web and health care analytics

UNIT - I (9)

Introduction to Business Analytics: Introduction to business analytics, why analytics, business analytics: the science of data-driven decision making, business context, technology data science, descriptive analytics, predictive analytics, prescriptive analytics descriptive, predictive, and prescriptive analytics techniques, big data analytics, web and social media analytics, machine learning algorithms, framework for data-driven decision making, analytics capability building, roadmap for analytics capability building, challenges in data-driven decision making and future

Descriptive Analytics: Introduction to descriptive analytics, data types and scale, structured and unstructured data, cross-sectional, time series, and panel data, types of data measurement scales, population and sample, measures of central tendency, percentile, decile, and quartile, measures of variation

UNIT - II (9)

Data Collection: Introduction, the value of data, data collection preliminaries, data collection methods, data types, problem formulation preliminaries, challenges in data collection, data collation, validation and presentation, data collection in the retailing industry

Data Visualization: Introduction, motivating example, methods of data visualization, software and data visualization

UNIT - III (9)

Text Analytics: Introduction, motivating text analysis, methods of text analysis, natural language processing

Simulation: Introduction, motivating examples, simulation modeling method and case studies

UNIT - IV (9)

Applications of Business Analytics: Introduction, what is social media and web analytics, display advertising in real time, A/B experiments for measuring value of digital media and

handling e-retailing challenges, strategies for mobile devices, the future of social media analytics

Health Care Analytics: Introduction, methods of health care analytics

Text Book(s):

[1] U Dinesh Kumar, *Business Analytics: The Science of Data-Driven Decision Making*, 1st ed., 2017. (*Unit-I*)

[2] Bhimasankam Pochiraju, Sridhar S, *Essentials of Business Analytics: A Textbook*, 1st ed. Springer Nature Switzerland, 2019. (*Units-II, III, IV*).

Reference Book(s):

[1] R N Prasad, Seema Acharya, *Fundamentals of Business analytics: Big Data*, 2nd ed. Wiley Publications, 2017.

[2] Foster Provest, Tom Fawcett, *Data Science for Business*, 1st ed. USA: O'Reilly, 2013.

Course Learning Outcomes (COs):

On completion of this course, the students will be able to …

CO1: describe the concepts of business analytics and descriptive analytics

CO2: apply the data collection and data visualization methods in business analytics

CO3: categorize text analysis and simulation methods in business analytics

CO4: apply social media & web analytics and health care analytics in real world problems

Course Articulation Matrix: P20OE302A BUSINESS ANALYTICS						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20OE302A.1**	-	-	-	1	1
CO2	**P20OE302A.2**	1	1	-	1	1
CO3	**P20OE302A.3**	1	1	-	1	1
CO4	**P20OE302A.4**	2	2	-	1	1
P20OE302A		**1.33**	**1.33**	**-**	**1**	**1**

P20OE302B INDUSTRIAL SAFETY

Class: M. Tech. III–Semester

Specialization(s):SCE, DE, VE, PE, SE, DS, DC & CSP

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives(LOs):

This course will develop students' knowledge in/on

LO1: need for safety in industries

LO2: fundamentals of maintenance engineering

LO3: causes for wear& corrosion and method of lubrication

LO4: faults tracing in equipments and importance of preventative maintenance

UNIT – I (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

UNIT – II (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

UNIT – III (9)

Prevention of Wear and Corrosion: Wear- types, causes, effects, wear reduction methods, lubricants; types and applications, lubrication methods, general sketch, working and applications- screw down grease cup, pressure grease gun, splash lubrication, gravity lubrication, wick feed lubrication, side feed lubrication, ring lubrication, definition, principle and factors affecting the corrosion, types of corrosion, corrosion prevention methods

UNIT – IV (9)

Fault Tracing and Preventative Maintenance: 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 - machine tool, pump, air compressor, internal combustion engine, boiler, electrical motors, types of faults in machine tools and their general causes, periodic and preventative maintenance; advantages of preventative maintenance, Repair cycle importance

Text Book(s):

[1] John Ridley and John Channing., *Safety at work*, 6th ed., UK: Elsevier Butterworth-Heinemann, 2003 (Unit 1 & Unit 2) (*Chapters: 2,3,5,6,7,8)*

[2] Amit Gupta., *Industrial Safety and environment*, New Delhi: Laxmi Publications (P) Ltd., 2006 (Unit 3 & Unit 4) (*Chapters:10,11,12,13,14,15,16,17*)

Reference Book(s):

[1] R. Keith Mobley Editor, Lindley R. Higgins Darrin J. Wikoff., *Maintenance Engineering Handbook*, 7th ed., New York: Mc Graw Hill International, 2008

[2] Mohammed Ben–Daya.,UdayKumar., Prabhakar Murthy D.N., *Introduction to Maintenance Engineering*, New Delhi: Wiley India Pvt. Ltd., 2016

Course Learning Outcomes(COs):

Upon completion of this course, students will be able to….

CO1: summarize the principles of industrial safety and maintenance

CO2: describe the functions of maintenance department and list the types of maintenance & tools used for maintenance

CO3: identify the causes for wear, tear& corrosion and suitable lubrication method for a given application

CO4: describe the significance of decision-tree and apply it for problems in equipment to detect and classify the faults and need of preventative maintenance

Course Articulation Matrix (CAM) : P20OE302B INDUSTRIAL SAFETY						
COs		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20OE302B.1**	1	1	1	-	-
CO2	**P20OE302B.2**	1	1	1	-	-
CO3	**P20OE302B.3**	1	1	1	-	-
CO4	**P20OE302B.4**	1	1	1	-	-
P20OE302B		**1**	**1**	**1**	**-**	**-**

P20OE302C: OPERATIONS RESEARCH

Class: M.Tech. III –Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on

LO1: linear programming problems
LO2: non linear optimization problem
LO3: sequencing, scheduling and network model
LO4: decision making theory and queuing models

UNIT – I (9)

Linear Programming Problem (LPP): Mathematical formulation of LPP, Solution of linear programming problems-Simplex method, artificial variable technique, Duality in LPP and Dual Simplex method; Sensitivity analysis.

UNIT – II (9)

Non-Linear Programming Problem (NLPP): Classification of NLPP, Unconstrained optimization techniques- Iterative methods - Random search methods, steepest decent method, Conjugate gradient method, Fibonacci method and Golden section method.

Constrained Optimization Techniques-- Lagrange's method and Kuhn-Tucker method.

UNIT – III (9)

Sequencing and Scheduling: Sequencing and scheduling of n jobs one, two and three machine problems, scheduling of n jobs through k machines problem.

Project Network: Network construction-CPM and PERT; Resource analysis in network problems.

UNIT - IV (9)

Decision Analysis and Game Theory: Introduction, Decisions under uncertainty- Laplace criterion, Max-min criterion, Savage Criterion and Hurwitz criterion; Game Theory- Introduction, two person zero sum games and the maximin-minimax principle; Mixed strategy games- graphical method and linear programming method, dominance property.

Queuing Theory- Elements and operating characteristics of a queuing system, Poisson queuing systems, study of single server queuing model with infinite capacity.

Text Book(s):

[1] Kanti swarup, P.K.Gupta, Man Mohan, *Operations Research,* S. Chand & Sons, New Delhi. 16th edn., 2013. (*Chapters: 2, 4, 5, 6, 12, 16, 17, 21, 25, 27*)

[2] S.S. Rao, *Optimization Techniques,* New Age International, New Delhi, 3rd edn., 2013. (*Chapter: 6*)

Reference Book(s):

[1] H.A. Taha, *Operations Research an Introduction,* Prentice Hall of India, 6th Edn., 2006

[2] N.D Vohra, *Quantitative Techniques in Management*, 3rd edn, TMH, 2010

Course Learning Outcomes (COs):

On completion of this course, students will be able to ...

CO1: model engineering real time problems and solve them using various LPP techniques

CO2: optimize the engineering problems using NLPP methods

CO3: apply the tools and techniques to solve sequencing and scheduling problems and project network models

CO4: analyze conflicting situations using game theory and solve various queuing model parameters

Course Articulation Matrix (CAM): P20OE302C OPERATIONS RESEARCH

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20OE302C.1**	2	1	1	-	-
CO2	**P20OE302C.2**	2	1	1	1	-
CO3	**P20OE302C.3**	2	1	1	-	-
CO4	**P20OE302C.4**	2	1	1	1	-
P20OE302C		**2**	**1**	**1**	**1**	**-**

P20OE302D: COST MANAGEMENT OF ENGINEERING PROJECTS

Class: M.Tech. III-Semester

Specialization(s): SCE, DE, VE, PE, SE, DS, DC & CSP

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge on /in

LO1: cost concepts, objectives of costing system, project management

LO2: standard costing, cost control and reduction

LO3: cost behavior, profit planning and types of budgets

LO4: quantitative techniques for cost management

UNIT - I (9)

Overview of Cost Accounting: Cost concepts in decision making, Objectives of a costing system, Different costs of Projects - Relevant cost, Differential cost, Incremental cost, Opportunity cost, Activity Based Costing.

Project: Meaning, Types of projects, Benefits of project management, Project life cycle.

UNIT - II (9)

Standard Costing: Meaning, Advantages and limitations, Standard costing in manufacturing and process industries, Standard costing and standardized costing, Standard cost and estimated cost.

Cost Control and Reduction: Cost control meaning, Distinction between cost control and cost reduction, Advantages and disadvantages of cost control and cost reduction, Cost control techniques, Essential for success of cost controls and cost reduction programme, Areas of cost reduction, Tools and techniques of cost reduction.

UNIT - III (9)

Cost Behavior and Profit Planning: Marginal Cost, Absorption Cost, Break-even analysis, Cost-Volume-Profit (CVP) analysis, Profit-Volume (PV) ratio, Sales ratio, Margin of safety.

Budgets: Budgetary control, Flexible budget, Performance based budgets, Zero based budgets.

UNIT - IV (9)

Quantitative Techniques for Cost Management: Linear Programming Problems (LPP includes graphic method and simplex method), Transportation problems, Assignment problems.

Text Book(s):

[1] S.P. Jain, K.L.Narang, *Advanced Cost Accounting*, New Delhi: Kalyani Publishers, 2014 (*Chapter 7, 10 ,11 13, 14, 16 &27*)

[2] N.D. Vohra, *Quantitative Techniques in Management*, 3rd ed. New Delhi: Tata McGraw Hill Book Co. Ltd. 2007 (*Chapter 2,3, 5 and 6*)

Reference Book(s):

[1] Ashish K. Bhattacharya, *Principles & Practices of Cost Accounting*, 3rd ed. New Delhi: Prentice Hall India Learning Private Limited, 2004.

[2] Harold Kerzner, *Project Management: A systems approach to Planning, Scheduling and Controlling,* 10th ed. New Delhi: John Wiley & Sons Inc., 2009.

[3] V K Kapoor, *Operations Research,* New Delhi: Sultan Chand & Sons, 2013.

[4] Charles T. Horngren and George Foster, *Cost Accounting A Managerial Emphasis*, New Delhi: Prentice Hall of India, 1991.

Course Learning Outcomes (COs):

Upon completion of this course, the student will be able to…

CO1: interpret overview of cost accounting and project management

CO2: distinguish standard costing in manufacturing and process industries, estimate cost control and reduction

CO3: estimate cost behavior, profit planning and budget

CO4: apply quantitative techniques for linear programming, transportation and assignment problems

Course Articulation Matrix (CAM): P20OE302D COST MANAGEMENT OF ENGINEERING PROJECTS

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20OE302D.1**	1	1	1	-	-
CO2	**P20OE302D.2**	1	1	1	-	-
CO3	**P20OE302D.3**	2	1	1	-	-
CO4	**P20OE302D.4**	2	1	1	-	-
P20OE302D		**1.5**	**1**	**1**	**-**	**-**

P20OE302E: COMPOSITE MATERIALS

Class: M. Tech. III-Semester

Specialization(s): SCE, DE, VE, PE, SE, DS, DC & CSP

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives(LOs):

This course will develop students' knowledge in/on

LO1: composite material properties and applications

LO2: properties and applications of fibers and rule of mixture

LO3: manufacturing and applications of metal matrix, ceramic matrix and carbon-carbon composites

LO4: polymer matrix composites, manufacturing and applications

UNIT - I (9)

Composite Materials: Definition, classification, characteristics, advantages, applications, functional requirements of reinforcement and matrix, effect of reinforcement on composite performance - size, shape, distribution and volume fraction

UNIT - II (9)

Reinforcements: Preparation - layup, curing, fibers-glass, carbon, kevlar, boron, properties and applications- fibers, whiskers, particle reinforcements, mechanical behavior of composites, rule of mixtures, inverse rule of mixtures, isostrain and isostress conditions

UNIT - III (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, properties and applications

Manufacturing of Carbon/carbon Composites: Knitting, braiding, weaving; properties and applications

UNIT - IV (9)

Manufacturing of Polymer Matrix Composites: Preparation of molding compounds and prepregs, manufacturing of polymer matrix composites - hand layup, autoclave, filament winding, compression molding and reaction injection molding, properties and applications

Text Book:

[1] Chawla K.K., *Composite Materials*, 4th ed., New York: Springer, Verlag, 2019. (*Chapters 1, 2, 5, 6, 7 & 8*)

Reference Book(s):

[1] Agarwal, B.D. and Broutman, L. J., *Analysis and Performance of Fiber Composites*, 4th ed., USA: John Wiley & Sons, 2017.

[2] Strong A.B., *Fundamentals of Composite Manufacturing*, 2nded., SME, 2007.
[3] Sharma S.C., *Composite materials*, 1sted., New Delhi: Narosa Publications, 2000.
[4] Mathews F.L. and Rawlings R.D., *Composite materials: Engineering and Science*, 1st ed., England: Chapman and Hall, 1994.
[5] Krishnan K., Chawla *Composite Materials Science and Engineering*, India: Springer Private Limited, 2009.
[6] P.K. Mallick, *Fiber Reinforced Composite materials, Manufacturing and Design*, New York: CRC Press, Taylor and Francis Group, 2010.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: classify composite materials and explain their applications
CO2: outline properties and applications of reinforcements.
CO3: categorize manufacturing methods for metal matrix composite, ceramic matrix composite, carbon/carbon composite and their properties.
CO4: compare manufacturing methods of polymer matrix composites.

Course Articulation Matrix (CAM) P20OE302E : COMPOSITE MATERIALS

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20OE302E.1**	1	1	1	-	-
CO2	**P20OE302E 2**	1	1	1	-	-
CO3	**P20OE302E.3**	1	1	1	-	-
CO4	**P20OE302E.4**	1	1	1	-	-
P20OE302E		**1**	**1**	**1**	**-**	**-**

P20OE302F: WASTE TO ENERGY

Class: M.Tech.III–Semester

Specialization(s): **SCE, DE, VE, PE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop students' knowledge on /in

LO1: concept of waste to energy

LO2: production of energy form waste.

LO3: technologies for waste to energy.

LO4: standards for waste to energy plants and carbon credits.

UNIT – I (9)

Introduction: Principles of waste management and waste utilization, Waste management hierarchy and 3R principle of reduce, Reuse and recycle, Waste as a resource and alternate energy source

Waste Sources & Characterization: Waste production in different sectors such as domestic, industry and agriculture, Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous), Characterization of waste for energy utilization

UNIT – II (9)

Technologies for Waste to Energy: Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation, Thermo-chemical conversion– combustion, Incineration and heat recovery, Pyrolysis, Gasification, Plasma arc technology

Waste to Energy Options: Landfill gas, Collection and recovery, Refuse Derived Fuel (RDF)– Fluff, Briquettes, Pellet, Alternate Fuel Resource (AFR) – Production and use in cement plants, Thermal power plants and Industrial boilers, Conversion of wastes to fuel resources for other useful energy applications, Energy from plastic wastes – Non-recyclable plastic waste for energy recovery, Energy recovery from wastes and optimization of its use, benchmarking and standardization, Energy analysis

UNIT – III (9)

Energy production: Waste activities – Collection, Segregation, Transportation and Storage requirements, Location and Siting of 'Waste to Energy' plants, Industry specific applications– In-house use – Sugar, Distillery, Pharmaceuticals, Pulp and Paper, Refinery and Petrochemical industry

Centralized and Decentralized Waste to Energy Plants: Centralized and decentralized energy production, distribution and use, Comparison of centralized and decentralized systems and its operations

UNIT - IV (9)

Waste to Energy & Environmental Implications: Environmental standards for waste to energy plant operations and gas clean-up, Savings on non-renewable fuel resources

Carbon Credits: Carbon foot print calculations and Carbon credits transfer mechanisms

Text Book(s):

[1] *Waste to Resources: A Waste Management Handbook*, NewDelhi: TERI Press,2014. (Unit – I, III & IV)

[2] Sunil Pandey, *Industrial and Urban Waste Management in India*, New Delhi : TERI Press, 2015 (Unit –II)

Reference Book(s):

[1] Banwari Lal and Patwardhan ,*Wealth from Waste: Trends and Technologies*, New Delhi :TERI Press, 2014.

[2] S.N Mukhopadhyay, *Fundamentals of waste and Environmental Engineering*, New Delhi: TERI Press, 2016.

[3] Gazette Notification on Waste Management Rules 2016.

[4] CPCB Guidelines for Co-processing in Cement/Power/Steel Industry.

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: outline the operations of waste sources and alternate energy sources
CO2: adopt waste to energy technologies
CO3: list the stages of waste to energy production
CO4: appraise environmental standards and estimate carbon foot print

Course Articulation Matrix: P20OE302F WASTE TO ENERGY

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20OE302F.1**	1	1	1	-	-
CO2	**P20OE302F.2**	1	1	1	-	-
CO3	**P20OE302F.3**	1	1	1	-	-
CO4	**P20OE302F.4**	1	1	1	-	-
P20OE302F		**1**	**1**	**1**	**-**	**-**

P20OE302G: RENEWABLE ENERGY SOURCES

Class: M.Tech. III– Semester

Specialization(s): **SCE, DE, VE, SE, DS, DC & CSP**

Teaching Scheme:

L	T	P	C
3	-	-	3

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):

This course will develop student's knowledge in/on

LO1: different types of renewable energy sources and principles of solar energy systems

LO2: principles of wind energy and geothermal energy systems

LO3: harnessing energy from oceans and biomass

LO4: working of fuel cells and different types of energy storage systems

UNIT - I (9)

Introduction: Conventional and non-conventional sources of energy – brief description of different renewable energy sources

Solar energy: Introduction to prospects of solar PV systems: photovoltaic effect and electrical equivalent circuit of a PV cell, dependence of a PV cell characteristic on temperature, Solar cell output characteristics, flat plate and concentrating collectors, solar applications-solar heating/cooling technique, solar distillation, drying, street lighting, domestic lighting, solar PV pumping systems

UNIT - II (9)

Wind energy: Principles of wind power, evaluation of wind intensity, operation of a wind turbine and wind power curve, different types of wind turbine generators, topography and classification of wind turbines and its applications

Geothermal Energy: Origin and types of geothermal energy, operational difficulties, liquid dominated systems

UNIT - III (9)

Energy from Oceans: Ocean temperature differences, ocean waves, energy from the waves Introduction of tidal power, basic principle of tidal power, components of tidal power plants

Bioenergy: Introduction, bio-mass conversion technologies, photo synthesis, biogas generation, biogas from power plant wastes, methods of maintaining biogas production, utilization of biogas, biogas gasification

UNIT - IV (9)

Chemical energy sources: Introduction to fuel cells, principle of operation of fuel cell, classification of fuel cells, advantages, disadvantages and applications of fuel cells

Types of energy storage systems: Introduction, mechanical energy storage systems, batteries, ultra-capacitors, super conducting magnetic storage, applications

Case study on present scenario of energy generation in India

Text Book:

[1] Rai G.D, *Non-Conventional Energy Sources*, 4th ed., New Delhi: Khanna Publishers, 2010.

Reference Book(s):

[1] B.H. Khan, *Non-conventional Energy Resources*, 2nd ed., New Delhi: McGraw Hill Publishers, 2006.

[2] Felix A. Farret, M. Godoy Simoes, *Integration of Alternative Sources of Energy*, New York: John Wiley & Sons, 2006.

[3] Bansal N. K. Kaleeman and M. Miller, *Renewable Energy Sources and Conversion Technology*, New Delhi: Mc Graw-Hill Publishers, 2006.

[4] Duffie and Beckman, *Solar Energy Thermal Process*, New York: John Wiley & Sons, 2006.

Course Learning Outcomes (COs):

Upon completion of this course, the student will be able to…

CO1: compare conventional and non-conventional energy resources; describe solar cell characteristics and discuss applications of solar energy

CO2: compute power output of wind and describe principle of geothermal energy system

CO3: describe harnessing of electric power from oceans and biomass

CO4: describe principle of operation of fuel cells and list different types of energy storage systems

Course Articulation Matrix: P20OE302G RENEWABLE ENERGY SOURCES						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20OE302G.1**	2	1	1	-	-
CO2	**P20OE302G.2**	2	1	1	-	-
CO3	**P20OE302G.3**	2	1	1	-	-
CO4	**P20OE302G.4**	2	1	1	-	-
P20OE302G		**2**	**1**	**1**	**-**	**-**

P20DS303: DISSERTATION PHASE-I /INDUSTRIAL PROJECT

Class: M.Tech. III- Semester **Specialization:** Data Science

Teaching Scheme:

L	T	P	C
-	-	18	9

Examination Scheme:

Continuous Internal Evaluation	100 marks
End Semester Examination	--

Course Learning Objectives (LOs):
This course will develop students' knowledge on /in…

LO1: selecting problem based Dissertation title in one of the areas of specialization

LO2: literature review and well-documented report writing

LO3: effective technical presentation skills with creating PPTs and speaking with technical knowledge

LO4: creating video pitch

Registration Presentation: The Registration Dissertation Presentation shall include a brief report and presentation focusing the identified topic, literature review, time schedule indicating the main tasks, and expected outcome.

Progress Presentation-I: At the end of first stage (third semester), student shall be required to submit a preliminary report of work done for evaluation to the project coordinator and present the same before the *Department Post Graduate Review Committee* (DPGRC).

Evaluation for Dissertation / Industrial Project:

Dissertation work shall be normally conducted in two stages: Dissertation *Phase-I* in third semester and Dissertation *Phase-II* in fourth semester.

Dissertation *Phase-I*:

(i) The Department *Post Graduate Review Committee (DPGRC)* shall be constituted with HoD as a Chairman, M.Tech. Coordinator as a Convener and three to five other faculty members representing various specializations in that particular programme as members.

(ii) (a) Student shall take up independent Dissertation Phase-I on innovative ideas, innovative solutions to common problems using their knowledge relevant to courses offered in their programme of study, which would supplement and complement the program assigned to each student

(or)

(b) Student shall take up industrial project (in any industry) relevant to the courses offered in their programme of study, which would supplement and complement the program assigned to each student

(iii) DPGRC shall allot a faculty supervisor to each student for guiding on
(a) Selection of topic
(b) Literature survey and 50% work to be carried out during phase-I
(c) Preparing a report in proper format
(d) Effective oral presentation on dissertation phase-I before the DPGRC
(e) Right conduct of research and academic activity to promote academic integrity
(f) Use of anti-plagiarism software to detect plagiarism in the report and submission of dissertation report within acceptable plagiarism levels

(iv) In case of students with industrial projects, internal guide shall be there to track the

progress from time to time

(v) There shall be only Continuous Internal Evaluation (CIE) for Dissertation Phase-I

(vi) CIE for the Dissertation Phase-I in third semester is as follows:

Assessment	Weightage
Dissertation Phase-I Supervisor Assessment	**50%**
DPGRC Assessment: *(i) Registration Presentation* ***(10%)*** *(ii) Progress Report on Phase-I* ***(10%)*** *(iii) Video pitch on Phase-I* ***(10%)*** *(iv) Progress Presentation -I and viva voce* ***(20%)***	**50%**
Total Weightage:	**100%**

Note: It is mandatory for the student to

(i) appear for progress presentation -I and viva voce to qualify for course evaluation

(ii) create a good video pitch on dissertation phase-I

(a) **Dissertation Topic:** The topic should be interesting and conducive to discussion. Topics may be found by looking through recent issues of peer reviewed Journals/Technical Magazines on the topics of potential interest

(b) **Working Model:** Each student is required to develop a working model/ process/software package/system, on the chosen work and demonstrate before the DPGRC as per the dates specified by DPGRC at the end of dissertation phase-II

(c) **Progress Report:** Each student is required to submit a well-documented progress report on dissertation phase-I as per format specified by DPGRC

(vii) The student has to register for the Dissertation Phase-I as supplementary examination in the following cases:

(a) he/she is absent for oral presentation and viva-voce

(b) he/she fails to submit the report in prescribed format

(c) he/she fails to fulfill the requirements of Dissertation Phase-I evaluation as per specified guidelines

(viii) (a) The CoE shall send a list of students registered for supplementary to the HoD concerned

(b) The DPGRC, duly constituted by the HoD, shall conduct Dissertation Phase-I evaluation and send the award list to the CoE within the stipulated time

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: select current topics in their specialization and allied areas from peer reviewed journals / technical magazines/ conference proceedings

CO2: demonstrate the skills for performing literature survey, identify gaps, analyze the technical content and prepare a well-documented Dissertation report

CO3: create informative PPTs with effective oral presentation, showing knowledge on the subject and sensitivity towards social impact of the Dissertation

CO4: demonstrate Dissertation through effective video pitch

Course Articulation Matrix (CAM): P20DS303 DISSERTATION PHASE-I /INDUSTRIAL PROJECT						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS303.1**	2	-	2	2	2
CO2	**P20DS303.2**	2	-	2	2	2
CO3	**P20DS303.3**	-	2	-	1	1
CO4	**P20DS303.4**	-	2	-	1	1
P20DS303		**2**	**2**	**2**	**1.5**	**1.5**

P20DS304 INTERNSHIP EVALUATION

Class: M.Tech. III - Semester **Specialization:** Data Science

Teaching Scheme:

L	T	P	C
-	-	2	-

Examination Scheme:

Continuous Internal Evaluation	100 marks
End Semester Examination	--

Course Learning Objectives (LOs):

This course will develop students' knowledge on /in

LO1: selection of internship in one of the areas of course specialization

LO2: practical and real time subject application

LO3: writing well-documented report

LO4: effective technical presentation skills with creating PPTs

Guidelines for Internship:

(1) The students shall undergo 6-8 weeks internship during summer/winter vacation at industry/R&D organization / Academic Institutes like IITs & NITs.

(2) The students preferably shall undergo internship at one organization only. In case of any difficulty, the stipulated period of internship shall be completed at different organizations with minimum of two weeks internship at every stage.

(3) The internship evaluation shall be done in the III semester of study and hence the students shall complete the prescribed period of internship before start of III semester (from end of I semester to commencement of III semester).

(4) The internship evaluation shall be done by *Department Post Graduate Evaluation Committee (DPGRC).*

Evaluation for Internship:

There shall be only Continuous Internal Evaluation (CIE) for Internship Evaluation

(i) CIE for the Internship in third semester is as follows:

Assessment	Weightage
Internship Supervisor's Evaluation: a) *Completion of Internship Assignment (**10%**)* b) *Quality of work in completing the Internship Assignment (**10%**)* c) *Attendance, punctuality and work hours (**10%**)*	***30%***
DPGRC Assessment: a) *Duration (8 /6 weeks) **(15%/10%)*** b) *Internship Report **(35%)*** c) *Oral Presentation (with PPT) and viva voce **(20%)***	***70%***
Total Weightage:	***100%***

Note: It is mandatory for the student to

(i) appear for oral presentation (with PPT) and viva voce to qualify for course evaluation

(a) Internship Report: Each student is required to submit a well-documented internship report as per format specified by DPGRC

(b) Anti-Plagiarism Check: The internship report should clear plagiarism check as per the Anti-Plagiarism policy of the institute

(c) Presentation: Each student should prepare PPT with informative slides and make an effective oral presentation before the DPGRC as per the schedule notified by the department

(ii) The student has to register for the Internship as supplementary examination in the following cases:
(a) he/she is absent for oral presentation and viva-voce
(b) he/she fails to submit the report in prescribed format
(c) he/she fails to fulfill the requirements of Internship evaluation as per specified guidelines

(iii) (a) The CoE shall send a list of students registered for supplementary to the HoD concerned
(b) The DPGRC, duly constituted by the HoD, shall conduct Internship evaluation and send the award list to the CoE within the stipulated time

Course Learning Outcomes (COs):

On completion of this course, students will be able to…

CO1: learn new concepts and apply them to the solution of engineering problems

CO2: function effectively on multidisciplinary teams and interface with other areas of organization

CO3: clearly communicate their ideas in writing and prepare a well-documented internship report

CO4: create informative PPTs and clearly communicate their ideas orally demonstrating technical knowledge

Course Articulation Matrix (CAM): P20DS304 INTERNSHIP EVALUATION						
CO		**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**P20DS304.1**	2	-	2	2	2
CO2	**P20DS304.2**	2	-	2	2	2
CO3	**P20DS304.3**	-	2	-	1	1
CO4	**P20DS304.4**	-	2	-	1	1
P20DS304		**2**	**2**	**2**	**1.5**	**1.5**

PRR-20

DEPARTMENT OF INFORMATION TECHNOLOGY
KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE, WARANGAL – 15
(An Autonomous Institute under Kakatiya University, Warangal)

SCHEME OF INSTRUCTION & EVALUATION FOR TWO YEAR POSTGRADUATE PROGRAMME

M.TECH. (DATA SCIENCE)

SEMESTER-IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits	Evaluation Scheme								
								CIE - TA							ESE	Total Marks
								I²RE				Minor	MSE	Total		
				L	T	P		ATLP	CRP	CP	PPT					
1	**PROJ**	**P20DS401**	**Dissertation Phase - II**	-	-	30	15	-	-	-	-	-	-	60	40	100
			Total:	**-**	**-**	**30**	**15**							**60**	**40**	**100**

[L= Lecture, T = Tutorials, P = Practicals, C = Credits, ATLP = Assignments, CRP = Course Research Paper, CP = Course Patent, PPT = Course Presentation, Minor=Minor Examination, MSE=Mid Semester Examination and ESE=End Semester Examination]

Total Contact Periods/Week: 30 **Total Credits: 15**

P20DC401: DISSERTATION PHASE-II

Class: M.Tech. IV-Semester **Specialization**: Data Science

Teaching Scheme:

L	T	P	C
-	-	30	15

Examination Scheme:

Continuous Internal Evaluation	60 marks
End Semester Examination	40 marks

Course Learning Objectives (LOs):
This course will develop students' knowledge on /in…

LO1: recognize and formulate a problem to analyze, synthesize, evaluate, simulate and create a their project
LO2: design an innovative product by applying current knowledge and adopt to emerging applications of engineering and technology
LO3: creating PPTs and effective technical presentation and knowledge skills
LO4: writing technical paper in scientific journal style & format

Progress Presentation -II shall be conducted during the 5th /6th week of IV semester.

Progress Presentation -III shall be conducted during the 12th /13th week of IV semester.

Evaluation for Dissertation Work:

Dissertation *Phase-II*:

(i) Student has to continue the Dissertation work in 4th semester as Dissertation Phase-II
(ii) There shall be Continuous Internal Evaluation (CIE) for 60 marks and End Semester Examination for 40 marks.
(iii) The evaluation for Dissertation Phase-II is as follows:

Assessment	Weightage
Dissertation Supervisor Assessment (10%) *DPGRC* Assessment: *(i) Progress Presentation -II (10%)* *(ii) Progress Presentation -III (10%)* *(iii) Working model/process/software package/system developed (10%)* *(iv) Dissertation Video pitch (10%)* *(v) Dissertation Paper (10%)*	**60%**
End Semester Examination: *(i) Dissertation Report (20%)* *(ii) Oral presentation with PPT and viva-voce (20%)*	**40%**
Total Weightage	**100%**

Note: It is mandatory for the student to
(i) appear for oral presentation (with PPT) and viva-voce to qualify for course evaluation
(ii) write dissertation paper in given journal format
(ii) create a good video pitch on dissertation phase-I & II

(a) **Working Model:** Each student is required to develop a working model/ process/system on the chosen work and demonstrate before the DPGRC as per the dates specified by DPGRC at the end of dissertation phase-II
(b) **Dissertation Report:** Each student is required to submit a well-documented dissertation report as per the format specified by DPGRC
(c) **Anti-Plagiarism Check:** The dissertation report should clear plagiarism check as per the Anti-Plagiarism policy of the institute
(d) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the DPGRC as per the schedule notified by the department
(e) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her dissertation Phase-I & II. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include key points about his / her business idea / plan (if any) and social impact

(iv) **Dissertation Synopsis Presentation (DSP):**

(a) Students, with the consent of supervisor, shall apply to the DPGRC for conduct of dissertation synopsis presentation (DSP). This shall normally happen when the supervisor feels that the student has done significant work to qualify for M.Tech. dissertation.
(b) Those students who clear DSP shall only be allowed to submit the dissertation report for end semester examination

(v) **Dissertation Report:**

After clearing DSP, student shall be required to submit two bound copies of dissertation report, one for the department and other for the Dissertation Supervisor. The Dissertation report shall be evaluated by the DPGRC and external examination shall be conducted on a pre-notified date.

Course Learning Outcomes (COs):
On completion of this course, students will be able to…

CO1: apply knowledge to practice to design & conduct experiments and utilize modern tools for developing working models / process / system leading to innovation and entrepreneurship
CO2: design the hardware/software to demonstrate the principle of working to correlate the analytical simulation and experimental results
CO3: create informative PPT and demonstrate communication skills through effective oral presentation showing knowledge on the subject and sensitivity towards social impact of the Dissertation
CO4: write a "Dissertation paper" in scientific journal style and format from the prepared Dissertation report and create a video pitch on Dissertation

Course Articulation Matrix (CAM): P20DS401 DISSERTATION PHASE-II

CO		PO1	PO2	PO3	PSO1	PSO2
CO1	**P20DS401.1**	2	-	2	2	2
CO2	**P20DS401.2**	2	-	2	2	2
CO3	**P20DS401.3**	-	2	-	1	1
CO4	**P20DS401.4**	-	2	-	1	1
P20DS401		**2**	**2**	**2**	**1.5**	**1.5**