GSFC UNIVERSITY
EDUCATION RE-ENVISIONED

COURSE CURRICULUM

M.Tech. CSE

M.Tech.:2024-2025
Academic Year: 2024-25
Updated on: March, 2024

GSFC University
School of Technology, Vigyan Bhavan, P. O. Fertilizernagar, Vadodara - 391750, Gujarat, India

VISION

- GSFCU strives to be the best compact boutique institution with a futuristic approach, encouraging student centric culture and sharpened focus on developing industry ready & employable students with all-round development.

MISSION

- Establish an institution, which promotes creativity and innovation.
- Develop unique quality standards for academic excellence and pedagogical innovations.
- Remain agile through learning ecosystem with flexible processes & systems.
- Holistic growth for industry readiness.

No.	Programme Outcomes (POs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PO1	Prepare students to pursue a career in Research and Development and Academics as a Computer Science professional.	Cognitive domain	Apply
PO2	Enhance technological competence to withstand the challenges in the volatile IT industry by developing expertise in the contemporary software engineering principles and paradigms.	Cognitive domain	Evaluate
PO3	Provide students a deep insight on various cutting-edge technologies & tools to create diverse career opportunities.	Cognitive domain	Create
PO4	Provide students with engineering project management skills, catering to the changing industry needs and constraints across the advancing domains of computing.	Cognitive domain	Create
PO5	Making students industry ready to solve real world challenges related to the computer science domain.	Cognitive domain	Create
PO6	To prepare students for careers in academia, research and development, and industry, including positions in technology companies, government agencies, and other organizations.	Cognitive domain	Create

No.	Programme Specific Outcomes (PSOs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PSO1	Equip students with the necessary knowledge and skills to excel in Research and Development (R&D) roles, academia, and professional careers within the field of Computer Science	Cognitive domain	Remember Evaluate Create
PSO2	Prepare students to address real-world challenges in the Computer Science domain, equipping them with the practical skills and industry readiness necessary to devise innovative solutions	Cognitive domain	Evaluate Analyze
PSO3	Cultivate a strong technological proficiency among students, enabling them to effectively navigate the dynamic IT industry landscape through mastery of contemporary software engineering principles and paradigms.	Cognitive domain	Apply Create

Mapping of POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	2	3	1	1	2	3
PSO2	2	2	3	1	3	1
PSO3	3	2	3	1	2	1
Avg.	2	2	2	1	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Definition of Credit:

1 Hour. Lecture (L) per week	1 credit
4 Hours Practical (P) per week	2 credits
2 Hours Practical (P) per week	1 credit
1 Hour Practical (P) per week	0.5 credit

Course code Definitions:

Lecture	L
Tutorial	T
Practical	P
Professional Subjects-Core (PC)	PC
Pool of Electives	PE
Value Added Courses	VAC
Open Subjects- Electives (OE)	OE
Project Work, Seminar and/or Internship in Industry or elsewhere.	IP

Structure of Postgraduate Programme:

Sr. No	Category	Course Category Title	Total Course Courses
1	PC	Professional Subjects-Core (PC)	3
2	PE	Pool of Electives	5
3	VAC	Value Added Courses	1
4	OE	Open Subjects- Electives (OE)	1
5	IP	Project Work, Seminar and/or Internship in Industry or elsewhere.	3
Total			13

Category-wise Courses:

PC Professional Subjects-Core (PC)

i. Number of Professional Subject Core: 3
ii. Credits: 12

Sr. No.	Course Code	Course Name	Sem	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MTCS101	PC for DS & AIML/IoT & Automation- Mathematics and Statistical Foundations	I	3	0	0	3	3	0	0	3

2	MTCS102	PC for DS & AIML/IoT & Automation- Advanced Data Structure and Algorithm	I	3	4	0	7	3	2	0	5
3	MTCS202	PC for DS & AIML/IoT & Automation- Computer Vision	II	3	2	0	5	3	2	0	4
		Total		9	6	0	**15**	9	0	0	**11**

Note:
L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

PE

i. Number of PE Core: 5
ii. Credits: 20

Sr. No.	Course Code	Course Name	Sem	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MTCS103	Specialization track for DS & AIML- Fundamentals of Artificial Intelligence and Machine learning	I	3	2	0	5	3	2	0	4
2	MTCS104	Specialization track for DS & AIML- Data Science for Engineers	I	3	2	0	5	3	2	0	4

3	MTCS106	Specialized Track For IoT & Automation- IoT Architecture, Process and Platforms	I	3	2	0	5	3	2	0	4
4	MTCS107	Specialized Track For IoT & Automation- Introduction to Machine Learning	I	3	2	0	5	3	2	0	4
5	MTCS203	Specialization track for DS & AIML- Big Data Analytics	II	3	2	0	5	3	2	0	4
6	MTCS204	Specialization track for DS & AIML- Deep Neural Network and its Applications	II	3	2	0	5	3	2	0	4
7	MTCS206	Specialized Track For IoT & Automation- Robotics and Process Automation	II	3	2	0	5	3	2	0	4
8	MTCS207	Specialized Track For IoT & Automation- Data Analytics for IoT	II	3	2	0	5	3	2	0	4
9	MTCS205	Specialized Track For DS & AIML/IoT & Automation Elective -I	II	3	2	0	5	3	2	0	4
		Total		15	10	0	**25**	15	10	0	**20**

OE

i. Number of PE Core: 1
ii. Credits: 2

Sr. No.	Course Code	Course Name	Sem	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MTCS201	Open elective for DS & AIML/IoT & Automation-NPTEL	II	2	0	0	2	2	0	0	2

		Course									
		Total		2	0	0	**2**	2	0	0	**2**

VAC

i. Number of PE Core: 1
ii. Credits: 2

Sr. No.	Course Code	Course Name	Sem	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MTCS105	VAC for DS & AIML/IoT & Automation-Research Methodology and Intellectual Property	I	2	0	0	2	2	0	0	2
		Total		2	0	0	**2**	2	0	0	**2**

IP

i. Number of PE Core: 3
ii. Credits: 32

Sr. No.	Course Code	Course Name	Sem	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MTCS301	IP for DS & AIML/IoT & Automation-Seminar	III	0	12	0	12	0	12	0	6
2	MTCS302	IP for DS & AIML/IoT & Automation-Dissertation-I/Industry Project	III	0	20	0	20	0	20	0	10
3	MTCS401	IP for DS & AIML/IoT & Automation-Dissertation-II/ Industry Project	IV	0	32	0	32	0	32	0	16

		Total		0	64	0	**64**	0	64	0	**32**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

About the Program:

GSFC University is committed to enhancing cutting-edge skills through its M.Tech. CSE program. Central to this commitment is strong industrial support, providing M.Tech. students with hands-on training alongside their classroom learning. This approach empowers them for diverse career opportunities.

The M.Tech. Computer Science Engineering program at GSFC University combines core fundamental knowledge with practical experience and exposure to entrepreneurship and research. The holistic development of M.Tech. students is prioritized through co-curricular and extra-curricular activities organized by various student-managed clubs and chapters. Continuous grooming of M.Tech. students includes developing soft skills, preparing for placements and competitive exams, and offering special sessions through foundation and bridge courses.

Recognizing the rapidly evolving field of Computer Science & Engineering, the M.Tech. program ensures that students are well-versed in both fundamental and emerging technologies. To impart cutting-edge knowledge, the M.Tech. program offers three specialized tracks:

1. Data Science, Artificial Intelligence, and Machine Learning
2. IoT and Automation

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Teaching Scheme

Semester 1

Course Category	Course Code	Course Title	L	T	P	C
PC	MTCS101	Mathematics and Statistical Foundations	3	0	0	3
PC	MTCS102	Advanced Data Structure and Algorithm	3	0	4	5
PE	MTCS103	Fundamentals of Artificial Intelligence and Machine learning	3	0	2	4
PE	MTCS104	Data Science for Engineers	3	0	2	4
VAC	MTCS105	Research Methodology and Intellectual Property	2	0	0	2
TOTAL			**14**	**0**	**8**	**18**
			22			

Semester 2

Course Category	Course Code	Course Title	L	T	P	C
OE	MTCS201	NPTEL Course	2	0	0	2
PC	MTCS202	Computer Vision	3	0	2	4
PE	MTCS203	Big Data Analytics	3	0	2	4
PE	MTCS204	Deep Neural Network and its Applications	3	0	2	4
PE	MTCS205	Elective -I	3	0	2	4
TOTAL			**14**	**0**	**8**	**18**
			22			

Semester 3

Course Category	Course Code	Course Title	L	T	P	C
IP	MTCS301	Seminar	0	0	12	6
IP	MTCS302	Dissertation-I/Industry Project	0	0	20	10
TOTAL			**0**	**0**	**32**	**16**
			32			

Semester 4

Course Category	Course Code	Course Title	L	T	P	C
IP	MTCS401	Dissertation-II/ Industry Project	0	0	32	16
TOTAL			**0**	**0**	**32**	**16**
			32			

Course Code	Professional Elective-Elective I
MTCS205A	Enterprise Resource Management
MTCS205B	Architecture of High Performance Computers
MTCS205C	Data Analytics for IoT
MTCS205D	Service Oriented Computing
MTCS205E	Block chain technology

Sr. No	Category	Course Category Title	Total Course Courses	Total Credits
1	PC	Professional Subjects-Core (PC)	7	12
2	PE	Pool of Electives	1	20
3	VAC	Value Added Courses	1	2
4	OE	Open Subjects-Electives (OE)	1	2
5	IP	Project Work, Seminar and/or Internship in Industry or elsewhere.	3	32
		Total	**13**	**68**

M. Tech. (Computer Science & Engineering-Specialized Track: Data Science, Artificial Intelligence & Machine Learning)

Semester I

Syllabus, Course objective and Course outcomes:-

MTCS101	**Mathematics and Statistics Foundations**	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:150**			
1	**Course Pre-requisites: Knowledge in mathematics and statistics**				
2	**Course Category: Professional Subjects-Core (PC)**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1TTo introduce the concept of linear system of equations, stochastic process, neural network, non- linear and combinational optimization.				
	4.2 Provide an understanding statistical concepts				
	4.3 Understand the matrix and vectors				
	4.4 computations for implementing various numerical linear algebra algorithms				
	4.5 Learn about the Recurrence Relation				

Course Content	**Weightage**	**Contact hours**	**Pedagogy**
Unit 1: Statistical Techniques Probability Models and Sampling Techniques, Square and distributions, Basic concepts of random sampling, sampling from normal distribution, properties of sample mean and sample variance. Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, the problem of overfitting model assessment. Random samples, sampling distributions.	20%	9	Chalk-Duster, PPT, notes
Unit 2: Optimization and linear Algebra Linear Programming Problem: Linear combination of vectors, Convex set,Convex hull, Linear programming problem, feasible solution, basic feasible solution, graphical solution, Simplex method, Charnes M method.	20%	9	Chalk-Duster, PPT, notes
Unit3: Matrix Algebra:Matrix operations ,Matrix Analysis Rank of Matrix,Eigenvalues, Eigenvectors and Diagonalizable matrices, Vector Norms, Matrix Norms. scalar multiplication,matrix	20%	9	Chalk-Duster, PPT,notes

multiplication, properties, inverse, rank, system of linear equations, linear transformation, Eigen values and Eigen vectors, positive definite matrix, Principle component analysis, Singular value decomposition. Vector Space: Definition, scalars, addition, scalar multiplication, inner product (dot product), vector projection, cosine similarity, orthogonal vectors, normal and orthonormal vectors, vector norm, vector space			
Unit 4: Stochastic Processes Definition and classification of general stochastic processes; Markov Chains: definition, transition probability matrices, classification of states, limiting properties; Poisson process, Birth and death processes, exponential queuing model.	20%	9	Chalk-Duster, PPT,notes
Unit 5: Recurrence Relations: Generating Functions, Function of Sequences, Partial Fractions, Calculating Coefficient of Generating Functions, Recurrence Relations, Formulation as Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, Method of Characteristic Roots, Solving Inhomogeneous Recurrence Relations	20%	9	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. Casella, G. and Berger, R. (2002), Statistical Inference, Cengage Learning. 2. Ross, S.M. (1996), Stochastic Processes, Wiley. 3. Erwin Kreyszig: Advance Engineering Mathematics, John Wiling & Sons, 8thEdition. 4. S. S. Sastry: Engineering Mathematics, VolII, 2n
2.	Reference Books: 1. 1.M. Mitzenmacher and E. Upfal, “Probability and Computing: Randomized Algorithms and Probabilistic Analysis”,

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Evaluation Scheme		**Total Marks**
Mid semester Marks	30	
End Semester Marks	50	
Practical Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1.Solve the system of linear equations and linear transformations.
	2.Implement the correct techniques to solve the nonlinear and combinational optimization Problems..
	3. Understand the concepts of matrix analysis and about vectors.
	4.Understand the concepts of stochastic theory and its application.
	5. Implement the Recurrence Relation

MTCS102	**Advanced Data Structure and Algorithm**	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:150**			
1	**Course Pre-requisites: Knowledge in Algorithm**				
2	**Course Category: Professional Subjects-Core (PC)**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1The fundamental design, analysis, and implementation of basic data structures.				
	4.2 Principles for good program design, especially the uses of data abstraction				
	4.3 Significance of algorithms in the computer field and Various aspects of algorithm development				
	4.4 Learn about Pattern Recognization				
	4.5 Understand the advanced Algorithm				

Course Content	**Weightage**	**Contact hours**	**Pedagogy**
Unit 1: Fundamental and Concept of Advanced Algorithm	20%	9	Chalk-Duster, PPT,notes

Algorithms, Performance analysis-time complexity and space complexity, Asymptotic Notation-Big Oh, Omega and Theta notations, Complexity Analysis Examples. Data structures-Linear and non linear data structures, ADT concept, Linear List ADT, Array representation, Linked representation, Vector representation, singly linked lists - insertion, deletion, search operations, doubly linked lists-insertion, deletion operations, circular lists. Representation of single, two dimensional arrays, Sparse matrices and their representation.			
Unit 2:Advanced abstract data type and data structures Stack and Queue ADTs, array and linked list representations, infix to postfix conversion using stack, implementation of recursion, Circular queue-insertion and deletion, Dequeue ADT, array and linked list representations, Priority queue ADT, implementation using Heaps, Insertion into a Max Heap, Deletion from a Max Heap, Binary search tree-Binary search tree ADT, insertion, deletion and searching operations, Balanced search trees.	20%	9	Chalk-Duster, PPT,notes
Unit3:Advanced Methodology in Binary Search Searching–Linear and binary search methods, Hashing-Hash functions, Collision Resolution methods-Open Addressing, Chaining, Hashing in java.util-HashMap, HashSet, Hashtable. Sorting –Bubble sort, Insertion sort, Quick sort, Merge sort, Heap sort, Radix sort, comparison of sorting methods. representations,	20%	9	Chalk-Duster, PPT,notes
Unit4:Advanced in Algorithm Recursive and non recursive traversals, Java code for traversals, Threaded binary trees.Graphs-Graphs terminology, Graph ADT, representations, graph traversals/search methods-dfs and bfs, Java code for graph traversals,	20%	9	Chalk-Duster, PPT,notes

Applications of Graphs-Minimum cost spanning tree using Kruskal's algorithm, Dijkstra's algorithm for Single Source Shortest Path Problem.			
Unit5 : Pattern Recognization Insertion, deletion and searching operations, Balanced search trees, AVL trees-Definition and examples only, Red Black trees – Definition and examples only, B-Trees-definition, insertion and searching operations, Trees in java.util- TreeSet, Tree Map Classes, Tries(examples only),Comparison of Search trees. Text compression-Huffman coding and decoding, Pattern matching-KMP algorithm.	20%	9	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. S. Sahni, "Data structures, Algorithms and Applications in Java", Universities Press. 2. Adam Drozdek, "Data structures and Algorithms in Java", 3rd edition, Cengage Learning.
2.	Reference Books: 1. R.Lafore "Data structures and Algorithms in Java", Pearson education. 2. J.P.Tremblay and G.A.Cheston "Data structures and Software Development in an Object.

Evaluation Scheme		**Total Marks**
Mid semester Marks	30	
End Semester Marks	50	
Practical Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks

	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1.Basic ability to analyze algorithms and to determine algorithm correctness and time efficiency class.
	2.Master a variety of advanced abstract data type (ADT) and data structures and their implementations.
	3. Ability to apply and implement learned algorithm design techniques and data structures to solve problems.
	4. Develop the Pattern Recognization
	5. Implement the Algorithm

MTCS103	**Fundamentals of Artificial Intelligence and Machine learning**	**L**	**T**	**P**	**C**	
		3	0	2	4	
Total Credits: 4	**Total Hours in semester: 45**	**Total Marks: 150**				
1	**Course Prerequisites:** None					
2	**Course Category:** Programme core					
3	**Course Revision/ Approval Date:**					
4	**Course Objectives:**					
4.1 Cover various paradigms that come under the broad umbrella of AI						
4.2 Provide motivation and understanding of the need and importance of Machine Learning in today's world						
4.3 Provide details about various algorithms in Machine Learning						

LECTURE WITH BREAKUP	**Weightage**	**Contact hours**	**Pedagogy**
Unit 1-Introduction to Artificial Intelligence Introduction to AI: Introductory session(1 lecture) Search: state space search, Uninformed strategies (BFS, DFS, Dijkstra), Informed strategies (A* search, heuristic functions, hill-climbing), Adversarial search (Minimax algorithm, Alpha-beta pruning) (10 lectures) Predicate logic: Knowledge representation, Resolution (6 lectures)	40%	17	Chalk duster, PPT,notes
Unit 2-Introduction to Machine Learning-I(Supervised learning) Introduction: Motivation, Different types of learning, Linear regression, Logistic regression (2 lectures) Gradient Descent: Introduction, Stochastic Gradient Descent, Subgradients, Stochastic Gradient Descent for risk minimization (2 lectures) Support Vector Machines: Hard SVM, Soft SVM, Optimality conditions, Duality, Kernel trick, Implementing Soft SVM with Kernels (4 lectures) Decision Trees: Decision Tree algorithms, Random forests (2 lectures)	30%	14	Chalk duster, PPT,notes

Neural Networks: Feedforward neural networks, Expressive power of neural networks, SGD and Backpropagation (3 lectures) Model selection and validation: Validation for model selection, k-fold cross-validation, TrainingValidation-Testing split, Regularized loss minimization (1 lecture)			
Unit 3-Introduction to Machine Learning-I(Unsupervised learning) Unsupervised Learning and Generative Models :Nearest Neighbour: k-nearest neighbour, Curse of dimensionality (1 lecture) Clustering: Linkage-based clustering algorithms, k-means algorithm, Spectral clustering (3 lectures) Dimensionality reduction: Principal Component Analysis, Random projections, Compressed sensing (2 lectures) Generative Models: Maximum likelihood estimator, Naive Bayes, Linear Discriminant Analysis, Latent variables and Expectation-maximization algorithm, Bayesian learning (5 lectures) Feature Selection and Generation: Feature selection, Feature transformations, Feature learning (3 lectures)	30%	14	Chalk duster, PPT,notes

Learning Resources	
1 .	Textbooks: 1. Stuart Russell and Peter Norvig (1995), Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003. 2. Shai shalev-shwartz, Shai Ben-David: Understanding Machine Learning from Theory to algorithms, Cambridge University Press, ISBN-978-1-107-51282-5, 2014.
2	Reference Books: 1. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH 2. http://nptel.ac.in
3	Journals & Periodicals:
4	Other Electronic Resources:

Evaluation Scheme	**Total Marks 150**
Mid semester Marks	30
End Semester Marks	50
Practical Marks	50

Continuous Evaluation Marks	<table><tr><td>Attendance</td><td>5 marks</td></tr><tr><td>Quiz</td><td>5 marks</td></tr><tr><td>Skill enhancement activities / case study</td><td>5 marks</td></tr><tr><td>Presentation/ miscellaneous activities</td><td>5 marks</td></tr></table>
Course Outcomes	1. Develop an understanding of where and how AI can be used.
	2. Develop a sense of Machine Learning in the modern context, and independently work on problems relating to Machine Learning.
	3. Design and program efficient algorithms related to Machine Learning, train models, conduct experiments, and deliver ML-based applications.

MTCS104	**Data Science for Engineers**	**L**	**T**	**P**	**C**
		3	0	0	3
Total Credits:3	**Total Hours in semester :45**	**Total Marks:100**			

1	**Course Prerequisites:** Programming: Python
2	**Course Category:** Programme core
3	**Course Revision/ Approval Date:**
4	**Course Objectives :**
4.1 To help students learn, understand, and practice basic of python and data structure	
4.2 To aware students about various data preprocessing techniques	
4.3 To give overview of visualization techniques	
4.4 To brief students data warnling methodologies,	
4.5 To provide knowledge about statistical analysis .	

LECTURE WITH BREAKUP	**Weightage**	**Contact hours**	**Pedagogy**
Unit 1-Overview of Python and Data Structures Basics of Python including data types, variables, expressions, objects and functions. Python data structures including String, Array, List, Tuple, Set, Dictionary and operations them. Discovering the match between data science and python: Considering the emergence of data science, Outlining the core competencies of a data scientist, Linking data science, big data, and AI , Understanding the role of programming, Creating the Data Science Pipeline, Preparing the data, Performing exploratory data analysis, Learning from data, Visualizing, Obtaining insights and data products Understanding Python's Role in Data Science: Introducing Python's Capabilities and	20%	5	Chalk duster, PPT,notes

Wonders: Why Python?, Grasping Python's Coxre Philosophy, Contributing to data science, Discovering present and future development goals, Working with Python, Getting a taste of the language, Understanding the need for indentation, Working at the command line or in the IDE			
Unit 2- Preprocessing Using the Jupyter Console, Interacting with screen text, Changing the window appearance, Getting Python help, Getting IPython help, Using magic functions, Discovering objects, Using Jupyter Notebook, Working with styles, Restarting the kernel, Restoring a checkpoint, Performing Multimedia and Graphic Integration, Embedding plots and other images, Loading examples from online sites, Obtaining online graphics and multimedia.Removing NAs/No Values , Basic Data Handling: Starting with Conditional Data Selection, Drop Column/Row, Subset and Index Data, Basic Data Grouping Based on Qualitative Attributes, Cross Tabulation, Reshaping, Pivoting, Rank and Sort Data, Concatenate, Merging and Joining Data Frames	20%	10	Chalk duster, PPT,notes
Unit 3-Data Visualization Visualizing Information: Starting with a Graph, Defining the plot, Drawing multiple lines and plots, Saving your work to disk, Setting the Axis, Ticks, Grids, Getting the axes, Formatting the axes, Adding grids, Defining the Line Appearance, Working with line style, Using colors, Adding markers, Using Labels, Annotations, and Legends, Adding labels, Annotating the chart, Creating a legend. Visualizing the Data: Choosing the Right Graph, Showing parts of a whole with pie charts, Creating comparisons with bar charts, Showing distributions using histograms, Depicting groups using boxplots, Seeing data patterns using scatterplots, Creating Advanced Scatterplots, Depicting groups, Showing correlations, Plotting Time Series, Representing time on axes, Plotting trends over time, Plotting Geographical Data, Using an environment in Notebook, Getting the Basemap toolkit, Dealing with deprecated library issues, Using Basemap to plot geographic data, Visualizing Graphs, Developing undirected graphs, Developing directed graphs.	20%	10	Chalk duster, PPT,notes
Unit 4- Data Wrangling Wrangling Data: Playing with Scikit-learn, Understanding classes in Scikit-learn, Defining applications for data science, Performing the Hashing Trick, Using hash functions, Demonstrating the hashing trick, Working with deterministic	20%	10	Chalk duster, PPT,notes

selection, Considering Timing and Performance, Benchmarking, with,timeit, Working with the memory profiler, Running in Parallel on Multiple Cores, Performing multicore parallelism, Demonstrating multiprocessing. Exploring Data Analysis: The EDA Approach, Defining Descriptive Statistics for Numeric Data, Measuring central tendency,Measuring variance and range ,Working with percentiles, Defining measures of normality, Counting for Categorical Data, Understanding frequencies, Creating contingency tables, Creating Applied Visualization for EDA ,Inspecting boxplots			
Unit 5- Statistical Analysis Important statistical concepts used in data science, Difference between population and sample, Types of variables, Measures of central tendency, Measures of variability, Coefficient of variance, Skewness and Kurtosis, Normal distribution, Test hypotheses, Central limit theorem, Confidence interval, T-test, Type I and II errors, Student's T distribution, Regression, ANOVA,R square, Correlation and causation	20%	10	Chalk duster, PPT,notes

Learning Resources	
1.	**Textbooks:** 1. Field Cady, 'The Data Science Handbook ', Wiley Publication ISBN-13: 978-1119092940 2. Jake VanderPlas, 'Python Data Science Handbook ESSENTIAL TOOLS FOR WORKING WITH DATA', O'REILLY ISBN:978-1-491-91205-8 3. Rachel Schutt and Cathy O'Neil, Doing Data Science, O'REILLY
2.	**Reference Books:** 1. Wes McKinney,Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition , O'REILLY 2. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012 3. John W. Foreman (Author), Data Smart: Using Data Science to Transform Information into Insight, WILEY 4. John Paul Mueller, Luca Massaron, Python for Data Science For Dummies , WILEY

Evaluation Scheme	**Total Marks:100**
Mid semester Marks	30
End Semester Marks	50

M. Tech. (Computer Science & Engineering-Specialized Track: Data Science, Artificial Intelligence & Machine Learning)

Continuous Evaluation Marks	Attendance	5
	Quiz	5
	Skill enhancement activities / case study	5
	Presentation/ miscellaneous activities	5

Course Outcomes	4.1 Able to understand and manipulate basic of python and data structure
	4.2 Able to implement various data preprocessing techniques
	4.3 Able to visualize the real time data
	4.4 Able to warnl the data.
	4.5 Able to do statistical analysis .

MTCS105	**Research Methodology and Intellectual Property**	L	T	P	C
		2	0	0	2
Total Credits:	**Total Hours in Semester:30**	**Total Marks:100**			

1	**Course Prerequisites:None**
2	**Course Category: Value Added Course**
3	**Course Revision/ Approval date**
4	**Course Objectives**
	4.1To give an overview of the research methodology and explain the technique of defining a research problem
	4.2 To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
	4.3 Understand the law of patent and copyrights.
	4.4 To explain various forms of the intellectual property, its relevance in innovation.

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Research Methodology Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. Defining the Research Problem: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation	20%	6	Chalk-Duster, PPT,notes
Unit 2:Literature Review and	20%	6	Chalk-Duster,

Research Ethics Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Plagiarism, Tools for plagiarism checking ,Research ethics			PPT,notes
Unit 3:Patenting Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents Patent Cooperation Treaty (PCT).	20%	6	Chalk-Duster, PPT,notes
Unit 4:Patent Rights 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.	20%	6	Chalk-Duster, PPT,notes
Unit 5:Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test ofDifference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.	20%	6	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International 4th Edition, 2018 2. Research Methodology a step-by step guide for beginners. Ranjit Kumar SAGE Publications Ltd
2.	Reference books 1. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications,2019 2. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme		**Total Marks**
Mid semester Marks	30	
End Semester Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks
Course Outcomes	1.Understand the research problem and research process and research ethics.	
	2.Explore on various IPR components and process of filing.	
	3. Prepare a well-structured research paper and scientific presentations.	
	4.Understand the adequate knowledge on patent and rights	
	5. Understand the formation of hypotheses.	

MTCS106	**IoT Architecture, Process and Platforms**	L	T	P	C
		3	0	2	4
Total Credits: 5	**Total Hours in Semester: 45**	**Total Marks:150**			
1	**Course Pre-requisites:** None				
2	**Course Category:** Professional Subjects-Core				
3	**Course Revision/ Approval date:**				
4	**Course Objectives**				
	4.1 Cover various paradigms that come under the broad umbrella of IoT				

	4.2 Provide motivation and understanding of the need and importance of IoT in today's world
	4.3 Provide details about various protocols and processes in IoT.

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: **Internet of Things:** Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart ObjectsAn Overview, Internet of Things, IoT conceptual framework, IoT architectural view, Technology behind IoT, Sources of IoT, M2M communication, Examples of IoT.	20%	09	Chalk- Duster, PPT, Notes
Unit 2:IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints-Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.	20%	09	Chalk- Duster, PPT, Notes
Unit 3: **IoT Protocols:** Web communication protocols for connected devices, Message communication protocols for connected devices, web connectivity for connected-devices network using gateway, Internet connectivity principles, IP addressing in IoT, Proxy authentication, Media Access control, Application Layer Protocols.	20%	09	Chalk- Duster, PPT, Notes

Unit 4: **IoT Platform overview:** Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Overview of IoT supported Hardware platforms such as: Raspberry pi, Arduino Board detail.	20%	09	Chalk- Duster, PPT, Notes
Unit 5: **IoT Protocols:** Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP. SCADA, WebSocket; IP-based protocols: 6LoWPAN, RPL; Authentication Protocols; IEEE 802.15.4.	20%	09	Chalk- Duster, PPT, Notes

Learning Resources	
1.	Textbook: 1. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 2. "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence",Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014. .
2.	Reference books: 1. Architecting the Internet of Things,Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer,2011. 2. Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition,Michael Margolis,Arduino Cookbook and O"Reilly Media,2011.
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme		**Total Marks:100**
Mid semester Marks	30	
End Semester Marks	50	
Practical Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks

	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1.Understand the basics of IoT.
	2.Implement the state of the Architecture of an IoT.
	3.Understand design methodology and hardware platforms involved in IoT.
	4.Understand how to analyze and organize the data.
	5.Design IoT-based systems for real-world problems.

MTCS107	**Introduction to Machine learning**	L	T	P	C
		3	0	0	3
Total Credits: 3	**Total Hours in Semester: 45**	**Total Marks:100**			

1	**Course Pre-requisites:** None
2	**Course Category:** Professional Subjects-Core
3	**Course Revision/ Approval date:**
4	**Course Objectives**
	4.1 Cover various paradigms that come under the broad umbrella of ML
	4.2 Provide motivation and understanding of the need and importance of Machine Learning in today's world
	4.3 Provide details about various algorithms in Machine Learning

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: **Introduction to Machine Learning:** Overview of Human Learning and Machine Learning, Types of Machine Learning, Applications of Machine Learning , Tools and Technology for Machine Learning, Machine Learning activities, Types of data in Machine Learning, Structures of data, Data quality and remediation, Data Pre-Processing: Dimensionality reduction, Feature subset selection	20%	09	Chalk- Duster, PPT, Notes
Unit 2: **Modelling and Evaluation:** Predictive/Descriptive, Training a Model for supervised learning, model representation and interpretability, Evaluating performance of a model, Improving performance of a mode, Feature and Feature Engineering, Feature transformation: Construction and extraction, Feature subset selection : Issues in high-dimensional data, key drivers, measure and overall process.	20%	09	Chalk- Duster, PPT, Notes

Unit 3: **Overview of Probability:** Statistical tools in Machine Learning, Concepts of probability, Random variables, Discrete distributions, Continuous distributions, Multiple random variables, Central limit,theorem, Sampling distributions, Hypothesis testing, Monte Carlo Approximation, Impotence of Bayesian methods, Bayesian theorem, Bayes' theorem and concept learning, Bayesian Belief Network.	20%	09	Chalk- Duster, PPT, Notes
Unit 4: **Supervised Learning:** Supervised Learning, Classification Model, Learning steps, Classification algorithms, Regression, Regression algorithms.	20%	09	Chalk- Duster, PPT, Notes
Unit 5: **Unsupervised Learning & Neural Network:** Supervised vs. Unsupervised Learning, Applications, Clustering, Association rules Introduction to neural network, Biological and Artificial Neurons, Types of Activation functions, Implementation of ANN, Architecture, Leaning process, Backpropagation, Deep learning.	20%	09	Chalk- Duster, PPT, Notes

Learning Resources	
1.	Textbook: 1. Mohri Mehryar, Afshin Rostamizadeh, and Ameet Talwalkar. "Foundations of machine learning", MIT press 2. Shai shalev-shwartz, Shai Ben-David: Understanding Machine Learning.
2.	Reference books: 1. Machine Learning, Saikat Dull, S. Chjandramouli, Das, Pearson
3.	Journal
4.	Periodicals
5.	Other Electronic resources

Evaluation Scheme	**Total Marks:100**
Mid semester Marks	30
End Semester Marks	50

Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1.Explore the fundamental issues and challenges in Machine Learning including data and model selection and complexity
	2.Appreciate the underlying mathematical relationships within and across Machine Learning algorithms
	3.Evaluate the various Supervised Learning algorithms using appropriate Dataset
	4.Evaluate the various unsupervised Learning algorithms using appropriate Dataset
	5.Design and implement various machine learning algorithms in a range of real-world applications.

Semester II

Syllabus, course objective and course outcomes :-

		L	T	P	C

MTCS202	**Computer Vision**	3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:100**			

1	**Course Pre-requisites: Basic understanding of fundamental concepts related to multidimensional signal processing, feature extraction, pattern analysis, visual geometric modelling, etc**
2	**Course Category: Professional Subjects-Core (PC)**
3	**Course Revision/ Approval date**
4	**Course Objectives**
	4.1 The computer vision focuses on development of algorithms and techniques to analyze and interpret the visible world around us.
	4.2 Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision
	4.3 Applications range from biometrics, medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Digital Image Formation and low-level processing Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.	15%	7	Chalk-Duster, PPT,notes
Unit 2:Depth estimation and Multi-camera views Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.	15%	7	Chalk-Duster, PPT,notes
Unit3: Feature Extraction Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	20%	8	
Unit 4: Image Segmentation Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.	15%	6	Chalk-Duster, PPT,notes
Unit 5:Pattern & Motion Analysis	20%	10	Chalk-Duster,

Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods. Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.			PPT,notes
Unit 6: Shape from X Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.	15%	7	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011. 2. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2ndEdition, Cambridge University Press, March 2004
2.	Reference Books: 1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Evaluation Scheme		Total Marks
Mid semester Marks	30	
End Semester Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1. To apply mathematical modeling methods for low-, intermediate- and high- level image processing tasks
	2. To be able to design new algorithms to solve recent state of the art computer vision problems.
	3. To perform software experiments on computer vision problems and compare their performance with the state of the art.
	4. To develop a broad knowledge base so as to easily relate to the existing literature.
	5. To gather a basic understanding about the geometric relationships between 2D images and the 3D world
	6. To build a complete system to solve a computer vision problem.

MTCS203	Big Data Analytics	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:100**			
1	**Course Pre-requisites: Understanding the basics of data mining algorithms & concept of big data & cloud computing**				
2	**Course Category: Professional Subjects-Core (PC)**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 The objective is to provide prerequisites related to data mining algorithms				
	4.2 The purpose of the course is to highlight concepts of big data and cloud computing				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Fundamental of Big Data Analytics Big Data Overview, 3Vs of Data - Volume, Velocity, Variety, Big Data Challenges, Application Areas ,Application Tools and Platforms	15%	8	Chalk-Duster, PPT,notes
Unit 2:Building Blocks of Big Data Designing and building big data applications , Big data architecture, Distributed Computing platforms, Security and Data Privacy, Multi-core scalability, Parallel and Distributed Processing	15%	8	Chalk-Duster, PPT,notes
Unit3:Distributed Processing & Data Storage Analytics Using MapReduce, MapReduce design patterns, Clustered Hadoop environment, Advanced HDFS, Graph Algorithms, Searching and Indexing approaches, MapReduce Applications, Introduction to Pig and HIVE- Programming Pig: Engine for executing data flows in parallel on Hadoop, Programming with Hive: Data warehouse system for Hadoop	25%	10	Chalk-Duster, PPT,notes
Unit 4:Big Data Analytics Components Analytical models and approaches, Relational and non relational Databases, Application areas, Design and analysis of Analytics model-Analytics design steps, Understanding different data processing models, Statistical models, Predictive models, Descriptive models,	25%	10	Chalk-Duster, PPT,notes

Introduction to Data analysis using R-Basics of R Language, Statistical models in R, Statistical techniques applied using R, Graphical analysis techniques			
Unit 5 :Big Data Applications and Case Study Real time stream processing using MapReduce and R and Text Analytics based on different documents for identifying interesting patterns and correlations Big Data in Scientific applications, Big data in Healthcare	20%	9	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. Big Data Application Architecture Q & A: A Problem-Solution Approach, Nitin Sawant and Himanshu Shah Apress 2013 ISBN:9781430262923 2. Big Data Management, Technologies, and Applications , Wen-Chen Hu and Naima Kaabouch (eds) IGI Global ,ISBN:9781466646995
2.	Reference Books: 1. Too Big to Ignore: The Business Case for Big Data., Phil Simon, John Wiley & Sons, ISBN:9781118638170 2. Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph David Loshin, Morgan Kaufmann Publishers ,ISBN:9780124173194

Evaluation Scheme		**Total Marks**
Mid semester Marks	30	
End Semester Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks

	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1.Demonstrates the basic operation in big data
	2.Awareness of Architectures use in big data
	3. Study about Big Data processing language Hadoop
	4. Describes about the modern databases
	5.Case studies in big data are analyzed

MTCS204	Deep Neural Network & its Application	L	T	P	C	
		3	0	0	3	
Total Credits: 4	Total Hours in semester: 45	Total Marks: 100				
1	Course Prerequisites: Fundamentals of networking & AI					
2	Course Category: Professional Subjects-Core (PC)					
3	Course Revision/ Approval Date:					
4	Course Objectives:					
4.1 The objective is to cover the fundamentals of neural network						
4.2 T o provide insight about advanced topics such as recurrent neural networks, long short term memory cells and convolutional neural networks						

Course Content	Weightage	Contact hours	Pedagogy
Unit 1-Introduction to Neural Network Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.	20%	9	Chalk duster, PPT,notes
Unit 2-Deep Neural Network & Feed forward Network Difficulty of training deep Neural networks, Greedy layerwise training.Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders.	20%	9	Chalk duster, PPT,notes
Unit 3-Better Training of Neural Networks & Generative models: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization). Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.	25%	10	Chalk duster, PPT,notes
Unit 4-Recurrent & Convolution Neural Network: Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs LeNet, AlexNet.	15%	8	Chalk duster, PPT,notes
Unit 5-Recent Trends & Applications: Variational Autoencoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning, Vision, NLP, Speech (just an overview of different applications in 2-3 lectures)	20%	9	Chalk duster, PPT,notes

Learning Resources

1.	Textbooks: 1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
2	Reference Books: 1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996 2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

Evaluation Scheme	**Total Marks 100**
Mid semester Marks	30
End Semester Marks	50
Continuous Evaluation Marks	Attendance: 5marks Quiz: 5 marks Skill enhancement activities /case study: 5 marks Presentation/ miscellaneousactivities: 5 marks
Course Outcomes	1. Develop an understanding of working of the Neural network . 2.Define the optimization methods for neural network 3.Describe the difficulty of training the deep neural network 4.Demonstrate the recent trends and applications related to neural network 5.Distinguish between the recurrent and convolution neural networks

MTCS205	Enterprise Resource Management	L	T	P	C
		3	0	2	4
Total Credits:3	**Total Hours in semester :45**	**Total Marks:100**			
1	**Course Prerequisites: Basic idea about management information & business modelling**				
2	**Course Category:Elective**				
3	**Course Revision/ Approval Date:**				
4	**Course Objectives :**				
4.1 To give an overview of ERP and related technologies					
4.2 To aware students about various ERP Tools					
4.3 To explain the benefits of ERP					

Course Content	Weightage	Contact hours	Pedagogy
Unit 1-Introduction to ERP & related technologies : Enterprise – An Overview, Integrated Management Information,Business Modeling, Integrated Data Model Business Processing Re engineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM),Customer Relationship Management(CRM), MIS - Management Information System,DSS - Decision Support System, EIS - Executive Information System.	20%	8	Chalk duster, PPT,notes
Unit 2- ERP Manufacturing Prospective & Modules: MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP - Distributed Requirement Planning, PDM - Product Data Management Finance, Plant Maintenance, Quality Management, Materials Management	15%	7	Chalk duster, PPT,notes
Unit 3-E-Business Architecture : Enterprise resource planning the E-business Backbone Enterprise architecture planning, ERP usage in Real world, ERP implementation, Future of ERP applications ,memo to CEO E-Procurement, E-Governance, Developing the E-Business Design	15%	7	Chalk duster, PPT,notes
Unit 4- ERP Implementation Life cycle : Pre-evaluation Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Re engineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post-implementation (Maintenance mode)	15%	8	Chalk duster, PPT,notes

Unit 5- Introduction to ERP tools & Benefits of ERP : JD-Edwards-Enterprise One Microsoft Dynamic CRm-Module Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality Costs, Improved Information Accuracy and Design-making Capability	20%	8	Chalk duster, PPT,notes
Unit 6- ERP Case Studies : E-Commerce to E-business E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications	15%	7	Chalk duster, PPT,notes

Learning Resources	
1.	**Textbooks:** 1. Enterprise Resource Planning - Alexis Leon, Tata McGraw Hill 2. Enterprise Resource Planning - Ravi Shankar & S. Jaiswal , Galgotia.
2.	**Reference Books:** 1. Enterprise Resource Planning – Diversified by Alexis Leon, TMH.

Evaluation Scheme	**Total Marks:100**
Mid semester Marks	30
End Semester Marks	50
Continuous Evaluation Marks	Attendance: 5 Quiz: 5 Skill enhancement activities / case study: 5 Presentation/ miscellaneousactivities: 5

Course Outcomes	1. Define the tasks and prerequisites of ERP & business models
	2. Discuss the ERP related technologies
	3. Demonstrate various ERP manufacturing perspectives
	4. Comparing the E- business architecture

	5. Evaluating the ERP implementation lifecycle
	6. Creating a case study based on the knowledge gained

MTCS206	Architecture of HPC	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:100**			
1	**Course Prerequisites:Infrastructure management & Virtualization**				
2	**Course Category: Elective**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 To get better understanding about computation and process performance				
	4.2 To focus on computation for achieving high performance				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Introduction to High Performance Computing HPC subsystems- Compute, Storage, Networking, Application Software, Orchestration, HPC tools & tactics, HPC Architecture, Difference from traditional computing architecture, HPC Clusters, Basic HPC Cluster components, HPC cluster design, HPC Storage, HPC advantages and disadvantages, Applications & trends	20%	9	Chalk-Duster, PPT,notes
Unit 2:Application porting, execution and scalability analysis: Compiler flags, vectorization, memory alignment of data, porting of application on Linux Measurement of Application execution time and memory consumption with small, medium and large datasets, Scalability analysis and identification of performance bottlenecks, Profiling of applications to find opportunities for performance optimization, Addition of directives, Restructuring of code for performance optimization, Communication optimization through configuration of MPI calls of the underlying MPI implementation, Partitioning applications for heterogeneous resources, Use of existing libraries, tools, and frameworks	20%	9	Chalk-Duster, PPT,notes

Unit 3: Bioinformatics and Molecular Dynamics: Basics of bio-informatics and Molecular Dynamics, Sequence Search: e.g. MPI-BLAST, Sequence Alignment: e.g. ClustalW-MPI, Sequence Assembly: e.g. ABySS, Molecular Dynamics: e.g. GROMACS , Scientific data visualization and analytics: Integration of simulation, data visualization and analytics on HPC	20%	9	Chalk-Duster, PPT,notes
Unit 4:Bioinformatics and Molecular Dynamics: Basics of bio-informatics and Molecular Dynamics, Sequence Search: e.g. MPI-BLAST, Sequence Alignment: e.g. ClustalW-MPI, Sequence Assembly: e.g. ABySS, Molecular Dynamics: e.g. GROMACS , Scientific data visualization and analytics: Integration of simulation, data visualization and analytics on HPC	20%	9	Chalk-Duster, PPT,notes
Unit 5:Case Studies (Scientific & Engineering Domains) Study and optimization of computational performance of applications Climatology: Basics of computational atmospheric and ocean sciences, Numerical Weather Prediction: e.g. WRF, Oceanography: e.g. MOM, ROMS, Climate: e.g. CFS	20%	9	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. High Performance Computing -Charles R Severance ,bookfusion 2. High Performance computing: Modern systems & practices -Thomas Sterling, Matthew Anderson, Maciet Brodowicz, MK publication
2.	Reference books 1. Introduction to high performance computing for scientists & Engineers- Georg Hager, Gerhard Wellein, CRC Press 2. High Performance Computing- Dr. Pankaj Agarkar, SPPU-TechNeo, Pragati books 3. Decode High Performance Computing- Pranjali Deshpande, Pragati books

Evaluation Scheme		Total Marks
Mid semester Marks	30	
End Semester Marks	50	
Continuous EvaluationMarks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1. Demonstrate the basic structure and operation of a high performance Computing
	2. Discuss in detail the operation of multi-processor instruction
	3. Use the concepts of bio informatics and molecular dynamics
	4. Analyse the complexity an performance of HPC
	5. Work in scientific and engineering domains related to high performance computing

		L	T	P	C
MTCS207	**Data Analytics for IOT**	3	0	2	4

Total Credits:	Total Hours in Semester: 45	Total Marks:100
1	**Course Prerequisites: Basics of Data structure**	
2	**Course Category: Elective**	
3	**Course Revision/ Approval date**	
4	**Course Objectives**	
	4.1 To get better understanding of basic concepts, technologies, and applications of the Internet of Things (IoT), with a focus on data analytics.	
	4.2 To focus on a range of enabling techniques in sensing, computing, analytics, learning for IoT and connects them to exciting applications in smart homes, healthcare, security, etc	

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Introduction to IOT Internet Of Things with its components, characteristics of IOT devices, Role of data analytics in IOT, building IOT, Advantages & disadvantages of IOT, Application Domain	15%	8	Chalk-Duster, PPT,notes
Unit 2:IOT Connectivity : Connectivity solutions, Industrial Connectors, connectivity Operations, Industrial connectivity services as a basis for IOT Integration, Industrial connectivity services in practice, Industry 4.0 implementation.	20%	8	Chalk-Duster, PPT,notes
Unit 3: Location Analytics, Mobile Analytics & Radio Analytics: Main features of location analytics, Use cases, Industry application, Service Orchestration and Routing	15%	7	Chalk-Duster, PPT,notes
Unit 4:IOT Sensing & Learning: Power, Energy, Efficient resource management, and Energy HarvestingNaming and Addressing: Advertising, Searching, and Discovery	20%	8	Chalk-Duster, PPT,notes
Unit 5: Analytics Systems in IOT Semantic technologies: Information and data models for interoperability Miniaturization: Sensors, CPU, and network	20%	8	Chalk-Duster, PPT,notes
Unit 6: Advanced topics & Emerging Technologies Virtualization: Multiple sensors aggregated, or a sensor shared by multiple users Privacy/Security/Trust/Identity/Anonymity Heter ogeneity in IOT	10%	6	Chalk-Duster, PPT,notes

Learning Resources

1.	Textbook: 1. Big Data Analytics for Cloud, IOT and cognitive computing- Kai Hwang & Min Chen, Wiley Publication 2. Internet Of Things and Data Analytics Handbook edited by Hwaiyu Geng, Wiley Publication
2.	Reference books: 1. Data Analytics: 3 Books in 1 - The New Ultimate Bible for Understanding & Using Data Analytics, Big Data + Data Science For Business + Data Mining -John Harper

Evaluation Scheme		**Total Marks**
Mid semester Marks	30	
End Semester Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1. To understand the concepts and applications of IoT, and understand the core problems for building IoT systems
	2. To understand and manage the knowledge of models and principles and compare the performance of key techniques for IoT data analytics.
	3. To identify and implement practical IoT applications with data analytics techniques

MTCS208	**Service Oriented Computing**	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:100**			
1	**Course Prerequisites: Basic knowledge of Web services**				
2	**Course Category: Elective**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 To gain understanding of the web services architectures and motivation for				

	composition
	4.2 To learn service basic concept of SOAP, WSDL and UDDI.
	4.3 To learn advanced concepts such as service composition, orchestration and Choreography
	4.4 To learn about collaboration, Agents, Multi agents system, Agent communication.

Course Content	Weightage	Contact hours	Pedagogy
Unit 1 Introduction: Brief history of information technology, Challenges for composition, Web Services Architectures and Standards. Computing with services, Visions for web, Semantic web, Peer to Peer Computing, Processes and Protocols. Pragmatic web, Open environments, Overview of web services like SOAP, REST, WSDL, UDDI	15%	8	Chalk-Duster, PPT,notes
Unit 2 Enterprise architectures and Service Oriented Computing : Integration versus inter operation, J2EE, .NET, Model Driven Architecture, Legacy systems. Use cases: Intra-enterprise and Inter-enterprise Inter operation, Application, Configuration, Dynamic Selection, Software Fault Tolerance, Grid, and, Utility Computing, Elements of Service Oriented Architectures, RPC versus Document, Orientation, Composing Services.	20%	9	Chalk-Duster, PPT,notes
Unit 3 Description: Modeling and representation XML primer, Conceptual modeling, Ontology and knowledge sharing, Relevant standards: RDF, RDFS, and OWL, Differences and tools, Matchmaking.	20%	8	Chalk-Duster, PPT,notes
Unit 4 Engagement: Execution Models: Messaging, CORBA, Peer to peer computing, Jini, Grid Computing, Transactions: ACID Properties, Schedules, Locking, Distributed Transactions, Transactions over Composed Services: Architecture, Properties, Compositional Serializability, Process specification: Processes, Workflows.	20%	8	Chalk-Duster, PPT,notes

Unit 5 Business Process Management: Introduction of Business process Management, Process Specification Language, Relevant standards: BPEL4WS, WSCI, WS-C, ebXML, Relaxed transactions, Exception handling.	15%	7	Chalk-Duster, PPT,notes
Unit 6 Collaboration: Describing collaborations, Agents, Multiagent systems, Agent communication, languages, Protocols, Commitments and contracts, Planning, Consistency maintenance, Relevant standards: FIPA, OWL-S, Economic models, Organizational models.	10%	5	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. Service-Oriented Architecture: Concepts, Technology, and Design-Thomas Erl,Pearson Education 2. Developing Enterprise Web Services, An Architect's GuideSandeep Chatterjee, James Webber,Pearson Education.
2.	Reference books 1. Understanding SOA with Web Services,Newcomer, Lomow,Pearson Education 2. Enterprise SOA Designing IT for Business Innovation-Dan Woods and Thomas Mattern, O'REILLY

Evaluation Scheme		**Total Marks**
Mid semester Marks	30	
End Semester Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks

	Presentation/miscellaneous activities	5 marks

Course Outcomes	1. To Understand primary concepts of SOA
	2. To Know the integration of SOA technological points with Web Services.
	3. To Implement of SOA in development cycle of Web Services.

MTCS209	**Blockchain Technology**	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:100**			
1	**Course Prerequisites: Fundamentals of Cyber security**				
2	**Course Category: Elective**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 This course is intended to study the basics of Blockchain technology.				
	4.2 The learner will explore various aspects of Blockchain technology like application in various domains.				
	4.3 By implementing, learners will have idea about private and public Blockchain, and smart contract				

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.	20%	9	Chalk-Duster, PPT,notes
Unit 2: BITCOIN AND CRYPTO-CURRENCY Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double- Spend Problem, Blockchain and Digital Currency, Transactional Blocks,	25%	10	Chalk-Duster, PPT,notes

Impact of Blockchain Technology in Cryptocurrency.			
Unit 3: INTRODUCTION TO ETHEREUM Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.	15%	8	Chalk-Duster, PPT,notes
Unit 4: INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING : Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.	25%	10	Chalk-Duster, PPT,notes
Unit 5: BLOCKCHAIN APPLICATIONS Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.	15%	8	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", 2nd Edition, Packt Publishing 2. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014
2.	Reference books 1. Drescher, Blockchain Basics. Apress, 2017 2. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.

Evaluation Scheme		Total Marks
Mid semester Marks	30	
End Semester Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	1. Understand and explore the working of Blockchain technology
	2. Analyze the working of Smart Contracts
	3. Understand and analyze the working of Hyperledger
	4. Apply the learning of solidity to build de-centralized apps on Ethereum
	5. Develop applications on Blockchain

MTCS210	**Robotics & Process Automation**	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:100**			
1	**Course Prerequisites: Basics of AI**				
2	**Course Category: Elective**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 To understand the basic concepts associated with the design, functioning, applications and social aspects of robots				

	4.2 To study about the electrical drive systems and sensors used in robotics for various applications
	4.3 To learn about various motion planning techniques and the associated control architecture

Course Content	Weightage	Contact hours	Pedagogy
Unit 1:Introduction Brief history, definition, anatomy, types, classification, specification and need based applications; role and need of robots for the immediate problems of the society, future of mankind and automation-ethical issues; industrial scenario local and global, case studies on mobile robot research platform and industrial serial arm manipulator	20%	9	Chalk-Duster, PPT,notes
Unit 2 : Building Blocks of a Robot Types of electric motors - DC, Servo, Stepper; specification, drives for motors - speed & direction control and circuitry, Selection criterion for actuators, direct drives, non-traditional actuators; Sensors for localization, navigation, obstacle avoidance and path planning in known and unknown environments – optical, inertial, thermal, chemical, biosensor, other common sensors; Case study on choice of sensors and actuators for maze solving robot and self driving cars	25%	9	Chalk-Duster, PPT,notes
Unit 3: KINEMATICS, DYNAMICS AND DESIGN OF ROBOTS & END-EFFECTORS Robot kinematics - Geometric approach for 2R, 3R manipulators, homogenous transformation using D-H representation, kinematics of WMR, Lagrangian formulation for 2R robot dynamics; Mechanical design aspects of a 2R manipulator, WMR; End-effector - common types and design case study.	15%	9	Chalk-Duster, PPT,notes

Unit 4: NAVIGATION, PATH PLANNING AND CONTROL ARCHITECTURE Mapping & Navigation – SLAM, Path planning for serial manipulators; types of control architectures - Cartesian control, Force control and hybrid position/force control, Behaviour based control, application of Neural network, fuzzy logic, optimization algorithms for navigation problems, programming methodologies of a robot	25%	9	Chalk-Duster, PPT,notes
Unit 5: AI AND OTHER RESEARCH TRENDS IN ROBOTICS Application of Machine learning - AI, Expert systems; Tele-robotics and Virtual Reality, Micro & Nanorobots, Unmanned vehicles, Cognitive robotics, Evolutionary robotics, Humanoids	15%	9	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook 3. Saeed. B. Niku, Introduction to Robotics, Analysis, system, Applications, Pearson educations, 2002 4. 2. Roland Siegwart, Illah Reza Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2011
2.	Reference books 3. Richard David Klafter, Thomas A. Chmielewski, Michael Negin, Robotic engineering: an integrated approach, Prentice Hall, 1989 4. 2. Craig, J. J., Introduction to Robotics: Mechanics and Control, 2nd Edition, Addison-Wesley, 1989.

Evaluation Scheme	**Total Marks**
Mid semester Marks	30
End Semester Marks	50

Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	6. Explain the concepts of industrial robots in terms of classification, specifications and coordinate systems, along with the need and application of robots & automation
	7. Examine different sensors and actuators for applications like maze solving and self driving cars.
	8. Design a 2R robot & an end-effector and solve the kinematics and dynamics of motion for robots
	9. Explain navigation and path planning techniques along with the control architectures adopted for robot motion planning.
	10. Describe the impact and progress in AI and other research trends in the field of robotics

MTCS207	**Data Analytics for IOT**	L	T	P	C
		3	0	2	4
Total Credits:	**Total Hours in Semester:45**	**Total Marks:100**			
1	**Course Prerequisites:**				
2	**Course Category: Elective**				
3	**Course Revision/ Approval date**				
4	**Course Objectives**				
	4.1 To get better understanding of basic concepts, technologies, and applications of the Internet of Things (IoT), with a focus on data analytics.				

	4.2 To focus on a range of enabling technologies in sensing, computing, analytics, learning for IoT and connects them to exciting applications in smart homes, healthcare, security, etc

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Introduction to IOT Internet Of Things with its components, characteristics of IOT devices,Role of data analytics in IOT, building IOT, Advantages & disadvantages of IOT, Application Domain	15%	8	Chalk-Duster, PPT,notes
Unit 2:IOT Connectivity : Connectivity solutions, Industrial Connectors, connectivity Operations, Industrial connectivity services as a basis for IOT Integration, Industrial connectivity services in practice, Industry 4.0 implementation.	20%	8	Chalk-Duster, PPT,notes
Unit 3: Location Analytics, Mobile Analytics & Radio Analytics: Main features of location analytics, Use cases, Industry application, Service Orchestration and Routing	15%	7	Chalk-Duster, PPT,notes
Unit 4:IOT Sensing & Learning: Power, Energy, Efficient resource management, and Energy Harvesting Naming and Addressing: Advertising, Searching, and Discovery	20%	8	Chalk-Duster, PPT,notes
Unit 5: Analytics Systems in IOT Semantic technologies: Information and data models for interoperability Miniaturization: Sensors, CPU, and network	20%	8	Chalk-Duster, PPT,notes
Unit 6: Advanced topics & Emerging Technologies Virtualization: Multiple sensors aggregated, or a sensor shared by multiple users Privacy/Security/Trust/Identity/Anonymity Heterogeneity in IOT	10%	6	Chalk-Duster, PPT,notes

Learning Resources	
1.	Textbook: 3. Big Data Analytics for Cloud, IOT and cognitive computing- Kai Hwang & Min Chen, Wiley Publication 4. Internet Of Things and Data Analytics Handbook edited by Hwaiyu Geng, Wiley Publication

2.	Reference books 2. Data Analytics: 3 Books in 1 - The New Ultimate Bible for Understanding & Using Data Analytics, Big Data + Data Science For Business + Data Mining -John Harper

Evaluation Scheme		**Total Marks**
Mid semester Marks	30	
End Semester Marks	50	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	5 marks
	Skill enhancement activities / case study	5 marks
	Presentation/ miscellaneous activities	5 marks

Course Outcomes	4. To understand the concepts and applications of IoT, and understand the core problems for building IoT systems
	5. To understand and manage the knowledge of models and principles and compare the performance of key techniques for IoT data analytics.
	6. To identify and implement practical IoT applications with data analytics techniques