

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 5

(Syllabi for Artificial Intelligence Programme Courses)



SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

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Syllabi for Higher Semester (3 - 8) AI Courses

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ACADEMIC CURRICULA

Engineering Science Courses

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21AIS201J	Course Name	FOUNDATIONS OF ARTIFICIAL INTELLIGENCE	Course Category	S	ENGINEERING SCIENCE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	analyse the various characteristics of intelligent agents	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	classify the different search strategies in AI															
CLR-3:	incorporating knowledge in solving AI problems															
CLR-4:	apply in different ways of designing software agents															
CLR-5:	identify and apply the AI methods in various applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	evaluate the characteristics and advantages of different intelligent agents	-	2	-	-	2	-	-	-	-	-	-	2	3	2	-
CO-2:	identify the different search strategies in AI	-	2	-	-	2	-	-	-	-	-	-	2	3	2	-
CO-3:	apply to solve AI problems	-	2	-	-	2	-	-	-	-	-	-	2	3	2	-
CO-4:	creating in different ways of designing software agents	-	2	-	-	2	-	-	-	-	-	-	2	3	2	-
CO-5:	develop the applications of AI & solve the problems	-	2	-	-	2	-	-	-	-	-	-	2	3	2	-

Unit-1 - Introduction	12 Hour
Introduction, Definition, Future of Artificial Intelligence, Characteristics, Typical Intelligent agents, Problem solving approach , Problem Solving methods , Search strategies ,Uniformed and informed , Heuristics ,Local search ,Algorithm and optimization problems, Searching with partial observations , Constraint satisfactory problems ,Constraint propagation ,Back tracking search ,Game playing ,Optimal decision.	
Unit-2 – Logical Reasoning	12 Hour
Alpha beta pruning, Stochastic games, First order predicate logic, Porlog programming, Unification, Forward Chaining, Backward chaining, Resolution, Knowledge Representation, Ontological Engineering ,Categories ,Objects, Events ,Mental Events ,Mental Objects ,Reasoning Systems ,Reasoning with default information ,Typical AI Problems	
Unit-3 – Agent Systems	12 Hour
Architecture for intelligent agents, Agent communication, Negotiation, Bargaining ,Argumentation ,Agents, Trust ,Reputation ,Multi agent systems ,AI applications ,Language Models ,Information Retrieval, Information extraction ,Natural language processing ,Machine translation ,Speech recognition ,Robot Hardware ,Perception	
Unit-4 – Proportional Logic	12 Hour
Planning, Moving, Frames, Semantic Net Scripts ,Goals, Plans ,Inheritance in Taxonomies ,Description logics ,Formal concept analysis ,Conceptual graphs ,Hierarchies in domain, Knowledge based reasoning ,Agents ,Facts of knowledge ,Logic and inference, Formal logic ,Propositional logic	
Unit-5 – Searching and Optimization Techniques	12 Hour
Resolution method, First order logic, Second order logic ,Genetic algorithms ,Travelling sales man problem ,Neural networks, Emergent systems ,Ant colony optimization ,Generate and search ,Depth first search ,Breadth first search ,Comparison of BFS and DFS, Quality of Solution ,Depth bounded DFS ,DF Iterative deepening ,Hill climbing ,Beam search ,Peak to peak methods	

Lab Experiments	
<ol style="list-style-type: none"> 1. Implement an approach to solve knapsack problem 2. Develop a local search algorithm 3. Develop a search strategy to determine the peak element in an array and find the square root of the peak number 4. Implement decision tree with alpha and beta as its parameters 5. Develop an approach to sort the elements in $m \times n$ matrix and shortest path to reach a given cell in the $m \times n$ matrix 6. Develop a solution for a typical AI problem that focus on finding the best move in Tic-Tac-Toe AI game 7. Develop an intelligent approach to create Linear Kernel to classify Iris Dataset available in the dataset library of Python 	<ol style="list-style-type: none"> 8. Implement an information retrieval using any supervised learning algorithms 9. Implement an information extraction using any supervised learning algorithms 10. Develop a speech recognition system to convert text to speech and speech to text 11. Implement K-means clustering algorithm using a dataset and provide its accuracy 12. Implement K Nearest Neighbour using a dataset and provide its outcome 13. Develop an effective solution for Travelling sales man problem 14. Develop BFS and DFS 15. Develop a Heuristic-based approach for a large set of inputs using Hill climbing optimization technique.

Learning Resources	Bibliography	
	1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2009.	5. William F. Clocksin and Christopher S. Mellish, Programming in Prolog: Using the ISO Standard, Fifth Edition, Springer, 2003.
	2. I. Bratko, —Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011	6. Gerhard Weiss, —Multi Agent Systems, Second Edition, MIT Press, 2013.
	3. M. Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science) II, Jones and Bartlett Publishers, Inc.; First Edition, 2008	7. David L. Poole and Alan K. Mackworth, —Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.
	4. Nils J. Nilsson, —The Quest for Artificial Intelligence, Cambridge University Press, 2009.	8. "A First Course in Artificial Intelligence", Deepak Khemani, McGraw Hill Education, 2013.
		9. "Artificial Intelligence" E. Rich and K. Knight, Mc Graw Hill Publishers INC, 3rd Edition 2017.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	-	15%	-
Level 2	Understand	15%	-	-	20%	15%	-
Level 3	Apply	40%	-	-	30%	40%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	20%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohanraj, Data Scientist, Standarad chartered	1. Dr. P.Visu, Professor, Velammal College of Engineering	1. Dr.R.Siva, SRMIST
2. Mr.N. Nagendran, Senior Software Engineer, Cognizant	2. Dr.S.Sibi Chakkaravarthy, Associate Professor, VIT- AP.	2. Dr.Varun Kumar K A, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC201J	Course Name	DATA STRUCTURES AND ALGORITHMS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Know about searching and sorting techniques used to handle a set of data along with time and space complexity												
CLR-2:	Utilize various categories of list structures to develop solutions												
CLR-3:	Explore usage of stack and queues in processing data for real time applications												
CLR-4:	Understand tree structure and its applications												
CLR-5:	Utilize hash tables for data storage and use graphs to solve real time problems												

Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Devise algorithms to arrange the data in required order and retrieve a specific datum in efficient manner												
CO-2:	Determine the type of list structure that could be used for solving a problem and implement it using C programming language												
CO-3:	Devise solutions using linear structures stack and queue												
CO-4:	Express proficiency in usage of tree for solving problems												
CO-5:	Implement hash tables for storing data and algorithms to find shortest path between nodes in a graph												

Program Outcomes (PO)												Program Specific Outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
1	2	3	-	-	-	-	-	-	-	-	3	3	-	-
2	3	3	-	-	-	-	-	-	-	-	3	3	-	-
2	3	3	-	-	-	-	-	-	-	-	3	3	-	-
2	3	3	-	-	-	-	-	-	-	-	3	3	-	-
3	2	3	-	-	-	-	-	-	-	-	3	3	-	-

Unit-1 - Introduction	15 Hour
Programming in C - Primitive data types, Structures, Self-referential structures, Pointers and structures, Dynamic memory allocation, Matrix multiplication; Data Structure – Definition, Types, ADT, Operations; Mathematical notations - Big O, Omega and Theta, Complexity – Time, Space, Trade off.	
Unit-2 - List Structure	15 Hour
Operations on List ADT – Create, Insert, Search, Delete, Display elements; Implementation of List ADT– Array, Cursor based and Linked; Types – Singly, Doubly, Circular; Applications - Sparse Matrix, Polynomial Arithmetic, Joseph Problem	
Unit-3 - Stack and Queue	15 Hour
Operations on Stack ADT – Create, Push, Pop, Top; Implementation of Stack ADT – Array and Linked; Applications - Infix to Postfix Conversion, Postfix Evaluation, Balancing symbols, Function Calls, Tower of Hanoi; Operations on Queue ADT - Create, Enqueue and Dequeue; Implementation of Queue ADT – Array and Linked; Types of Queue - Circular, Double ended and Priority Queue, Applications – Scheduling	
Unit-4 - Trees and Hashing	15 Hour
Introduction to Trees, Tree traversals, Complete Binary Tree and its height, Binary Search Trees, Need for Balance, Rotation, AVL trees, B Trees, Heaps, trees and array implementations and applications; Hash functions - Introduction, functions, Collision avoidance, Separate chaining, Open Addressing, Linear Probing, Quadratic probing.	
Unit-5 - Graph	15 Hour
Introduction to Graph, Graph Traversal, Topological sorting, Minimum spanning tree – Prims Algorithm, Kruskal's Algorithm, Shortest Path Algorithm - Dijkstra's Algorithm	

Lab Experiments

Lab 1: Implementation of Structures
 Lab 2: Implementation of Structures using Pointers
 Lab 3: Implementation of Matrix Multiplication – Dynamic Memory allocation
 Lab 4: Array Implementation of List
 Lab 5: Implementation of Linked List
 Lab 6: Implementation of Doubly linked List
 Lab 7: Implementation of Stack using array and Linked List
 Lab 8: Implementation of Queue using array and Linked list
 Lab 9: Applications of Stack, Queue
 Lab 10: Implementation of Tree using array
 Lab 11: Implementation of BST using linked list
 Lab 12: Implementation of B-Trees
 Lab 13: Implementation of Graph using Array
 Lab 14: Implementation of Shortest path Algorithm
 Lab 15: Implementation of Minimal Spanning Tree

Learning Resources	1. Seymour Lipschutz, <i>Data Structures with C</i> , McGraw Hill, 2014	4. Mark Allen Weiss, <i>Data Structures and Algorithm Analysis in C</i> , 2nd ed., Pearson Education, 2015
	2. R.F.Gilberg, B.A.Forouzan, <i>Data Structures</i> , 2nd ed., Thomson India, 2005	5. Reema Thareja, <i>Data Structures Using C</i> , 1st ed., Oxford Higher Education, 2011,
	3. A.V.Aho, J.E Hopcroft, J.D.Ullman, <i>Data structures and Algorithms</i> , Pearson Education, 2003	6. Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, <i>Introduction to Algorithms</i> 3 rd ed., The MIT Press Cambridge, 2014

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	-	-	10%	25%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	20%	-	-	30%	20%	-
Level 4	Analyze	20%	-	-	30%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mariappan Vaithilingam, Senior Engineering Manager, Uber India Research and Development Pvt Centre, Bangalore.	1. Dr. Venkatesh Raman, Professor, Mathematical Institute of Science	1. Dr. K. Vijaya, SRMIST
		2. Dr. S. Poornima, SRMIST
		3. Dr. P. Saranya, SRMIST

Course Code	21CSC202J	Course Name	OPERATING SYSTEMS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	Outline the structure of OS and basic architectural components involved in OS design	1	2	3	4	5	6	7	8	9	10	11	12							
CLR-2:	Introduce the concept of deadlock and various memory management mechanism	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CLR-3:	Familiarize the scheduling algorithms, file systems, and I/O schemes																			
CLR-4:	Identify and tell the various embedded operating systems and computer security concepts																			
CLR-5:	Name the various computer security techniques in windows and Linux																			
Course Outcomes (CO):		At the end of this course, learners will be able to:				Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	Use the appropriate concepts of operating system for resource utilization	3	3	2	2	-	-	-	-	-	-	-	3	2	-	-				
CO-2:	Choose the relevant process and thread concepts for solving synchronization problems	3	3	3	2	-	-	-	-	-	-	-	3	2	-	-				
CO-3:	Exemplify different types of scheduling algorithms and deadlock mechanism.	3	3	3	2	-	-	-	-	-	-	-	3	2	-	-				
CO-4:	Experiment the performance of different algorithms used in management of memory, file and I/O and select the appropriate one.	3	3	3	2	-	-	-	-	-	-	-	3	2	-	-				
CO-5:	Demonstrate different device and resource management techniques for memory utilization with security mechanisms	3	2	3	2	-	-	-	-	-	-	-	3	2	-	-				

Unit-1 - Introduction	15 Hour
Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Kernel Data Structures, Computing Environments, Open-Source Operating Systems, Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure, Operating-System Debugging, Operating-System Generation, System Boot.	
Unit-2 - Process Management	15 Hour
Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication, Communication in Client- Server Systems, Threads: Multicore Programming, Multithreading Models, Thread Libraries, Implicit Threading, Threading Issues. Process Synchronization: The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors	
Unit-3 - CPU Scheduling	15 Hour
Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Real-Time CPU Scheduling. Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock	
Unit-4 - Memory Management	15 Hour
Main Memory, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table. Virtual Memory: Introduction, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory. STORAGE MANAGEMENT: Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure. File-System Interface: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection. .	

Unit-5 - Protection and Security **15 Hour**

Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems, Language-Based Protection, The Security Problem, Program Threats, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks, Computer-Security Classifications.

Lab Experiments

Lab 1: Operating system Installation, Basic Linux commands	Lab 6: Dining Philosopher problem	Lab 11: LRU and LFU Page Replacement Algorithm
Lab 2: Process Creation using fork() and Usage of getpid(), getppid(), wait() functions	Lab 7: Bankers Algorithm for Deadlock avoidance	Lab 12: Best fit and Worst fit memory management policies
Lab 3: Multithreading	Lab 8: FCFS and SJF Scheduling	Lab 13: Disk Scheduling algorithm
Lab 4: Mutual Exclusion using semaphore and monitor	Lab 9: Priority and Round robin scheduling	Lab 14: Sequential and Indexed file Allocation
Lab 5: Reader-Writer problem	Lab 10: FIFO Page Replacement Algorithm	Lab 15: File organization schemes for single level and two-level directory

Learning Resources	1. Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, "Operating System Concepts", John Wiley & Sons (Asia) Pvt. Ltd, Tenth Edition, 2018	6. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education, 2017
	2. RamazElmasri, A. Gil Carrick, David Levine, "Operating Systems – A Spiral Approach ", Tata McGraw Hill Edition, 2010	7. https://nptel.ac.in/courses/106/105/106105214/
	3. Dhananjay M. Dhamdhare, "Operating Systems – A Concept Based Approach", Third Edition, Tata McGraw Hill Edition, 2019	8. https://nptel.ac.in/courses/106/106/106106144/
	4. Andrew S. Tanenbaum, "Modern Operating Systems", Fourth Edition, Global Edition, Pearson, 2015.	9. https://nptel.ac.in/courses/106/102/106102132/
	5. William Stallings, "Operating Systems: Internals and Design Principles", Pearson Education, Sixth Edition, 2018.	10. https://onlinecourses.nptel.ac.in/noc21_cs44/preview
		11. https://nptel.ac.in/courses/106/105/106105172/

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	0%	20%	-
Level 2	Understand	40%	-	-	40%	40%	-
Level 3	Apply	20%	-	-	40%	20%	-
Level 4	Analyze	20%	-	-	10%	10%	-
Level 5	Evaluate	-	-	-	10%	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.T.Madhan, Team Leader, Tata Consultancy Services, siruseri Campus, Chennai, madhan.tk@gmail.com	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. N. Prasath, SRMIST
2. Mrs.K.Saranya, IT Analyst, Tata Consultancy Services, siruseri Campus, Chennai, saranya.k6@gmail.com	2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr. M. Eliazer, SRMIST

Course Code	21CSC203P	Course Name	ADVANCED PROGRAMMING PRACTICE	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the paradigm functionalities and their hierarchy			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	deploy structural, procedural, and Object-Oriented Programming Paradigm																	
CLR-3:	demonstrate the event, Graphical User Interface, and declarative Paradigm with a java application																	
CLR-4:	extended knowledge on logic, functional, network and concurrent Paradigm																	
CLR-5:	symbolic, Automata-based, and Event with a python application																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	devise solutions to the various programming paradigm			3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	express proficiency in the usage of structural, procedural, and Object-Oriented Program			3	2	-	1	-	-	-	-	-	-	-	-	2	-	-
CO-3:	determine the Java application using declarative, event, and graphical user interface paradigm			3	-	2	1	2	-	-	-	1	-	-	-	2	-	-
CO-4:	express proficiency in the usage of logic, functional, network, and concurrent Paradigm			3	2	-	1	-	-	-	-	-	-	-	-	2	-	-
CO-5:	determine the Python application using symbolic, automata-based, and graphical user interface programming paradigms			3	-	2	1	2	-	-	-	1	-	-	-	2	-	-

Unit-1 - Introduction to Programming Paradigm	12 Hour
Programming Languages – Elements of Programming languages - Programming Language Theory - Bohm- Jacopini structured program theorem - Multiple Programming Paradigm – Programming Paradigm hierarchy – Imperative Paradigm: Procedural, Object-Oriented and Parallel processing – Declarative programming paradigm: Logic, Functional and Database processing - Machine Codes – Procedural and Object-Oriented Programming – Suitability of Multiple paradigms in the programming language - Subroutine, method call overhead and Dynamic memory allocation for message and object storage - Dynamically dispatched message calls and direct procedure call overheads – Object Serialization – parallel Computing	
Unit-2 - Java Programming Paradigms	12 Hour
Object and Classes; Constructor; Data types; Variables; Modifier and Operators - Structural Programming Paradigm: Branching, Iteration, Decision making, and Arrays - Procedural Programming Paradigm: Characteristics; Function Definition; Function Declaration and Calling; Function Arguments - Object-Oriented Programming Paradigm: Abstraction; Encapsulation; Inheritance; Polymorphism; Overriding - Interfaces: Declaring, implementing; Extended and Tagging - Package: Package Creation.	
Unit-3 - Advanced Java Programming Paradigms	12 Hour
Concurrent Programming Paradigm: Multithreading and Multitasking; Thread classes and methods - Declarative Programming Paradigm: Java Database Connectivity (JDBC); Connectivity with MySQL – Query Execution; - Graphical User Interface Based Programming Paradigm: Java Applet: Basics and Java Swing: Model View Controller (MVC) and Widgets; Develop a java project dissertation based on the programming paradigm.	
Unit-4 - Pythonic Programming Paradigm	12 Hour
Functional Programming Paradigm: Concepts; Pure Function and Built-in Higher-Order Functions; Logic Programming Paradigm: Structures, Logic, and Control; Parallel Programming Paradigm: Shared and Distributed memory; Multi-Processing – Ipython; Network Programming Paradigm: Socket; Socket Types; Creation and Configuration of Sockets in TCP / UDP – Client / Server Model.	

Unit-5 - Formal and Symbolic Programming Paradigm**12 Hour**

Automata Based programming Paradigm: Finite Automata – DFA and NFA; Implementing using Automaton Library - Symbolic Programming Paradigm: Algebraic manipulations and calculus; Sympy Library - Event Programming Paradigm: Event Handler; Trigger functions and Events – Tkinter Library. Develop a python-based project dissertation based on the programming paradigm.

Learning Resources	1. Elad Shalom, A Review of Programming Paradigms throughout the History: With a suggestion Toward a Future Approach, Kindle Edition, 2018	3. Herbert Schildt, Java: The Complete Reference Seventh Edition, 2016.
	2. Maurizio Gabbrielli, Simone Martini, Programming Languages: Principles and Paradigms, 2010.	4. Mark Lutz, Programming Python: Powerful Object-Oriented Programming, 2011.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	--	20%	-	10%	-	-
Level 2	Understand	30%	-	-	20%	-	10%	-	-
Level 3	Apply	20%	-	-	20%	-	10%	-	-
Level 4	Analyze	20%	-	-	20%	-	10%	-	-
Level 5	Evaluate	-	-	-	10%	-	30%	-	-
Level 6	Create	-	-	-	10%	-	30%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. N. Venkatesh, Tech Lead, Honeywell, Bengaluru, Karnataka, India	1. Dr. Sudeepa Mishra, Assistant Professor, Computer Science and Engineering, Indian Institute of Information Technology, Ropar, Punjab.	1. Dr Ramkumar J, SRMIST

Course Code	21CSC204J	Course Name	DESIGN AND ANALYSIS OF ALGORITHMS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	design efficient algorithms in solving complex real time problems	Engineering Knowledge	2	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3											
CLR-2:	analyze various algorithm design techniques to solve real time problems in polynomial time																											
CLR-3:	utilize various approaches to solve greedy and dynamic algorithms																											
CLR-4:	utilize back tracking and branch and bound paradigms to solve exponential time problems																											
CLR-5:	analyze the need of approximation and randomization algorithms, utilize the importance Non polynomial algorithms																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	apply efficient algorithms to reduce space and time complexity of both recurrent and non-recurrent relations	2	1	2	1	-	-	-	-	-	3	-	3	1	1	2												
CO-2:	solve problems using divide and conquer approaches	2	1	2	1	-	-	-	-	-	3	-	3	1	1	2												
CO-3:	apply greedy and dynamic programming type's techniques to solve polynomial time problems	2	1	2	1	-	-	-	-	-	3	-	3	1	1	2												
CO-4:	create exponential problems using backtracking and branch and bound approaches	2	1	2	1	-	-	-	-	-	3	-	3	1	1	2												
CO-5:	interpret various approximation algorithms and interpret solutions to evaluate P type, NP Type, NPC, NP Hard problems	2	1	2	1	-	-	-	-	-	3	-	3	1	1	2												

Unit-1 - Introduction-Algorithm Design	9 Hour
Fundamentals of Algorithms- Correctness of algorithm - Time complexity analysis - Insertion Sort-Line count, Operation count Algorithm Design paradigms - Designing an algorithm and its analysis-Best, Worst and Average case - Asymptotic notations Based on growth functions. O, O, Θ, ω, Ω - Mathematical analysis - Induction, Recurrence relations -Solution of recurrence relations - Substitution method - Solution of recurrence relations - Recursion tree - Solution of recurrence relations - examples.	
Unit-2 - Introduction-Divide and Conquer	9 Hour
Maximum Subarray Problem Binary Search - Complexity of binary search Merge sort - Time complexity analysis -Quick sort and its Time complexity analysis Best case, Worst case, Average case analysis - Strassen's Matrix multiplication and its recurrence relation - Time complexity analysis of Merge sort - Largest sub-array sum - Time complexity analysis of Largest sub- array sum - Master Theorem Proof - Master theorem examples - Finding Maximum and Minimum in an array - Time complexity analysis-Examples - Algorithm for finding closest pair problem - Convex Hull problem	
Unit-3 - Introduction-Greedy and Dynamic Programming	9 Hour
Examples of problems that can be solved by using greedy and dynamic approach Huffman coding using greedy approach Comparison of brute force and Huffman method of encoding - Knapsack problem using greedy approach Complexity derivation of knapsack using greedy - Tree traversals - Minimum spanning tree – greedy Kruskal's algorithm - greedy - Minimum spanning tree - Prims algorithm Introduction to dynamic programming - 0/1 knapsack problem - Complexity calculation of knapsack problem - Matrix chain multiplication using dynamic programming - Complexity of matrix chain multiplication - Longest common subsequence using dynamic programming - Explanation of LCS with an example - Optimal binary search tree (OBST)using dynamic programming - Explanation of OBST with an example.	

Unit-4 - Introduction to Backtracking	9 Hour
Branch and bound - N queen's problem – backtracking - Sum of subsets using backtracking Complexity calculation of sum of subsets Graph introduction Hamiltonian circuit - backtracking - Branch and bound - Knapsack problem Example and complexity calculation. Differentiate with dynamic and greedy Travelling salesman problem using branch and bound - Travelling salesman problem using branch and bound example - Travelling salesman problem using branch and bound example - Time complexity calculation with an example - Graph algorithms - Depth first search and Breadth first search - Shortest path introduction - Floyd-Warshall Introduction - Floyd-Warshall with sample graph - Floyd-Warshall complexity	
Unit-5 - Introduction to Randomized and Approximation Algorithm	9 Hour
Randomized hiring problem Randomized quick sort Complexity analysis String matching algorithm Examples - Rabin Karp algorithm for string matching Example discussion - Approximation algorithm - Vertex covering - Introduction Complexity classes - P type problems - Introduction to NP type problems - Hamiltonian cycle problem - NP complete problem introduction - Satisfiability problem - NP hard problems – Examples	
Lab Experiments	30 Hour
Lab 1: Simple Algorithm-Insertion sort Lab 2: Bubble Sort Lab 3: Recurrence Type-Merge sort, Linear search Lab 4: Quicksort, Binary search Lab 5: Strassen Matrix multiplication Lab 6: Finding Maximum and Minimum in an array, Convex Hull problem Lab 7: Huffman coding, knapsack and using greedy Lab 8: Various tree traversals,	Lab 9: Longest common subsequence Lab 10: N queen's problem Lab 11: Travelling salesman problem Lab 12: BFS and DFS implementation with array Lab 13: Randomized quick sort Lab 14: String matching algorithms Lab 15: Discussion over analyzing a real time problem

Learning Resources	1. Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms, 3rd ed., The MIT Press Cambridge, 2014 2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2006	3. Ellis Horowitz, Sartaj Sahni, Sanguthevar, Rajesekaran, Fundamentals of Computer Algorithms, Galgotia Publication, 2010 4. S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2015
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	-	30%	30%	-
Level 2	Understand	70%	-	-	30%	30%	-
Level 3	Apply	-	-	-	40%	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. G. Venkiteswaran, Wipro Technologies, gvenki@pilani.bits-pilani.ac.in	1. Mitesh Khapra, IITM Chennai, miteshk@cse.iitm.ac.in	1. Dr. K.Senthil Kumar, SRMIST
2. Dr.Sainarayanan Gopalakrishnan, HCL Technologies, sai.jgk@gmail.com	2. V. Masilamani. IIITDM, masila@iiitdm.ac.in	2. Dr. V. Sivakumar, SRMIST
		3. Dr. R.Vidhya,SRMIST

Course Code	21CSC205P	Course Name	DATABASE MANAGEMENT SYSTEMS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the fundamentals and need of Database systems, Architecture, Languages			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	conceive database design through Relational model, Relational Algebra																	
CLR-3:	design Logical schema with constraints, Familiarize SQL Queries																	
CLR-4:	standardization of Database through Normalization																	
CLR-5:	understand Storage Management, the practical problems of Concurrency control, Failures and recovery, NoSQL database																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	acquire knowledge on DBMS architecture and languages			-	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-2:	acquire knowledge on Relational languages and design a database			1	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-3:	implement the Database structure with SQL			1	-	2	-	-	-	-	-	-	-	-	-	2	1	-
CO-4:	removal of anomalies using Normalization concepts			1	-	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-5:	visualizing storage structure, handling concurrency, Failure and recovery principles, NoSQL concept			1	2	-	-	-	-	-	-	-	-	-	-	2	1	-

Unit-1 - Introduction	12 Hour
Issues in File Processing System, Need for DBMS, Basic terminologies of Database, Database system Architecture, Various Data models, ER diagram basics and extensions, Case study: Construction of Database design using Entity Relationship diagram for an application such as University Database, Banking System, Information System	
Unit-2 – Relational DBMS	12 Hour
Conversion of ER model to Relational Table, Case study: Apply conversion concept. Discussion of various design issues. Pitfalls in Relational Database systems, Understanding various Relational languages such as Tuple Relational calculus, Domain relational calculus, Calculus Vs Algebra, Computational capabilities. Case Study: Applying Relational Algebra for all the queries of application Designed.	
Unit-3 – SQL	12 Hour
SQL commands, Constraints, Joins, set operations, Sub queries, Views, PL – SQL, Triggers, and Cursors. Case Study: Implement all the queries using SQL, PL-SQL, Cursor and Triggers	
Unit-4 - Normalization	12 Hour
Normalization, Need for Normalization, NF1, NF2, NF3, NF4, NF5. Case study: Apply Conversion rules and normalize the Database	
Unit-5 – Concurrency Control	12 Hour
Storage Structure, Transaction control, Concurrency control algorithms, Issues in Concurrent execution, Failures and Recovery algorithms Case study: Demonstration of Entire project by applying all the concepts learnt with minimum Front end requirements, NoSQL Databases-Documents Oriented, Key value pairs, Column Oriented and Graph	

Learning Resources	1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Conceptsll, Seventh Edition, Tata McGraw Hill, 2019.	4. RaghuramaKrishnan, Johannes Gehrke, Database Management Systems, 3rdEdition, McGrawHill Education, 2003.
	2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systemsll, Sixth Edition, Pearson Education, 2011.	5. Principles of Database Systems, J.D. Ullman, Galgoti, 1982
	3. C.J Date, A Kannan, S Swamynathan, An Introduction to Database Systems, Eight Edition, Pearson Education, 2006.	6. NoSQL Distilled, A brief guide to the emerging world of Polygot persistence, First Edition, Promod J, Sadalage Martin Fowler, 2012

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	-	-	-	-	-
Level 2	Understand	40%	-	-	-	-	-	-	-
Level 3	Apply	40%	-	-	30%	-	-	-	-
Level 4	Analyze	-	-	-	30%	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	50%	-	-
Level 6	Create	-	-	-	40%	-	50%	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms.Sangeetha Jayaprakash, Database Architect, BOSCH India	1. Dr.J.Sheeba Rani, Indian Institute of Space Science and Technology, Trivandrum	1. Dr.M.Thenmozhi, SRMIST
2. Dr.Manipoonchelvi, Senior Technical Manager, HCL Technologies	2. Dr.K.Nandhini, Central University of Thiruvavur	2. Ms.K.Srividya, SRMIST

Course Code	21CSC301T	Course Name	FORMAL LANGUAGE AND AUTOMATA	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	construct automata for any equivalent regular expressions	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	acquire brief knowledge about automata languages	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	analyze about context free grammars and its implementation in Push down automata															
CLR-4:	interpret the power of Turing machine and the decidable nature of a problem															
CLR-5:	categorize undecidable problems and NP class problems															
Course Outcomes (CO):	At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	summarize the basic concepts of deterministic and non-deterministic finite automata and its applications	-	1	1	-	-	-	-	-	-	-	-	-	1	3	-
CO-2:	analyze the formal relationships among machines, languages and Context free grammars and its normalization	-	3	3	-	-	-	-	-	-	-	-	-	1	3	-
CO-3:	construct the Push down stack machine and its context free language acceptance and its equivalence with CFG	-	2	2	-	-	-	-	-	-	-	-	-	1	3	-
CO-4:	analyze the techniques for Turing machine construction and its recursive languages and functions	-	2	2	-	-	-	-	-	-	-	-	-	1	3	-
CO-5:	evaluate the computational complexity of various problems	-	3	3	-	-	-	-	-	-	-	-	-	1	3	-

Unit-1 - Finite Automata and Regular Expressions	9 Hour
Deterministic and Non-Deterministic Finite Automata, Finite Automata with ϵ -moves, regular expressions – equivalence of NFA and DFA, two-way finite automata, Moore and Mealy machines, Equivalence of Moore and Mealy machines, applications of finite automata.	
Unit-2 - Regular Sets and Context Free Grammars	9 Hour
Properties of regular sets, context-free Grammars, and Languages – derivation trees, Simplification of CFG: Elimination of Useless Symbols Simplification of CFG: Unit productions, Null productions - Chomsky Normal Forms and Greibach Normal Forms, ambiguous and unambiguous grammars; minimization of finite automata	
Unit-3 - Pushdown Automata and Parsing Algorithms	9 Hour
Deterministic Push Down Automata – Non-Deterministic Push Down Automata – Equivalence of Pushdown Automata and context-free languages; Properties of CFL; Applications of pumping lemma — closure properties of CFL and decision algorithms; Overview of Top-down parsing and Bottom-up parsing	
Unit-4 - Turing Machines	9 Hour
Turing machines (TM) – computable languages and functions – Turing machine constructions – storage in finite control – variations of TMs – Church-Turing thesis – Universal Turing machine– recursive and recursively enumerable languages	
Unit-5 - Introduction to Computational Complexity	9 Hour
Time and Space complexity of TMs – complexity classes – introduction to NP-Hardness and NP-Completeness Post Correspondence Problems (PCP) – Modified PCP – Halting Problems – Undecidability Problems	

Learning Resources	1. Hopcroft J.E., Motwani R. and Ullman J.D, "Introduction to Automata Theory, Languages and Computations", Second Edition, Pearson Education, 2008.	3. John.C. Martin, "Introduction to Languages and the Theory of Computation" McGraw-Hill Education, 01- May-2010.
	2. Michael Sipser, "Introduction to the Theory of Computation" Cengage Learning, 2012	4. Peter Linz, "An introduction to formal languages and automata", Jones & Bartlett Learning, Sixth Edition, 2017

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Santhosh Muniswami, Cisco Systems, Inc.	1. Dr. P. Victor Paul, Indian Institute of Information Technology Kottayam	1. Dr. N. Arunachalam, SRMIST
2. B. Divya, TCS	2. Dr.C. Punitha Devi, Pondicherry University,	2. Dr. K. Vijaya, SRMIST

Course Code	21CSC303J	Course Name	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	familiarize the software life cycle models and software development process			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	illustrate the various techniques for requirements, planning and managing a technology project																	
CLR-3:	examine basic methodologies for software design, development, testing, and implementation																	
CLR-4:	understand manage user's expectations and the software development team																	
CLR-5:	apply the project management and analysis principles to software project development																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	identify the process of project life cycle model and process			-	-	-	-	-	-	-	-	2	-	2	-	3	-	-
CO-2:	analyze and translate end-user requirements into system and software requirements			-	3	-	-	-	-	-	-	2	-	2	-	3	-	-
CO-3:	identify and apply appropriate software architectures and patterns to carry out high level design of a system			-	-	2	-	-	-	-	-	2	-	2	-	3	-	-
CO-4:	develop Test plans and incorporate suitable testing strategies			-	-	-	-	-	-	-	-	2	-	2	-	3	-	-
CO-5:	examine the risk strategies and maintenance measures			-	-	-	-	-	-	-	-	2	-	3	-	3	-	-

Unit-1 - Introduction to Software Engineering	12 Hour
The evolving role of software, changing nature of software, Generic view of process: Software engineering- a layered technology, a process framework, Software Project Management - life cycle activities, Process models: The waterfall model, incremental process models, evolutionary process models, the unified process, Conventional- Agile, XP, Scrum, Project Initiation management – Project Charter, Project Scope, Project Objectives, Practical considerations.	
Unit-2 - Software Requirements	12 Hour
Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document. Requirements engineering process: Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management, Software project effort and cost estimation – Cocomo model I, Cocomo Model II, LOC, Function point metrics	
Unit-3 - Software Design	12 Hour
Software Design Fundamentals, Design process – Design Concepts-Design Model– Design Heuristic , Design techniques– Architectural Design - Architectural styles, Creating an architectural design- software architecture, data design, architectural styles and patterns, architectural design, conceptual model of UML, basic structural modeling, class diagrams, sequence diagrams, collaboration diagrams, use case diagrams, component diagrams, Design of User Interface design Elements of good design, Design issues Features of modern GUI - Menus, Scroll bars, windows, Buttons, icons, panels, error Messages etc.	
Unit-4 - Software Construction	12 Hour
Coding Standards, Coding Frameworks. Reviews: Deskchecks, Walkthroughs, Code Reviews, Inspections, Coding Methods, Testing Strategies: A strategic approach to software testing, test strategies for conventional software, black-box and white-box testing, validation testing, system testing, Unit Testing – Integration Testing – Validation Testing – System Testing and Debugging	
Unit-5 – Product Management	12 Hour
Product Release Management, Risk management: Reactive Vs proactive risk strategies, software risks, risk identification, risk projection, risk refinement, RMMM, RMMM plan, Maintenance and Reengineering	

Lab Experiments

Lab 1: Identify the Software Project, Create Business Case, Arrive at a Problem Statement
 Lab 2: Analyse Stakeholder and User Description and Identify the appropriate Process Model
 Lab 3: Identify the Requirements, System Requirements, Functional Requirements, Non-Functional Requirements and develop a SRS Document
 Lab 4: Prepare Project Plan based on scope, Find Job roles and responsibilities, Calculate Project effort based on resources
 Lab 5: Prepare the Work, Breakdown Structure based on timelines, Risk Identification and Plan
 Lab 6: Design a System Architecture, Use Case Diagram, ER Diagram (Database)
 Lab 7: DFD Diagram (process) (Upto Level 1), Class Diagram (Applied For OOPS based Project),
 Lab 8: Interaction Diagrams, State chart and Activity Diagrams
 Lab 9: State and Sequence Diagram, Deployment Diagram,
 Lab 10: Sample Frontend Design (UI/UX)
 Lab 11: Sample code implementation
 Lab 12: Master Test Plan, Test Case Design (Phase 1)
 Lab 13: Manual Testing
 Lab 14: User Manual, Analysis of Costing, Effort and Resource
 Lab 15: Project Demo and Report Submission with the team

Learning Resources	1. Roger S. Pressman, Software Engineering – A Practitioner Approach, 6th ed., McGraw Hill, 2005	4. Ramesh, Gopalaswamy, Managing Global Projects, Tata McGraw Hill, 2005
	2. Ian Sommerville, Software Engineering, 8th ed., Pearson Education, 2010	5. Ashfaq Ahmed, Software Project Management: a process-driven approach, Boca Raton, Fla.: CRC Press, 2012
	3. Rajib Mall, Fundamentals of Software Engineering, 4th ed., PHI Learning, Private Limited, 2014	6. Walker Royce, Software Project Management, Pearson Education, 1999
		7. Jim Smith Agile Project Management: Creating Innovative Products, Pearson 2008

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	40%	-	-	40%	40%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. DHINAKAR JACOB SELWYN, CAP GEMINI TECHNOLOGY		1. Mrs. Anupama C G, SRMIST
2. Mr. Girish Raghavan, Wipro Technologies		

Course Code	21AIC202J	Course Name	NEURAL NETWORKS AND MACHINE LEARNING	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	recognize the basics of learning problems	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	illustrate the decision tree algorithm for classification and prediction																											
CLR-3:	identify the probability based and instance-based learning methods to solve the real-world problems																											
CLR-4:	express the perception of neurons and network functioning																											
CLR-5:	demonstrate the working NN models to solve real world problems																											
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	2	-	-	3	-	-	-	-	-	3	-	2	3	-
CO-1:	formulate the Learning problems	-	3	-	-	3	-	-	-	-	-	3	-	2	3	-												
CO-2:	apply the decision tree algorithm for classification and prediction	-	3	-	-	3	-	-	-	-	-	3	-	2	3	-												
CO-3:	apply probability based and instance-based learning to solve the real-world problems	-	3	-	-	3	-	-	-	-	-	3	-	2	3	-												
CO-4:	analyze the perception of neurons and network functioning	-	3	-	-	3	-	-	-	-	-	3	-	2	3	-												
CO-5:	implement NN models to solve real world problems	-	3	-	-	3	-	-	-	-	-	3	-	2	3	-												

Unit-1 – Introduction	12 Hour
Basics of Learning, Introduction to Machine Learning, well posed learning problems, designing a Learning system, Perspectives in Machine Learning, Issues in Machine Learning, Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias	
Unit-2 – Decision Tree	12 Hour
Introduction to Decision Tree, Decision tree representation, Decision Tree Learning, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, ID3, Entropy and Information gain, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning	
Unit-3 - Classification Techniques	12 Hour
Introduction to Bayesian Learning, Naive Bayes classifier, Bayesian belief networks, EM algorithm, Instance Based Learning, Introduction to k-nearest neighbour learning, cased-based reasoning, SVM classifier, Maximum margin linear separators, Quadratic programming solution to finding maximum margin separators, Kernels for learning, non-linear functions, PCA, Covariance, Correlation	
Unit-4 – Neural Networks	12 Hour
Introduction to Neurons, biological motivation, Neural Networks, Neuron Modelling, Linear threshold units, Perceptron, Representational limitation, gradient descent training, Stochastic Gradient Descent, Linear regression, Logic Regression, locally weighted regression	
Unit-5 – Multi Layer Architecture	12 Hour
Multilayer networks, Hidden layers, Error Calculation Functions, Different Activation Functions, Backpropagation, constructing intermediate representations, Distributed representations, Overfitting, Learning network structure, Recurrent networks, Convolution Neural Networks, ReLu, Pooling, SoftMax, Long Short-Term Memory (LSTM)	

Lab Experiments

1. Water jug problem
2. FIND-S algorithm
3. Candidate Elimination
4. Decision tree based ID3 algorithm
5. Naïve Bayesian classifier
6. Linear Regression
7. Logic Regression
8. Single Layer perceptron
9. Multi-Layer Perceptron
10. Backpropagation
11. KNN classifier
12. Clustering using k-Means
13. EM for clustering
14. Training SVM classifier
15. Feature Extraction by PCA

Learning Resources	1. Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2006	5. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008
	2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012	6. Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009
	3. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005	7. Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series in statistics.
	4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.	8. Ethem Alpaydin, Introduction to machine learning, second edition, MIT press.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	-	15%	-
Level 2	Understand	20%	-	-	30%	20%	-
Level 3	Apply	35%	-	-	35%	35%	-
Level 4	Analyze	30%	-	-	35%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohanraj, Data Scientist, Standarad chartered	1. Dr. P.Visu, Professor, Velammal College of Engineering	1. Dr.R.Siva , SRMIST
2. Mr.N. Nagendran, Senior Software Engineer, Cognizant	2. Dr.S.Sibi Chakkaravarthy ,Associate Professor, VIT- AP.	2. Dr.Varun Kumar K A, SRMIST

Course Code	21AIC301J	Course Name	DEEP LEARNING TECHNIQUES	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	introduce the Mathematical models and basic key concepts in Deep learning			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	build the linear models and stochastic optimization methods for training deep neural networks																	
CLR-3:	describe the Convolution Neural Networks and Recurrent Neural Networks																	
CLR-4:	exemplify the Basic principles of auto encoders																	
CLR-5:	emphasize the Various deep architectures and applications of computer vision																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	illustrate the basic concepts of linear algebra for Mathematical models and Deep neural network model			-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-2:	construct the feed forward network using gradient descent and regularization techniques			-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-3:	model the Convolutional neural network and articulate the sequence modelling using Recurrent models for processing high dimensional			-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-4:	articulate the concepts of auto encoders			-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-5:	design the deep neural network to model computer vision related applications such as object detection, image captioning			-	3	-	-	3	-	-	-	-	-	3	-	2	3	3

Unit-1 - Introduction	15 Hour
Introduction--Machine Learning Basics: Learning Algorithm, Supervised and Unsupervised Training, Linear Algebra for machine Learning, Dimensionality reduction, Over/Under-fitting, Cross-Validation, Hyper parameters, Training set, Test set and validation set, Estimators, Bias, Variance, Regularization, Historical Trends in Deep Learning, Introduction to a simple DNN, Deep learning software Libraries.	
Unit-2 – Feed Forward Networks and Back Propagation	15 Hour
Deep feed forward networks-Introduction, Shallow Neural Network, Deep Neural Network, Hyper-parameter Tuning, Batch Normalization, Learning XOR, Gradient-Based Learning, Back propagation, Activation Functions, Error Functions, Architecture Design, differentiation algorithms, - Regularization for Deep learning, Early Stopping, Drop out.	
Unit-3 – Advanced Deep Learning	15 Hour
Convolutional Networks, Convolutional operation, Pooling, Normalization, Applications in Computer Vision, Sequence Modelling, Recurrent Neural Networks, Difficulty in Training RNN, LSTM, GRU, Encoder Decoder architectures, Application, Spam classification, sentiment analysis	
Unit-4 – Generative Networks	15 Hour
Auto encoders – Architecture, under complete, regularized, stochastic, denoising, contractive, Variational Autoencoders, Applications, Optimization for Deep Learning, RMSprop for RNNs, SGD for CNNs, Adversarial Generative Networks, Applications	
Unit-5 – Deep Architectures	15 Hour
Deep Architectures in Computer Vision, imagenet and imagenet Large Scale Visual Recognition Challenge (ILSVRC), Resnet, Graph Convolution Network (GCN), , Applications in image captioning, Applications in video Tasks-	

Lab Experiments

Lab 1: Exploring the Deep learning platforms
 Lab 2: Implement a classifier using open-source dataset
 Lab 3: Study of the classifiers with respect to statistical parameters
 Lab 4: Build a simple feed forward neural network to recognize handwritten character. (MNIST Dataset)
 Lab 5: Study of activation functions and its role
 Lab 6: Implement gradient descent and backpropagation in deep neural network
 Lab 7: Build a CNN model to classify Cat and dog image
 Lab 8: Experiment using LSTM
 Lab 9: Build a Recurrent Neural Network
 Lab 10: Perform compression on mnist dataset using auto encoder
 Lab 11: Experiments using Variational Autoencoder
 Lab 12: Implement a Deep Convolutional GAN to generate complex color images
 Lab 13: Understanding the architecture of Pre-trained Model.
 Lab 14: Implement a Pre-trained CNN model as a Feature Extractor using Transfer Learning models
 Lab 15: Implement a YOLO model to detect object.

Learning Resources	1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press,	4. Jason Brownlee, "Deep Learning with Python", 2016.
	2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012 3. Michael Nielsen, "Neural Networks and Deep Learning", Online book, 2016	5. Aaron Courville, Ian Goodfellow, and Yoshua Bengio, "Deep Learning", MIT Press, 2015.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	10%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	25%	-	-	30%	25%	-
Level 4	Analyze	25%	-	-	30%	25%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohan Raj, Data Scientist, Standard Chartered	1. Dr. Jani Anbarasi, Associate Professor, VIT, Chennai	1. Dr.S.Sadagopan, SRMIST
2. Mr. N. Nagendran, Senior Software Developer, Cognizant Technology Solutions	2. Dr. P. Visu, Professor, Velammal Engineering College	2. Dr.K.A.Varun, SRMIST

Course Code	21AIC302J	Course Name	REINFORCEMENT LEARNING TECHNIQUES	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	gain knowledge about Reinforcement learning paradigm	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-2:	understand the art of trial and learning process that is needed for the any ML and AI model	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	develop a mathematical foundation of Reinforcement learning and behavioural psychology															
CLR-4:	acquire Knowledge in Reinforcement techniques to solve real world applications															
CLR-5:	implement Reinforcement techniques															

Course Outcomes (CO):	At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PO-1	PO-2	PO-3
CO-1:	understand the basic concepts of RL and its early history	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-2:	apply Reinforcement learning techniques in code common algorithms with tabular methods to solve classical control problems	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-3:	formalize problems as Markov decision processes	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-4:	understand the importance of exploration when using sampled experience rather than dynamic programming sweeps within a model	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-5:	understand the basic concepts of RL and its early history	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3

Unit-1 - Introduction to Reinforcement Learning	12 Hour
Reinforcement learning – Elements of Reinforcement learning – Early History of Reinforcement Learning – Extended example of Tic- Tac – Toe	
Unit-2 - Tabular Solution Methods	12 Hour
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 – Goals and Rewards – Returns and Episodes – Unified Notation for episode and Continuing Tasks.	
Unit-3 - Finite Markov Processes	12 Hour
The Agent Environment Interface- Interface-MDP Selection Introduction -Grid World- The Agent Environment Interface- The Markov Property- Markov Decision Processes – Value Functions – Optimal Value Functions - The Bellman Equation – Optimal Policy and Optimal value Function – Optimality and Approximation.	
Unit-4 - Dynamic Programming	12 Hour
Policy Evaluation – Policy Improvement- Policy Iteration- Value Iteration - Asynchronous Dynamic Programming- Dynamic Programming Section Introduction Efficiency of Dynamic Programming– Iterative Policy Evaluation – Designing Your RL Program – Grid world in Code – Lpi Convergence	
Unit-5 - Monte Carlo & Temporal Difference Methods	12 Hour
Monte Carlo Prediction – Monte Carlo Estimation of Action Values – Monte Carlo Control- MC Control Without Exploring starts - Off Policy MC – UCT – TD - Q-Learning – After state – Eligibility Traces – Eligibility Trace Control – Thompson Sampling – Function Approximation - LSTD and LSTDQ – Hierarchical Reinforcement Learning – Temporal Prediction – Advantage of TD Prediction – Optimality of TD – Maximization Bias and Double Learning.	

Lab Experiments

Lab 1: Apply RL Techniques for binary classification problem
 Lab 2: Apply RL Algorithms for solving real world classification problem
 Lab 3: Implement Tic Tac Toe problem
 Lab 4: Implement K-armed bandit problem with gradient descent
 Lab 5: Implement linear regression with stochastic mini-batch gradient descent and compare the results with previous exercise
 Lab 6: Optimizing RL using Rewards, Returns and early stopping
 Lab 7: Implement Markov chain process
 Lab 8: Build an Optimal value estimation problem
 Lab 9: Building RL to perform Object detection
 Lab 10: Reinforcement Learning for driving autonomous vehicle
 Lab 11: Apply Dynamic Programming for finding Longest common subsequence
 Lab 12: Implement Matrix chain multiplication
 Lab 13: Case study on Image processing
 Lab 14: Case study on game play for Poker, StarCraft
 Lab 15: Neural Machine Translation with attention.

Learning Resources	1. Reinforcement Learning and Dynamic Programming using Function Approximators. Busoniu, Lucian; Robert Babuska; Bart De Schutter; Damien Ernst.	3. Reinforcement Learning: State-of-the-Art. Vol. 12 of Adaptation, Learning and Optimization. Wiering, M., van Otterlo, M. (Eds.), 2012
	2. Markov Decision Processes in Artificial Intelligence, Sigaud O. & Buffet O. editors, ISTE Ltd., Wiley and Sons Inc.	4. From Bandits to Monte-Carlo Tree Search: The Optimistic Principle Applied to Optimization and Planning" by Remi Munos (New trends on Machine Learning).

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	30%	-	-	30%	30%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.C.Sathishkumar, Project Manager, GoDB Technology Private Limited, Chennai	1. Mr.V.Sakthivel, Assistant Professor Senior Grade, School of Computer Science and Engineering , Vellore Institute of Technology - Chennai Campus	1. Dr.G Sivashankar SRMIST

Course Code	21AIC303T	Course Name	COMPUTER NETWORKS AND COMMUNICATIONS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the basic services and concepts related to Internetwork			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand the layered network architecture																	
CLR-3:	acquire knowledge in IP addressing																	
CLR-4:	exploring the services and techniques in physical layer																	
CLR-5:	understand the functions of Data Link layer & implement and analyze the different Routing Protocols																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	apply the knowledge of communication			2		3	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	identify and design the network topologies			2		3	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	design the network using addressing schemes			2	-	3	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	identify and correct the errors in transmission			2	-	3	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	identify the guided and unguided transmission media & Design and implement the various Routing Protocols			2	-	3	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	6 Hour
Evolution of Computer Networks, Network Categories, Data Transmission Modes, Network Topologies, Circuit Switching and Packet Switching, Protocols and standards, Layers in the OSI model, Functions of Physical layer, data link layer, Functions of Network layer, Transport layer, Functions of Session, Presentation layer and Application layer, TCP/IP protocol suite.	
Unit-2 - Addressing	6 Hour
IPv4 Addressing, Address space, Dotted Decimal Notation, Classful Addressing, Subnet Mask, Subnetting, Special Addresses, Classless Addressing, Problem Solving, Private Address, NAT, Supernetting, Routing Devices: Hub, Repeaters, Switch, Bridge.	
Unit-3 – Physical Layer	6 Hour
Line Coding: Unipolar Scheme, Polar Schemes, Bipolar Schemes, Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying, Pulse Code Modulation, Delta Modulation, Multiplexing: FDM, TDM, WDM, Guided Media: Twisted Pair, Coaxial Cable Fiber optic cable, Unguided media: Radio waves, Microwaves, Infrared	
Unit-4 – Data Link Layer	6 Hour
Framing, Flow Control Mechanisms, Sender side Stop and Wait Protocol, Receiver side Stop and Wait Protocol, Go back N ARQ, Selective Reject ARQ, CRC, Checksum, Forward Error Correction, CSMA, CSMA/CD, Hamming Distance, Correction Vs Detection.	
Unit-5 – Network Layer	6 Hour
Forward Techniques, Routing Table, Intradomain Routing and Interdomain Routing, Static Routing and Dynamic Routing, Distance Vector Routing, Problem Solving, Link State Routing, Problem Solving, Path vector Routing, RIP v1, RIP v2, OSPF, EIGRP, BGP.	

Learning	1. Behrouz A. Forouzan, "Data Communications and Networking" 5th ed., 2013	3. William Stallings, Data and Computer Communications, 9th ed., 2014
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Resources	2. Bhushan Trivedi, "Data Communication and Networks" 2016	4. Todd Lammle, CCNA Study Guide, 7th ed. 2011
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. S. Prabhu, Associate Manager, DXC technologies	1. Dr.Ghanapriya Singh, Associate Professor, NIT Kurukshetra.	1. Dr.N.Snehalatha, SRMIST
		2. Dr.D.Anitha, SRMIST

Course Code	21AIC401T	Course Name	INFERENTIAL STATISTICS AND PREDICTIVE ANALYTICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	gain the fundamentals of inferential statistics and techniques and methodologies of sampling distribution and estimation	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	understand parametric and non-parametric algorithms	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	describe predictive analytics in decision making															
CLR-4:	study boosting methods to solve real-world applications															
CLR-5:	create automating models															

Course Outcomes (CO):	At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	analyze the sample data makes an interference of the datasets	-	2	-	3	-	-	-	-	-	-	-	2	1	2	3
CO-2:	apply the hypothesis testing techniques and procedures	-	2	-	3	-	-	-	-	-	-	-	2	1	2	3
CO-3:	implement Correlation & Regression techniques & knowledge on predictive analytics	-	3	-	3	-	-	-	-	-	-	-	2	1	2	3
CO-4:	create models using various algorithms	-	3	-	3	-	-	-	-	-	-	-	2	1	2	3
CO-5:	utilize different tools to deploy, assess & update the model	-	2	-	3	-	-	-	-	-	-	-	2	1	2	3

Unit-1 - Introduction to Inferential Statistics	9 Hour
Introduction to inferential statistics, sampling distribution and estimation -Introduction-probability sampling-sampling distribution, Introduction to estimation-bias and efficiency-estimation procedures for sample means-sampling distribution of the sample mean and sample proportion-continuous probability distributions-confidence interval for the mean of population, for the population proportion, for the variance of population, for two population parameters. Case study: Set up data, from a suitable quantitative study, for data analysis using Excel, SPSS, and other statistical software. Perform population parameters for health and medical applications	
Unit-2 - Hypothesis Testing	9 Hour
Hypothesis testing procedures, Hypothesis testing I: The one sample case, Hypothesis testing II: The two sample case, Hypothesis testing III: The analysis of variance (ANOVA), Covariance (ANCOVA) Hypothesis testing IV: Chi Square. Non-parametric tests- T Test, Paired T-Test Case Study: Use ANOVA or ANCOVA where appropriate to analyze and interpret data collected from factorial designs	
Unit-3 - Correlation & Regression and Analytics	9 Hour
Correlation, Inference for correlation, Introduction to simple linear regression, Inference for regression parameters, Inference for prediction; Introduction to Analytics, Analytics in Decision Making, Predictive Analytics, Data Preparation: Reading, Data visualization, Distributions and summary statistics, Relationships among variables, Extent of Missing Data. Segmentation, Outlier detection, Automated Data Preparation, Combining data files, Aggregate Data, Duplicate Removal, Sampling DATA, Data Caching, Partitioning data, Missing Values.	
Unit-4 - Model Development & Techniques	9 Hour
Data Partitioning, Model selection, Model Development Techniques, Generalized additive models, Regression and classification trees, Neural networks, Decision trees, Logistic regression, Discriminant analysis, Support vector machine, Bayesian Networks, Cox Regression, Association rules. Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting	

Unit-5 - Model Evaluation and Deployment**9 Hour**

Introduction, Model Validation, Rule Induction Using CHAID, Automating Models for Categorical and Continuous targets, Comparing and Combining Models, Evaluation Charts for Model Comparison, MetaLevel Modeling, Deploying Model, Assessing Model Performance, Updating a Model

Learning Resources	1. <i>Essentials of Inferential Statistics-Fourth Edition, Malcolm O.Asadoorian, Demetri Kantarelis, University Press of America</i>	2. <i>The Essentials of STATISTICS A Tool for Social Research”, Second Edition, Joseph F. Healey, Christopher Newport University, Wadsworth Cengage Learning</i>
		3. <i>Predictive & Advanced Analytics (IBM ICE Publication)</i>

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%-	-	30%-	-	30%-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Sakthivel E, Lead Engineer – Development, FIS Global Business India Pvt, Ltd.	1. Dr. P.Sriramya, SIMATS, Chennai	1. Dr. R A Karthika, SRMIST
	2. Dr. K M Monica, VIT, Chennai	

Course Code	21AIC402T	Course Name	DESIGN OF ARTIFICIAL INTELLIGENCE PRODUCTS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the fundamental concepts of AI and Machine Learning			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	explore the concepts of AI applied to issues in medical field and to develop solution model			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3
CLR-3:	explain the dynamics of Gaming and the design of Gaming with AI			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3
CLR-4:	explore the concepts, methods and application of Artificial Intelligence in Robotics			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3
CLR-5:	design of AI products as Human Centered			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3

Course Outcomes (CO):		At the end of this course, learners will be able to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	explore the basics of AI and Machine learning			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3
CO-2:	design and Develop AI based solution to healthcare industry			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3
CO-3:	structure the design of Gaming with AI			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3
CO-4:	apply Artificial Intelligent techniques in Robotics			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3
CO-5:	examine the Human Centered AI products			-	-	3	-	3	-	-	-	-	-	-	1	3	3	3

Unit-1 - Introduction to AI Design	9 Hour
What's AI - Risks and Benefits of AI – Types of intelligence - Narrow artificial intelligence - General intelligence, Super intelligence – Training AI with Design - How can AI help in a creative process?- AI Characteristics - AI Design Principles - How does AI become intelligent - Machine Learning, the first step to AI - Types Of Machine Learning - Supervised Machine Learning Algorithms - Unsupervised Machine Learning Algorithms- Support Vector Machines - Neural Networks - Naïve Bayesian Classifier - Hidden Markov Models - k-Means Clustering	
Unit-2 - AI in Healthcare	9 Hour
The rise of AI in healthcare applications – Drug discovery and Molecular modeling in AI – Cancer diagnostics and treatment decisions using Ai – Ai for medical imaging – Outputs of AI in radiology/medical imaging – X-rays and AI in medical imaging (Zebra medical Vision) – Ultrasound and AI in medical imaging (Butterfly iQ) – development of AI in medical devices – Limitations of AI in medical imaging – The future frontiers of AI in medical devices	
Unit-3 - AI in Gaming	9 Hour
Model of Game AI –Algorithms and Data structures used in Gaming - The Complexity Fallacy – The kind of AI in Games – Speed and Memory Constraints – The AI engine – Basic and Kinematic movement algorithms – Steering Behaviors – Combining Steering behaviors – Coordinated movement – Path finding – Hierarchical Pathfinding – Continuous time pathfinding – Movement planning – Designing Game AI – AI Based Game Genres	
Unit-4 - AI in Robotics	9 Hour
Foundation for advanced robotics and AI technical requirements – Setting up your robot technical requirements – A concept for a practical robot design process a system engineering-based approach – use cases for cleaning up the playroom – Storyboards	

Unit-5 - Human Centered AI**9 Hour**

What is Human Centered AI – HCI framework – Implications for design – The influence of AI + HCI on Teachers' psychological changes in academic management in colleges – Case study about AI products (Self driving cars, Smart assistant, social media monitoring)

Learning Resources	1. Stuart J. Russell and Peter Norvig, <i>Artificial Intelligence A Modern Approach</i> , Fourth Edition, Pearson, 2020.	3. Ian Millington, <i>Artificial Intelligence for Games</i> , CRC Press, Third Edition, 2019
	2. Adam Bohr and Kaveh Memarzadeh, <i>Artificial Intelligence in Healthcare</i> , Academic press, 2020	4. Francis X Govers, <i>Artificial Intelligence for Robotics</i> , Packt publishing, 2018 5. Ben Schneiderman, <i>Human-Centered AI</i> , Oxford University Press, 2022

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	25%	-	20%	-	20%	-
Level 4	Analyze	25%	-	20%	-	20%	-
Level 5	Evaluate	10%-	-	20%	-	20%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Somasundaram, VDSI	1. Dr.Sivasankar, NIT,Trichy	1. Dr.S.Aruna, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



SRM
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21AIE321T	Course Name	STOCHASTIC DECISION MAKING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	outline the overall view of Stochastic Decision-Making system			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	build the DSS using various tools and techniques			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3
CLR-3:	analyze the process of Intelligent Decision support System building			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3
CLR-4:	identifying the stochastic optimization techniques			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3
CLR-5:	applying the DSS in different areas, how it is used for real world problems			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3

Course Outcomes (CO):		At the end of this course, learners will be able to:		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	outline the use of Stochastic decision making and know the components			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3
CO-2:	infer various tools to build the DSS			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3
CO-3:	interpret knowledge of how Intelligent DSS to be build			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3
CO-4:	relate knowledge on different types optimization techniques			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3
CO-5:	utilize the concepts of DSS in various fields			-	2	-	-	2	-	-	-	-	-	-	-	1	2	3

Unit-1 - Introduction	9 Hour
Introduction to Stochastic Processes- Stochastic Systems- What is Stochastic in machine learning –Stochastic process –Decision making –Online decision making under Stochastic constraints	
Unit-2 - Decision Support System Development	9 Hour
SDLC-Prototyping-DSS technology levels and Tools- Development platforms-Tools selection	
Unit-3 - Intelligent Decision Support System	9 Hour
The needs of decision support tools- Modelling of Decision Process- IDSS Architecture, Analysis, Design, Requirements, and Validation- Impact of IDSS in Industrial Performance. Economic Impact of IDSS in industry- Agile Approach for Smart Production	
Unit-4 - Stochastic Optimization	9 Hour
What is Stochastic Optimization – SGD for machine learning - Stochastic Gradient Descent - what is Gradient Descent and Stochastic Gradient Descent - Stochastic Approximation Statistical Average Approximation - Machine Learning as Stochastic Optimization - Stochastic Convex Optimization in Machine Learning	
Unit-5 - Applications	9 Hour
Application of DSS in the areas of Transportation-Healthcare-Food Industry- Urban Design –Case study	

Learning	1. Stochastic modeling using machine learning and stochastic differential	5. Gupta, J.N.D., Forgionne, G.A., and Manuel, M.T., Intelligent Decision-making Support
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Resources	equations, Chalmers University Of Technology, Gothenburg, Sweden 2022	Systems: Foundations, Applications and Challenges, Springer, 2016
	2. Efraim Turbon, Jay.E.Aronson, Ting Peng Liong-Decision Support System and Intelligent systems-9 th edition Printice hall of india., 2015	6. Tweedale, J.W., Neves-Silva, R., Jain, L.C., Phillips-Wren, G., Watada, J., and Howlett, R.J., Intelligent Decision Technology Support in Practice, Springer, 2016
	3. Iantovics, B., and Kountchev, R., Advanced Intelligent Computational Technologies and Decision Support Systems, Springer, 2014	7. Valencia-Garcia, R, Paredes-Valverde, M.A., Salas-Zarate, M.P. and Alor-Hernandez, Giner., Exploring Intelligent Decision Support Systems, Springer, 2018
	4. Kumer. K., Zindani, D. and Davim, J.P., Digital Manufacturing and Assembly Systems in Industry 4.0, CRC Press, 2019	8. Stochastic Optimization for Large-scale Machine Learning By Vinod Kumar Chauhan, Taylor and Francis Group, 2022

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Shravan Kumar, Outreach and partnership Manager, Crion Learn by Crion Technologies, IITM Incubated Company at IIT Madras Research Park.	1. Dr. V. Pandiyaraju, Assistant professor, VIT Chennai	1. Dr.K.Vijayalakshmi, SRMIST

Course Code	21AIE322T	Course Name	COGNITIVE SCIENCE ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	gain knowledge about applications of cognitive computing			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand assess cognitive computing and Artificial Intelligence Applications use and their requirements			-	2	-	-	2	-	-	-	-	-	-	-	3	3	2
CLR-3:	describe Cognitive analytics and AI powered applications techniques			-	2	-	-	2	-	-	-	-	-	-	-	3	3	2
CLR-4:	study various analytics techniques to solve real world applications			-	2	-	-	2	-	-	-	-	-	-	-	3	3	2
CLR-5:	create cognitive analytics			-	2	-	-	2	-	-	-	-	-	-	-	3	3	2

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

CO-1:	understand the concepts of AI and its related applications
CO-2:	apply machine learning techniques in various domains
CO-3:	develop skills in analysing, interpreting, and assessing the empirical data
CO-4:	create cognitive computing models using various algorithms
CO-5:	develop the ability to choose knowledge representation method for different problems

Unit-1 – Introduction to Image Processing	9 Hour
Introduction to Digital Image and Video Processing - Gray-Level Image Processing – Tools for Image Fourier Analysis- Binary Image Processing - Basic Linear Filtering with Application to Image Enhancement - Nonlinear Filtering for Image Analysis and Enhancement - Methods for Image Restoration and Identification- Regularization in Image Restoration – Image Reconstruction	
Unit-2 – Imaging Models	9 Hour
3-D Shape Reconstruction from Multiple Views - Image Sequence Stabilization - Mosaicking - Super Resolution - Image Representations and Image Models - Computational Models of Early Human Vision - Multi scale Image Decompositions and Wavelets - Random Field Models - Image Modulation Models - Image Noise Models - Color and Multispectral Image Representation and Display	
Unit-3 – Classification and Segmentation	9 Hour
Image Modulation Models - Image Noise Models - Image Classification and Segmentation - Multiband Techniques for Texture Classification and Segmentation - Video Classification and Segmentation - Adaptive and Neural Methods for Image Segmentation - Gradient and Laplacian-Type Edge Detection - Diffusion-Based Edge Detectors - Software for Video Processing	
Unit-4 – Image Compression Techniques	9 Hour
Image Compression - Lossless Coding - Block Truncation Coding - Fundamentals of Vector Quantization - Structured VQ - Wavelet Image Compression - The JPEG Lossy Image Compression Standard - The JPEG Lossless Image Compression Standards - Multispectral Image Coding	
Unit-5 – Video Compression Techniques	9 Hour
Video Compression - Techniques of Video Coding - H.261 Standard - Spatiotemporal Subband/Wavelet Video Compression – Object Based Video Coding - MPEG1 and MPEG2 Video Standards - Emerging MPEG Standards: MPEG4 and MPEG7 - Image Scanning. Sampling and Interpolation - Video Sampling and Interpolation	

Learning Resources	1. <i>Cognitive Computing and Big Data Analytics</i> By Judith S. Hurwitz, Marcia Kaufman, Adrian	3. Raghavan, Vijay V., et al. <i>Cognitive computing: Theory and applications</i> . Elsevier, 2016.
	2. Hariom Tatsat, Sahil Puri and Brad Lookabaugh, <i>Machine Learning and Data Science</i> O'Reilly Media, 2020.	4. <i>Python for Data Analysis</i> by Wes McKinney 2020.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.C.Sathishkumar, Project Manager, GoDB Technology Private Limited, Chennai	1. Mr.V.Sakthivel, Assistant Professor Senior Grade, School of Computer Science and Engineering, Vellore Institute of Technology - Chennai Campus	1. Dr.G Sivashankar SRMIST

Course Code	21AIE323T	Course Name	INTERNET OF THINGS: ARCHITECTURE AND PROTOCOLS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes				
CLR-1:	describe the IoT Architecture	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-2:	state IoT Reference Architecture and its Real-world Design Constraints																													
CLR-3:	comprehend the various IoT Data link layer and network layer protocols																													
CLR-4:	interpret the various IoT transport and session layer protocols																													
CLR-5:	understand the IoT service layer protocols and security																													
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	-	-	-	2	-	2	-	-	-	-	-	-	-	1	-	3
CO-1:	obtain the IoT architecture overview	-	-	-	-	2	-	2	-	-	-	-	-	1	-	3														
CO-2:	acquire the concepts of IoT Architecture Reference model and IoT reference architecture	-	-	-	-	2	-	2	-	-	-	-	-	1	-	3														
CO-3:	utilize various IoT layer Protocols in real time systems.	-	-	-	-	2	-	2	-	-	-	-	-	1	-	3														
CO-4:	apply IP based protocols and Authentication Protocols for IoT applications	-	-	-	-	2	-	2	-	-	-	-	-	1	-	3														
CO-5:	infer the essentials of IoT security and its applications	-	-	-	-	2	-	2	-	-	-	-	-	1	-	3														

Unit-1 - Overview	9 Hour
IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management	
Unit-2 - Reference Architecture	9 Hour
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.	
Unit-3 - IoT Data Link Layer & Network Layer Protocols	9 Hour
Physical Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z-Wave, Bluetooth Low Energy, Zig bee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP.	
Unit-4 - Transport & Session Layer Protocols	9 Hour
Transport Layer Transmission Control Protocol, MultipathTCP, User Datagram Protocol, Datagram Congestion Control Protocol, Stream Control Transmission Protocol- Transport Layer Security, Datagram Transport Layer Security – Session Layer- Hypertext Transfer Protocol, Constrained Application Protocol, Extensible Messaging and Presence Protocol, Advanced Message Queuing Protocol, MQ Telemetry Transport.	
Unit-5 - Service Layer Protocols & Security	9 Hour
Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, Routing Protocol for Low-Power and Lossy Networks.	

Learning Resources	1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer	4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
	2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.	5. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Wiley Publications.
	3. Peter Waher, "Learning Internet of Things", PACKT publishing, Birmingham – Mumbai	6. Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2014.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.N.Prakash, Associate Professor, Department of Information technology, B.S.A Crescent Institute of Science and Technology.	1. Mrs.B. Jothi SRMIST

Course Code	21AIE324T	Course Name	INTELLIGENT AUTONOMOUS SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	introduction to general aspects to develop intelligent autonomous systems			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	demonstrate the approaches and solution to handle the IA system			-	-	2	-	-	-	-	2	-	-	-	-	2	2	3
CLR-3:	illustrate the issues related to design and development of autonomous mobile robots			-	-	2	-	-	-	-	2	-	-	-	-	2	2	3
CLR-4:	describe the fundamental aspects of Autonomous Vehicle design			-	-	2	-	-	-	-	2	-	-	-	-	2	2	3
CLR-5:	discuss about different features of autonomous stair climbing mechanism			-	-	2	-	-	-	-	2	-	-	-	-	2	2	3

Course Outcomes (CO):		At the end of this course, learners will be able to:	
CO-1:	get the outline of various types of intelligent agents		
CO-2:	able to understand the real time problems and provide solutions by following the constraints		
CO-3:	recognize the conventional potential design methods for planning the robot motion without any human intervention		
CO-4:	identify the different levels of automation involved in an Autonomous Vehicle		
CO-5:	construct motion on plane surface and navigation on stair- case		

Unit-1 – Introduction to Intelligence Autonomous Systems	9 Hour
Towards Intelligent autonomous system – Introduction, General aspect of intelligent autonomous-Preliminaries and Motivations- Agents, the structure of agents through an example of the vacuum agent, Autonomy and intelligent, motivation for intelligent autonomous agents. Representative examples of state of art – simple reflex agent, Model based reflex agent, Random agent program, all agent's activity.	
Unit-2 - IAA Technology	9 Hour
IAA Technology In process: AI methods in store for IAAS, Longer term perspective, Five challenges, Logical approach, Consideration for the development. Embedding values into autonomous and intelligent system-identifying norms for autonomous and intelligent systems, implementing the norms, Evaluating the implantation of A/IS. Develop a snake game in python with intelligent, self-learning agents. Train the intelligent agent for object detection.	
Unit-3 - Design and Development of Intelligent Autonomous Robots	9 Hour
Autonomous Mobile Robots, Robot Motion Planning Approaches- Algorithmic Approaches - Soft Computing-Based Approaches, Environment Modeling, Road Map and path construction with RRT algorithm, Proposed Motion Planning Scheme and Mathematical Formulation of the Problem, Developed Motion Planning Approaches. Construction, Exploration of environment with unknow obstacle's location using Random walk algorithm. Performance Testing through Computer Simulations, Camera Calibration and Image Processing, Performance Testing through Real Experiments. Monitor the position of robot based on given four directions.	
Unit-4 - Autonomous Vehicle Technology	9 Hour
Driverless Car Technology-Different Levels of Automation -Localization - Path Planning. Controllers to Actuate a Vehicle - PID Controllers -Model Predictive Controllers, ROS Framework. Kinematics and Control of a differential drive vehicle, Place Recognition & Line Fitting. Autonomous Vehicles' Biggest Challenges, Technical Issues, Security Issues, Moral and Legal Issues. Develop system for performing planning with Map-Based Localization along with Potential Field Methods	
Unit-5 – Case Studies	9 Hour

Mobile Robotic Vehicle for Stair-Case Navigation- Genesis, Kinematics, Dynamics and Control, Dynamic Model for Stair Climbing, Modeling of the Payload Platform Orientation Mechanism, Fuzzy Logic Controller, Vision System Intelligent Autonomous Systems in Psychiatry and production industry.

Learning Resources	1. Intelligent Autonomous Systems- Foundations and Applications, Dilip Kumar Pratihari Lakhmi C. Jain, https://link.springer.com/book/10.1007/978-3-642-11676-6 , 2010, 2. Studies in Computational Intelligence, Volume 275.(unit 1 to 5)	3. Hong Cheng, "Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation", Springer, 2011. (Unit 4) 4. Sebastian Thrun, Wolfram Burgard, Dieter Fox: Probabilistic Robotics. MIT Press, 2005(Reference material for unit 3)
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	20%	-	20%	-
Level 2	Understand	50%	-	30%	-	30%	-
Level 3	Apply	-	-	50%	-	50%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Marriappan Vaithilingam, Senior Director of Engineering, Fresh works	1. Dr. Udendran, Dept. of CSE., Bharathidasan University, Tiruchirappalli	1. Mrs.A.Saranya, SRMIST

Course Code	21AIE325T	Course Name	INTELLIGENCE OF BIOLOGICAL SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	outline the Fundamentals of Evolutionary Systems															
CLR-2:	articulate Modeling with Cellular Systems															
CLR-3:	illustrate Neural Systems with different Learning Methods															
CLR-4:	implement Developmental and Immune System Algorithms															
CLR-5:	experiment Behavioral Systems for Robots															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	understand the Fundamentals of Evolutionary Systems	-	-	2	-	2	-	-	-	-	-	-	-	2	3	-
CO-2:	analyze Cellular Systems	-	-	2	-	2	-	-	-	-	-	-	-	2	3	-
CO-3:	analyze Neural Systems with different types of Learning	-	-	2	-	2	-	-	-	-	-	-	-	2	3	-
CO-4:	apply Developmental and Immune Systems Algorithms	-	-	2	-	2	-	-	-	-	-	-	-	2	3	-
CO-5:	apply Behavioral Systems for Robots	-	-	2	-	2	-	-	-	-	-	-	-	2	3	-

Unit-1 - Evolutionary Systems	9 Hour
Pillars of Evolutionary Theory – The Genotype – Artificial Evolution – Genetic Representations – Initial Population – Fitness Functions – Selection and Reproduction – Genetic Operators – Evolutionary Measures – Types of Evolutionary Algorithms – Schema Theory – Human-Competitive Evolution – Evolutionary Electronics - The Role of Abstraction – Analog and Digital Circuits – Extrinsic and Intrinsic Evolution – Digital Design – Evolutionary Digital - Analog Design - Evolutionary Analog Design	
Unit-2 - Cellular Systems	9 Hour
The Basic Ingredients - Cellular Automata – Modeling with Cellular Systems - Some Classic Cellular Automata - Other Cellular Systems – Computation - Artificial Life - Complex Systems - Analysis and Synthesis of Cellular Systems	
Unit-3 - Neural Systems	9 Hour
Biological Nervous Systems - Artificial Neural Networks - Neuron Models - Architecture - Signal Encoding - Synaptic Plasticity - Unsupervised Learning - Supervised Learning - Reinforcement Learning - Evolution of Neural Networks - Neural Hardware - Hybrid Neural Systems	
Unit-4 - Developmental and Immune Systems	9 Hour
Potential Advantages of a Developmental Representation - Rewriting Systems - Synthesis of Developmental Systems - Evolution and Development - Defining Artificial Evolutionary Developmental Systems - Evolutionary Rewriting Systems - Evolutionary Developmental Programs - Evolutionary Developmental Processes-How Biological Immune Systems Work - The Constituents of Biological Immune Systems - Lessons for Artificial Immune Systems - Algorithms and Applications - Shape Space - Negative Selection Algorithm - Clonal Selection Algorithm	
Unit-5 - Behavioral Systems	9 Hour
Behavior in Cognitive Science - Behavior in Artificial Intelligence - Behavior-Based Robotics - Biological Inspiration for Robots - Robots as Biological Models - Robot Learning - Evolution of Behavioral Systems - Evolution and Learning in Behavioral Systems - Evolution and Neural Development in Behavioral Systems - Coevolution of Body and Control - Toward Self-Reproduction - Simulation and Reality	

Learning Resources	1. Darion Floreano and Claudio Mattiussi, <i>Bio-Inspired Artificial Intelligence Theories, Methods, and Technologies</i> , MIT Press, 2008.	3. Shuxiang Xu and Yunling Liu, <i>Nature-Inspired Computing Concepts, Methodologies, Tools, and Applications</i> , IGI Global, 2017
	2. Tao Song, Pan Zheng, Mou Ling Dennis Wong, <i>Bio-inspired Computing Models and Algorithms</i> , World Scientific, 2019.	4. Srikanta Patnaik, Xin-She Yang, Kazumi Nakamatsu, <i>Nature-Inspired Computing and Optimization Theory and Applications</i> , Springer, 2017 5. Karthik Raman, <i>An Introduction to Computational Systems Biology (Systems Level Modeling of Cellular Networks)</i> , CRC Press, 2021.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	20%	-	20%	-
Level 2	Understand	50%	-	30%	-	30%	-
Level 3	Apply	-	-	50%	-	50%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Guruprasad Lakshmanan, Chief Technology Officer, Twice Group & Blocksrus, Chennai	1. Dr. B.Sathish Babu, Professor, Department of AI & ML, RV College of Engineering, Bengaluru, Karnataka	1. Dr.M.S.Abirami, SRMIST

Course Code	21AIE330T	Course Name	TEXT PROCESSING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	introduce the fundamental concepts and techniques of text processing			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	gain an in-depth understanding of the computational properties of natural languages																	
CLR-3:	understand the concepts of grammar, context-free grammar and text feature structures																	
CLR-4:	make use of logics, semantic analysis and thesaurus																	
CLR-5:	acquire knowledge in lexical resources																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	recognize the concepts and techniques of text processing			-	3	-	-	3	-	-	-	-	-	3	-	-	3	2
CO-2:	formulate natural language and algorithms for processing Linguistic Information			-	3	-	-	3	-	-	-	-	-	3	-	-	3	2
CO-3:	investigate the different natural language processing models			-	3	-	-	3	-	-	-	-	-	3	-	-	3	2
CO-4:	implement a rule-based system to tackle morphology/syntax of a language			-	3	-	-	3	-	-	-	-	-	3	-	-	3	2
CO-5:	compare and contrast the use of different statistical approaches for different types of natural language processing applications			-	3	-	-	3	-	-	-	-	-	3	-	-	3	2

Unit-1 - Introduction	9 Hour
Origins and challenges of NLP – Language Modelling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.	
Unit-2 - Word Level Analysis	9 Hour
Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.	
Unit-3 - Syntactic Analysis	9 Hour
Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures. Case study: Segment the given sentence and normalise, perform normalization and tagging of text in a given file.	
Unit-4 - Semantics and Pragmatics	9 Hour
Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods. Case study: Text Paraphrasing, Identify the named entities and display a parse tree, Perform Noun Phrase Chunking for the given text and exclude the specified sequence using chunking.	

Unit-5 - Discourse Analysis and Lexical Resources**9 Hour**

Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC). Case study: Text Classification using Naive Bayes, Text Analysis.

Learning Resources	1. Daniel Jurafsky and James H Martin, "Speech and Language Processing", 3e, Pearson Education, 2018.	3. Breck Baldwin, —Language processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.
	2. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana "Practical Natural Language Processing", O'Reilly; First edition, 2020	4. Richard M Reese, — Natural Language Processing with Java, O'Reilly Media, 2015. 5. Nitin Indurkha and Fred J. Damerau, — Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

Learning Assessment

		Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
			Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
			Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	
Level 2	Understand	20%	-	20%	-	20%	-	
Level 3	Apply	30%	-	30%	-	30%	-	
Level 4	Analyze	30%	-	30%	-	30%	-	
Level 5	Evaluate	-	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	-	
		Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. J.Aparna, Tata Consultancy Services	1. Dr. Balarengadurai Chinnaiah, Marri Laxman Reddy Institute of Technology & Management, Hyderabad	1. Dr. Gopirajan PV, SRMIST
2. Mr.K.P.Amarnath, Senior Data scientist, Vectone	2. Dr. V. Sathiesh, Madras Institute of Technology Campus, Anna University	2. Dr.K.Suresh, SRMIST

Course Code	21AIE331T	Course Name	ADVANCED SOCIAL, TEXT AND MEDIA ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes												
CLR-1:	outline the fundamentals Digital Media and web analytics	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	demonstrate the overview of text data analytics for various types of data streams																											
CLR-3:	understand the various dimensions of social data analytics																											
CLR-4:	explain different advanced analytics tools to predict social data analytics and applications																											
CLR-5:	introduce the concepts of media analytics and visualisation strategy																											
Course Outcomes (CO):		At the end of this course, learners will be able to:		-	3	-	-	3	-	-	-	3	-	-	3	-	-	-	-	-	-	3	-	-	-	3	-	
CO-1:	apply state of the art web mining tools and libraries on realistic datasets as a basis for business decisions and applications	-	3	-	-	3	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	-	-	-	3	-	
CO-2:	perform social network analysis to identify important social actors, subgroups and network properties in social media sites	-	3	-	-	3	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	-	-	-	3	-	
CO-3:	provide solutions to the emerging problems with social media such as behavior analytics and Recommendation systems	-	3	-	-	3	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	-	-	-	3	-	
CO-4:	interpret the terminologies, metaphors and perspectives of social media analytics	-	3	-	-	3	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	-	-	-	3	-	
CO-5:	design new solutions to opinion extraction, sentiment classification and data summarization, visualisation	-	3	-	-	3	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	3	-	-	-	3	-	

Unit-1 - Introduction to Text Analytics	9 Hour
Data mining - data mining functionalities- Data Pre-processing - Descriptive Data Summarization - Data Cleaning - Data Integration and Transformation - Data Reduction- Data Discretization and Concept Hierarchy Generation- A multidimensional Data Model - Data Warehouse - Data Warehouse Architecture.	
Unit-2 - Mining Text Stream, Time-Series, and Sequence Data	9 Hour
Mining Data Streams - Methodologies for Stream Data Processing and Stream Data Systems - Stream OLAP and Stream Data Cubes -Frequent-Pattern Mining in Data Streams - Classification of Dynamic Data Streams - Clustering Evolving Data Streams - Mining Time-Series Data- Trend Analysis - Similarity Search in Time-Series Analysis- Contents - Mining Sequence Patterns in Transactional Databases -Sequential Pattern Mining: Concepts and Primitives - Scalable Methods for Mining Sequential Patterns -Constraint-Based Mining of Sequential Patterns - Periodicity Analysis for Time-Related Sequence Data- Mining Sequence Patterns in Biological Data- Alignment of Biological Sequences -Hidden Markov Model for Biological Sequence Analysis.	
Unit-3 - Social Network Analytics	9 Hour
Essentials- Graph Essentials - Graph Basics - Graph Representation - Types of Graphs - Connectivity in Graphs - Special Graphs - Graph Algorithms- Network Measures - Centrality - Transitivity and Reciprocity - Balance and Status - Similarity- Network Models - Properties of Real-World Networks - Random Graphs - Small-World Model - Preferential Attachment Model.	
Unit-4 - Advanced Social Analytics and its Application	9 Hour
Communities and Interactions-Community Analysis - Community Detection - Community Evolution - Community Evaluation-Information Diffusion in social media - Herd Behavior - Information Cascades - Diffusion of Innovations - Epidemics-Recommendation in social media - Challenges - Classical Recommendation Algorithms - Recommendation Using Social Context - Evaluating Recommendations -Behavior Analytics - Individual Behavior - Collective Behavior	

Unit-5 - Media Analytics**9 Hour**

The four dimensions of analysis taxonomy - Depth of Analysis- Machine capacity-Domain of analysis- Data Integrity - Ad-Hoc Analysis-Responding to leads identified in social media-support for deep analytics in analytics software-Enterprise social network- visualisation as an aid to analytics

Learning Resources	1. Data Mining: Concepts and Techniques Second Edition, Jiawei Han and Micheline Kamber. [Unit 1, 2]. 2. Social Media Mining an Introduction - Reza Zafarani, Mohammad Ali Abbasi Huan Liu [Unit 3, 4]. 3. Social Media Analytics - Techniques and insights for extracting business value out of social media - Matthew Ganis and Avinash Kohirkar [Unit 5]
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. K.Selvanayagam, Practise lead,CPQ ,Salesforce, Preludesys India Pvt Ltd	1. Dr.M.Mariamammal, Anna University	1. Dr.M.Maheswari SRMIST

Course Code	21AIE332T	Course Name	IMAGE AND VIDEO PROCESSING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	outline the fundamentals of various image and video processing concepts												
CLR-2:	describe the concepts of Reconstruction from Multiple Images												
CLR-3:	discuss the various image and Video Segmentation												
CLR-4:	apply the different coding techniques												
CLR-5:	use the concepts of various video coding techniques for video compression												

Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	articulate the fundamentals of various image and video processing techniques												
CO-2:	demonstrate different image Representation and Reconstruction models												
CO-3:	illustrate the various image and Video Segmentation methods												
CO-4:	implement different coding techniques and vector quantization for image compression												
CO-5:	apply various video coding techniques for video compression												

Program Outcomes (PO)												Program Specific Outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Introduction to Digital Image and Video Processing	9 Hour
Gray-Level Image Processing – Tools for Image Fourier Analysis- Binary Image Processing - Basic Linear Filtering with Application to Image Enhancement - Nonlinear Filtering for Image Analysis and Enhancement - Methods for Image Restoration and Identification- Regularization in Image Restoration – Image Reconstruction	
Unit-2 - Image Representation and Reconstruction Models	9 Hour
3-D Shape Reconstruction from Multiple Views - Image Sequence Stabilization - Mosaicking - Super Resolution - Image Representations and Image Models - Computational Models of Early Human Vision - Multi scale Image Decompositions and Wavelets - Random Field Models - Image Modulation Models - Image Noise Models - Color and Multispectral Image Representation and Display	
Unit-3 - Image and Video Segmentation Methods	9 Hour
Image Modulation Models - Image Noise Models - Image Classification and Segmentation - Multiband Techniques for Texture Classification and Segmentation - Video Classification and Segmentation - Adaptive and Neural Methods for Image Segmentation - Gradient and Laplacian-Type Edge Detection - Diffusion-Based Edge Detectors - Software for Video Processing	
Unit-4 - Image Compression Techniques	9 Hour
Lossless Coding - Block Truncation Coding - Fundamentals of Vector Quantization - Structured VQ - Wavelet Image Compression - The JPEG Lossy Image Compression Standard - The JPEG Lossless Image Compression Standards - Multispectral Image Coding	
Unit-5 - Video Compression Techniques	9 Hour
Techniques of Video Coding - H.261 Standard - Spatiotemporal Subband/Wavelet Video Compression – Object Based Video Coding - MPEG1 and MPEG2 Video Standards - Emerging MPEG Standards: MPEG4 and MPEG7 - Image Scanning. Sampling and Interpolation - Video Sampling and Interpolation	

Learning	1. Alan Bovik, "Handbook of Image and Video Processing", Second Edition, Academic	4. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University
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Resources	Press, 2005	Press, 2012. Michael Berthold, David J.Hand, <i>Intelligent Data Analysis</i> , Springer.
	2. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Ed., Prentice-Hall, 2008	5. Rama Chellappa, Amit K.Roy-Chowdhury, Kevin Zhou.S, "Recognition of Humans and their Activities using Video", Morgan&Claypool Publishers, 2005.
	3. A. Murat Tekalp, "Digital Video Processing", Second Edition, Prentice Hall, 2015.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. A. Mohan Raj, Senior Data Analyst, Standard Chartered	1. Dr. V. Vijayarajan, Associate Professor/HOD, VIT, Vellore	1. Dr. S.Vimal, SRMIST
	2. Dr. T. SudalaiMuthu, Professor, Hindustan University, Chennai	

Course Code	21AIE335T	Course Name	SURVEILLANCE VIDEO ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes					
CLR-1:	explore the fundamental concepts of video analytics	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-2:	apply various methods to perform object classification																														
CLR-3:	use different models to recognize human activity																														
CLR-4:	demonstrate different methods to perform video object tracking																														
CLR-5:	create machine learning models for surveillance applications																														
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	-	3	-	3	-	-	2	-	-	-	-	-	-	-	-	2	3
CO-1:	articulate the basics of video analytic components	-	-	3	-	3	-	-	2	-	-	-	-	-	-	3	-	-	2	-	-	-	-	-	-	2	3				
CO-2:	illustrate different methods for object classification	-	-	3	-	3	-	-	2	-	-	-	-	-	-	3	-	-	2	-	-	-	-	-	-	2	3				
CO-3:	interpret different models for human activity recognition	-	-	3	-	3	-	-	2	-	-	-	-	-	-	3	-	-	2	-	-	-	-	-	-	2	3				
CO-4:	examine various methods for video object tracking	-	-	3	-	3	-	-	2	-	-	-	-	-	-	3	-	-	2	-	-	-	-	-	-	2	3				
CO-5:	develop machine learning models for surveillance applications	-	-	3	-	3	-	-	2	-	-	-	-	-	-	3	-	-	2	-	-	-	-	-	-	2	3				

Unit-1 - Video Analytic Components	9 Hour
Need for Video Analytics-Overview of video Analytics- Video compression - Motion segmentation - Motion segmentation algorithms - Optical flow methods - Applications- Background modelling techniques - Shadow detection and removal	
Unit-2 - Object Tracking	9 Hour
Object classification - Shape based - object classification - Motion based object classification - Viola Jones object detection framework - Object classification using CNN - Object classification using Regional CNN	
Unit-3 - Human Activity Recognition	9 Hour
Motion history based-Human Activity Recognition - Hidden Markov Models - HMM based activity recognition - Dynamic time warping - based activity recognition - Abnormal activity recognition Challenges of Intelligent Human Activity Recognition.	
Unit-4 - Video Object Tracking	9 Hour
Introduction - Tracking challenges - Steps of video object tracking system - Kalman filter - Region based tracking - Contour based tracking - Feature based tracking - Model based tracking - KLT tracker - Mean-shift-based tracking.	
Unit-5 - Surveillance Systems and Applications	9 Hour
Introduction - Video content analytics - Baggage exchange detection - Fence crossing detection - Military applications - Abandoned object detection- perimeter security - human behavioral analysis - Transportation - crowd analysis and prediction of crowd congestion.	

Learning	1. Maheshkumar H Kolekar. Intelligent video surveillance systems an algorithmic	4. Zhihao Chen (Author), Ye Yang (Author), JingyuXue (Author), Liping Ye (Author), Feng Guo
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Resources	approach. Tylor and Francis publisher (2019).	(Author), The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video Analytics Suite, CreateSpace Independent Publishing Platform, 2014
	2. Graeme A. Jones (Editor), Nikos Paragios (Editor), Carlo S. Regazzoni (Editor) Video-Based Surveillance Systems: Computer Vision and Distributed Processing, Kluwer academic publisher, 2001	5. 5. Caifeng Shan (Editor), Fatih Porikli (Editor), Tao Xiang (Editor), Shaogang Gong (Editor) Video Analytics for Business Intelligence, Springer, 2012
	3. Nilanjan Dey (Editor), Amira Ashour (Editor) and Suvojit Acharjee (Editor), Applied Video Processing in Surveillance and Monitoring Systems (IGI global) 2016	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Shenbagavalli, Senior Specialist, AXA Insurance Pte Ltd, Singapore	1. Dr.Y.V.Lokeshwari, Associate Professor, SSN College of Engineering, Kalavakkam	1. Ms A L Amutha, SRMIST
2. Shakar K Pillai, QuDact Pte Ltd, Singapore	2. Gopinath, Assistant Professor, Sairam College of Engineering, Tambaram	

Course Code	21AIE337T	Course Name	SPEECH RECOGNITION AND UNDERSTANDING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	provide a broad understanding of the basic techniques of speech Recognition			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	learn categorization of signals and Representation of Signals																	
CLR-3:	provide a broad understanding of various speech Analysis Techniques																	
CLR-4:	learn concepts related in speech Recognition																	
CLR-5:	applications of Speech Understanding and Recognition																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	explain all basic speech recognition techniques			-	2	-	-	2	-	-	2	-	2	-	-	2	3	-
CO-2:	infer knowledge in various signals and representations			-	2	-	-	2	-	-	2	-	2	-	-	2	3	-
CO-3:	apply various speech Analysis techniques			-	2	-	-	2	-	-	2	-	2	-	-	2	3	-
CO-4:	acquire knowledge in speech Recognition techniques			-	2	-	-	2	-	-	2	-	2	-	-	2	3	-
CO-5:	solve with Applications of Speech Recognition with case studies			-	2	-	-	2	-	-	2	-	2	-	-	2	3	-

Unit-1 - Introduction	9 Hour
Introduction, Human Speech Production System, Speech Generation, Speech Perception, Voiced and Unvoiced Speech, Model of Human Speech, Audio Indexing and Classic Information Retrieval Problem, Large Vocabulary Continuous Speech Recognition (LVCSR), Recognition Errors and Vocabulary Limitations, Phonetic Search, Phases of Phonetic Search, Pros and Cons of Phonetic Search,	
Unit-2 - Signals and Representation	9 Hour
Introduction to Signals, Continuous-Time and Discrete-Time Signal, Analog Versus Digital Signal Processing, Examples of Simple Functions, Signal Operations, Time Shifting, Time Scaling, Time Reversal, Amplitude Shift, Simple Symmetries: Even and Odd Functions, Products of Even and Odd Functions, Sine Integral Function, Derivatives and Integrals of Functions, Integrals of Functions with Symmetries, Signal Classification Based on Integrals - Effects of Operations on Signals, Periodic Functions, Sum of Two Periodic Functions	
Unit-3 - Speech Analysis	9 Hour
Speech Signal, Speech Production, Source-filter Models of Speech Production, Speech Perception, Speech Signal Representation, Short-time Fourier Analysis, Parametric Representation of the Spectral Analysis, Front-end Analysis for Automatic Speech Recognition, Pre-emphasis, Frame Blocking and Windowing, Mel-Cepstrum, Linear Prediction, Distance Measure for Speech Processing: RMS Log Spectral Measure	
Unit-4 - Speech Recognition	9 Hour
History of Automatic Speech Recognition, Structure of Automatic Speech Recognition, Neural Network and Speech Recognition System, Pronunciation Model, Language Model, Central Decoder, Central Decoder, Feature Extraction Techniques: Linear Prediction Coding (LPC), Mel-Frequency Cepstral Coefficient (MFCC), Perceptual Linear Prediction (PLP), Discrete Wavelet Transform (DWT), Speech recognition and speech to text, Text to speech, Language detection and translation,	
Unit-5 - Applications	9 Hour
Speech Recognition Applications, Speech Processing Tools, Case Study: Chatbot -Voice-to-Text applications, Case Study: Story Teller, Case Study: NLP IN Search Engine, Case Study: Cepstral analysis of speech, Case Study: Linear prediction analysis of speech	

Learning Resources	<ol style="list-style-type: none"> 1. Soumya Sen, Anjan Dutta, Nilanjan Dey, "Audio Processing and Speech Recognition, Concepts, Techniques and Research Overviews," Springer briefs in Applied sciences and technology, 2019 (UNIT -1 & 4) 2. Noelia Alcaraz Meseguer, "Speech Analysis for Automatic Speech Recognition" Norwegian University of Science and Technology, 2009 (UNIT -3) 3. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes Unlocking Text Data with Machine Learning and Deep Learning using Python, Apress, 2019 (UNIT – 5) 	<ol style="list-style-type: none"> 4. R.K. Rao Yarlagadda, Analog and Digital Signals and Systems, Springer 2010 (UNIT -2) 5. Zheng-Hua Tan and Børge Lindberg, "Automatic Speech Recognition on Mobile Devices and over Communication Networks" Springer 2008 6. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes Unlocking Text Data with Machine Learning and Deep Learning using Python, press 2019 7. Jain, Deep Learning for Natural Language Processing, Creating Neural Networks with Python, Apress 2019
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%-	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr V Aditya Pothan Raj, CTS Chennai	1. Dr K.Uma , VIT , Vellore	1. Dr T R Saravanan, SRMIST

Course Code	21AIE338P	Course Name	HIGH PERFORMANCE COMPUTING SYSTEM	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:																									
CLR-1:	introduce high-performance computing concepts like parallelism, vectorization, multi-threading concepts.	Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcomes													
CLR-2:	understand the basic Parallel Programming and Design Issues													Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	understand Vectorization and Multi threading with open MP																										
CLR-4:	work with Memory Traffic, Clusters and MPI																										
CLR-5:	provides an exposure to High performance computing with Intel parallel Studio XE																										
Course Outcomes (CO):		At the end of this course, learners will be able to:																									
CO-1:	understand and familiar with different high-performance computing concepts like parallelism, vectorization, multi-threading concepts.	3	2	3	2	-	-	-	-	-	-	-	2	3	1	-											
CO-2:	explore Parallel Programming and Design Issues	3	2	3	2	-	-	-	-	-	-	-	2	3	2	-											
CO-3:	apply Vectorization and Multi threading with openMP	3	2	3	2	-	-	1	-	-	-	-	2	3	2	-											
CO-4:	understand and work with Memory Traffic, Clusters and MPI	3	2	3	2	-	-	-	-	-	-	-	2	3	2	-											
CO-5:	apply High performance computing with Intel parallel StudioXE	3	2	3	3	-	-	-	-	-	-	-	3	3	2	-											

Unit-1 - An Introduction to Parallelism	9 Hour
Why High-Performance Computing(HPC)?, The Arrival of Parallelism, The Power Density Race- The Emergence of Multi-Core and Many-Core Computing, The Top Six Challenges, Types of Parallelism, Stored Program Computer Architecture-General purpose microprocessors, Performance based metrics and benchmarks-Moorie's Law, Pipelining, Vector Processors, Maximize Performance estimations, Intel Architecture, Modern Code - Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPDM, Dataflow models, demand -driven computation) - Architectures: N-wide superscalar architectures, Multi-core, multi-threaded and vectorization.	
Unit-2 - Parallel Programming, Design Issues and Limitations in Parallel Computing	9 Hour
Processor Architecture, Interconnect, Communication, Memory Organization, Memory hierarchy and transaction specific memory design, Thread Organization, Design Issues-(Synchronization, Scheduling, Job Allocation), Job Partitioning, Dependency Analysis, Limitations – (Bandwidth Limitations, Latency Limitations, Latency Hiding or Tolerating techniques)	
Unit-3 - Vectorization and Multi-threading with Open MP	9 Hour
Vector Operations, Vectorizing of code, automatic vectorization, Stencil, SIMD enabled Functions, Strip mining, integral vectorization Cored and Threads, Creating Threads, Variable sharing, parallel loops, and Data Races mutexes.	
Unit-4 - Memory Traffic, Clusters and MPI	9 Hour
Cheap Flops, memory hierarchy, high bandwidth memory, Memory allocation, bypassing caches, locality in space, locality in time, Computing Clusters, message passing interface, programming with MPI, Compiling and Running with MPI, Peer-Peer Messaging, Collective Communication.	

Unit-5 - High Performance Computing with Intel Parallel Studio XE**9 Hour**

IntelParallel Studio XE- The Advisor Workflow, Surveying the Site, Annotating Code, Checking Suitability, Checking Correctness, Replacing Annotations- Intel C/C++ Optimizing Compiler, Profile-Guided Optimization, OpenMP, Intel Threading Building Blocks, Intel Integrated Performance Primitives, An Application Example, IPP and Threading, Intel Parallel Debugger Extension, Intel Debugger, IntelMath Kernel Library- VTune AmplifierXE: Hotspot Analysis, Concurrency Analysis, Locks and Waits Analysis, Disassembly Source View -Parallel InspectorXE: Predefined Analysis Types, Errors and Warnings.

Lab Experiments:

1. Code example of mixing and matching parallel constructs	9. Building the example application using auto vectorization Options
2. Code example of profile guided optimization	10. Run a static security analysis with Intel Inspector on the application that has security errors that could be used in an attack.
3. Build an OpenMP code with intel compiler	11. Example of a code to find loops and linked lists that can be made parallel using Cilk Plus, OpenMP, and TBB.
4. Build a code using the parallel_for algorithm to print the value of a loop variable.	12. Detect different threading errors in a application code with InspectorXE.
5. Application to perform a matrix multiplication on two matrices, A and B, and are filled with random numbers using the MKL.	13. Use the NQueens example program with Intel Advisor to demonstrate how Advisor works.
6. Analyse a serial code using Intel Parallel AmplifierXE for Hotspot Analysis.	14. Example of optimizing the sudoku generator with Intel parallel StudioXE.
7. Analyse a serial program and implement parallelism using Intel C++ compiler with OpenMP.	15. A pipelined application using TBB
8. Tune the OpenMP program with Intel Parallel studio XE Amplifier by checking concurrency and efficiency with in the OpenMP program.	

Learning Resources	1. JohnL. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.	3. Parallel programming with Intel parallel studio by Stephen Blair-Chappell, Andrew Stokes
	2. John Paul Shen and MikkoH. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hill	4. Kai H wang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill 5. Introduction to High Performance Computing for Scientists and Engineers, Georg Hager Gerhard Wellein, CRC Press, 2010.

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	-	15%	-	-
Level 2	Understand	15%	-	-	15%	-	15%	-	-
Level 3	Apply	30%	-	-	30%	-	30%	-	-
Level 4	Analyze	40%	-	-	40%	-	40%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Gireesh, SoC Engineer, INTEL, Bangaluru	1. Dr. E. Sivasankar, Assistant Professor, Department of CSE, NIT, Trichy	1. Dr. C. Lakshmi, SRMIST
2. Mr. G. Pradeep, Executive Director, Edulateral Foundation, Bangaluru		2. Mr. S. Joseph James, SRMIST
3. Mr. Dilip Kumar, Director, Edulateral Foundation, Bangaluru		3. Mr. C. Arun, SRMIST

Course Code	21AIE422T	Course Name	AUTONOMOUS NAVIGATION AND VEHICLES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand autonomous navigation technology and autonomous driving algorithms			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	study of various sensor and actuator and to relate their functionalities			-	-	-	2	2	-	2	-	-	-	-	-	-	2	3
CLR-3:	predict the route and control the motion, path and speed of autonomous vehicles			-	-	-	2	2	-	2	-	-	-	-	-	-	2	2
CLR-4:	illustrate client system requirements, cloud platform and GNSS system of autonomous navigation system			-	-	-	2	2	-	2	-	-	-	-	-	-	2	2
CLR-5:	analyse tasks of autonomous vehicle in complex traffic environment			-	-	-	2	2	-	2	-	-	-	-	-	-	2	2
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	understand various techniques associated with autonomous vehicles			-	-	-	2	2	-	2	-	-	-	-	-	-	2	3
CO-2:	prepare and process sensor and actuator data			-	-	-	2	2	-	2	-	-	-	-	-	-	2	3
CO-3:	discover autonomous vehicles speed, path and motion			-	-	-	2	2	-	2	-	-	-	-	-	-	2	2
CO-4:	prepare ROS requirements, Cloud platform and GNSS navigation technique			-	-	-	2	2	-	2	-	-	-	-	-	-	2	2
CO-5:	deliver autonomous vehicle in complex traffic environment			-	-	-	2	2	-	2	-	-	-	-	-	-	2	2

Unit-1 - Introduction to Autonomous Driving	9 Hour
Autonomous Driving Technologies Overview- Autonomous Driving Algorithms- Sensing - Perception - Object Recognition and Tracking - Action - Autonomous Driving Client System - Robot Operating System (ROS)- Hardware Platform- Autonomous Vehicle Localization - Localization with GNSS - Localization with LiDAR and High-Definition Maps- Visual Odometry - Dead Reckoning and Wheel Odometry - Sensor Fusion	
Unit-2 - Sensing and Actuation in Intelligent Vehicles	9 Hour
Sensing - General In-Vehicle Sensors - Perception Sensors - Virtual Sensors - Actuation - Categories of Actuators According to Energy Source - ABS, ESC and ACC Systems - Highly Automated Vehicles - General architecture for a fully autonomous vehicle - Perception in Autonomous Driving – Data set – Detection – Segmentation - Stereo and Depth - Optical Flow - Scene Flow – Tracking - Deep Learning in Autonomous Driving Perception - Convolutional Neural Networks	
Unit-3 - Prediction and Routing	9 Hour
Planning and Control Overview - Architecture: Planning and Control in a Broader Sense - Scope of Each Module: Solve the Problem with Modules - Traffic Prediction - Behaviour Prediction as Classification - Vehicle Trajectory Generation - Lane Level Routing - Constructing a Weighted Directed Graph for Routing - Typical Routing Algorithms - Routing Graph Cost: Weak or Strong Routing - Decision, Planning, and Control - Behavioural Decisions - Markov Decision Process Approach - Scenario-Based Divide and Conquer Approach - Motion Planning - Vehicle Model, Road Model, and SL-Coordination System - Motion Planning with Path Planning and Speed Planning - Motion Planning with Longitudinal Planning and Lateral planning - Feedback Control - Bicycle Model - PID Control	
Unit-4 - Client Systems for Autonomous Driving	9 Hour
Autonomous Driving: A Complex System - Operating System for Autonomous Driving - ROS Overview - System Reliability - Resource Management and Security - Computing Platform Implementation - Existing Computing Solutions - Computer Architecture Design Exploration - Cloud Platform for Autonomous Driving – Infrastructure – Simulation - Model Training - HD Map Generation - Global Navigation Satellite Systems: An Enabler for In-Vehicle Navigation - The GNSS Technology - Pseudo range and Position Relation - Received Signal and Pseudorange Relation - Position Estimation - Measuring Pseudoranges - GNSS Receivers	

Unit-5 - Autonomous Last-Mile Delivery Vehicles in Complex Traffic Environments **9 Hour**

JD.com: An Autonomous Driving Solution - Safety and Security Strategies - Perception's Autonomous Vehicles Lite - Expensive Autonomous Driving Technologies - Achieving Affordability and Reliability - Perception Tasks: Lane – Detection - Lane Detection Requirements Lane Detection Requirements - A Lane Detection Algorithm - Perception Tasks: Obstacle Detection - Sensors for Obstacle Detection - Obstacle Detection Methods - Perception Tasks: Traffic Sign Recognition - Color Analysis - - Shape Detection Based on Sobel Phase Analysis - Classification

Learning Resources	<ol style="list-style-type: none"> 1. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, Creating Autonomous Vehicle Systems Second Edition, Morgan & Claypool Publishers, 2020. 2. Azim Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer, 2012. 3. Sumit Ranjan, Dr. S. Senthilarasu, Applied Deep Learning and Computer Vision for Self-Driving Cars, build autonomous vehicles using deep neural networks and behavior-cloning techniques, Packt Publishing, 2020. 	<ol style="list-style-type: none"> 4. Amir Khajepour- Editor, Deep Learning for Autonomous Vehicle Control Algorithms, State-of-the-Art, and Future Prospects , Synthesis Lectures on Advances in Automotive Technology, Morgan & Claypool Publishers, 2019 5. Huafeng Yu ,Xin Li, Richard M. Murray, S. Ramesh, Claire J. Tomlin Editors, Safe, Autonomous and Intelligent Vehicles, , 2019. 6. Nyle Phillips Editor, Autonomous Vehicles Safety, Deployment and Effect on Infrastructure, Transportation Issues, Policies and R&D , Nova Science Publishers, 2021
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Vasanthi, Senior Consultant, Slalom · Sydney, New South Wales, Australia	1. Dr.A.Punitha, Associate Professor, Annamalai University	1. Dr. A. Revathi, SRMIST

Course Code	21AIE423T	Course Name	MOBILE GAME DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes			
CLR-1:	understand the solid foundation in software engineering for mobile games	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-2:	gained an understanding of Unity and popular tools & plugins																												
CLR-3:	familiarized themselves with mobile usability and design concerns																												
CLR-4:	implemented several individual game project prototypes																												
CLR-5:	implemented a larger, demo-able game project in a team environment																												
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	-	3	-	3	-	-	-	-	-	-	-	3	-	3	-
CO-1:	acquire the knowledge on the fundamentals of game development techniques	-	-	3	-	3	-	-	-	-	-	-	3	-	3	-	3	-	-	-	-	-	-	3	-	3	-		
CO-2:	acquire the ability to apply the tools and plugins	-	-	3	-	3	-	-	-	-	-	-	3	-	3	-	3	-	-	-	-	-	-	3	-	3	-		
CO-3:	utilize the design and mobile usability on various problems	-	-	3	-	3	-	-	-	-	-	-	3	-	3	-	3	-	-	-	-	-	-	3	-	3	-		
CO-4:	acquire the ability to prototype the game project	-	-	3	-	3	-	-	-	-	-	-	3	-	3	-	3	-	-	-	-	-	-	3	-	3	-		
CO-5:	apply the knowledge gained on larger game projects	-	-	3	-	3	-	-	-	-	-	-	3	-	3	-	3	-	-	-	-	-	-	3	-	3	-		

Unit-1 – Introduction to Game Design	9 Hour
Game Design and Paper Prototyping, Game Analysis Frameworks, Inscribed Layer, Dynamic Layer, Cultural Layer, Design Goals, Paper Prototyping, Puzzle Design, The Digital Game Industry, Digital Prototyping, Introducing Our Development Environment: Unity, Thinking in Digital Systems, Introducing Our Language: C#, Variables and Components, Boolean Operations and Conditionals, Lists and Arrays, Classes, Functions and Parameters, case study- Develop an environment of puzzle Lab	
Unit-2 - Basics of Game Development	9 Hour
Scenes, Game Objects, Components, Working with Unity 2D & 3D, 2D graphics, Camera, Sprites a Texture Atlases, Animation, Scrolling, Overview of vector math, Physics principles, 3D math primer, Basics of 3D World, 3D rendering essentials, Using Unity for 3D development- case study by showing a demo on any 3D game	
Unit-3 - Mobile Game Development	9 Hour
Mobile Game Input, Designing for Mobile, Basic Touch, Multi Touch Gestures, Get the inputs to the game, Accelerometer, Virtual joypads, Usability, designing for the impatient gamer, Audio, Particle Effects, Alternate Game Development Solutions, Cross-platform game engines, Platform specific game creation tools, case study- Demo on adding audio for the game	
Unit-4 - Game Designing and Prototyping	9 Hour
MDA: Mechanics, Dynamics, Aesthetics, Formal, Dramatic, Dynamic Elements, The Elemental Tetrad, The Layered Tetrad, Artificial Intelligence, Tile maps, AI behavior Pathfinding, Augmented, Virtual Reality Games, case study- Design location finder for your friend using app	
Unit-5 - Advanced Graphics	9 Hour
Native Development, Shaders on mobile, Advanced 3D effects, Plugins, Publishing, Advanced Deploying on the App Store, Software Engineering for Games, Game Architecture and Implementation Patterns, Optimization, Pipelines and Tools, Profiling, Build Systems, Testing- case study on advanced 3D effects.	

Learning Resources	1. Jeremy Gibson, "Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#" ISBN-10:0321933168. 2014	3. Jonathon Manning, Paris Buttfield-Addison, "Mobile Game Development with Unity: Build Once, Deploy Anywhere", O'Reilly Media Inc., 2017
	2. Sanjay Madhav, "Game Programming Algorithms and techniques", Addison-Wesley, 2013	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Joe Antony, Senior Manager, Cognizant	1. Dr.T.Sukumar, Associate Professor, SVCE	1. Dr.S.Karthick, SRMIST
2. Mr.Sasiram, Senior Software Engineer, TCS	2. Dr.P.Sudakar, Associate Professor, Annamalai University	

Course Code	21AIE428T	Course Name	TIME SERIES ANALYSIS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand time series analysis, trends and characteristic of stochastic component of time series			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	apply appropriate filters and understand the smoothing technique																	
CLR-3:	analyse the Auto-Regressive Model for Stationary models																	
CLR-4:	analyse auto regression for non-stationary models																	
CLR-5:	understand the structure and Application of VAR, filtering method																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	understand the mathematical considerations for analyzing time series and gain knowledge about correlation, autocorrelation and data analysis			-	-	-	3	-	-	2	-	-	-	-	-	-	2	3
CO-2:	work on different properties of linear predictor operators, and apply various linear forecasting techniques and smoothing techniques			-	-	-	3	-	-	2	-	-	-	-	-	-	2	3
CO-3:	estimate models for time-series data including the modules like seasonal autoregressive moving average (SARIMA) models, regression with ARMA model			-	-	-	3	-	-	2	-	-	-	-	-	-	2	3
CO-4:	interpret the results of Autoregressive Integrated Moving Average for Non- Stationary Time Series Models			-	-	-	3	-	-	2	-	-	-	-	-	-	2	3
CO-5:	implement the techniques of ADL and VAR for regression models and perform hypothesis testing and error correlation method for prediction			-	-	-	3	-	-	2	-	-	-	-	-	-	2	3

Unit-1 - Introduction	9 Hour
Introduction to probability and statistics, Time series: basic concepts, Definition of time series, Main characteristics of time series and statistical models, Decomposition models, Measures of dependence autocorrelation and cross correlation, stationary time series – Estimation of correlation, vector valued and multidimensional series, classical regression in the time series context, Exploratory data analysis. Description of data.	
Unit-2 - Linear Forecasting Techniques and Smoothing Techniques	9 Hour
Limit theorems, OLS, and HAC, Linear Filtering, Regression Analysis: Least Squares Estimation in Linear Regression Models, Statistical Inference in Linear Regression, Generalized Least Squares, Weighted Least Squares, Discounted Least Squares, and Regression Models for General Time Series Data. Exponential Smoothing Methods: single and double exponential smoothing – Holt's and winter's methods - Exponential smoothing techniques for series with trend and seasonality-Basic evaluation of exponential smoothing.	
Unit-3 – ARIMA Models	9 Hour
Autoregressive Integrated Moving Average (ARIMA) Models: Stationary Time series data, Finite Order Moving Average Processes, Finite Order Autoregressive Processes, Mixed Autoregressive–Moving Average Processes	

Unit-4 – Non Stationary Processes **9 Hour**

Some Examples of ARIMA (p, d, q) Processes, Time Series Model Building, Forecasting Arima Processes, Seasonal Processes, Arima Modeling of Biosurveillance Data, ARIMA Models for Nonstationary Time Series, Unit Roots in Time Series Models, Regression with ARMA Errors- ARIMA Models: Basic formulation of the ARIMA Model and their statistical properties - Autocorrelation function (ACF), Partial autocorrelation function (PACF) and their standard errors.

Unit-5 - Regressive Dynamic Models and Hypothesis Testing **9 Hour**

Autoregressive models with distributed lags (ADL). Vector autoregression (VAR) model, Structural VAR, Application of VAR, Time series co-integration, Co-integration regression, testing of co-integration, Co-integration and error correction model, Hypothesis testing on rational expectations, Hypothesis testing on market efficiency, Periodogram, VECM (Vector Error Correction Model)

Learning Resources	1. Shumway & Stoffer (2011) Time Series Analysis and its applications, with examples in R, 3rd edition, Springer.	4. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series Analysis: Forecasting and Control, Fifth Ed., Wiley, 2016.
	2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, Introduction to Time Series Analysis and Forecasting, Second Ed., Wiley, 2016.	5. Cryer & Chan (2008) Time Series Analysis with Applications in R, Springer
	3. Brockwell & Davis (2016) Introduction to Time Series and Forecasting, 3rd edition, Springer	6. Prado & West (2010) Time Series: Modeling, Computation, and Inference Chapman & Hall
		7. Petris, Petrone, Campagnoli (2009) Dynamic Linear Models with R, Springer

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	20%	-
Level 2	Understand	20%	-	10%	-	20%	-
Level 3	Apply	30%	-	40%	-	30%	-
Level 4	Analyze	30%	-	40%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Soundararajan Dhakshinamoorthy, Principal software Engineer, Tech Leadership, OptumInsights India Pvt Ltd., Chennai	1. Dr. S. Muthurajkumar, Anna University	1. Mrs.A.Saranya SRMIST

Course Code	21AIE430T	Course Name	DISTRIBUTED SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	discuss the fundamentals of distributed systems and its architecture			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	describe the concepts of Virtualization and Code migration																	
CLR-3:	discuss the various types of Communication methods																	
CLR-4:	apply various Name space and resolution methods, and coordination schemes																	
CLR-5:	demonstrate various Consistency, replication models and Security																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	articulate the fundamentals of distributed systems and its architecture			2	-	2	-	3	-	-	-	-	-	-	-	-	-	3
CO-2:	illustrate the concepts of Virtualization and Code migration			2	-	2	-	2	-	-	-	-	-	-	-	-	-	3
CO-3:	implement various message communication based on Sockets and Multicasting methods			2	-	3	-	2	-	-	-	-	-	-	-	-	-	3
CO-4:	simulate various Name space and Resolution, and Process Synchronization methods in distributed environment			2	-	3	-	3	-	-	-	-	-	-	-	-	-	3
CO-5:	construct various Consistency and replication models			2	-	3	-	3	-	-	-	-	-	-	-	-	-	3

Unit-1 – Fundamentals of Distributed Systems	9 Hour
Introduction - Middleware and distributed systems-Design goals - Types of distributed systems - Architectural styles, Layered architectures - Object-based and service-oriented architectures-Resource-based architectures - Publish-subscribe architectures - Middleware organization - System architecture, Centralized organizations - Decentralized organizations: peer-to-peer systems - Hybrid Architectures - Example architectures, The Network File System, The Web.	
Unit-2 - Virtualization and Code Migration	9 Hour
Processes: Threads - Threads in distributed systems – Virtualization, Principle of virtualization - Application of virtual machines to distributed systems – Clients, Networked user interfaces – Client-side software for distribution transparency – Servers, General design issues - Object servers - Example: The Apache Web server, Server clusters - Code migration - Reasons for migrating code -Migration in heterogeneous systems.	
Unit-3 - Communication	9 Hour
Foundations, Layered Protocols - Types of Communication - Remote procedure call, Basic RPC operation - Parameter passing – RPC based application support - Variations on RPC -Example: DCE RPC - Message-oriented communication - Simple transient messaging with sockets -Advanced transient messaging - Message-oriented persistent communication - Example: IBM's WebSphere message-queuing system - Multicast communication: Application-level tree-based multicasting - Flooding-based multicasting - Gossip-based data dissemination.	
Unit-4 - Naming	9 Hour
Flat naming Simple solutions- Home-based approaches - Distributed hash tables- Hierarchical approaches - Structured naming - Name spaces - Name resolution - The implementation of a name space - Attribute-based naming – Coordination: Clock synchronization - Logical clocks - Mutual exclusion -Election algorithms - Location systems.	

Unit-5 - Consistency and Replication**9 Hour**

Data-centric consistency models- Client-centric consistency models - Replica management- Content distribution- Consistency protocols - Fault tolerance: Basic concepts- Failure masking by redundancy - Process resilience – Security: Security threats, policies, and mechanisms- Secure channels - Message integrity and confidentiality- Example: Kerberos.

Learning Resources	1. M. van Steen and A.S. Tanenbaum, "Distributed Systems", 3rd edition. Distributed-systems.net, 2017.	4. George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed Systems Concepts and Design", Fifth Edition, Pearson Education, 2012.
	2. Kshemkalyani, Ajay D., and Mukesh Singhal. Distributed computing: principles, algorithms, and systems. Cambridge University Press, 2011.	5. Tanenbaum A.S., Van Steen M., "Distributed Systems: Principles and Paradigms", Pearson Education, 2007.
	3. Pradeep K Sinha, "Distributed Operating Systems: Concepts and Design", Prentice Hall of India, 2007.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohanraj, Data Scientist, Standard chartered	1. Dr. V. Vijayarajan, Associate Professor/HOD, VIT, Vellore	1. Dr.S.Vimal, SRMIST
	2. Dr. T. SudalaiMuthu, Professor, Hindustan University, Chennai	

Course Code	21AIE431T	Course Name	BIG DATA ANALYTICS: HADOOP, SPARK, AND NOSQL	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	understand the basics of Big data and Hadoop architecture	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	analyze the Hadoop and Map Reduce technologies associated with big data analytics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	compare conventional SQL query language and NoSQL basic concepts															
CLR-4:	design, build and query MongoDB based big data Applications															
CLR-5:	analyze Big Data use cases and solutions															

Course Outcomes (CO):	At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	gain the knowledge in basics of Big data analytics	-	3	-	-	3	-	-	-	-	-	-	2	-	2	3
CO-2:	explain and Analyze the Big Data using Map-reduce programming in Both Hadoop and Spark framework	-	2	-	-	3	-	-	-	-	-	-	2	-	2	3
CO-3:	explore the origins of NoSQL databases and the characteristics that distinguish them from traditional relational database management systems	-	3	-	-	3	-	-	-	-	-	-	2	-	2	3
CO-4:	apply the MongoDB based big data Applications	-	3	-	-	3	-	-	-	-	-	-	2	-	2	3
CO-5:	implement Big Data use cases and solutions	-	2	-	-	3	-	-	-	-	-	-	2	-	2	3

Unit-1 - Introduction to Big Data	9 Hour
Introduction– distributed file system–Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce	
Unit-2 - Introduction to Hadoop and Hadoop Architecture	9 Hour
Big Data – Apache Hadoop & Hadoop Ecosystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of Map Reduce -, Data Serialization	
Unit-3 - Spark	9 Hour
Introduction to Data Analysis with Spark, Downloading Spark and Getting Started, Programming with RDDs, Machine Learning with MLlib, case study: Implementation of Matrix algorithms in Spark Spark SQL programming, Building Spark Streaming application	
Unit-4 – No SQL	9 Hour
Introduction to NoSQL, History of NoSQL Exploring NoSQL, Interfacing and Interacting with NoSQL, NoSQL Storage Architecture, , Querying, Modifying and Managing. Data Storage in NoSQL, Working with NoSQL, Surveying Database Internals, Migrating from RDBMS to NoSQL, Web Frameworks and NoSQL, using MySQL as a NoSQL, case study: implement Advanced columnar data model functions for the real time applications	
Unit-5 - Data Base for the Modern Web	9 Hour
Introduction to MongoDB, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents, MongoDB Query Language. Developing Web Application with NOSQL and NOSQL Administration Php and MongoDB, Python and MongoDB, Creating Blog Application with PHP. Case Study: Create a system which can use of Web search, web crawlers and web information retrieval.	

Learning Resources	1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.	3. MongoDB in Action, Kyle Banker, Piter Bakkum, Shaun Verch, Dream tech Press
	2. Chris Eaton, Dirk deRooset al., "Understanding Big data", McGraw Hill, 2012. BIG Data and Analytics, Sima Acharya, Subhashini Chhellaippan, Wiley.	4. Tom White, "HADOOP: The definitive Guide", O Reilly 2012. 5. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packet Publishing 2013. 6. Learning Spark: Lightning-Fast Big Data Analysis Paperback by Holden Karau Professional NOSQL Shashank Tiwari WROX Press

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	50%	-	50%	-	50%	-
Level 4	Analyze	10%	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Shraddha Sanjeev, Full Stack Engineer, PricewaterhouseCoopers, Australia	1. Dr.R.Hari Krishnan, Symbiosis International University, Pune	1. Dr.P.Sridevi Ponmalar, SRMIST

Course Code	21AIE434T	Course Name	BIO INFORMATICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	adapt basic knowledge on different forms of biological data acquisition			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand development of biological databases, display, annotation, and retrieval tools of biological data																	
CLR-3:	understand the genesis of Bioinformatics, comparison with its allied disciplines, theoretical and computational models to study data processing																	
CLR-4:	discover the practical use of analysis tools for specific bioinformatics areas																	
CLR-5:	explain applications of bioinformatics in the area of biological and biomedical sciences, statistical mining of gene																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	apply efficient data acquisition techniques based on the type of biological data			-	-	3	-	-	-	-	3	-	-	-	2	2	2	-
CO-2:	develop biological databases, display, annotation, and retrieval tools			-	-	3	-	-	-	-	3	-	-	-	2	2	2	-
CO-3:	determine Bioinformatics' origins, associated fields, and theoretical and computational frameworks for data processing			-	-	3	-	-	-	-	3	-	-	-	2	2	2	-
CO-4:	apply appropriate analysis tool for biological data analysis			-	-	3	-	-	-	-	3	-	-	-	2	2	2	-
CO-5:	describe bioinformatics' applications in biological and biomedical sciences, including gene			-	-	3	-	-	-	-	3	-	-	-	2	2	2	-

Unit-1 - Biological Data Acquisition	9 Hour
The form of biological information. Retrieval methods for DNA sequence, protein sequence and protein structure information	
Unit-2 - Databases	9 Hour
Format and Annotation-Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence and structure databases, Organism specific databases	
Unit-3 - Data Processing	9 Hour
Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Local versus global. Distance metrics. Similarity and homology. Scoring matrices.	
Unit-4 - Methods of Analysis	9 Hour
Dynamic programming algorithms, Needleman-Wunsch and Smith-waterman. Heuristic Methods of sequence alignment, FASTA, and PSI BLAST. Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment	
Unit-5 - Applications	9 Hour
Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis: Comparative genomics, orthologs, paralogs. Genome analysis – Genome annotation	

Learning Resources	1. <i>Introduction to Bioinformatics</i> by Arthur K. Lesk, Oxford University Press, May 2019.	4. <i>Bioinformatics Sequence and Genome Analysis</i> by David W. Mount, Cold Spring Harbor Laboratory Press, 2004
	2. <i>Algorithms on Strings, Trees and Sequences</i> by Dan Gusfield, Cambridge University Press, 2010	5. <i>Beginning Perl for Bioinformatics: An introduction to Perl for Biologists</i> by James Tindall, O'Reilly Media, 2017.
	3. <i>Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids</i> by Durbin, S.Eddy, A.Krogh, G.Mitchison, 2012	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Santhosh C, Senior Consultant, Infosys	1. Mr.Yuvaraj D, Assistant Professor, BIT, Sakinagalam	1. Dr.S.Salomi, SRMIST

Course Code	21AIE435T	Course Name	THEORETICAL AND COMPUTATIONAL NEUROSCIENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	understand the basics of Computational Neuroscience	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	apply the concept of Neuron, Associations and learning	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	acquire with Cortical organization and Feed forward mapping networks																	
CLR-4:	design the mapping and Learning concepts																	
CLR-5:	understand the Cognition concepts and its related theories																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	gain the knowledge in basics of Computational NeuroScience	-	2	2	-	-	2	-	-	-	-	-	-	3	-	-		
CO-2:	demonstrate Simple Neuron, Associations, and learning	-	2	2	-	-	2	-	-	-	-	-	-	3	-	-		
CO-3:	categorize Cortical organization and Feed forward mapping networks	-	3	3	-	-	2	-	-	-	-	-	-	3	-	-		
CO-4:	apply the different learning methods	-	3	3	-	-	2	-	-	-	-	-	-	3	-	-		
CO-5:	implement Cognition concepts and theories	-	3	3	-	-	2	-	-	-	-	-	-	3	-	-		

Unit-1 - Introduction	9 Hour
Tools and Specialization, Levels of Organization in the brain, Model: Phenomenological and explanatory, models in Computational Neuroscience, Brain Theory: Emergence and adaption Level of Analysis, Computational Theory of brain, anticipating brain, Structural Properties of basic neuron, Information Processing Mechanisms, Membrane Potential, Ion Channel, Chemical Synapses and neurotransmitters, Excitatory and inhibitory Synapses, Modelling synaptic responses Non-Linear superposition of PSP, Minimal mechanism, Ion Lumps, Hodgkin -Huxley Equations, Numerical Integration	
Unit-2 - Basic Neuron	9 Hour
Basic Spiking Neurons, Leaky, Integrate and Fire Neuron, Response of IF, Activation function, Spike response, Izhikevich, McCullon-Pitts Neuron, Spike Time variability, Basic Irregularities, Noise models, Simulation of Real Neurons, Activation function depend on input, Associative memory, Hebbian learning, Associations, Hebbian learning in conditional framework.	
Unit-3 - Basic Network	9 Hour
Large scale brain anatomy, Hierarchical architecture of brain, Rapid Transmission, Layered Structure of neocortex, Columnar organization, Cortical parameters, Simple Perceptron: OCR, Mapping functions, Population mode as perceptron, Boolean functions Learning the delta rule, Multilayer Perceptron: update rule, Generalization of delta rules, plausibility, Advanced MLP: Kernel and RBF, Advanced learning, Batch Vs online algorithm, self-organizing network architectures and Genetic algorithm, Mapping with Context units, Probability mapping of network, SVM	
Unit-4 - System-level Model	9 Hour
Modular Mapping: Mixture of expert, what, Where -Task, Product experts, coupled attractor Networks, Sequential Learning, Memory: Distributed Model, Limited capacity model, Spurious synchronization hypothesis, Interacting reverberating hypothesis, Motor learning and control, Feedback control, Forward and inverse motor controller, Cerebellum and motor control, Reinforcement learning, Classical conditioning, Temporal delta rule, difference learning, Actor, critic scheme	

Unit-5 - Cognitive Brain**9 Hour**

Hierarchical maps and attentive vision, Invariant object recognition, Attentive vision, Bias in visual search and object recognition, Interconnecting global workspace, Brain anticipatory system, Boltzmann machine, Restricted Boltzmann machine, Contrastive Hebbian learning, Helmholtz machine, Probabilistic reasoning, Causal models and Bayesian network, Expectation maximization, Adaptable resonance theory

Learning Resources	1. Thomas P. Trappenberg, "Fundamentals of Computational Neuroscience", OXFORD University Press, Second Edition, 2010.	3. Hans Peter A.Mallot, "Computational NeuroScience: A First Course" Springer 2013.
	2. Paul Miller, an Introductory Course in Computational Neuroscience, MIT Press ISBN: 9780262038256, October 2018.	4. E. Kandel, "Principles of Neural Science", McGraw-Hill, 2000. 5. Eric L. Schwartz, "Computational Neuroscience" Cambridge, Mass: A Bradford Book. 1990

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Shraddha Sanjeev, Full Stack Engineer, PricewaterhouseCoopers, Australia	1. Dr.R.Hari Krishnan, Symbiosis International University, Pune	1. Dr.P.Sridevi Ponmalar, SRMIST

Course Code	21CSE252T	Course Name	BIOMETRICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	understand the basic concept of biometrics												
CLR-2:	gain knowledge on the basics of biometric traits, sensors, data acquisition and finger print process												
CLR-3:	introduce the process of Multibiometric system												
CLR-4:	acquire knowledge on biometric system authentication												
CLR-5:	understand the real time application of biometrics												

Program Outcomes (PO)												Program Specific Outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
3	-	1	2	-	-	-	-	-	-	-	-	-	1	-
3	-	-	1	-	-	-	-	2	-	-	-	-	1	-

Unit-1 - Introduction	9 Hour
Basics of biometric systems, Biometric functionalities: verification, identification- Introduction to unimodal system, Introduction to multimodal system, what is image, acquisition, type, point operations, Geometric transformations-First and Second Derivatives- steps in edge detection, smoothing, enhancement, thresholding, localization, Low level feature extraction, Describing image motion- High level feature extraction, Template matching	
Unit-2 - Process of Biometric System	9 Hour
Biometrics Sensors, Data Acquisition and Database, Biometrics Pre-processing Techniques-Image restoration and segmentation, Pattern Extraction and Classification, Fingerprint Identification Technology- Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges -Fingerprint Image Processing – Minutiae Determination – Fingerprint Matching: Fingerprint Classification, Matching policies.	
Unit-3 – Multi Biometric System	9 Hour
Introduction to Multibiometric – Information Fusion in Biometrics – Issues in Designing a Multibiometric System – Sources of Multiple Evidence – Levels of Fusion in Biometrics – Sensor level, Feature level, Rank level, Decision level fusion – Score level Fusion. Introduction to various matching methods – LDA, PCA, Eigen Vectors and Values-Covariance, Correlation- Introduction to decision theory and their examples	
Unit-4 - Authentication Procedure	9 Hour
physiological and behavioral properties of biometric system, Software biometrics systems, Hardware biometrics systems, Security of biometric systems- Advisory, insider, infrastructure attacks- Attacks at the user interface- impersonation ,obfuscation, spoofing Attacks on system module and interconnections- Counter measure: Biometric template security- Challenges in biometric systems like fool proofing, false positives	
Unit-5 - Applications	9 Hour
access control like a lock or an airport check-in area- immigration and naturalization- welfare distribution- military application- banking, e.g., check cashing, credit card, ATM- computer login; intruder detection; smart card- multi-media Communication; WWW and an electronic purse- sensor fusion; decision fusion- categorization: e.g., age and gender- industrial automation - efficient enrollment gesture interpretation; on-line shopping- other commercialized service: Fingerprint, Face detection, Irish Recognition.	

Learning Resources	1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, Biometric Systems, Technology Design and Performance Evaluation, Springer, 2005.	4. Digital Image Processing using MATLAB, By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2019
	2. James wayman, Anilk.Jain, ArunA.Ross, Karthik Nandakumar, —Introduction to. BiometricsII, Springer, 2011	5. Guide to Biometrics, By: Ruud M. Bolle, SharathPankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell, Springer 2009
	3. Mark S.Nixon, Alberto S.Aguado, Feature Extraction and image processing for computer vision, Third Edition, , Elsevier 2012	6. Pattern Classification, By: Richard O. Duda, David G.Stork, Peter E. Hart, Wiley 2007 7. Shimon K.Modi , —Biometrics in Identity Management :concepts to applicationsII, Artech House 2011

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.L.Parthiban, Exceillity Technologies	1. Dr.S.P.Raja, Associate Professor, VIT, Vellore,	1. Dr.E.Poongothai, SRMIST

Course Code	21CSE311P	Course Name	ROBOT PROGRAMMING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	introduce the fundamentals of robot programming												
CLR-2:	explain the fundamentals of Embedded programming												
CLR-3:	acquire knowledge for selection and calibration of sensors, actuator and how to interface with Robot												
CLR-4:	understand the Robot operating system fundamentals												
CLR-5:	understand the integration of Hardware controllers with ROS												

Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	gain the knowledge of robot building system												
CO-2:	create the program for robot												
CO-3:	gain knowledge on the sensor signal calibration, and actuator control for interfacing with Robot												
CO-4:	obtain the insights of Robot Operating system												
CO-5:	design and program the robot for its intelligent operation												

Program Outcomes (PO)														Program Specific Outcomes		
1	2	3	4	5	6	7	8	9	10	11	12					
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
2	2	-		-	-	-	-	-	-	-	-	1	-	-		
-	2	-	3	-	-	-	-	-	-	-	-	2	-	-		
-	2	-	3	-	-	-	-	-	-	-	-	-	-	3		
-	-	-	3	-	-	-	-	-	-	-	-	-	-	3		
-	-	-	3	-	-	-	-	-	-	-	-	1	-	3		

Unit-1 - Robot Fundamentals	9 Hour
Basic of Robots – Anatomy - Links and joints - Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom - Robot Movement: Pitch, Roll, Yaw - Mechanisms and transmission - Work volume - End effectors.	
Tutorial:	
<ol style="list-style-type: none"> Study the anatomy of Robot and create a Robot structure for pick and place operation. Problems on Degrees of Freedom, understanding robot work space and movement. 	
Unit-2 - Embedded Programming	9 Hour
Basic Embedded File system – hex files - Simulators and Emulators - Integrated development environments - commonly used IDE. Basics of Embedded C for Robot Programming –. Python for Robot Programming - Program structure, data types, control structure.	
Practice:	
<ol style="list-style-type: none"> Understanding file system and using IDE. Create a Embedded C program for I/O operation. 	

Unit-3 - Robot Programming Interface	9 Hour
Sensor- Principle of sensors - Analog signal - Digital signal - I/O of Sensors – Calibration of sensors – Interfacing -Serial - I2C. Actuator – Types – I/O of Actuator, Direct control, and speed control, PWM, analog control. Programming and interfacing of sensors. Programming and interfacing of actuators. Practice: 1. Interfacing of sensor and calibration. 2. Interfacing of motor and control of motors.	
Unit-4 - Robot Operating System	9 Hour
ROS Basics- Sensors and Robots Supporting ROS - ROS Architecture and Concepts - ROS File system - ROS Computation Graph Level, ROS Community Level - Creating ROS Workspace and Package, Using ROS Client Libraries, Programming Embedded Board using ROS - Interfacing Arduino with ROS, ROS on a Raspberry Pi. Practice: 1. Serial and I2C communication. 2. Programming with Raspberry Pi.	
Unit-5 - Building the Robots	9 Hour
Introduction to Wheeled Robot - Building Robot Hardware - Block Diagram and Assembling Robot Hardware - Programming Robot Firmware - path planning. Case study: Tetrix – NAO – Ned Niryo – Auto Auto. Practice: 1. Programs of Tetrix and NAO. 2. Programs on Ned Niryo and Auto Auto.	

Learning Resources	1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012 2. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018. 3. Mark Siegesmund, "Embedded C Programming Techniques and Applications of C and PIC® MCUS", Newnes, 2014	4. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018. 5. John J. Craig, "Introduction to Robotics", 3rd Edition, Addison Wesley, ISE 2008. 6. Jacob Fraden, "Handbook of Modern Sensors", Springer 2016 7. W. Bolton, "Mechatronics", Pearson, 2018
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Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rijo Jackson Tom Lead Data Scientist Augusta hitech soft solution	1. Dr. Thiyagarajan R Assistant Professor, Department of Mechanical Engineering, Indian Institute of Technology Tirupati	1. Dr.J.J. Jayakanth, SRMIST

Course Code	21CSE312P	Course Name	SOFTWARE ENGINEERING IN ARTIFICIAL INTELLIGENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	learn the different GPU Components												
CLR-2:	know to access NGC Containers and docker images												
CLR-3:	utilize the Pytorch and Jupyter notebook												
CLR-4:	learn the CUDA ecosystem												
CLR-5:	explore the DL deployments												

Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	distinguish the different components in GPU systems												
CO-2:	create environments to work with different NGC container packages												
CO-3:	implement codes using jupyter notebook and pytorch												
CO-4:	develop and work with CUDA												
CO-5:	visualize different DL deployments for various scientific applications												

Program Outcomes (PO)												Program Specific Outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Introduction to System Software Engineering	9 Hour
System S/W Platforms: Virtualization, Containerization- Introduction to NVIDIA NGC Cloud, DockerHub T1: Accessing DGX A100 T2: Working DOCKER Images and NGC Container T3: Installation and Pulling Specific NGC Packages	
Unit-2 - Scheduling and Resource Management	9 Hour
Introduction to Schedulers/Orchestration Tools - Fundamentals of Ansible/Kubernetes/KubeFlow/SLURM T4: Implementing and executing Kubernetes T5: Working with Ansible T6: Demo Executions on Kubeflow/SLURM	
Unit-3 - Introduction to IDE / Exploratory Programming	9 Hour
Introduction to various IDE like VSCode/PyCharm/Others-Introduction to Jupyter-Ecosystem for Exploratory Programming- Features of Jupyter-Ecosystem for building Python Packages/Scientific Manuscript T7: Working with VScode/ Pycharm T8: Using Jupyter note and PyTorch T9: Run a simple data centric application using Jupyter note.	

Unit-4 - System Software for Accelerated Computing	9 Hour
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ML/DL/DS/HPC Workloads-Overview of CUDA Platform: GPGPU Computing Platform - Overview of CUDA-X Platform: cuBLAS/cuDNN/cuTensor [Compute]- Framework for Differential Computation	
T10: Testing the GPGPU Computing	
T11: Testing and working with Tensor (CUDA-X)	
T12: Implementing Mixed Precision and Quantization Aware training	
Unit-5 – GPU Programming	9 Hour
Distributed Computing Software Stack-Multi-GPU/Multi-Node: [MPI/NCCL/RDMA] Horovod- Accelerating DL Deployments- ML Ops: Hands-on	
T13: Accelerating Neural Network Inferencing: TensorRT & Triton Inference Server	
T14: Monitoring load Balancers & Schedulers	
T15: Deployment of various services for monitoring, jupyter environment and other services.	

Learning Resources	1. Ekman, M., 2021. Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, NLP, and Transformers Using TensorFlow. Addison-Wesley Professional.	3. Christopher Love, Jay Vyas, Core Kubernetes, 2022
	2. Sanders, J. and Kandrot, E., 2010. CUDA by example: an introduction to general-purpose GPU programming. Addison-Wesley Professional.	4. Chollet, F., 2021. Deep learning with Python. Simon and Schuster.

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. A.G.Rangaraj, Deputy Director (Technical), R&D, RDAF and SRRA Division, National Institute of Wind Energy (NIWE)	1. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	1. Dr.Kottilingam K

Course Code	21CSE313P	Course Name	ACCELERATED DATA SCIENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes				
CLR-1:	learn the different GPU Components													1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	know to work with GPUs for Accelerated Data Sciences													Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning					
CLR-3:	utilize CUDA and RAPIDS for Accelerated Data Science and Array Computing																													
CLR-4:	learn and work with Data Wrangling and Machine learning																													
CLR-5:	explore the cu Signal worklets																													
Course Outcomes (CO):		At the end of this course, learners will be able to:												1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3		
CO-1:	distinguish the different components in GPU systems													1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	create environments to work with different packages for data science environments													-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	implement codes using CUDA and RAPIDS for Data Science and Array Computing													-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2	
CO-4:	develop and work with cu ML and RAPIDS Memory manager													-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2	
CO-5:	working with cu Signal													-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to GPU Systems	9 Hour
Introduction to GPU and DGX A100, Accessing DGX A100, Working DOCKER Images and NGC Container, Installation and Pulling Specific NGC Packages	
Unit-2 - GPUs for Data Sciences	9 Hour
Introduction to Data Science Packages in Python Ecosystem: NumPy, Pandas, Scikit-Learn, SciPy, NetworkX- Overview of Jupyter Environment, GPU Accelerated Data Science Workflow with RAPIDS, Data Preparation- NVTABULAR, ETL for RecSys-Model Training and XGBoost: Distributed XGBoost with DASK Visualization- cuXFilter	
Unit-3 – CUDA and RAPIDS	9 Hour
Accelerated Data Science and Array Computing, CUDA and GP-GPU Computing, RAPIDS: GPU Accelerated Data Science Python Ecosystem, CuPy, cuDF, cuML, cuSignal,cuGraph, Deep-Dive: CuPy & Numba for accelerated Array Computation- Dask: Distributed Array Processing Scheduler, Multi-GPU training	
Unit-4 - Accelerated Data Wrangling and Machine Learning	9 Hour
GPU Accelerated Data Wrangling using cuDF- RAPIDS Memory Manager & NVTabular, Hands-on practical labs on cuDF with practical problem statement & benchmarking, GPU Accelerated Machine Learning using cuML -Hands-on practical on cuDF + cuML on a practical problem statement & benchmarking	
Unit-5 - Accelerated Signal Processing	9 Hour
GPU Accelerated Signal Processing using cuSignal, Hands-on practical on cuSignal, Hands-on practical on cuSignal + Dask on a practical problem statement & benchmarking	

Learning Resources	<ol style="list-style-type: none"> Goodfellow, I., Bengio, Y. and Courville, A., 2017. Deep learning (adaptive computation and machine learning series). Cambridge Massachusetts, pp.321-359. Ng, A., 2017. Machine learning yearning. URL: http://www.mlyearning.org/ (96), 139. Christopher Love, Jay Vyas, Core Kubernetes, 2022 Chollet, F., 2021. Deep learning with Python. Simon and Schuster.
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Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Thamaraiselvam S, Zoho Corporation Private Limited, Estancia IT Park, Guduvancherry, Tamil Nadu-603202	1. T. Sudhakar Associate professor School of computer science and engineering VIT-AP University	1. Dr. K. Kottilingam SRMIST
		2. Dr.N. Arivazhagan, SRMIST

Course Code	21CSE320T	Course Name	EVOLUTIONARY COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	provide a broad understanding about evolutionary computing			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	gain knowledge about various representations and selection process																	
CLR-3:	describe about various evolutionary algorithm																	
CLR-4:	exemplify about hybridization of EA																	
CLR-5:	emphasize on interactive algorithms																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	understand the need for optimization and components of evolutionary algorithms			3	1	2	2	-	-	-	-	-	-	-	-	2	-	-
CO-2:	distinguish the various representation and selection process in evolutionary computing			3	1	2	-	-	-	-	-	-	-	-	-	2	2	-
CO-3:	analyze the different EA variants and parameter control			3	1	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	discover about memetic algorithms			3	1	2	-	-	-	-	-	-	-	-	-	2	2	-
CO-5:	illustrate the various interactive evolutionary Algorithms			3	1	2	2	-	-	-	-	-	-	-	-	2	3	-

Unit-1 - Introduction	9 Hour
Introduction: Evolutionary computing metaphor, Optimization, Modelling and Simulation Problems, Optimization versus Constraint Satisfaction, Famous NP Problems, Evolutionary Algorithms, Components of Evolutionary Algorithms, Example Applications, Operation of an evolutionary algorithms.	
Unit-2 – Representation and Selection Process	9 Hour
Representation, Mutation, and Recombination: Representation and the Roles of Variation Operators, Binary, Integer, Real-valued, Permutation and Tree Representation, Fitness, Selection, and Population Management: Parent Selection, Survivor Selection, Selection Pressure, Fitness Sharing, Crowding, Automatic Speciation Using Mating Restrictions.	
Unit-3 - Popular Evolutionary Algorithms	9 Hour
Genetic Algorithms, Evolution Strategies, Evolutionary Programming, Genetic Programming, Learning Classifier Systems, Differential Evolution, Particle Swarm Optimisation, Estimation of Distribution Algorithms, Parameter Control: Changing Parameter examples, Classification of Control Techniques, Varying EA Parameters, Test Problems for Experimental Comparisons.	
Unit-4 - Hybridization with Other Techniques	9 Hour
Memetic Algorithms, Structure of a Memetic Algorithm, Adaptive Memetic Algorithms, Design Issues for Memetic Algorithms. Nonstationary and Noisy Function Optimisation: Characterisation, Effect of Different Sources of Uncertainty, Algorithmic Approaches. Multiobjective Evolutionary Algorithms: Multiobjective Optimization, Dominance and Pareto Optimality, EA Approaches to Multiobjective Optimisation	
Unit-5 - Interactive Evolutionary Algorithms	9 Hour
Characteristics, Algorithmic Approaches, Interactive Evolution as Design vs. Optimisation, Example Application: Automatic Elicitation of User Preferences. Coevolutionary Systems.	

Learning Resources	1. A.E.Eiben, J.E.Smith, "Introduction to Evolutionary Computing", Second Edition, Natural Computing Series, 2015.	3. T Back, D B Fogel and T Michalewicz, "Evolutionary Computation 1, Basic Algorithms and Operations", CRC Press, Taylor & Francis Group, 2018
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	2. Benjamin Doerr, Frank Neumann, "Theory of Evolutionary Computation, Recent Developments in Discrete Optimization", Springer International Publishing, 2020.	
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. S. Prabhu, Associate Manager, DXC technologies	1. Dr. Ghanapriya Singh, Associate Professor, NIT Kurukshetra.	1. Dr. Anitha D, SRMIST

Course Code	21CSE323T	Course Name	MARKETING ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	learn to build brand architecture on brand value	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	know to create functions to access and manipulate numbers, strings and date time data																											
CLR-3:	know the emphasis on scaling for brands																											
CLR-4:	utilize the information for strategic marketing alternatives																											
CLR-5:	explore the experiments for digital marketing efforts																											
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	-	-	-	-	-	-	3	-	3	-	-	1	-	-
CO-1:	analyse user Generated Contents	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-												
CO-2:	analyse the digital products	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-												
CO-3:	understand customer Lifetime Value	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-												
CO-4:	analyse the marketing with ML models	-	-	-	-	-	-	-	3	-	-	-	-	2	-	-												
CO-5:	communicate with digital analytics	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-												

Unit-1 - User Generated Contents	9 Hour
Marketing Analytics, Data for Marketing Analytics, Business Intelligence, Analytics, and Data Science, Analysis, Exploratory Data Analysis, Descriptive Analysis, Predictive Analytics, Prescriptive Analytics, Benefits of Customer Analytics, Factors Essential for Obtaining Benefits from Customer Analytics, Segmentation Analytics, Cluster Analysis.	
T1: Data for Marketing Analytics	
T2: Predictive Analysis	
T3: Segmentation and cluster analysis	
Unit-2 - Product Analysis	9 Hour
Product Analytics, Perceptual Mapping, White Spaces, Umbrella Brands, Multidimensional Scaling, Analyzing Digital Products, Analyzing Non-Digital Products,	
T4: Product analysis	
T5: Multimodel scaling	
T5: Digital and Non - digital Products	
Unit-3 - Customer Lifetime Value	9 Hour
Customer Lifetime Value (CLV), Calculating CLV, Understanding the CLV Formula, Applying the CLV Formula, Extending the CLV Formula, Using CLV to Make Decisions, A Forward-Looking Measure.	
T7: Customer Lifetime Value (CLV)	
T5: Applying the CLV Formula,	
T6: Using CLV to Make Decisions	

Unit-4 - Market Analysis	9 Hour
Market Mix Modeling, Variables in Market Mix Modeling, Techniques of Market Mix Modeling, Metrics for Tracking Customer Experience, Upgrading Customers: Use Case of Upselling, Logistic Regression Analysis, Use of Logistic Regression as a Classification Technique T10: Regression Analysis T11: Multivariable Regressions T12: Marketing Mix Models	
Unit-5 - Digital Analytics	9 Hour
Search Engine Marketing, Search Engine Optimization, Social Media Analytics, App Marketing Metrics, Importance of AI in Marketing, Random Forests, Model Evaluation Using ROC, AUC, and Confusion Matrix, Simple Feed-Forward Network, Deep Neural Network, Recommendation Systems, Necessity of Data Visualization, Visualizations Useful with Common Data Science Techniques T13: Search Engine Marketing T14: AI in Marketing T15: Data Visualization Techniques	

Learning Resources	<ol style="list-style-type: none"> Seema Gupta, Avadhoot Jathar, "Marketing Analytics", ISBN: 9789354242625 Brea Cesar (2014), "Marketing and Sales Analytics: Proven Techniques and Powerful Applications from Industry Leaders", FT Press, ISBN-0133761711 Emmett Cox (2012), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1 Fok Dennis (2003), "Advanced Econometric Marketing Models", ERIM, ISBN 90-5892-049-6 Mireles Carlos Hernandez (2010), "Marketing Modeling for New Products", ERIM, ISBN 978-90-5892-237-3 Rackley Jerry (2015), "Marketing Analytics Roadmap: Methods, Metrics, and Tools", Apress, ISBN-1484202597
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.K.Jafar Ali MBA, Ph.D. Consultant, iSpark Learning Solutions, Chennai.	1. Angeline Gautami Fernando, Associate Professor (Marketing & Analytics) at Great Lakes Institute of Management	1. Dr. R. Rajkumar, SRMIST

Course Code	21CSE362T	Course Name	CLOUD COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	understand the cloud concepts with its features																											
CLR-2:	learn the cloud architecture and services																											
CLR-3:	comprehend Security aspects for Cloud platforms																											
CLR-4:	study the basic concepts of Virtualization and capacity planning																											
CLR-5:	gain knowledge on Cloud Applications of different service providers																											
Course Outcomes (CO):		At the end of this course, learners will be able to:												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	exhibit knowledge on basics of Cloud Computing																											
CO-2:	identify then type of services for various applications																											
CO-3:	predict the type of security to be applied for various cloud services																											
CO-4:	examine the concept of virtualization and capacity planning																											
CO-5:	recommend the service provider for specific requirement																											

Unit-1 - Fundamentals of Cloud Computing	9 Hour
Define Cloud Computing, Cloud Types, Characteristics of Cloud Computing, Benefits and disadvantages of cloud systems, Assessing the Value Proposition, Measuring the Cloud's Value, Capital Expenditures, Total Cost of Ownership, Service Level Agreements, Licensing Models	
Unit-2 - Cloud Architecture and Services	9 Hour
Cloud Computing Stack, Composability, Infrastructure, Platforms and Virtual Appliances, Communication Protocols and Applications, Connecting to the Cloud, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)	
Unit-3 - Cloud Security	9 Hour
Cloud Security Challenges, Software-as-a-Service Security, End-User Access to Cloud Computing Overview, Identity Protocol Standards, Windows Azure Identity Standards	
Unit-4 - Virtualization and Capacity Planning	9 Hour
Virtualization Technologies, Abstraction versus Virtualization, Load Balancing and Virtualization, The Google Cloud, Hypervisors, Virtual Machine Imaging, Porting Applications, Capacity Planning	
Unit-5 - Cloud Computing Applications	9 Hour
Web Services: Amazon, Microsoft, Google, Case Studies:, Cloud as Infrastructure for an Internet Data Center (IDC), Cloud Computing for Software Parks, Enterprise with Multiple Data Centers	

Learning Resources	1. Barrie Sosinsky (2011), "Cloud Computing Bible" Wiley Publishing Inc.	4. Michael Kavis, (2014) "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, AND IaaS)", John Wiley & Sons.
	2. John W. Rittinghouse and James F. Ransome (2010), "Cloud Computing, Implementation, Management, and Security", CRC Press.	5. Sunil kumar Manvi, Gopal K. Shyam (2021) "Cloud Computing: Concepts and Technologies", CRC Press, 1st edition.
	3. Borko Furht, Armando Escalante (2010), "Handbook of Cloud Computing", Springer.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	20%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Ruso, Senior Project Lead, HCL Technologies, Chennai	1. Dr. P. Varalakshmi, Professor, MIT, AnnaUniversity, Chennai	1. Dr. D. Malathi, SRM IST
2. Mr. Saju G Nair, Senior Development Manager Kyndryl India Pvt Ltd.	2. Dr. S. Gopika, Kristu Jayanti College, Bangalore.	2. Dr. J. D. Dorathi Jayaseeli, SRM IST

Course Code	21CSE376T	Course Name	NATURE INSPIRED COMPUTING TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	analyze concepts of Natural systems and its applications												
CLR-2:	study new basic natural systems functions(operations)												
CLR-3:	introduce fundamentals of nature inspired techniques which influence computing												
CLR-4:	integrate Hardware and software in Natural applications												
CLR-5:	understand natural design considerations												

Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	illustrate the basic concepts of Swarm Intelligence processes												
CO-2:	examine the principle of Immune computing techniques												
CO-3:	manage the scope changes of nature inspired techniques which influence computing												
CO-4:	identify optimization Techniques to provide functionality and value												
CO-5:	understand the needs and familiarize the DNA Computing												

Unit-1 - Introduction	9 Hour
Introduction, Overview of Philosophy, Nature to Nature Computing, A Brief Overview of Three Branches, Computing Inspired by nature, Simulation and Emulation of Nature i Computers, Computing with Natural Materials, Nature Inspired Computing Approaches.	
Unit-2 - Conceptualization	9 Hour
Natural Phenomena, Models and metaphors, Nature to computing and back again, Individuals, Entities and agents, Parallelism and Distributivity Interactivity, Adaptation- Feedback, Self-Organization, Complexity, Emergence, Bottom-up Vs Top-Down Approach, Determination, Chaos and Fractals.	
Unit-3 - Evolutionary Computing	9 Hour
Hill Climbing, Simulated Annealing, Simulated Annealing, Genetics Principles, Standard Evolutionary Algorithm, Genetic Algorithms, Reproduction, Crossover Mutation, Evolutionary Programming, Genetic Programming	
Unit-4 - Neurocomputing	9 Hour
The Nervous System, Levels of Organization in the Nervous System, Networks Layers and Maps, Basis of learning and Memory, Artificial Neural Networks, Network Architectures, Learning Approaches, ANNS and Learning Algorithms- Hebbian Learning, Single Layer Perceptron, Multilayer Perceptron. Case Study: Bank loan approval using ANN	
Unit-5 - Swarm Intelligence	9 Hour
Introduction, Ant Colony Optimization, Ant Foraging Behaviour, Ant Colony Optimization, SACO algorithm, Ant Colony Algorithm (ACA), scope of ACO algorithms, Swarm Robotics, Social Adaptation of Knowledge, Particle Swarm Optimization - Case Study: Swarm Intelligence in Bio Inspired Computing Problem.	

Learning	1. "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", 4. AlbertY.Zomaya,"Handbook of Nature-Inspired and Innovative Computing ", Springer, 2006 4.
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Resources	Chapman & Hall/CRC, Taylor and Francis Group, 2007.	Marco Dorigo, Thomas Stutzle, <i>Ant Colony Optimization</i> , PHI, 2005.
	2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies", MIT Press, Cambridge, MA, 2008. 3. Nature-Inspired Computing and Optimization Theory and Applications, Srikanta Patnaik • Xin-She Yang, Kazumi Nakamatsu, Springer, 2018	5. Nature-Inspired Computing Concepts, Methodologies, Tools, and Applications, IGI Global, 2016

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Jothi Basu Kamaraj, jothibas.kamaraj@gmail.com	1. Dr.D.Paulraj, Professor, RMKCET, kingrajapaul@gmail.com	1. Dr.B.Hariharan, SRMIST
2. Mr. Sankara Mukunthan sankaramukunthan@gmail.com	2. Dr.S.Kaliraj, Assistant Professor, MAHE, kaliraj.se@gmail.com	

Course Code	21CSE398T	Course Name	LOGIC AND KNOWLEDGE REPRESENTATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	gain knowledge on propositional logic and First order logic	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	understand the concept of description logic and reasoning methods	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	know about uncertainty, probability notations and non-monotonic reasoning																	
CLR-4:	gain knowledge on Qualitative modeling representations																	
CLR-5:	understand and construct Bayesian Networks and Apply inference techniques																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	understand and illustrate propositional and First order logic representations	-	2	-	2	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	understand inference in FOL and Description logic representations	-	1	-	3	-	-	-	-	-	-	-	-	2	-	-		
CO-3:	apply Bayes rule in uncertainty and understand non-monotonic reasoning methods	-	2	-	2	-	-	-	-	-	-	-	-	-	-	2		
CO-4:	illustrate qualitative modeling representation techniques	-	2	-	2	-	-	-	-	-	-	-	-	-	-	2		
CO-5:	construct Bayesian network and apply its inference methods	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3		

Course Outcomes (CO):		At the end of this course, learners will be able to:		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand and illustrate propositional and First order logic representations	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-											
CO-2:	understand inference in FOL and Description logic representations	-	1	-	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-											
CO-3:	apply Bayes rule in uncertainty and understand non-monotonic reasoning methods	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2											
CO-4:	illustrate qualitative modeling representation techniques	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2											
CO-5:	construct Bayesian network and apply its inference methods	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3												

Unit-1 - Introduction to Knowledge and Logic	9 Hour
Knowledge Representation terminologies: syntax –Semantics, Representation languages, Inference validity and satisfiability, Inference in Computers, Logics, Fuzzy logic Propositional Logic: syntax, semantics, validity and inference, Rules of inference for propositional logic, An agent for the Wumpus world, First order Logic: syntax and semantics, Extensions and Notational variations, Logical agent for Wumpus world	
Unit-2 - Procedural Control of Reasoning	9 Hour
Inference in FOL: inference rules involving quantifiers forward and backward chaining, Resolution, Description Logics, Introduction A basic DL and its Extensions, Relationships with other Formalisms, Tableau Based Reasoning Techniques, The Automata Based Approach, Structural Approaches.	
Unit-3 - Uncertainty	9 Hour
Uncertainty: Handling uncertain knowledge basic probability notation, Conditional probability, The axioms of probability, The joint probability distribution, Bayes' rule and its use Applying Bayes' rule. Nonmonotonic Reasoning Introduction, Default Logic, Auto epistemic Logic, Circumscription, Nonmonotonic Inference Relations, Semantic Specification of Inference Relations, Default Conditionals, Relating Default and Auto epistemic Logics, Case study: Relating Default Logic and Circumscription	
Unit-4 - Qualitative Modelling	9 Hour
Qualitative Modelling, introduction Qualitative Mathematics, Ontology, Component Ontologies, Process Ontologies, Field Ontology, Causality, Compositional Modelling, Qualitative Spatial Reasoning, Topological Representations, Shape, Location, and Orientation Representations, Diagrammatic Reasoning, Qualitative Modelling Applications, Automating or Assisting Professional Reasoning, Education, Cognitive Modelling	
Unit-5 - Bayesian Networks	9 Hour
Bayesian Networks: Introduction Syntax and Semantics of Bayesian Networks Exact Inference, Inference with Local (Parametric) Structure, Solving MAP and MPE by Search, Compiling Bayesian Networks, Inference by Reduction to Logic, Approximate Inference: Inference by Stochastic Sampling, Inference as Optimization, Constructing Bayesian Networks: Knowledge Engineering, High-Level Specifications, Learning Bayesian Networks, Case study: Knowledge representation and Question Answering	

Learning Resources	1. S. Russell and P. Norvig. Artificial Intelligence 2nd ed. Prentice Hall, 2002.	3. Boolos, G. S., Burgess, J. P., Jeffrey, R. C. Computability and logic. – Cambridge university press, 2002.
	2. Handbook of Knowledge Representation. Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). Foundations of Artificial Intelligence, 2008.	4. An Introduction to Description Logic. Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Kanitha Anand, CTS	1. Dr. A. Padmavathy, Amrita University, Chennai Campus	1. Dr. A. Maheswari, SRMIST

Course Code	21CSE411T	Course Name	ARTIFICIAL INTELLIGENCE IN GENOMICS AND DISEASE PREDICTION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	generate knowledge about biological macromolecules and bioinformatics			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	provide knowledge on bioinformatics terms and file formats																	
CLR-3:	create an interest about integrating artificial intelligence and genomics																	
CLR-4:	initiate interest on the role of artificial intelligence cancer diagnosis																	
CLR-5:	understand the applications of artificial intelligence in proteomics and drug discovery																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	illustrate knowledge about biological macromolecules and bioinformatics			-	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	discuss about different file formats, NGS pipelines and tools			3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	outline the concepts of artificial intelligence in genomics and pandemic predictions			-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	demonstrate applicability of AI in cancer forecasting and diagnosis			2	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	develop an approach in artificial intelligence for proteomics and drug discovery			2	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 – Introduction to Molecular Biology	9 Hour
Overview of Central Dogma of Molecular Biology - Post Transcriptional & Post Translational Modifications; Classification of Nucleic Acid Bases and Amino Acids; Genomics, Transcriptomics and Proteomics; Mutation and its types; Evolution of Sequencing methods – first, next and third generation – differences; Sequence Data and Quality	
Unit-2 – File Formats and NGS Pipelines	9 Hour
Evolution of Bioinformatics – Sequence alignment – Indels – Homology, Identity, Similarity, Orthology, Paralogy&Xenology; Similarity Search Tools and its types; NCBI – Genbank; Unitprot – Swissprot; KEGG; File formats – Fasta, Fastq, CSFasta; Mutalyzer and HGVS Python Package - Transvar	
Unit-3 – AI Genomics and Pandemic Prediction	9 Hour
Numpy, Pandas, Supervised learning algorithms, Random Forest, KNN, SVM, ANN, Clustering in bioinformatics, Supervised learning methods in analyzing transcriptomics data, AI and ML methods to the investigation of Pandemics, Case study: Forecasting of pandemic using LSTM and in infectious disease diagnostics	
Unit-4 – AI in Cancer Forecasting and Diagnosis	9 Hour
AI, ML and DL in cancer – determining cancer susceptibility, enhanced cancer diagnosis and staging, treatment response, recurrence and survival and personalized cancer pharmacotherapy, Random Forest classification for breast cancer, ML approach to diagnose cancer at early stage.	
Unit-5 – AI in Proteomics and Drug Discovery	9 Hour
AI in proteomics, AI in proteomics data integration, Scope of AI in drug discovery, Molecular modeling and databases in AI for drug molecules, computational mechanics ML methods in molecular modeling, Drug characterization using isopotential surfaces, Case study: Drug design for neuroreceptors using ANN techniques	

Learning	1. Krane, D. E., Raymer, M. L. "Fundamental Concepts of Bioinformatics", Benjamin	5. Christophe Lambert, Darrol Baker, George P. Patrinos. "Human Genome Informatics - Translating
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Resources	Cummings, (2003).	Genes into Health", Elsevier Science, (2018).
	2. Federico Divina, Francisco A. Gómez Vela, Miguel García-Torres. "Computational Methods for the Analysis of Genomic Data and Biological Processes", MDPI (AG) (2021).	6. Smith KP, Kirby JE. Image analysis and artificial intelligence in infectious disease diagnostics. Clin Microbiol Infect. 2020 Oct; 26(10):1318-1323. doi: 10.1016/j.cmi.2020.03.012.
	3. Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th Reprint, Pearson Education. 2005.	7. Mann M, Kumar C, Zeng WF, Strauss MT. Artificial intelligence for proteomics and biomarker discovery. Cell Syst. 2021 Aug 18; 12(8):759-770. doi: 10.1016/j.cels.2021.06.006.
	4. Adam Bohr and Kaveh Memarzadeh. Artificial Intelligence in Healthcare. 1st Edition. Academic publishers. Elsevier Science. 2020	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	25%	-	25%	-	25%	-
Level 4	Analyze	25%	-	25%	-	25%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.C.Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@arontier.co	1. Dr Shandar Ahamad, Professor, Jawaharlal Nehru University,shandar@jnu.ac.in	1. Dr.Habeeb. S. K. M, SRMIST
2. Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru sudheendra@datalore.ai	2. Dr. Balachandran Manavalan, Research Professor, Department of Physiology, Ajou University School of Medicine, World Cup-ro, Yeongtong-gu, Suwon,	2. Dr.ThirumurthyMadhavan, SRMIST
		3. Dr.G.Maragatham, SRMIST

Course Code	21CSE412T	Course Name	MACHINE LEARNING IN DRUG DISCOVERY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes					
CLR-1:	generate knowledge about macromolecules and their structural importance	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-2:	acquire the basis of small molecule descriptor calculations and their algorithms																														
CLR-3:	provide the knowledge about drug discovery process																														
CLR-4:	manipulate data using Python																														
CLR-5:	understand various ML algorithms and their application in biological dataset																														
Course Outcomes (CO):		At the end of this course, learners will be able to:												2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-1:	recall knowledge about macromolecules and their structural importance	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2			
CO-2:	apply knowledge on developing various models	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2				
CO-3:	discuss knowledge about drug discovery pipeline	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-4:	learn how to use Scikit-learn to apply powerful machine learning algorithms	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3				
CO-5:	apply knowledge on ML models and learn best practices for drug discovery dataset	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				

Unit-1 - Macromolecules and Their Structural Importance	9 Hour
Central Dogma of molecular Biology, Structure of DNA, RNA, Amino acids, Classes of Proteins, Protein architecture, Structure stabilizing interactions, Protein folding problem, Solving protein structures, Mechanisms of enzyme actions	
Unit-2 - Computer Representation for Developing 2D and 3D Models	9 Hour
Computer representation of 2D chemical structures, Graph theory to represent Chemical Structures, Connection table, Computer representation of 3D chemical structures, biological databases	
Unit-3 - Drug Discovery Pipeline	9 Hour
Sequence analysis, Methods of sequence analysis, Introduction to drug discovery process and computational approaches, "Drug-Likeness" and Compound Filters, ligand and Structure based drug design, Virtual screening, Protein-Ligand Docking	
Unit-4 - Scikit-Learn for Machine Learning Analysis	9 Hour
Basics of Python for ML data analysis, String function for nucleic acid sequence, Numpy, and Pandas, basic graph theory	
Unit-5 - Knowledge of ML Models for Drug Discovery	9 Hour
Machine learning pathway overview, Types of Machine learning algorithms, Cross validation: Test and Training split, Introduction to Biological Dataset construction, case studies of drug molecules benchmarking datasets and ML model generation	

Learning	1. Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th	4. Online Sources: https://wiki.python.org/moin/BeginnersGuide/Programmers .
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Resources	Reprint, Pearson Education. 2005. 2. Murthy.C.S.V. "Bioinformatics", 1st Edition, Himalaya Publishing House.2003. 3. Rastogi.S.C. Namita., M., Parag, R., "Bioinformatics- Concepts, Skills, and Applications", CBS Publishing. 2009.	5. Mount D., "Bioinformatics: Sequence and Genome Analysis", 2 nd Edition, Cold Spring Harbor Laboratory Press, New York. 2004.
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	10%	-
Level 2	Understand	25%	-	20%	-	20%	-
Level 3	Apply	30%	-	35%	-	35%	-
Level 4	Analyze	30%	-	35%	-	35%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.C.Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@arontier.co	1. Dr Shandar Ahamad, Professor, Jawaharlal Nehru University, shandar@jnu.ac.in	1. Dr.ThirumurthyMadhavan, SRMIST
2. Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru	2. Dr. Balachandran Manavalan, Research Professor, Department of Physiology, Ajou University School of Medicine, Yeongtong-gu, Suwon, South Korea	2. Dr. Habeeb. S. K. M, SRMIST
		3. Dr.G.Maragatham G, SRMIST

Course Code	21CSE418T	Course Name	CYBER PHYSICAL SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	outline the basic concepts, requirements, principles, and techniques in emerging cyber physical systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand the components that define the physical and cyber aspects of real-world technologies															
CLR-3:	analyze the processing units applicable for cyber physical system															
CLR-4:	understand embedded systems vs Internet of Things implementing a cyber-physical system from a computational perspective															
CLR-5:	acquire knowledge on Security and Privacy in Cyber Physical System															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	acquire the basic concepts and purpose of the different components of Cyber Physical Systems	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	analyze the new system and ability to interact with Cyber Physical System	1	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	illustrate the abstraction of various system architectures and understand the semantics of a CPS model	2	2	-	-	-	-	-	-	-	-	-	-	1	-	2
CO-4:	implement the ability to interact with cyber-physical systems protocols with Internet of Things	3	3	2	-	-	-	-	-	-	-	-	-	2	-	3
CO-5:	apply the common methods used to secure cyber-physical systems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Framework for Cyber-Physical Systems (CPS)	9 Hour
Introduction to CPS- IoT Vs CPS- Concept map- CPS analysis by example- Application Domains-Significance of CPS- Hybrid System Vs. CPS- Multi dynamical system- Component of CPS- Physical- Cyber and Computational Components.	
Unit-2 - Physical Components	9 Hour
Introduction to sensors and actuators – Deployment- assignment and coordination – Network criteria designs- Importance of sensors- causality-sensor reliability-memory requirement- computational complexity-redundant sensors-Operational criteria- Testbed.	
Unit-3 - Cyber Components	9 Hour
Networking technologies for CPS- sensing networks and data connectivity- M2M communication- characteristics of IP and Non-IP solutions, 6LoWPAN, RPL- CoAP and HTTP- CoAP- Mobile cloud computing- Definition and types.	
Unit-4 - Computational Components	9 Hour
Embedded system design flow for CPS- processing units-Overview-ASIC-Processor-DSP, Multimedia processor- VIEW-microcontroller and MPSoC- Reconfigurable logics.	
Unit-5 - Secure Deployment of CPS & Applications of CPS	9 Hour
Secure Task mapping and Partitioning - State estimation for attack detection - Automotive Vehicle ABS hacking - Power Distribution Case study: Attacks on Smart Grids – Virtual Instrumentation; Case study: Applications of CPS.	

Learning Resources	1. A.Platzer, Logical Foundations of Induction.2018	6. Wolf, Marilyn. High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing. Elsevier, 2014.
	2. Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015	7. Guido Dartmann, Houbing song, Anke schmeink, "Big data analytics for Cyber Physical System", Elsevier, 2019
	3. E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber-Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2	8. Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press, 2019
	4. P.Ashok, G. Krishnamoorthy, and D. Tesar, "Guidelines for managing sensors in cyber physical systems with multiple sensors," J. Sensors, vol.2011, 2011.	9. Christopher Greer, Martin Burns, David Wollman, Edward Griffor "Cyber-Physical Systems and Internet of Things", NIST Special Publication, https://doi.org/10.6028/NIST.SP.1900-202
	5. P.Marwedel, Embedded System Design:Embedded system foundations of Cyber-Physical Systems,vol.16.2010.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	20%	-	20%	-
Level 2	Understand	50%	-	30%	-	30%	-
Level 3	Apply	-	-	20%	-	20%	-
Level 4	Analyze	-	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Ponnambalam Mudivai Arun, Director of Products Citrix System, Bangalore	1. Dr. Munesh Pal Singh,IIITDM,Kancheepuram	1. Dr. Krishnaveni, SRMIST
	2. Dr. N.Balaji, SSN College of Engineering	

Course Code	21CSE421T	Course Name	BUSINESS INTELLIGENCE AND ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	familiarize with Business Intelligence, Analytics and Decision Support												
CLR-2:	understand the technologies for Decision making												
CLR-3:	familiarize with predictive modeling techniques												
CLR-4:	familiarize with sentiment analysis techniques												
CLR-5:	understand about Decision-making systems												

Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	gain knowledge on Business Intelligence, Analytics and Decision Support												
CO-2:	understand the technologies for Decision making												
CO-3:	apply predictive modeling techniques												
CO-4:	apply sentiment analysis techniques												
CO-5:	gain knowledge on Decision-making systems												

Unit-1 - Introduction: Business Intelligence, Analytics and Decision Support	9 Hour
Information Systems Support for Decision Making - An Early Framework for Computerized Decision Support - The Concept of Decision Support Systems - A Framework for Business Intelligence - Business Analytics Overview - Brief Introduction to Big Data Analytics - Clickstream Analysis – Metrics - Clickstream Analysis - Practical Solutions - Competitive Intelligence Analysis	
T1: Introduction to Power BI and SSMS	
T2: Installing Power BI and SSMS	
T3: Prepare data in Power BI Desktop	
Unit-2 - Decision Making	9 Hour
Decision Making - Introduction and Definitions - Phases of the Decision - Making Process - The Intelligence Phase - Design Phase - Choice Phase - Implementation Phase - Decision Support Systems Capabilities - Decision Support Systems Classification - Decision Support Systems Components	
T4: Load data in Power BI Desktop	
T5: Model data in Power BI Desktop part-1	
T6: Model data in Power BI Desktop part-2	

Unit-3 - Predictive Modeling and Sentiment Analysis	9 Hour
Basic Concepts of Neural Networks - Developing Neural Network - -Based Systems - Illuminating the Black Box of ANN with Sensitivity - Support Vector Machines - A Process Based Approach to the Use of SVM - Nearest Neighbor Method for Prediction -Sentiment Analysis Overview - Sentiment Analysis Applications - Sentiment Analysis Process - Sentiment Analysis - Speech Analytics T7: Implement data model using SQL in Power BI T8: Create DAX calculations in Power BI Desktop part-1 T9: Create DAX calculations in Power BI Desktop part-2	
Unit-4 - Multi-Criteria Decision-Making Systems	9 Hour
Decision Support Systems modeling - Structure of mathematical models for decision support - Decision making under certainty - Uncertainty and Risk - Decision modeling with spreadsheets - Mathematical programming optimization - Decision analysis introduction - Decision tables - Decision Trees - Multi-criteria decision making - Pairwise comparisons T10: Design a report in Power BI Desktop part-1 T11: Design a report in Power BI Desktop part-2 T12: Create a Power BI dashboard	
Unit-5 - Automated Decision Systems	9 Hour
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems - Location based Analytics - Cloud Computing - Business Intelligence T13: Create a Power BI paginated report T14: Perform data analysis in Power BI Desktop T15: Enforce Row-level security	

Learning Resources	<ol style="list-style-type: none"> 1. Ramesh Sharda, Dursun Delen, EfraimTurban, J.E.Aronson, Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10th Edition, Pearson Global Edition, 2013. 2. Brett Powell, "Mastering Microsoft Power Bi: Expert techniques for effective data analytics and business intelligence", 2018 3. Alberto Ferrari Marco Russo, "Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel", Second Edition, By Pearson, 2020
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Selvakumar,Hexaware Technologies, selvakumarv@hexaware.com	1. Dr. T. Veerakumar, Professor, NIT Goa	1. Dr. T. Karthick, SRMIST

Course Code	21CSE439T	Course Name	VIRTUAL REALITY AND AUGMENTED REALITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	illustrate the fundamentals concepts of VR	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	remember about standard Color models															
CLR-3:	discuss about VR Environment Concepts															
CLR-4:	apply and use of 3D Manipulation and interaction															
CLR-5:	understand the usage of Augmented Reality															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	discuss Virtual Reality Fundamentals	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	illustrate various color models concepts	1	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	apply the knowledge in VR Environment	1	2	1	-	-	-	-	-	-	-	-	-	2	-	2
CO-4:	identify the concepts of 3D features	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	apply Virtual Reality applications	2	-	-	2	3	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to VR	9 Hour
Historical development of VR, Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, Visual Displays, Auditory Displays, Haptic Displays, Choosing Output Devices, Building Objects, Complex Shapes. Generation of fractal curves and landscapes using algorithms, Illustrate the aliasing and anti-aliasing techniques, Generation of Mandelbrot and Julia set fractals.	
Unit-2 - Color Models	9 Hour
Standard Primaries and the Chromaticity Diagram, Intuitive Color Concepts, RGB and CMY color models, HSV Colour Model, Colour Selection and Applications, World Space, World Coordinate, World Environment example, VR Environment Example. Construct the primitives with different color models and simulate the conversion from one model to another, Develop a new texture and apply various mapping on 3D objects Implementation of ray tracing concepts with the collection of 3D models	
Unit-3 - Basic of VR Data Base	9 Hour
R Database, Tessellated Data, LODs, Lights and Cameras, Cullers, Occluders, Scripts, Graphical User Interface, Control Pane, VR toolkits, Software' s for VR, Available operating systems, Available software, Example, illustration	
Unit-4 - Basic of 3D Task	9 Hour
3D Manipulation tasks, Example and Case study, Manipulation Techniques, Input Devices, Interaction Techniques for 3D Manipulation, 3D Travel Tasks, Environment Centered Wayfinding Support, Theoretical Foundations of Wayfinding, Overview of Augmented Reality, Tracking for Augmented Reality, Augmented Reality Interaction, Collaborative Augmented Reality	
Unit-5 - Basic of Augmented Reality	9 Hour
3D Augmented Reality Interfaces, Augmented Surfaces, and Tangible Interfaces, Agents in AR, Transitional AR-VR Interfaces, Heterogeneous user interfaces, Mobile Augmented Reality, annotating environment, Annotating environment, Applications, Optical AR, Video AR, Heterogeneous AR, Mixed Reality case studies: Electronic circuit, Virtual class room, interior design, healthcare etc.	
Learning	1. Virtual Reality Systems, By John Vince, Pearson Education 2002 6. Steve Aukstakalnis , "Practical Augmented Reality: A Guide to the Technologies,

Resources	2. <i>Virtual Reality Technology</i> , 2nd, by Grigore C. Burdea (Author), Philippe Coiffet (Author), Wiley Publications. June 2003 3. <i>Augmented Reality: Principles & Practice</i> Paperback – 12 Oct 2016 by Schmalstieg/Hollerer (Author) 4. <i>Virtual & Augmented Reality for Dummies</i> by Paul Mealy, Publication by John Wiley & Son July 2018 5. Daniela, Linda. "New perspectives on virtual and augmented reality." Available at: https://www.taylorfrancis.com/books/edit/10.4324/9781003001874/new-perspectives-virtual-augmented-reality-lindadaniela , 2020.	<i>Applications, and Human Factors for AR and VR</i> 2016, Publisher(s): Addison-Wesley Professional 7. Course on Virtual Reality, IIT Madras https://nptel.ac.in/courses/106/106/106106138/ 8. Foundation Course on Virtual Reality and Augmented Reality, IIT Madras, NPTEL https://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual-reality-and-augmented-reality/ , 3rd ed, Pearson, 2016
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Mr.Venington K Assistant Professor in Computer Science and Engineering at National Institute of Technology Srinagar	1. Dr. M. Ramprasath, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	2. Dr.K.Sitara Assistant Professor in Computer Science and Engineering at National Institute of Technology, Trichy	2. Dr. Athira M Nambiar, SRMIST

ACADEMIC CURRICULA

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**Volume – 5A
(Syllabi for Artificial Intelligence (Integrated)
Programme Courses)**



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**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



SRM
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21AIC501T	Course Name	AMBIENT INTELLIGENCE	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes					
CLR-1:	gain knowledge in the fundamental principles, technologies for the development of Ambient Intelligence systems	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-2:	exemplify the design process that supports the manipulation of physical, functional and conceptual structures																														
CLR-3:	understand the concept of distributed networks and multiple camera surveillance system																														
CLR-4:	integrate the information from multiple camera views																														
CLR-5:	infer knowledge in real-time detection applications																														
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	create a new synergy between human and machine	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-2:	understand the concept of context based ambient intelligence	-	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-			
CO-3:	acquire the knowledge of multi camera coordination and its surveillance	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-4:	analyze the methodology for learning activity-based semantic scene models from observing activity, in the application area of automatic visual surveillance	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-5:	develop and implement user friendly and effective real-time systems	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			

Unit-1 - Introduction to Ambient Intelligence and Smart Environments	12 Hour
The Essex Approach, The iDorm – A Testbed for Ubiquitous Computing and Ambient Intelligence, The iDorm Embedded Computational Artifacts, Integrating Computer Vision-User Detection, Estimating reliability of detection, An integrated Supervision System, E-service based Integrated Schemata, Robot localization and Tracking System, The Plan Execution Monitoring System, Integrating sensing and Execution Monitoring: a Running Example	
Unit-2 - Scaling Ambient Intelligence and Context based Ambient Intelligence Architecture	12 Hour
I-BLOCKS Technology, Design process, Scaling Ambient Intelligence at level of compositional devices, Linguistic scenario, Scaling Ambient Intelligence at level of configurable environment, Main tasks of Ambient Intelligence systems, Architecture design, Context aware systems	
Unit-3 - Distributed Active Multicamera Networks	12 Hour
Sensing modalities, Vision for Ambient Intelligence, Architecture of People Vision system, Tracking and object detection, Normalization, Multi-camera coordination, multi-scale image acquisition. Multicamera Surveillance System- System architecture, Motion detection and single-view tracking, Multi view tracking.	
Unit-4 - Mapping an Ambient Environment	12 Hour
Semantic Scene Model, learning point-based regions, Learning trajectory-based regions- Route model, Learning algorithm, Activity analysis, Integration of information from multiple views - Multiple Camera Activity Network (MCAN), Database, Metadata Generation.	
Unit-5 - Ambient Intelligence in Practice	12 Hour
Fast Online Speaker Adaptation for Smart Room Applications, Stereo-Based 3D Face Recognition System, Security and Building Intelligence, Sustainable Cybernetics Systems	

Learning Resources	1. Paolo Remagnino, Gian Luca Foresti, Tim Eills, (Eds.), "Ambient Intelligence – A Novel Paradigm", Springer, 2005	3. Nak-Young Chong, Fulvio Mastrogiovanni, "Handbook of Research on Ambient Intelligence and Smart Environments-Trends and Perspectives", Clarivate Analytics, 2011.
	2. G. Riva (Editor), Francesco Vatalaro (Editor), F. Davide (Editor), M. Alcaniz (Editor) "Ambient Intelligence-The Evolution of Technology, Communication and Cognition Towards the Future of Human Computer Interaction", IOS Press, 2005	4. Wim Verhaegh, Emile Aarts, Jan Korst, (Eds.), "Algorithms in Ambient Intelligence", Philips Research Book Series, Vol 2, Kluwer Academic Publishers, 2004.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	20%	-
Level 3	Apply	20%	-	20%	-	15%	-
Level 4	Analyze	15%	-	20%	-	25%	-
Level 5	Evaluate	15%	-	20%	-	25%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.S. Smilin Sam, LMTS, Athena Health Private Limited	1. Dr. R. Gayathri, Professor, SVCE	1. Dr. C. Sherin Shibi, SRMIST

Course Code	21AIC502J	Course Name	EMERGING ARTIFICIAL INTELLIGENCE APPLICATIONS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	understand the concept of Artificial Intelligence and knowledge-based representations	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	learn the algorithms of AI in the perspective of real time applications	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	design web-based applications require access to multiple data sources to supply relevant information															
CLR-4:	apply the artificial intelligence tools in medicine and healthcare provision															
CLR-5:	understand the implementation of various real-time applications of AI															

Course Outcomes (CO):	At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	solve the concept of Artificial Intelligence and knowledge-based representations	-	-	1	-	-	-	-	-	-	-	-	-	-	3	-
CO-2:	develop an understanding of modern concepts in AI and where they can be used	-	-	1	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	implement information retrieval concepts and methods to return documents automatically based on user queries	-	-	-	-	3	-	-	-	-	-	-	-	-	3	-
CO-4:	design user interfaces to improve human-AI interaction and real-time decision-making	-	-	1	-	-	-	-	-	-	-	-	-	-	3	-
CO-5:	design, implement and apply novel AI techniques based on emerging real-world requirements	-	-	3	2	3	-	-	-	-	-	-	-	-	3	-

Unit-1 - Introduction to AI	15 Hour
Introduction-A.I. Representation-Non-AI & AI Techniques-Representation of Knowledge- Knowledge Base Systems-State Space Search-Blind search: Depth first search, Breadth first search, Informed search: Heuristic function, Hill climbing search, best first search, A* & AO* Search-Intelligent Agents and Environments-Nature of environments-Structure of agents-problem solving agents.	
Unit-2 - Applications of AI	15 Hour
Supervised Machine Learning-Issues of Supervised Learning Algorithms-Overview of the Dimension Reduction Methods- SOM- Sammon Mapping- Applications-A Brief Overview Recommender Systems- Knowledge Modelling Using UML-Case Study: Clinical Practice Guideline Recommendations.	
Unit-3 - Ontology Learning for Semantic Web	15 Hour
Semantic Web and Need – Ontologies –Ontology Learning Algorithms -Methods for Evaluating Ontologies-A Semantic-Based Navigation Approach for Information Retrieval in the Semantic Web-Ontology-based Management of Pervasive Systems-DIYD.	
Unit-4 - Intelligent Human-Computer Interaction & Health	15 Hour
High-Level Concept Detection in Video Using a Region Thesaurus - Intelligent Human-Computer Interaction - Medical Images in the Wavelet Domain -Automated Pressure Ulcer Lesion Diagnosis - Fuzzy Systems in Biomedicine - Interpretation of Gene Expression Microarray - State of the Art AI Systems for Skin Cancer Diagnosis	
Unit-5 - Real World AI Applications	15 Hour
Intrusion Detection for Network-Prediction Models of an Indoor Smart Antenna System- Video Watermarking and Benchmarking- Face Detection System-Robotic Sensor Networks: An Application to Monitoring Electro-Magnetic Fields-Assembling Composite Web Services from Autonomous Components	
Lab Experiments	
Lab 1: Implement any search strategy algorithm to reach goal state	

Lab 2: Use of Hill climbing algorithm for solving real world problem
 Lab 3: Write a Program to implement informed A* search method.
 Lab 4: Design a fuzzy set for shape matching of handwritten character
 Lab 5: Implement voice and text chat applications using popular frameworks
 Lab 6: Implement to predict the price of a house in a different area using AI
 Lab 7: To develop the plagiarism detector for detecting the matches within text copies & notices the plagiarism percentage.
 Lab 8: To implement CV Analysis based Prediction System of Personality
 Lab 9: To predict the heart disease using any AI applications
 Lab 10: To develop An Ontology-Based Method for Domain Expert Matching
 Lab 11: To implement the Software Testing Ontology for AI-based Systems
 Lab 12: To implement a Web-based Game-Oriented College Selection System Employing Fuzzy Rule Trees
 Lab 13: A Case Study on How Artificial Intelligence (AI) is Used by 20th Century Studios
 Lab 14: A Case Study on Artificial Intelligence Application in Medical Diagnostics
 Lab 15: A Case Studies of Real AI Applications

Learning Resources	1. Ilias Maglogiannis, Kostas Karpouzis, Manolis Wallace, John Soldatos, 'Emerging AI applications in Computer engineering real world AI system with application in eHealth, HCI, Information retrieval, Pervasive tech', IOS Press, US (1 January 2007)	2. Kevin Knight, Elaine Rich, B. Nair, 'Artificial Intelligence' McGraw Hill Education, 2012
		3. An Introduction to Artificial Intelligence by Prof. Mausam IIT Delhi 4. (https://onlinecourses.nptel.ac.in/noc22_cs56/)

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	-	-	10%	25%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	20%	-	-	30%	20%	-
Level 4	Analyze	20%	-	-	30%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Hemachandiran ,Trainer, Capgemini Technology Services Pvt Ltd, Chennai	1. Dr.P. Marikkannu, Anna University Regional Campus, Coimbatore	1. Mr. K. Babu, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21AIE531T	Course Name	MATRIX THEORY FOR ARTIFICIAL INTELLIGENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	solve basic matrix operations	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	illustrate Eigen values and eigenvectors and similarity operations	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	study canonical forms, Triangular factorizations															
CLR-4:	understand the importance of Gradient and optimization															
CLR-5:	solve decomposition and linear problems															

Course Outcomes (CO):	At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	interpret the basic matrix operations and solve problems in Vectorization and Matricization for spatial feature extraction	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	illustrate Eigenvalues, Eigenvectors and Similarity for pre-processing	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	demonstrate the Hermitian, symmetric matrices and congruences methods for dimensionality reduction	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	apply Gradient and optimization methods for feature selection	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	solve linear and least square problem using QR factorization and triangularization	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Matrix Theory	9 Hour
Vector spaces, Matrices, Determinants, Rank, Norms, Inverse Matrices and Moore–Penrose Inverse Matrices, Products – Hadamard, Kronecker, Vectorization and Matricization, Problems in Vectorization and Matricization	
Unit-2 - Eigenvalues, Eigenvectors and Similarity	9 Hour
The eigenvalue–eigenvector equation, The characteristic polynomial and algebraic multiplicity, Similarity, Left and right eigenvectors and geometric multiplicity, Unitary Similarity and Unitary Equivalence, Unitary matrices and the QR factorization, Introduction to triangularization and Decomposition	
Unit-3 - Canonical Forms, Triangular Factorizations and Hermitian Matrices	9 Hour
The Jordan canonical form theorem, Consequences of the Jordan canonical form, Minimal polynomial and companion matrix, Real Jordan and Weyr canonical forms, Triangular factorizations and canonical forms, Hermitian Matrices, Symmetric Matrices and Congruences, Properties and characterizations of Hermitian matrices, Variational characterizations and subspace intersections, Eigenvalue inequalities for Hermitian matrices, Unitary congruence and complex symmetric matrices, Congruences and diagonalizations	
Unit-4 - Gradient and Optimization	9 Hour
Jacobian Matrix and Gradient Matrix- Calculation of Partial Derivative and Gradient, Complex Gradient Matrices - Holomorphic Function and Complex Partial Derivative, Complex Matrix Differential, Complex Gradient Matrix Identification, Real Gradient, Gradient of Complex Variable Function, Convex Sets and Convex Function Identification, Gradient Methods for Smooth and non-smooth Convex Optimization	
Unit-5 - Solution of Linear Systems	9 Hour
Location and Perturbation of Eigenvalues, Gaussian Elimination, Conjugate Gradient Methods, Singular Value Decomposition, Least Squares Method, Problems in Least Square method, Tikhonov Regularization and Gauss–Seidel Method, Eigenvalue Decomposition, Optimization in Machine Learning	

Learning Resources	1. David W. Lewis, "Matrix Theory", World Scientific Publishing Co. 1991.	3. Robert R. Stoll "Linear Algebra and Matrix Theory", Dover Publications Inc., 2012.
	2. Xian-Da Zhang A Matrix Algebra Approach to Artificial Intelligence, Springer Nature Singapore Pte Ltd. 2020.	4. Alexander Graham "Matrix Theory and Applications for Scientists and Engineers", Dover Publications Inc., 2018.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	50%	-	50%	-	50%	-
Level 4	Analyze	10%	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohan Raj, Data Scientist, Standard Chartered	1. Dr. Jani Anbarasi, Associate Professor, VIT, Chennai	1. Dr.S.Sadagopan, SRMIST
2. Mr. N. Nagendran, Senior Software Developer, Cognizant Technology Solutions	2. Dr. P.Visu, Professor, Velammal Engineering College	2. Dr.K.A.Varun, SRMIST

Course Code	21AIE532T	Course Name	SOFT COMPUTING AND ITS APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	get familiar with fuzzy sets, fuzzy logic, fuzzy membership and fuzzification	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand fuzzy classification and pattern recognition															
CLR-3:	design and implement feed forward, Back propagation neural networks and Hybrid systems															
CLR-4:	understand and implement genetic algorithms and its applications															
CLR-5:	understand swarm and colony based evolutionary computing techniques															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	gain knowledge on Fuzzy sets to recognize the appropriateness of computational task	-	1	-	1	-	-	-	-	-	-	-	-	2	-	-
CO-2:	design a fuzzy based soft computing system to address the computational task	-	-	-	3	-	2	-	-	-	-	-	-	2	-	-
CO-3:	apply a given computational task to solve it through neuro-fuzzy based hybrid model	-	3	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-4:	acquire and apply Genetic Algorithm operations for solving a computational task	-	3	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-5:	apply soft computing system based on swarm and colony optimization to achieve a computational solution	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fuzzy Logic and Fuzzy System	9 Hour
Introduction to Soft Computing- Evolution from Conventional AI to Computational intelligence - Evolutionary Search Strategies. Fuzzy Sets – Fuzzy relations, value assignments, Fuzzy Membership Functions – Fuzzification, Defuzzification. to Crisp Set, problems on fuzzification- classical logic, Fuzzy Logic-Approximate reasoning, fuzzy systems, problems on fuzzy logic –Development of Membership functions: membership value assignments, intuition, Inference, rank ordering –Neural Network, Problems on membership value assignments.	
Unit-2 - Fuzzy Decision Making and Classification	9 Hour
Fuzzy Decision Making: Fuzzy Bayesian Decision Method, Decision Making under Fuzzy States and Fuzzy Actions - Fuzzy Classification and Pattern Recognition: c-Means Clustering, Fuzzy c-Means - Boltzmann's Machine Learning Algorithm –problems on fuzzy classification, Pattern Recognition: Single sample Identification, Multifeature pattern recognition, problems on Multifeature pattern recognition -case study: Handwritten character recognition using fuzzy logic.	
Unit-3 - Artificial Neural Networks	9 Hour
Neural Networks in Computer Science – Basic models of artificial neural network – important terminologies of ANNs-McCulloch-Pitts Model- Back propagation network: architecture, training algorithm, learning factors, Layered Feed Forward Neural Networks – Generative adversarial network- Kohonen's Self Organizing Maps- Learning Vector Quantization – limitations of neural network – Neuro Fuzzy Hybrid Systems –Case study: Colour Recipe Prediction	
Unit-4 - Evolutionary Algorithms	9 Hour
Components of evolutionary algorithms – natural versus artificial Evolution –Development of Genetic Algorithm – genetic algorithm and search space – basic terminologies in GA- chromosomes, parameters and parameter tuning, convergence - GA operators– Genetic modelling: inheritance - inversion & deletion - Generational Cycle, working principle of GA - Applications & advances in GA, genetic neuro hybrid systems- job shop scheduling using genetic algorithm approach	

Unit-5 – Optimization Techniques**9 Hour**

Simulated annealing – particle swarm optimization: basic PSO parameters - local best, global best, velocity component, working principle of PSO– Travelling salesman problem optimization using PSO - Ant colony optimization – Multi objective evolutionary algorithms – case study: Internet search techniques.

Learning Resources	<ol style="list-style-type: none"> 1. Ross, T. J., "Fuzzy logic with engineering applications," John Wiley & Sons, Second Edition, 2017 2. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer, 2018. 3. S.N.Sivanandam, S.N.Deepa, "Priciples of Soft Computing", 2nd Edition, John-Wiley India, 2011. 4. A.E.Eiben and J.E.Smith, "Introduction to Evolutionary Computing", Second edition, Springer, 2015. 5. References 6. Saroj koushik & Sunita Tiwari "Soft Computing, Fundamentals, Techniques and Applications" 1st Edition, McGraw Hill Publication, 2018 	<ol style="list-style-type: none"> 7. Samir Roy and Udit Chakraborty, "Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms" Pearson Education, 2013. 8. Marco Dorigo and Thomas Stützle, "Ant Colony Optimization", MIT press, 2004. 9. Maurice Clerc, "Particle Swarm Optimization", ISTE, 2006 10. https://hal-enac.archives-ouvertes.fr/hal-01887543/document
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Vasanthi, Senior Consultant, Slalom · Sydney, New South Wales, Australia	1. Dr. B. Rajesh Kanna, Professor, VIT	1. Mr. S. Joseph James, SRMIST

Course Code	21AIE533T	Course Name	ARTIFICIAL INTELLIGENCE AND HIGH-PERFORMANCE COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	understand the Basics of High-Performance computing, Artificial Intelligence and Deep Learning			Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	learn the High-Performance Computing Enablers in AI																	
CLR-3:	understand the High-Performance Computing Architectures, Networks and Infrastructure, Data, Storage and Visualization																	
CLR-4:	analyse the various HPC Algorithms in AI																	
CLR-5:	learn High Performance Role in Data Analytics and AI applications																	
Course Outcomes (CO):		At the end of this course, learners will be able to:		-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	formulate a problem to build intelligent agents			-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	use High Performance Computing Enablers in AI			-	2	3	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	infer the various Architectures, Networks and Infrastructure, Data, Storage and Visualization techniques			-	2	-	-	-	-	3	-	-	-	-	-	-	-	3
CO-4:	apply Various HPC Algorithms in AI			-	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	formulate a problem to build intelligent agents			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
Introduction to Artificial Intelligence, Deep Learning and Edge Computing Solution for High-Performance Computing -High-Performance Computing: A Deep Learning Perspective, Deep Learning and Edge Computing Solution for High-Performance Computing- HPC - New Challenges, Same Goals -High-performance Computing Objectives - What are the best performance indicators? - Measuring Performance Indicators - Trends in High-performance Computing- Emphasis on Energy Efficiency -Data Driven Discovery -The Rise of Dedicated Silicon Acceleration Technologies -Pushing HPC to Data Sources (Edge) -What is quantum computing? -Rise of the Metaverse and Digital Twins	
Unit-2 - High Performance Computing Enablers	9 Hour
High-Performance Computing Key Enablers -HPC Application Support and Breadth -HPC and AI Convergence -Speeding Simulations -Equation Enhanced Machine Learning -Transforming HPC Coherent System and Accelerator Memory -Advances in Computer Networks -Network Bandwidth for Scaling -Interconnects for Multi-GPU and Multi-Node Acceleration -Cloud-Native Supercomputing -SmartNIC Offload -Converged Accelerator and Network Interface Card -HPC Developer Ecosystem -Vibrant Community -Standard, Open, and Portable Parallel Programming Models -Cloud, VMs, and Containers	
Unit-3 - Architectures Networks and Infrastructure	9 Hour
FASTHash: FPGA-Based High Throughput Parallel Hash Table- Running a Pre-exascale, Geographically Distributed, Multi-cloud Scientific Simulation- Scalable Hierarchical Aggregation and Reduction Protocol (SHARP)TM Streaming-Aggregation Hardware Design and Evaluation Data, Storage and Visualization - Shared-Memory Parallel Probabilistic Graphical Modeling Optimization: Comparison of Threads, OpenMP, and Data-Parallel Primitives-Opportunities for Cost Savings with In-Transit Visualization -Semi-automatic Assessment of I/O Behavior by Inspecting the Individual Client-Node Timelines—An Explorative Study on 106 Jobs	

Unit-4 - HPC Algorithms **9 Hour**

Solving Acoustic Boundary Integral Equations Using High Performance Tile Low-Rank LU Factorization -DGEMM Using Tensor Cores, and Its Accurate and Reproducible Versions-Predicting Job Power Consumption Based on RJMS Submission Data in HPC Systems-HyPar-Flow: Exploiting MPI and Keras for Scalable Hybrid-Parallel DNN Training with TensorFlow-Time Series Mining at Petascale Performance-Time Series Mining at Petascale Performance

Unit-5 - High Performance AI Applications **9 Hour**

Economy/Finance/Banking - Customer Service, Mobile Banking, Security and Fraud Detection, Algorithmic Trading and Risk Management, And Chatbots and Other Bots, Monitoring - Autonomous Driving, Autonomous Surveillance, Autonomous Transportation, Gaming, Interaction & Services, Customer Service/Support with AI Chatbots, Emotional Ai, Customized Elements, Applications of Machine Learning and High-Performance Computing in the Era of COVID-19

Learning Resources	1. Introduction to High Performance Computing for Scientists and Engineers, Georg Hager, Gerhard Wellein, CRC Press, 2010.	4. Deepak Kemhani, First course in Artificial Intelligence, McGrawHillPvtLtd,2013
	2. Deep Learning and Edge Computing Solutions for High Performance Computing, A. Suresh, Sara Paiva, (EAI/Springer Innovations in Communication and Computing) Springer; 1st ed. 2021 edition (27 January 2021)	5. High-Performance Computing for the Age of AI and Cloud Computing by NVIDIA
	3. Parag Kulkarni, Prachi Joshi, Artificial Intelligence –Building Intelligent Systems, 1st ed., PHI learning,2015	6. High Performance Computing 35th International Conference, ISC High Performance 2020, Frankfurt/Main, Germany, June 22–25, 2020, Proceedings
		7. Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, 2007

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	10%	-	20%	-
Level 3	Apply	30%	-	30%	-	25%	-
Level 4	Analyze	10%	-	30%	-	25%	-
Level 5	Evaluate	20%	-	10%	-	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100%		100%		100%	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Tejas Gowda, Co-Founder & Chief Data Scientist, TenzAI	1. Dr. T. Senthilkumar, Associate Professor, Amrita School of Engineering, Amrita Vishwa Vidyapeetham	1. Dr.J. Jeyasudha,SRMIST.

Course Code	21AIE535T	Course Name	ARTIFICIAL INTELLIGENCE AND INTERNET OF THINGS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the fundamentals and Foundation of Artificial Intelligence and IOT	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	learn basics of Machine Learning in IOT and Deep Learning,															
CLR-3:	remembering knowledge on the Internet of Things for the implementation in Detection, Computer Vision															
CLR-4:	acquire knowledge on IOT for the implementation of NLP and Q- Learning															
CLR-5:	understand the impact of Artificial Intelligence Design for different IoT Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	illustrate the knowledge on the fundamentals of Artificial intelligence and IOT	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-
CO-2:	make use of the knowledge of fundamentals in Machine learning and Deep Learning	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	understand the basic ideas of Implementation on the detection and computer vision	-	-	-	2	-	-	2	-	-	-	-	-	-	-	3
CO-4:	analysing the implementation of IoT in Q-Learning and NLP	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	organize the concept to use Machine Learning based AI algorithms in IoT applications	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-

Unit-1 - Principles, Foundations and Data Handling in IoT	9 Hour
Principles and Foundations of IoT and AI, IoT reference model, Platforms, Verticals, Infusion of AI, Data Science in IOT, Setting Up the IoT and AI Environment, Dev kits, Setting up Databricks, IoT Hub and an IoT Edge device, Deploying ML modules to Edge devices, Setting up Kafka, Installing ML libraries on Databricks, PyTorch, GraphX and Graph Frames, Importing TensorFlow. Data Access for IOT –TXT, CSV, XLSX, Working with JSON,HDF5 format, NoSQL data, HDFS, Using hdfs3 with HDFS, Using PyArrow's filesystem interface for HDFS, Handling Data- Storing data for analysis using Delta Lake, Data collection design, Windowing, Exploratory factor analysis, Visual exploration, Implementing analytic queries in Mongo/hot path storage, Ingesting IoT data into Spark	
Unit-2 - Machine Learning, Deep Learning for IoT	9 Hour
Analyzing chemical sensors with anomaly detection, Logistic regression with the IoT, Classifying chemical sensors with decision trees, Simple predictive maintenance with XGBoost, Detecting unsafe drivers, Face detection on constrained devices, Deep learning, Deep learning—why now? Deep Learning for Predictive Maintenance, enhancing data using feature engineering, using keras for fall detection, Energy output prediction using MLPs in TensorFlow Wine quality classification using MLPs in TensorFlow, Implementing LSTM to predict device failure, Deploying models to web services, Convolutional neural networks -LeNet to recognize handwritten digits Autoencoders	
Unit-3 - IOT Implementation - I	9 Hour
Anomaly Detection -Using Z-Spikes on a Raspberry Pi and Sense HAT, Using auto encoders to detect anomalies in labeled data, Using isolated forest for unlabeled datasets, Detecting time series anomalies with Luminol, Detecting seasonality-adjusted anomalies Detecting spikes with streaming analytics, Detecting anomalies on the edge. Computer Vision - Connecting cameras through OpenCV- Using Microsoft's custom vision to train and label your images - Detecting faces with deep neural nets and Caffe -Detecting objects using YOLO on Raspberry Pi 4 -Detecting objects using GPUs on NVIDIA Jetson Nano-Training vision with PyTorch on GPUs	

Unit-4 - IOT Implementation - II**9 Hour**

Reinforcement Learning for IoT -Introduction -RL terminology -Deep reinforcement learning -Some successful applications- Simulated environments, OpenAI gym-Q-learning -Taxi drop-off using Q-tables -Q-Network -Taxi drop-off using Q-Network -DQN to play an Atari game -Policy gradients, Pong using policy gradients-The actor-critic algorithm, NLP and Bots for Self-Ordering Kiosks-Wake word detection-Speech-to-text using the Microsoft Speech API-Implementing smart bots-Creating a custom voice-Enhancing bots with QnA Maker

Unit-5 - IoT Applications**9 Hour**

Personal and Home IoT, Personal IoT - SuperShoes by MIT-Continuous glucose monitoring-Hypoglycemia prediction using CGM data-Heart Monitor-Digital assistants. AI for the Industrial IoT, -Predictive maintenance using AI -Predictive maintenance using Long Short-Term Memory -Predictive maintenance advantages and disadvantages -Electrical load forecasting in industry, AI for Smart Cities IoT, -, Smart traffic management, Smart parking, Smart waste management, Smart policing, Smart lighting and Smart governance, Computing in the cloud, AWS, Google Cloud Platform and Microsoft Azure

Learning Resources	1. Michael Roshak "Artificial Intelligence for IoT", Packt publishing, March 2021	4. Farid Meziane, Sunil Vadera, Khiary Kobbacy and Nathan Proudlove, "Intelligent Systems in Manufacturing: Current Developments and Future Prospects", (unit 1),2000
	2. Amita Kapoor "Hands-On Artificial Intelligence for IoT",Mapt Publishing, January 2019	5. Digital Signal Processing: A Practical Guide for Engineers and Scientists, Steven Smith (unit 2) ,2002
	3. Catherine Elsen, Jean Noël Demaret, Maria C. Yang and Pierre Leclercq," Artificial Intelligence for Engineering Design, Analysis and Manufacturing " / Volume 26 / Special Issue 03 / August 2012, pp 281 - 01 DOI: 10.1017/S08900630412000157, Published online: 14 August 2012.	6. ArshdeepBahga, Vijay Madiseti, – Internet of Things, A Hands -on ApproachII, 1st Edition 2015, University Press, ISBN: 978-81-7371-954-7 6) InternetofThings: Legal Perspectives by RolfH.Weber, RomanaWeber, Springer,2010

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	25%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	20%	-
Level 3	Apply	20%	-	20%	-	15%	-
Level 4	Analyze	15%	-	20%	-	25%	-
Level 5	Evaluate	15%	-	20%	-	25%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Pavanthan Arumugum, Director (R&D), ERNET India	1. Dr. S. Srinivasan, Professor and Head, Dept. of Computer Science & Engineering, Anna University, Madurai	1. Dr.J.Jeyasudha, SRMIST
2. Mr. Vinay Solanki, Head IoT, Lenovo (APAC & MEA)	2. Dr. R. Krishnamurthy, Professor, Department of CSE and IT, BIT Campus, Anna University, Trichy	
3. Mr.Hariharan Ramalingam, Vertical Delivery Head, Wipro ltd	3. Dr.S.Chithra Selvaraj, Associate Professor, Department of IT, SSN College of Engineering	

Course Code	21AIE536T	Course Name	ARTIFICIAL INTELLIGENCE ENGINES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes							
CLR-1:	learn the fundamentals of Artificial Neural Networks and Linear Associative Networks													1	2	3	4	5	6	7	8	9	10	11	12								
CLR-2:	gain Knowledge on Hopfield Network, Boltzmann Machines													Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3					
CLR-3:	gain Knowledge on Hopfield Network, Boltzmann Machines																																
CLR-4:	illustrate the Variational Auto encoders and Deep Back propagation Networks																																
CLR-5:	learn Reinforcement Learning function																																
Course Outcomes (CO):		At the end of this course, learners will be able to:																															
CO-1:	describe the features of Artificial Neural network and Linear Associative Networks.													3	2	1	-	-	-	-	-	-	-	-	-	-	-	1	1	1			
CO-2:	understand the Perceptrons and Back propagation algorithms													3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-			
CO-3:	apply AI techniques in Hopfield Networks and Boltzmann Machines													3	1	1	-	-	-	-	-	-	-	-	-	-	1	2	1				
CO-4:	articulate AI systems that are used in Convolutional Neural Networks and Autoencoder networks													3	1	2	-	-	-	-	-	-	-	-	-	-	-	1	-				
CO-5:	understand the Reinforcement Learning function and Applications													3	2	1	-	-	-	-	-	-	-	-	-	-	1	1	1				

Unit-1 - Introduction	9 Hour
Artificial Neural Networks- Origins of Neural Networks, From Backprop to Deep Learning, Linear Associative Networks- Setting One Connection Weight, Learning One Association, Gradient Descent, Learning Two Associations, Learning Many Associations, Learning Photographs	
Unit-2 - Perceptrons and Backpropagation	9 Hour
Perceptron Learning Algorithm- Exclusive OR Problem, Exclusive OR Matters, Backpropagation Algorithm- Sigmoidal Hidden Units, Generalisation and Overfitting, Vanishing Gradients, Speeding Up Backprop, Local and Global Mimima, Temporal Backprop, Early Backprop Achievements	
Unit-3 - Hopfield Nets and Boltzmann Machines	9 Hour
Hopfield Network- Content Addressable Memory, Tolerance to Damage, Energy Function, Boltzmann Machines- Generative Models, Energy Function, Simulated Annealing, Learning by Sculpting Distributions, learning in Boltzmann Machines, Learning by Maximising Likelihood, Restricted Boltzmann Machines, Autoencoder and Deep Autoencoder Networks, Deep RBMs - Restricted Boltzmann Machines, Training Restricted Boltzmann Machines, Deep Autoencoder Networks	
Unit-4 - Variational Autoencoder and Deep Backprop Networks	9 Hour
Variational Autoencoders- Overview of Variational Autoencoders, Latent Variables and Manifolds, Key Quantities, VA Work, Evidence Lower Bound, Alternative Derivation, Maximising the Lower Bound, Conditional Variational Autoencoders Applications, Convolutional Neural Networks- LeNet1, LeNet5, AlexNet, GoogLeNet and ResNet, Ladder Autoencoder Networks- Denoising Autoencoders- Fooling Neural Networks- Generative Adversarial Networks- Temporal Deep Neural Networks- Capsule Networks, Case Studies: Backpropagation neural network for Landslide monitoring,	

Unit-5 - Reinforcement Learning	9 Hour
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Reinforcement Learning- Markov Decision Processes- Formalising the Problem- Bellman Equation- Learning State-Value Functions- Eligibility Traces- Learning Action-Value Functions- Balancing a Pole- Applications, Case Studies: Adaptive Traffic Signal Control, Pommernan.

Learning Resources	1. <i>Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning</i> , James V Stone, Sebtel Press 2019.	5. <i>Machine learning with neural networks</i> : Bernhard Mehlig, Cambridge University Press 2021.
	2. <i>Deep learning</i> : Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT press 2016.	6. https://www.elsevier.com/books/artificial-intelligence-and-data-driven-optimization-of-internal-combustion-engines/badra/978-0-323-88457-0
	3. <i>Dive into Deep Learning</i> : Aston Zhang, Zachary C. Lipton, Mu Li, And Alexander J. 2018.	7. https://www.deeplearningbook.org/lecture_slides.html
	4. <i>MATLAB Deep Learning-with Machine Learning, Neural Networks and Artificial Intelligence</i> : Phil Kim, Springer, Apress 2017.	8. https://d2l.ai/d2l-en-mxnet.pdf

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Kodainathan, Data Scientist Elpis IT solutions pvt Ltd	1. Dr. A. Menaka Pushpa, Assistant Professor (SG) SCOPE, VIT, Chennai Campus	1. Dr.AR. Arunarani,, SRMIST,

Course Code	21AIE537T	Course Name	ARTIFICIAL INTELLIGENCE IN FINANCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	gain knowledge about applications of artificial intelligence in finance	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand various machine learning techniques in finance															
CLR-3:	gain knowledge about the role of artificial intelligence in financial applications															
CLR-4:	study various trading algorithms that will be useful for creating financial models															
CLR-5:	create financial models															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	understand the concepts of AI and related applications in finance	-	-	-	-	-	-	3	-	-	-	3	-	-	2	-
CO-2:	apply machine learning techniques in finance	-	-	-	-	-	-	3	-	-	-	3	-	-	-	-
CO-3:	create financial solutions using various Artificial intelligence concepts	-	-	1	-	-	-	3	-	-	-	3	-	-	2	-
CO-4:	create financial business models using various trading algorithms	-	-	2	-	-	-	3	-	-	-	3	-	-	-	-
CO-5:	implement various financial models and analyse financial strategies	-	-	2	-	-	-	3	-	-	-	3	-	-	-	2

Unit-1 - Artificial Intelligence	9 Hour
Algorithms - Neural Networks - Importance of Data - Importance of Hardware - Forms of Intelligence - Paths to Super intelligence - Intelligence Explosion - Goals and Control - Potential Outcomes.	
Unit-2 - Finance and Machine Learning	9 Hour
Normative Finance: Uncertainty and Risk - Expected Utility Theory - Mean-Variance Portfolio Theory - Capital Asset Pricing Model - Arbitrage Pricing Theory, Data-Driven Finance: Scientific Method and Financial Econometrics and Regression - Data Availability - Normative Theories Revisited - Debunking Central Assumptions, Machine Learning.	
Unit-3 - Role of AI in Finance	9 Hour
AI First Finance: Efficient Markets - Market Prediction Based on Returns Data - Market Prediction with More Features - Market Prediction Intraday, Dense Neural Networks: The Data - Baseline Prediction - Normalization - Dropout - Regularization - Bagging – Optimizers, Recurrent Neural Networks: Example - Financial Price Series - Financial Return Series - Financial Features - Estimation - Simple Finance Gym - Better Finance Gym - FQL Agent.	
Unit-4 - Algorithmic Trading	9 Hour
Vectorized Backtesting : Backtesting an SMA-Based Strategy - Backtesting a Daily DNN-Based Strategy - Backtesting an Intraday DNN-Based Strategy, Risk Management: Vectorized Backtesting - Event-Based Backtesting - Assessing Risk - Backtesting Risk Measures.	
Unit-5 - Financial Outlook	9 Hour
Execution and Deployment: Oanda Account - Data Retrieval - Order Execution - Trading Bot – Deployment-Python Code, Market Impact - Competitive Scenarios - Risks, Regulation, and Oversight, Financial Singularity: Notions and Definitions - What Is at Stake? - Paths to Financial Singularity - Orthogonal Skills and Resources - Scenarios Before and After - Star Trek or Star Wars	

Learning	1. Yves Hilpisch, Artificial Intelligence in Finance a Python based Guide, O'Reilly Media, 2020.	4. Artificial Intelligence, Machine Learning and Big Data in Finance- Opportunities, Challenges
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Resources	2. Hariom Tatsat, Sahil Puri and Brad Lookabaugh , Machine Learning and Data Science Blueprints for Finance, 3. O'Reilly Media, 2020.	and Implications for Policy Makers, OECD 2021. 5. Yves Hilpisch, Python For Finance, 2nd Edition, O'Reilly Media, 2019.
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.C.Sathishkumar, Project Manager, GoDB Technology Private Limited, Chennai	1. Mr.V.Sakthivel, Assistant Professor Senior Grade, School of Computer Science and Engineering , Vellore Institute of Technology - Chennai Campus	1. Dr.K.Moorthi, SRMIST

Course Code	21AIE538T	Course Name	ARTIFICIAL INTELLIGENCE FOR INDUSTRIAL APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	analyze the various characteristics of Intelligent agents	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	understand the growth of AI Technology in Industry	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	learn the technical elements and algorithm for solving problems using Artificial Intelligence																											
CLR-4:	apply knowledge to establish Industrial AI Technology and its assessment																											
CLR-5:	apply the concepts of AI to attain industrial automation and its application																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	use appropriate search algorithms for any AI problem	-	-	-	3	3	-	-	-	-	1	-	2	1	2	-												
CO-2:	identify appropriate AI methods and new opportunity spaces AI for industrial application	-	-	-	2	2	-	-	-	-	1	-	1	1	2	-												
CO-3:	understand the categories of Algorithm in Industrial AI	-	-	-	2	2	-	-	-	-	1	-	1	1	3	2												
CO-4:	understanding the assessment and capability to establish industrial AI	-	-	-	2	2	-	-	-	-	1	-	2	1	2	2												
CO-5:	understand the levels of automation and its application	-	-	-	2	2	-	-	-	-	-	-	2	1	2	-												

Unit-1 - Introduction to AI and Production Systems	9 Hour
Introduction to AI - Problem formulation, Problem Definition - Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production systems - Problem solving methods -Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing, Depth first and Breath first, Constraints satisfaction, Knowledge Representation and Reasoning.	
Unit-2 - The Development and Application of AI Technology	9 Hour
Why do we need Industrial AI – New Perspective in industrial systems for AI, Basic problem in Industry, Basic method of problem solving with AI, what kind of AI Technology is most suitable for industry, Machine Intelligence meets industry, Difference between industry AI and AI, Challenge of AI in Industry, New opportunity spaces for industry AI to realize industrial value transformation. Definition and Meaning of Industrial AI – The Beginning of Industrial AI, Purpose and value of Industrial AI, GE predix success and failure.	
Unit-3 - Technical Elements and Algorithm of Industrial AI	9 Hour
Technical Element – Data, Analytics, Platform, Operation and Human Machine Technology, CPS, Industrial AI: Categories of Algorithm, Industrial AI Algorithm: Selection and Application. Application Scenario Types of Industrial AI, Enabling Industrial AI system – Intelligence monitoring and maintenance platform for CNC machine, Intelligence operation, intelligence rail transit predictive maintenance system.	
Unit-4 - How to Establish Industry AI Technology and Capability	9 Hour
Assessment of Basic capability Maturity during industrial intelligence transformation – Assessment Tools for global industrial AI enterprise transformation achievement – Foxconn Lighthouse factory – How to construct organizational intelligence transformation ability in industrial enterprises – Open-source industrial big data competitions.	
Unit-5 - Industrial AI applications and Case Studies	9 Hour
Applications of Industrial AI in Monitoring, optimization and control.AI applications in Industry Automation using -Natural Language Processing-Speech Recognition-Computer vision. Machine Learning Models for Industrial Applications, AI & Digital Platforms case study. A Framework for Learning System for Complex Industrial Processes.	

Learning	1. Elaine Rich, "Artificial Intelligence", 2nd Edition, McGraw Hill, 2005	4. Anuradha Srinivasaraghavan, Vincy Joseph "Machine Learning", Wiley, 2019
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Resources	2. <i>AI and Learning Systems - Industrial Applications and Future Directions</i> , Konstantinos Kyprianidis and Erik Dahlquist, published in London, United Kingdom, 2021.	5. Wolfgang Ertel, "Introduction to Artificial Intelligence", Second Edition, Springer, 2017.
	3. <i>Industrial AI – Application with sustainable performance</i> , Jay Lee, Springer Publication, 2020.	6. Rajiv Chopra, "Deep Learning", 1st edition, Khanna Publishing House, 2018.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	20%	-
Level 2	Understand	15%	-	10%	-	20%	-
Level 3	Apply	30%	-	35%	-	20%	-
Level 4	Analyze	30%	-	25%	-	20%	-
Level 5	Evaluate	10%	-	20%	-	20%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Naveen Baskaran, ADP Solution Chennai	1. Dr.P.SivaKumar, VIT Chennai 2. Dr.Senthil, NHCE Bangalore	1. Dr.S.Nagendra Prabhu, SRMIST

Course Code	21AIE539T	Course Name	ARTIFICIAL INTELLIGENCE IN MEDICAL IMAGING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes				
CLR-1:	discuss the fundamentals of Medical Imaging	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-2:	introduce the concepts of Diagnostic Radiology																													
CLR-3:	impart knowledge on Nuclear Medicine																													
CLR-4:	become familiar in applying AI techniques in medical imaging																													
CLR-5:	explore various future perspectives of medical imaging Technology																													
Course Outcomes (CO):		At the end of this course, learners will be able to:												3	2	1	-	-	-	-	-	-	-	-	-	-	-	1	2	2
CO-1:	understand the fundamentals of Medical Imaging	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-2:	summarizes the concepts of Diagnostic Radiology	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-3:	utilize the features and characteristics of Nuclear Medicine	3	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2			
CO-4:	articulate AI systems that are used in medical imaging	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-5:	apply various AI techniques in medical imaging	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2			

Unit-1 - Introduction	9 Hour
Introduction to medical imaging – The modalities – Digital imaging basics – Image properties – Radiation and the atom – Interaction of radiation with matter – Image Quality – Spatial resolution – contrast resolution – Medical imaging informatics – Ontologies, standards and profiles – Algorithms for image and non-image analytics – Security and privacy.	
Unit-2 - Diagnostic Radiology	9 Hour
X-Ray Production tubes and generators – Production of X-Rays – X-Ray tubes – X-Ray generators – Factors affecting X-Ray emission – Radiography – Geometry of projection radiography – scattered radiation in projection radiographic imaging – Computed Radiography – Artifacts in digital radiography – Dual energy subtraction radiography- Fluoroscopy – Computed Tomography – X-Ray Dosimetry – Magnetic Resonance Basics – Ultrasound.	
Unit-3 - Nuclear Medicine	9 Hour
Radioactivity and nuclear Transformation – Radiation detection and measurement – Nuclear Imaging – The Gamma camera – Planar Nuclear Imaging – Computers in Nuclear Imaging – Nuclear Tomographic Imaging – Single Photon and Positron Emission Tomography (SPECT and PET) – Dual modality Imaging – Advances in PET Imaging.	
Unit-4 - Applying AI in Medical Imaging	9 Hour
Historical perspective – Quantitative image analysis – Computer aided detection and diagnosis – Triage – image registration – Radiomics: Radiology meets Big Data – Applications beyond image interpretation – Applications beyond radiology – Case Studies: CAD in CT Colonography – CAD in Mammography – Diabetic Retinopathy	
Unit-5 - Future Perspectives	9 Hour
Progress in established imaging modalities: X-Ray and CT – Magnetic Resonance Imaging – Ultra sound Imaging – PET and Multimodality Imaging – Molecular Imaging – Optical Tomography – Advanced Image processing.	

Learning Resources	1. Jerrold T. Bushberg, , J. Anthony Seibert PhD (Author), Edwin M. Leidholdt The Essential Physics of Medical Imaging, 2021 (1,2,3)	4. Artificial Intelligence in Medical Imaging, Opportunities, Applications and Risks, Erik R. Ranschaert, Sergey Morozov, Paul R. Algra, Springer, 2019.
	2. Mark A.Haidekker, Medical Imaging Technology, Springer Briefs in Physics, 2013.(5) 3. Artificial Intelligence in Medical Imaging from theory to clinical practise, Lia Morra, Silvia Delsanto, Loredana Correale, CRC Press 2019 (4)	5. Haidekker, M. A., "Medical Imaging Technology", Springer, 2013.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	20%	-
Level 2	Understand	20%	-	10%	-	20%	-
Level 3	Apply	30%	-	40%	-	30%	-
Level 4	Analyze	30%	-	40%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.R. Durairaj, Clayfin Technologies Private Limited, Chennai	1. Dr.M.S. Bhuvaneswari, Asso. Professor, Mepco Schlenk Engineering College, Sivakasi	1. Dr.R. Beaulah Jeyavathana, SRMIST

Course Code	21AIE540T	Course Name	SUPER INTELLIGENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand path to Super intelligence and forms of super intelligence	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	analyze the technology needed to create machine super intelligence															
CLR-3:	categorize the classes of transition from human level intelligence to super intelligence															
CLR-4:	explore the catastrophe of intelligence explosion and its control methods															
CLR-5:	classify the stages of bot adoption and its types															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	understand various types of super intelligence	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
CO-2:	classify the technology required to create machine super intelligence	-	-	1	-	-	2	-	-	-	-	-	-	-	-	2
CO-3:	determine Emulation, AI paths, Cognitive Superpowers	-	-	2	3	-	-	-	-	-	-	-	-	-	2	-
CO-4:	identify the drawbacks of super intelligence and its control methods	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	categorize the bots with real-time application	-	-	3	3	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Introduction to Super Intelligence **9 Hour**
 Past development and big history- Great Expectations – State of the art of AI – Opinions about the future of Machine Intelligence - Growth - Path to Super Intelligence – Artificial Intelligence(AI) Vs Artificial Narrow Intelligence(ANI) Vs Artificial General Intelligence Vs Artificial Super Intelligence(ASI) – whole brain emulation – biological cognition – Brain-computer interfaces – Networks and Organizations – Forms of Super Intelligence – Speed Superintelligence- Collective Super Intelligence – Quality Superintelligence – Direct and indirect reach – Sources of advantage of digital Intelligence

Unit-2 - Creation of Machine Super Intelligence **9 Hour**
 Intelligence as a form of information processing – Classical Computing – Quantum Computing – Artificial Intelligence and Machine learning – Artificial Neural Networks and Deep Learning – Building Artificial General Intelligence – Few words about Control problem

Unit-3 - Kinetics of an Intelligence Explosion **9 Hour**
 Timing and Speed of the takeoff – classes of transition from human level intelligence to super intelligence – Emulation and AI paths – Optimization power and explosivity – Decisive Strategic Advantage - Will the frontrunner get a decisive strategic advantage? – paths to assess successful project – Monitoring – International Collaboration – From decisive Strategic advantage to singleton – Cognitive Superpowers – Functionalities and Superpowers – Phases in AI takeover Scenario – The mail ordered DNA Scenario – Power over nature and agents

Unit-4 - Catastrophe of Intelligence Explosion **9 Hour**
 The treacherous turn – Malignant failure modes – Perverse instantiation – Infrastructure profusion – Mind crime – Control Problem – Two agency problems – Capability control methods – Boxing methods – Incentive methods – Stunting – Tripwires – Motivation Selection methods – Direct specification – Domesticity – Indirect normativity – Augmentation

Unit-5 - Designing Bots **9 Hour**

Bots, Difference between bots and RPA, The Bot Revolution and Evolution, Stages of Bot adoption, Both Types – Personal Vs Team Bots, Super Bots Vs Domain Specific Bots, Business Bots Vs Consumer Bots, Voice Vs Text Bots, Net New Bots Vs Integrations Exposing Legacy Systems - The Business Bot Platform: Slack, The Consumer Bot Platform: Facebook Messenger, The Voice Bot Platform: Alexa, The Teens' Bot Platform: Kik, The Legacy Bot Platforms: Email, SMS, How to Choose a Platform - Bot Anatomy – Breaking Down Bots – Core Purpose and Functionality, Branding, Personality, and Human Involvement: Branding – Visual Branding, Logo, Stickers, Images, Naming; Personality – WordsBot, Poncho, Expressing Your Personality; Human Intervention

Learning Resources	1. Nick Bostrom, <i>Superintelligence paths, dangers, strategies</i> , Oxford Univeresity Press, 2016. (Unit 1, 3)	3. Artem Kovera, <i>how to create Machine Superintelligence</i> , Createspace Independent publication, 2018 (Unit 2)
	2. Roman V Yampolsky, <i>Artificial Superintelligence a Futuristic Approach</i> , CRC Press, 2016. (Unit 4)	4. Amir Shevat, <i>Designing Bots</i> , O'reilly, Media Inc., 2017 (Unit 5)

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Somasundaram/VDSI	1. Dr. Murugavalli/Professor/PEC	1. Dr.S.Aruna, SRMIST

Course Code	21AIE541T	Course Name	MULTIMODAL MACHINE LEARNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	provide the basic understanding of multimodal data and its importance in various fields	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	various representations used in multimodal machine learning using different models	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	understand the details about the translation and mapping algorithms of multimodal data																											
CLR-4:	create interest to develop a project using various applications of multimodal machine learning framework																											
CLR-5:	importance of multimodal deep learning and behavior generations functions																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	outline the critical elements of multimodal data and models	3	3	3	-	-	-	-	-	-	-	-	-	1	-	-												
CO-2:	illustrate different kinds of unimodal and multimodal representations	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-												
CO-3:	demonstrate multimodal translation and mapping	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-												
CO-4:	classify machine learning techniques and frameworks of multimodal applications in real time scenario	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-												
CO-5:	analyze various multimodal fusion and behavior generation for multimodal applications	3	2	2	-	-	-	-	-	-	-	-	-	1	-	2												

Unit-1 - Introduction	9 Hour
Introduction – Multimodal, Basic Concepts - Linear models - Score and loss functions – regularization, Neural networks - Activation functions - multi-layer perceptron, Optimization - Stochastic gradient descent – back propagation	
Unit-2 - Unimodal and Multimodal Representations	9 Hour
Language representations - Distributional hypothesis and word embedding, Visual representations - Convolutional neural networks, Acoustic representations - Spectrograms – Auto encoders, Multimodal representations - Joint representations - Visual semantic spaces - multimodal auto encoder, Orthogonal joint representations - Component analysis, Parallel multimodal representations - Similarity metrics, canonical correlation analysis	
Unit-3 - Multimodal Translation and Mapping	9 Hour
Language models – Unigrams – bigrams - skip-grams - skip-thought, Unimodal sequence modelling - Recurrent neural networks, LSTMs, Optimization - Back propagation through time, Multimodal translation and mapping - Encoder-decoder models - Machine translation - Image captioning, Generative vs retrieval approaches - Viseme generation - visual puppetry, Modality alignment - Latent alignment approaches - Attention models - multi-instance learning, Explicit alignment - Dynamic time warping	
Unit-4 - Multimodal Applications	9 Hour
Multimodal fusion and co-learning - Model free approaches - Early and late fusion - hybrid models, Kernel-based fusion - Multiple kernel learning, Multimodal graphical models - Factorial HMM, Multi-view Hidden CRF, Case studies - Automatic Face Recognition - Video Segmentation and Keyframe Extraction - Gesture Recognition - Biometric-based System	
Unit-5 - Deep Learning for Multimodal	9 Hour
Deep Learning for multimodal data fusion – Basics of multimodal deep learning – Multimodal image-to-image translation networks – Multimodal encoder decoder networks, Multimodal applications - Image captioning - Video description - AVSR, Core technical challenges - Representation learning – translation – alignment - fusion and co-learning	

Learning Resources	1. <i>Multimodal Scene Understanding: Algorithms, Applications and Deep Learning</i> , Michael Ying Yang, Bodo Rosenhahn, Vittorio Murino, Academic Press, Elsevier, 2019, ISBN:978-0-12-817358-9 (Unit V)	4. <i>Unifying Visual-Semantic Embeddings with Multimodal Neural Language Models</i> . Ryan Kiros, Ruslan Salakhutdinov, and Richard S. Zemel; TACL 2015
	2. <i>Representation Learning: A Review and New Perspectives</i> . Yoshua Bengio, Aaron Courville, and Pascal Vincent	5. <i>Multi-View Latent Variable Discriminative Models for Action Recognition</i> . Yale Song, Louis-Philippe Morency, Randall Davis, CVPR 2012
	3. <i>Visualizing and understanding recurrent networks</i> . Andrej Karpathy, Justin Johnson, Li Fei-Fei, 2015	6. M. Gori, "Machine Learning: A Constraint-Based Approach", 2017, Morgan Kauffman, ISBN: 978-0081006597
		7. F. Camastra, A. Vinciarelli, "Machine Learning for Audio, Image and Video Analysis: Theory and Applications", 2nd Edition, 2016, Springer Verlag, ISBN: 978-1447168409

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Sanjay Hotwani, Senior Manager – Data Science, Products &Technology, PwC US	1. Dr. Tulasi Prasad Sariki, Associate Professor, VIT, Chennai, tulasiprasad.sariki@vit.ac.in	1. Dr.T.Subha, SRMIST

Course Code	21CSE525T	Course Name	AGENT TECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	understand the basic of software agents and agent development	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	understand the implementation of agents	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	gain Knowledge in Multi agent and Intelligent agents																											
CLR-4:	understand Agents and security																											
CLR-5:	gain Knowledge in Agent Applications																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	understand development of software agents	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-												
CO-2:	implement the agents in different programming platform	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-												
CO-3:	gain Knowledge in Multi agent and Intelligent agents	-	1	2	-	-	2	-	-	-	-	-	-	-	-	3												
CO-4:	implement the intelligent software agents in mobile applications	-	-	3	-	-	2	-	-	-	-	-	-	-	-	3												
CO-5:	analyze the security issues of software agents	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-												

Unit-1 - Agents – Overview	9 Hour
Agent definition – agent programming paradigms – Agents Vs objects – aglets – mobile agents – agent frame works – agent reasoning	
Unit-2 - Agents Implementation	9 Hour
Processes – threads – daemons – components – Java Beans – ActiveX – Sockets, RPCs – distributed computing – aglets programming – JINI architecture – actors and agents – typed and proactive messages.	
Unit-3 - Multi Agent Systems	9 Hour
Interaction between agents – reactive agents – cognitive agents – interaction protocols – agent coordination – agent negotiation – agent cooperation – agent organization – self –interested agents in electronic commerce applications	
Unit-4 - Intelligent Software Agents	9 Hour
Interface Agents – Agent Communication Languages – Agent Knowledge Representation – Agent Adaptability – Belief Desire Intension – Mobile Agent Applications -Case Study- Mobile Agents in Wireless Networks	
Unit-5 - Agents and Security	9 Hour
Agent Security Issues – Mobile Agents Security – Protecting Agents Malicious Hosts – Untrusted Agents – Black box Security – Authentication for Agents – Security issues for Aglets-Case Study- Agents in ecommerce	

Learning Resources	1. Joseph P. Bigus and Jennifer Bigus, "Constructing Intelligent Agents Using Java: Professional Developer's Guide", Wiley, Second edition, 2001.	4. Richard Murch and Tony Johnson, "Intelligent Software Agents", Prentice Hall, 2000.	5. Mohammad Essaaidi, Maria Ganzha, and Marcin Paprzycki, Software Agents, Agent Systems and
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2. Bradshaw, "Software Agents", MIT Press, 2000 3. Stuart Jonathan Russell, Peter Norvig, John F. Canny Contributor, Peter Norvig and John F. Canny, "Artificial Intelligence: A Modern Approach", Prentice Hall, Second edition, 2003.	Their Applications, IOS Press, 2012
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Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	20%	-
Level 3	Apply	20%	-	20%	-	15%	-
Level 4	Analyze	15%	-	15%	-	20%	-
Level 5	Evaluate	15%	-	15%	-	20%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.S. Smilin Sam, LMTS, Athena Health Private Limited	1. Dr. R. Gayathri, Professor, SVCE	1. Dr. C. Sherin Shibi, SRMIST

Course Code	21CSE543T	Course Name	BRAIN MACHINE INTERFACE: SCIENCE, TECHNOLOGY AND APPLICATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the basic concepts of brain computer/machine interface			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	study the various signal acquisition methods of Brain Machine/Computer Interface																	
CLR-3:	interpret signal processing methods used in Brain Machine/Computer Interface																	
CLR-4:	understand the various machine learning methods of Brain Machine/Computer Interface																	
CLR-5:	learn the various applications of Brain Machine/Computer Interface																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	summarize the Brain Machine /Computer Interface			2	1	-	2	-	-	-	-	-	-	-	-	1	-	-
CO-2:	assess concept of BCI			2	1	-	2	-	-	-	-	-	-	-	-	-	1	-
CO-3:	assign functions appropriately to the human and to the machine			3	1	-	2	-	-	-	-	-	-	-	-	1	-	-
CO-4:	choose appropriate feature extraction methods			2	1	-	3	-	-	-	-	-	-	-	-	-	1	-
CO-5:	apply machine learning algorithms for translation			3	2	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to BCI	9 Hour
Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System- BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI-10-20 electrode positions.	
Unit-2 - Brain Activation	9 Hour
Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.	
Unit-3 - Feature Extraction Methods	9 Hour
Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence. Case study : Application of Feature extraction methods	
Unit-4 - Machine Learning Methods for BCI	9 Hour
Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis. Case study: Machine learning methods in BCI applications.	
Unit-5 - Applications of BCI	9 Hour
Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Non-invasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.	

Learning Resources	1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2019.	5. Ali Bashashati, MehrdadFatourehchi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals" Journal of Neural Engineering, Vol.4, 2007, PP.32-57.
	2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, January 2012.	6. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.Bishop C.M., "Neural networks for Pattern Recognition", Oxford, Clarendon Press, 1995.
	3. Ella Hassianien, A &Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.	7. Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002.
	4. Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M.Prakash Team Lead(Associate Consultant) Virtusa ,Chennai	1. Dr.V Haribaabu Associate Faculty in Entrepreneurship Development Institute of India Gandhi Nagar, Gujarat.	1. Dr.M.UMA, SRMIST

Course Code	21CSE545T	Course Name	COMPUTATIONAL PERCEPTION AND COGNITION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	introduce the computational models, and perception of cognition	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	illustrate the basic parameter estimation techniques	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	introduce the bayesian parameter estimation techniques and Hierarchical modeling																											
CLR-4:	relate the different computational models																											
CLR-5:	analyze the models in psychology																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	understand the computational models, and Cognition	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-												
CO-2:	apply the basic parameter estimation techniques	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-												
CO-3:	interpret the bayesian parameter estimation techniques and Hierarchical modeling	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-												
CO-4:	compare the different computational models	-	-	3	3	-	-	-	-	-	-	-	-	-	-	3												
CO-5:	analyze the models in psychology	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-												

Unit-1 - Introduction to Modeling	9 Hour
Introduction to Modeling: Models and Theories in Science - Quantitative Modeling in Cognition - Potential Problems: Scope and Falsifiability from Words to Models: Response Times in Speeded-Choice Tasks - Building a Simulation - The Basic Toolkit	
Unit-2 - Basics Parameter Estimation	9 Hour
Basic Parameter Estimation Techniques- Discrepancy Function- Fitting Models to Data: Parameter Estimation Techniques- Least-Squares Estimation in a Familiar Context- Inside the Box: Parameter Estimation Techniques- Variability in Parameter Estimates - Maximum Likelihood Parameter Estimation- Basics of Probabilities- Defining a Probability Distribution- Finding the Maximum Likelihood Combining Information from Multiple Participants	
Unit-3 - Parameter Estimation	9 Hour
Bayesian Parameter Estimation- Bayesian Inference- Analytic Methods for Obtaining Posteriors- Determining the Prior Distributions of Parameters- Markov Chain Monte Carlo Methods- Problems Associated with MCMC Sampling- Gibbs Sampling - Multilevel or Hierarchical Modeling- Conceptualizing Hierarchical Modeling- Bayesian Hierarchical Modeling- Hierarchical Maximum Likelihood Modeling.	
Unit-4 - Model Comparison	9 Hour
Psychological Data and the Very Bad Good Fit- Model Comparison- The Likelihood Ratio Test- Akaike's Information Criterion- Other Methods for Calculating Complexity and Comparing Models- Parameter Identifiability and Model Testability Bayesian Model Comparison using Bayes Factors: Marginal Likelihoods and Bayes Factors- Methods for Obtaining the Marginal Likelihood- Bayes Factors for Hierarchical Models- The Importance of Priors. Case study on Model comparison.	

Unit-5 - Models in Psychology**9 Hour**

Models in Psychology: Broad Overview of the Steps in Modeling- Drawing Conclusions from Models- Good Practices to Enhance Understanding and Reproducibility Neural Network Models- Hebbian Models- back propagation Models in Neuroscience- Methods for Relating Neural and Behavioral Data- Reinforcement Learning Models- Neural Correlates of Decision-Making. Case study: Applications of Cognition towards model building.

Learning Resources	1. <i>Computational Modeling of Cognition and Behavior</i> , Simon Farrell and Stephan Lewandowsky, Cambridge University Press, 2018	4. <i>Emmanuel M. Pothos, Andy J. Wills, Formal Approaches in Categorization</i> , Cambridge University Press, 2011
	2. <i>Jerome R. Busemeyer, Zheng Wang, James T. Townsend, Ami Eidels (ed.), The Oxford Handbook of Computational and Mathematical Psychology</i> , Oxford University Press, 2015	5. <i>Ron Sun (ed.), The Cambridge Handbook of Computational Psychology</i> , Cambridge University Press, 2008
	3. <i>Jerome R. Busemeyer, Peter D. Bruza, Quantum Models of Cognition and Decision</i> , Cambridge University Press, 2014	6. <i>Nils J. Nilsson, The Quest for Artificial Intelligence</i> , Cambridge University Press, 2009
		7. <i>Bernard J. Bears, Nicole M. Gage, Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience (2010)</i> , Academic Press, 2010

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. <i>Mr. Guruprasad Lakshmanan, Chief Technology Officer, Twice Group & Blocksrus, Chennai</i>	1. <i>Dr. B.Sathish Babu, Professor, Department of AI & ML, RV College of Engineering, Bengaluru, Karnataka</i>	1. <i>Dr. M. Uma, SRMIST</i>

Course Code	21CSE546T	Course Name	MEDICAL SIGNAL PROCESSING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the basic concepts of signals and frequency-based transforms			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand the basics of digital filters																	
CLR-3:	investigate the events in the signal and interpret the basic architecture of the processor																	
CLR-4:	study of spectral and cross-spectral features of electrocardiographic signals																	
CLR-5:	interpret the basic architecture of the DSP processor and its applications																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	comprehend and analyse the signals in different statistical methods			1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	gain the transforms enactments on bio-signal			-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	comprehend the implementations of filters in bio signals			-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	ecg signal analysis and modelling			-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	familiarize the digital signal processors and its application in medical fields			-	-	3	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Signal Processing	9 Hour
Z transform introduction, definition, convergence. Inverse Z transforms, Analysis of discrete-time systems using Z transforms. Solutions of differential equations. Transfer functions and stability.	
Unit-2 - Time-Frequency Domain Analysis	9 Hour
Fourier transforms for continuous signals. Energy spectrum, Properties (without proof), Gibbs phenomena, Auto and cross-correlation. Discrete Fourier transforms. Properties (without proof), Inverse DFT, introduction to FFT.	
Unit-3 - Digital Filters	9 Hour
Types of artefacts and noise - Time domain filters, frequency domain filters, notch and comb filters, optimal filtering, and adaptive filters - Signal decomposition-based filtering.	
Unit-4 - Event Detection and Feature Extraction Techniques	9 Hour
Signal segmentation - Envelop extraction and analysis, temporal, spectral, statistical, information theoretic and cross spectral features - Waveform complexity.	
Case Studies: Estimating fractal connectivity with an application to neurophysiological signals, Cross spectral analysis of electrocardiographic signals.	
Unit-5 - Digital Signal Processors	9 Hour
Introduction, General purpose DSP processors, architecture, hardware configuration, software development tools - Implementation considerations. TMS 320 Family of DSP Processors-Architecture - Functional units - Pipelining-Registers - Linear and Circular addressing - Types of instructions - Sample Programs - Real Time Implementation on DSP processors. Case Studies: - Linear Discrimination-Detection of motor activity from EMG, Harmonic analysis - Estimation of heart rate in ECG - Auto-regressive model - Estimation of spectrum of thoughts in EEG	

Learning	1. Digital signal processing, Proakis (PHI)	6. Malmivuo, J. and Plonsey, R. Bioelectromagnetism: Principles and Applications of
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Resources	2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis", 2015, 2nd Edition, Wileyl EEE Press, New	Bioelectric and Biomagnetic Fields, Oxford University Press, New York, 1995. 7. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", 2012, 1st Edition, Wiley, New York. 8. Nasser Kehtarnavaz, "Real Time Signal Processing Based on TMS320C6000", 2011, 2nd Edition, Elsevier, Netherlands.
	3. Signal Analysis by R. P. Singh, Second edition Tata McGraw – Hill	
	4. Engineering Electronics by Mauro R Prentice – Hall	
	5 D C Reddy, McGraw Hill, Biomedical Signal Processing.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Selvaraj, Caterpillar, Bangalore	1. Dr. S.Shoba, VIT, Chennai	1. Dr.R.Athilakshmi, SRMIST
	2. Dr.R.Rajavel,ECE, SSN College of Engineering, Chennai	

Course Code	21CSE548T	Course Name	SPATIAL AND TEMPORAL COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes									
CLR-1:	outline the ideas of traditional relational data and spatial data															1	2	3	4	5	6	7	8	9	10	11	12								
CLR-2:	illustrate the basics of spatial databases															Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3					
CLR-3:	gain knowledge on spatial data models																																		
CLR-4:	gain knowledge on Spatio-Temporal computing Techniques																																		
CLR-5:	learn about different Application programming Interfaces																																		
Course Outcomes (CO):		At the end of this course, learners will be able to:																																	
CO-1:	illustrate the concepts of traditional relational data and spatial data															-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	learn the spatial databases															-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
CO-3:	understand the spatial data models															-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-		
CO-4:	analyze Spatio-Temporal computing Techniques															-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	2	-			
CO-5:	analyze various Application programming Interfaces															-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2		

Unit-1 - Introduction to Spatiotemporal Data	9 Hour
Representation of Spatio temporal data, Visualization of Spatio-Temporal Data – Spatial plots – Time series plots - Hovmoller plot – Interactive plots, Visualizing large spatial temporal datasets –Visualizing Uncertainty- Exploratory Analysis of Spatio-Temporal Data - Empirical Spatial Means and Covariances - Spatio-Temporal Covariograms and Semivariograms - Empirical Orthogonal Functions (EOFs) - Spatio-Temporal Canonical Correlation Analysis	
Unit-2 - Introduction to Spatial Databases	9 Hour
Requirements, Principles, and Concepts for Spatial Database Management Systems (SDBMS) – Spatial Databases and Geographic Information Systems SDBMS and GIS Applications. Spatial networks: conceptual, logical and physical level design issues, Spatial networks Query: shortest path from a start-point to a destination, shortest route to deliver packages to a set of homes, Query processing in spatial network databases.	
Unit-3 - Models for Spatial Data: Geographic Space Modelling	9 Hour
Representation Models – Geometry of Collection of Objects – Vector Data – Raster Data. Modelling Spatial Data. Spatial Access Methods (SAM): Issues in SAM Design – Space Driven Structures versus Data Driven Structures – The Grid File – Quadtree and Variants – R-Tree and Variants – k-d-B Tree. Case study- SAM Cost Models	
Unit-4 - Spatio-Temporal Computing	9 Hour
Techniques of spatial and temporal analysis, point patterns, spatio - temporal database applications. Geo statistics, spectral analysis, wavelet analysis, interpolation, and mapping. Spatial information services: virtual globes, location-based services, Case study-Enterprise consulting service.	
Unit-5 - Application Programming Interfaces	9 Hour
HTML5 Geolocation API, Google Maps API, Bing Maps API, Maps SDK, Flickr location API, Twitter location API, OSHDB: a framework for spatio-temporal analysis of OpenStreetMap history data.	

Learning	1. Christopher K. Wikle, Andrew Zammit-Mangion, Noel Cressie, Spatio Temporal	4. Noel Cressie, Christopher K. Wikle, Statistics for Spatio-Temporal data, Wiley, 2015.
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Resources	Statistics with R, CRC Press, 2019.	5. Narayan Panigrahi, Computing in Geographic Information Systems, CRC press, 2014.
	2. Philippe Rigaux, Michel Scholl, Agnes Voisard, "Spatial Databases with Applications to GIS", Morgan Kaufman, 2002.	6. Shashi Shekhar and Sanjay Chawla "Spatial Databases: A Tour "Pearson.
	3. Shashi Shekhar, Pamela Vold, Spatial Computing, The MIT Press, 2020.	7. Evangelos Petroutsos, Google Maps: Power Tools for maximizing the API, McGraw-Hill, 2014.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs.Savitha Boomiperumal, Technical Lead, Accenture Technology Solutions, Portugal, Europe	1. Dr.Anusha K, Associate Professor, School of Computing, VIT Chennai.	1. Dr.Sumathy G, SRMIST

Course Code	21CSE551T	Course Name	AFFECTIVE COMPUTING AND INTERACTION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	understand the role of emotion and machine interaction	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	understand the aesthetic aspect of machine design																											
CLR-3:	develop systems to reduce the emotional gap between humans and machines, all within the context of interactions																											
CLR-4:	understand the Neurological Mechanisms involved in Emotion																											
CLR-5:	provide the insight of emotion goals, Implications and social cognition																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	gain the knowledge in basics of Computational Neuroscience	-	2	2	2	-	-	-	-	-	-	-	-	1	1	-												
CO-2:	demonstrate Simple Neuron, Associations, and learning	-	2	2	2	-	-	-	-	-	-	-	-	1	1	-												
CO-3:	categorize Cortical organization and Feed forward mapping networks	-	3	3	3	-	-	-	-	-	-	-	-	1	1	-												
CO-4:	apply the different learning methods	-	3	3	3	-	-	-	-	-	-	-	-	1	1	-												
CO-5:	implement Cognition concepts and theories	-	2	2	2	-	-	-	-	-	-	-	-	1	1	-												

Unit-1 - Introduction	9 Hour
Affective Computing and the Challenge of Mood Measurement and forecasting. Affective phenomena: emotion, mood, attitude/sentiment, personality. Computers, robots, smartphones with emotional intelligence.	
Unit-2 - Emotion Theory	9 Hour
Dual-process theories of emotion, Constructivist theories, Appraisal theories. Affective Technology Interaction and Empathy: Computational Appraisal Theory, reinforcement learning based approaches, recognizing emotional context, facial affect recognition.	
Case Study: Track your employees in the workplace and conduct sentiment analysis in internal social networks and forum messages to improve physical workspace design and comfort.	
Unit-3 - Emotion Intelligence	9 Hour
Ethical issues related to emotion and AI, Emotionally Intelligent Human Computer Interaction, Emotion and Perception, Decision-making, and Creativity, Emotion and Learning, Physiology of Emotion, Behavioral game theory.	
Case Study: Identify emotional response of learners can have a profound impact in the online education space. Use Emotion AI to reveal the interest level of students and provide predictive output to help teachers devise and implement better teaching strategies.	
Unit-4 – Neuro Scientific Perspectives of Emotion	9 Hour
Neurological Mechanisms involved in Emotion, Affect Recognition by Wearables and other Machines, Communicating Frustration/Stress in Autism and in Customer Experience, Responding to User Emotion to Reduce User Frustration, Inducing Emotion, Robots/Agents with Emotion.	
Unit-5 - Affect in Non-Verbal Communication	9 Hour
Expression of Emotion by Machines/Agents/Synthetic characters, Philosophical, Social, Ethical Implications of Affective Computing, Machine/Mobile Empathy and Emotional Support, Lie Detection and Stress Detection.	

Learning Resources	1. Didem Gökçay and Gülsen Yildirim, IGI Global, <i>Affective Computing and Interaction: Psychological, Cognitive and Neuroscientific Perspectives</i> , 2010.	4. R.A. Calvo, S.K. D'Mello, J. Gratch, and A. Kappas, <i>The Oxford Handbook of Affective Computing</i> by, Oxford University Press, 2014
	2. Jonas Lowgren, John M. Carroll, Marc Hassenzahl, and Thomas Erickson, <i>The Encyclopedia of Human-Computer Interaction</i> , Interaction Design Foundation, 2014	5. Gerardus Blokdyk, <i>Affective Computing a Complete Guide</i> , 2020.
	3. R.W. Picard, <i>Affective Computing</i> , MIT Press, 1997.	6. Cem Dilmegani, <i>Affective Computing: In-depth Guide to Emotion AI</i> , 2022.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Damodaran Palanisamy - Associate Vice President, Standard Chartered Bank	1. Dr.K. Geetha, Professor, School of Computing, SASTRA University, Tanjore	1. Dr. Karpagam.M, SRMIST

Course Code	21CSE552T	Course Name	COMPUTATIONAL LINGUISTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific Outcomes		
CLR-1:	introduce the Basic Concepts of Computational Linguistics in NLP	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	illustrate the knowledge on language Interpretation	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	analyze the classification of computer in accomplishing linguistics tasks																											
CLR-4:	illustrate the uniqueness of text meaning with linguistics multistage transformation																											
CLR-5:	illustrate the various modelling techniques based on linguistics																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	summarize the concepts in Computational Linguistics	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-												
CO-2:	construct the various applications of computers in linguistics and language studies	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2												
CO-3:	design the various Tools for Linguistic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2												
CO-4:	apply the text transformation of linguistic and strengthen NLP systems	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-5:	apply the different model techniques based on linguistics	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3												

Unit-1 - Introduction	9 Hour
The Role of Natural Language Processing – Linguistics and Its Structure - What We Mean by Computational Linguistics - The Important Role of The Fundamental Science - Current State of Applied Research on Spanish.	
Unit-2 - Overview of Grammar	9 Hour
A Historical Outline - The Structural list Approach - Initial Contribution of Chomsky - A Simple Context-Free Grammar - Transformational Grammars - The Linguistic Research After Chomsky: Valencies and Interpretation – free grammar allows for a lot of different types of ungrammatical sentences. - Linguistic Research After Chomsky: Constraints - Head-Driven Phrase Structure Grammar - The Idea of Unification - Multistage Transformer and Government Patterns - Dependency Trees - Semantic Links	
Unit-3 - Products of Computational Linguistics	9 Hour
Present And Prospective - Classification of Applied Linguistic Systems - Automatic Hyphenation - Spell Checking - Grammar Checking - Style Checking - References To Words And Word Combinations - Information Retrieval - Topical Summarization - Automatic Translation - Natural Language Interface - Extraction Of Factual Data From Texts - Text Generation - Systems Of Language Understanding - Related Systems.	
Unit-4 - Language as A Meaning	9 Hour
Text Transformer - Possible Points Of View On Natural Language - Language As A Bi-Directional Transformer Text – Two Ways To Represent Meaning - Decomposition And Atomization Of Meaning - Not-Uniqueness Of Meaning –Text Mapping: Synonymy - Not-Uniqueness Of Text - Meaning Mapping: Homonymy - More On Homonymy - Multistage Character Of The Meaning - Text Transformer - Translation As A Multistage Transformation - Two Sides Of A Sign - Linguistic Sign - Linguistic Sign In The MMT - Linguistic Sign In HPSG - Generative, MTT, And Constraint Ideas In Comparison - Case Study writing simple parsers in groups for regional languages.	

Unit-5 - Linguistic Models	9 Hour
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What Is Modeling In General - Neurolinguistic Models - Psycholinguistic Models - Functional Models Of Language - Research Linguistic Models - Common Features Of Modern Models Of Language - Specific Features Of The Meaning - Text Model - Reduced Models - Analogy In Natural Languages - Empirical Versus Rationalist Approaches - Limited Scope of The Modern Linguistic Theories – Case Study applications involving language models, Demonstration of simple application specific modules using tools.

Learning Resources	1. Igor Bolshakov & Alexander Gelbukh, "Computational Linguistics Models, Resources and applications ", Ciencia De La Computación. 2004.	3. Ralph Fasold & Jeff Connor-Linton, "An Introduction to Language and Linguistics", Cambridge University Press. 2018
	2. Alexander Clark, Chris Fox, & Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", A John Wiley & Sons. 2010	4. Roland Hausser, "Man-Machine Communication in natural language ". 5. Stabler, "Notes on computational linguistics", UCLA, Winter 2003

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
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Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohanraj, Data Scientist, Standarad chartered	1. Dr.P.Visu, Professor, Velammal College of Engineering	1. Dr.P.G. Om Prakash, SRMIST
2. Mr.N. Nagendran, Senior Software Engineer, Cognizant	2. Dr.K.Sathishkumar, Associate Professor, KLEF- AP.	2. Dr.R.Siva, SRMIST