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 AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Engineering Science Courses

Regulations 2021

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	21AIS201J	Course Name	FOUNDATION 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):	*The purpose of learning this course is to:*
CLR-1:	*analyse the various characteristics of intelligent agents*
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:*	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
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	
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 * n matrix and shortest path to reach a given cell in the m * 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*	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		
	1. *S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009.* 2. *I.Bratko, ―Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011* 3. *M. Tim Jones, ―Artificial Intelligence: A Systems Approach (Computer Science) ‖, Jones and Bartlett Publishers, Inc.; First Edition, 2008* 4. *Nils J. Nilsson, ―The Quest for Artificial Intelligence‖, Cambridge University Press, 2009.*	5. *William F. Clocksin and Christopher S. Mellish, Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003.* 6. *Gerhard Weiss, ―Multi Agent Systems‖, Second Edition, MIT Press, 2013.* 7. *David L. Poole and Alan K. Mackworth, ―Artificial Intelligence: Foundations of Computational Agents‖, Cambridge University Press, 2010.* 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

Regulations 2021

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	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:*	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
CO-1:	*devise algorithms to arrange the data in required order and retrieve a specific datum in efficient manner*	*1*	*2*	*3*	-	-	-	-	-	-	-	-	*3*	*3*	-	-
CO-2:	*determine the type of list structure that could be used for solving a problem and implement it using C programming language*	*2*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	*3*	-	-
CO-3:	*devise solutions using linear structures stack and queue*	*2*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	*3*	-	-
CO-4:	*express proficiency in usage of tree for solving problems*	*2*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	*3*	-	-
CO-5:	*implement hash tables for storing data and algorithms to find shortest path between nodes in a graph*	*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, Data Structures with C, McGraw Hill, 2014* 2. *R.F.Gilberg, B.A.Forouzan, Data Structures, 2nd ed., Thomson India, 2005* 3. *A.V.Aho, J.E Hopcroft , J.D.Ullman, Data structures and Algorithms, Pearson Education, 2003*	4. *Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2015* 5. *Reema Thareja, Data Structures Using C, 1st ed., Oxford Higher Education, 2011,* 6. *Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms 3rd 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:***
CLR-1:	*outline the structure of OS and basic architectural components involved in OS design*
CLR-2:	*introduce the concept of deadlock and various memory management mechanism*
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:***	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
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 2: Process Creation using fork() and Usage of getpid(), getppid(), wait() functions* *Lab 3: Multithreading* *Lab 4: Mutual Exclusion using semaphore and monitor* *Lab 5: Reader-Writer problem*	*Lab 6: Dining Philosopher problem* *Lab 7: Bankers Algorithm for Deadlock avoidance* *Lab 8: FCFS and SJF Scheduling* *Lab 9: Priority and Round robin scheduling* *Lab 10: FIFO Page Replacement Algorithm*	*Lab 11: LRU and LFU Page Replacement Algorithm* *Lab 12: Best fit and Worst fit memory management policies* *Lab 13: Disk Scheduling algorithm* *Lab 14: Sequential and Indexed file Allocation* *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* 2. *RamazElmasri, A. Gil Carrick, David Levine, "Operating Systems – A Spiral Approach ", Tata McGraw Hill Edition, 2010* 3. *Dhananjay M. Dhamdhere, "Operating Systems – A Concept Based Approach", Third Edition, Tata McGraw Hill Edition, 2019* 4. *Andrew S. Tanenbaum, "Modern Operating Systems", Fourth Edition, Global Edition, Pearson, 2015.* 5. *William Stallings, "Operating Systems: Internals and Design Principles", Pearson Education, Sixth Edition, 2018.*	6. *Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education, 2017* 7. *https://nptel.ac.in/courses/106/105/106105214/* 8. *https://nptel.ac.in/courses/106/106/106106144/* 9. *https://nptel.ac.in/courses/106/102/106102132/* 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:
CLR-1:	understand the paradigm functionalities and their hierarchy
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:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
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* 2. *Maurizio Gabbrielli, Simone Martini, Programming Languages: Principles and Paradigms, 2010.*	3. *Herbert Schildt, Java: The Complete Reference Seventh Edition, 2016.* 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. Sudeepta 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:***
CLR-1:	*design efficient algorithms in solving complex real time problems*
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:***	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
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, Sartajsahni, Sanguthevar, Rajesekaran, Fundamentals of Computer Algorithms, Galgotia Publication, 2010* 4. *S. Sridhar, Design and Analysis of Algorithms, Oxford University 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*	*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:***
CLR-1:	*understand the fundamentals and need of Database systems, Architecture, Languages*
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:***	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
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-Document Oriented, Key value pairs, Column Oriented and Graph	

Learning Resources	1. *Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Conceptsǁ, Seventh Edition, Tata McGraw Hill, 2019.* 2. *Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systemsǁ, Sixth Edition, Pearson Education, 2011.* 3. *CJ Date, A Kannan, S Swamynathan, An Introduction to Database Systems, Eight Edition, Pearson Education, 2006.*	4. *RaghuramaKrishnan, Johannes Gehrke, Database Management Systems, 3rdEdition, McGrawHill Education, 2003.* 5. *Principles of Database Systems, J.D. Ullman, Galgoti,1982* 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 Thiruvarur*	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:*
CLR-1:	*construct automata for any equivalent regular expressions*
CLR-2:	*acquire brief knowledge about automata languages*
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:*	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
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 – tuning 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.* 2. *Michael Sipser, "Introduction to the Theory of Computation" Cengage Learning, 2012*	3. *John.C. Martin, "Introduction to Languages and the Theory of Computation" McGraw-Hill Education, 01- May-2010.* 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. Victer 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:***
CLR-1:	*familiarize the software life cycle models and software development process*
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:***	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
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* 2. *Ian Sommerville, Software Engineering, 8th ed., Pearson Education, 2010* 3. *Rajib Mall, Fundamentals of Software Engineering, 4th ed., PHI Learning, Private Limited, 2014*	4. *Ramesh, Gopalaswamy, Managing Global Projects, Tata McGraw Hill, 2005* 5. *Ashfaque Ahmed, Software Project Management: a process-driven approach, Boca Raton, Fla: CRC Press, 2012* 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 TECHNNOLOGY*		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:*
CLR-1:	*recognize the basics of learning problems*
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:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*formulate the Learning problems*	-	*2*	-	-	*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* 2. *Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012* 3. *Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005* 4. *Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.*	5. *Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008* 6. *Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009* 7. *Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series in statistics.* 8. *Ethem Alpaydın, 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:***
CLR-1:	*introduce the Mathematical models and basic key concepts in Deep 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:***	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
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,* 2. *Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012* 3. *Michael Nielsen, "Neural Networks and Deep Learning", Online book, 2016*	4. *Jason Brownlee, "Deep Learning with Python", 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:*
CLR-1:	*gain knowledge about Reinforcement learning paradigm*
CLR-2:	*understand the art of trial and learning process that is needed for the any ML and AI model*
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:*	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
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.* 2. *Markov Decision Processes in Artificial Intelligence, Sigaud O. & Buffet O. editors, ISTE Ld., Wiley and Sons Inc.*	3. *Reinforcement Learning: State-of-the-Art. Vol. 12 of Adaptation, Learning and Optimization. Wiering, M., van Otterlo, M. (Eds.), 2012* 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:*
CLR-1:	*understand the basic services and concepts related to Internetwork*
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:*	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
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 Resources	1. *Behrouz A. Forouzan, "Data Communications and Networking" 5th ed., 2013* 2. *Bhushan Trivedi," Data Communication and Networks" 2016*	3. *William Stallings, Data and Computer Communications,9th ed., 2014* 4. *Todd Lammle, CCNA Study Guide, 7th ed. 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*	*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:*
CLR-1:	*gain the fundamentals of inferential statistics and techniques and methodologies of sampling distribution and estimation*
CLR-2:	*understand parametric and non-parametric algorithms*
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:*	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
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. *Essentials of Inferential Statistics-Fourth Edition, Malcolm O.Asadoorian, Demetri Kantarelis, University Press of America*	2. *The Essentials of STATISTICS A Tool for Social Research", Second Edition, Joseph F. Healey, Christopher Newport University, Wadsworth Cengage Learning* 3. *Predictive & Advanced Analytics (IBM ICE Publication)*

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:*
CLR-1:	*understand the fundamental concepts of AI and Machine Learning*
CLR-2:	*explore the concepts of AI applied to issues in medical field and to develop solution model*
CLR-3:	*explain the dynamics of Gaming and the design of Gaming with AI*
CLR-4:	*explore the concepts, methods and application of Artificial Intelligence in Robotics*
CLR-5:	*design of AI products as Human Centered*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	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
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 – HCAI 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, Artificial Intelligence A Modern Approach, Fourth Edition, Pearson, 2020.* 2. *Adam Bohr and Kaveh Memarzadeh, Artificial Intelligence in Healthcare, Academic press, 2020*	3. *Ian Millington, Artificial Intelligence for Games, CRC Press, Third Edition, 2019* 4. *Francis X Govers, Artificial Intelligence for Robotics, Packt publishing, 2018* 5. *Ben Schneiderman, Human-Centered AI, 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 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:*
CLR-1:	*outline the overall view of Stochastic Decision-Making system*
CLR-2:	*build the DSS using various tools and techniques*
CLR-3:	*analyze the process of Intelligent Decision support System building*
CLR-4:	*identifying the stochastic optimization techniques*
CLR-5:	*applying the DSS in different areas, how it is used for real world problems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	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
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 Resources	1. *Stochastic modeling using machine learning and stochastic differential equations,Chalmers University Of Technology, Gothenburg, Sweden 2022* 2. *Efraim Turbon,Jay.E.Aronson,Ting Peng Liong-Decision Support System and Intelligent systems-9 th edition Printice hall of india.,2015* 3. *Iantovics, B., and Kountchev, R., Advanced Intelligent Computational Technologies and Decision Support Systems, Springer, 2014* 4. *Kumer. K., Zindani, D. and Davim, J.P., Digital Manufacturing and Assembly Systems in Industry 4.0, CRC Press, 2019*	5. *Gupta, J.N.D., Forgionne, G.A., and Manuel, M.T., Intelligent Decision-making Support Systems: Foundations, Applications and Challenges, Springer, 2016* 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* 7. *Valencia-Garcia, R, Paredes-Valverde, M.A., Salas-Zarate, M.P. and Alor-Hernandez, Giner., Exploring Intelligent Decision Support Systems, Springer, 2018* 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 AND 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:*
CLR-1:	*gain knowledge about applications of cognitive computing*
CLR-2:	*understand assess cognitive computing and Artificial Intelligence Applications use and their requirements*
CLR-3:	*describe Cognitive analytics and AI powered applications techniques*
CLR-4:	*study various analytics techniques to solve real world applications*
CLR-5:	*create cognitive analytics*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	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
CO-1:	*understand the concepts of AI and its related applications*	-	2	-	-	2	-	-	-	-	-	-	-	3	3	2
CO-2:	*apply machine learning techniques in various domains*	-	2	-	-	2	-	-	-	-	-	-	-	3	3	2
CO-3:	*develop skills in analysing, interpreting, and assessing the empirical data*	-	2	-	-	2	-	-	-	-	-	-	-	3	3	2
CO-4:	*create cognitive computing models using various algorithms*	-	2	-	-	2	-	-	-	-	-	-	-	3	3	2
CO-5:	*develop the ability to choose knowledge representation method for different problems*	-	2	-	-	2	-	-	-	-	-	-	-	3	3	2

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. *Cognitive Computing and Big Data Analytics By Judith S. Hurwitz, Marcia Kaufman, Adrian* 2. *Hariom Tatsat, Sahil Puri and Brad Lookabaugh , Machine Learning and Data Science O'Reilly Media, 2020.*	3. *Raghavan, Vijay V., et al. Cognitive computing: Theory and applications. Elsevier, 2016.* 4. *Python for Data Analysis 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:*
CLR-1:	*describe the IoT Architecture*
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:*	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
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* 2. *Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.* 3. *Peter Waher, "Learning Internet of Things", PACKT publishing, Birmingham – Mumbai*	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* 5. *Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.* 6. *Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on Approach)", 1 st 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:*
CLR-1:	*introduction to general aspects to develop intelligent autonomous systems*
CLR-2:	*demonstrate the approaches and solution to handle the IA system*
CLR-3:	*illustrate the issues related to design and development of autonomous mobile robots*
CLR-4:	*describe the fundamental aspects of Autonomous Vehicle design*
CLR-5:	*discuss about different features of autonomous stair climbing mechanism*

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

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 Pratihar 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)*

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):	*The purpose of learning this course is to:*
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:*	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
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, Bio-Inspired Artificial Intelligence Theories, Methods, and Technologies, MIT Press, 2008.* 2. *Tao Song, Pan Zheng, Mou Ling Dennis Wong, Bio-inspired Computing Models and Algorithms, World Scientific, 2019.*	3. *Shuxiang Xu and Yunling Liu, Nature-Inspired Computing Concepts, Methodologies, Tools, and Applications, IGI Global,2017* 4. *Srikanta Patnaik, Xin-She Yang, Kazumi Nakamatsu, Nature-Inspired Computing and Optimization Theory and Applications , Springer, 2017* 5. *Karthik Raman, an Introduction to Computational Systems Biology (Systems Level Modeling of Cellular Networks), 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:*
CLR-1:	*introduce the fundamental concepts and techniques of text processing*
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:*	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
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 chinking.

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.* 2. *Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana "Practical Natural Language Processing", O'Reilly; First edition, 2020*	3. *Breck Baldwin, —Language processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.* 4. *Richard M Reese, —Natural Language Processing with Java, OReilly Media, 2015.* 5. *Nitin Indurkhya 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:*
CLR-1:	*outline the fundamentals Digital Media and web analytics*
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:*	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
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*	-
CO-2:	*perform social network analysis to identify important social actors, subgroups and network properties in social media sites*	-	*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*	-
CO-4:	*interpret the terminologies, metaphors and perspectives of social media analytics*	-	*3*	-	-	*3*	-	-	-	-	-	*3*	-	-	*3*	-
CO-5:	*design new solutions to opinion extraction, sentiment classification and data summarization, visualisation*	-	*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]*

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.Mariammal, 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:*	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
CO-1:	*articulate the fundamentals of various image and video processing techniques*	-	-	*3*	-	*3*	-	-	*2*	-	-	-	-	-	*3*	*3*
CO-2:	*demonstrate different image Representation and Reconstruction models*	-	-	*3*	-	*2*	-	-	*2*	-	-	-	-	-	*3*	*3*
CO-3:	*illustrate the various image and Video Segmentation methods*	-	-	*3*	-	*2*	-	-	*2*	-	-	-	-	-	*3*	*3*
CO-4:	*implement different coding techniques and vector quantization for image compression*	-	-	*3*	-	*2*	-	-	*2*	-	-	-	-	-	*3*	*3*
CO-5:	*apply various video coding techniques for video compression*	-	-	*3*	-	*3*	-	-	*2*	-	-	-	-	-	*3*	*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 Resources	1. *Alan Bovik, "Handbook of Image and Video Processing", Second Edition, Academic Press, 2005* 2. *Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Ed., Prentice-Hall, 2008* 3. *A. Murat Tekalp, "Digital Video Processing", Second Edition, Prentice Hall, 2015.*	4. *Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012. Michael Berthold, David J.Hand, Intelligent Data Analysis, Springer.* 5. *Rama Chellappa, Amit K.Roy-Chowdhury, Kevin Zhou.S, "Recognition of Humans and their Activities using Video", Morgan&Claypool Publishers, 2005.*

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 Charted*	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:*
CLR-1:	*explore the fundamental concepts of video analytics*
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:*	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
CO-1:	*articulate the basics of video analytic components*	-	-	*3*	-	*3*	-	-	*2*	-	-	-	-	-	*2*	*3*
CO-2:	*illustrate different methods for object classification*	-	-	*3*	-	*3*	-	-	*2*	-	-	-	-	-	*2*	*3*
CO-3:	*interpret different models for human activity recognition*	-	-	*3*	-	*3*	-	-	*2*	-	-	-	-	-	*2*	*3*
CO-4:	*examine various methods for video object tracking*	-	-	*3*	-	*3*	-	-	*2*	-	-	-	-	-	*2*	*3*
CO-5:	*develop machine learning models for surveillance applications*	-	-	*3*	-	*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 Resources	1. *Maheshkumar H Kolekar. Intelligent video surveillance systems an algorithmic approach. Tylor and Francis publisher (2019).* 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* 3. *NilanjanDey (Editor), Amira Ashour (Editor) and SuvojitAcharjee (Editor), Applied Video Processing in Surveillance and Monitoring Systems (IGI global) 2016*	4. *Zhihao Chen (Author), Ye Yang (Author), JingyuXue (Author), Liping Ye (Author), Feng Guo (Author), The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video Analytics Suite, CreateSpace Independent Publishing Platform, 2014* 5. *Caifeng Shan (Editor), FatihPorikli (Editor), Tao Xiang (Editor), Shaogang Gong (Editor) Video Analytics for Business Intelligence, Springer, 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. *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:***
CLR-1:	*provide a broad understanding of the basic techniques of speech Recognition*
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:***	**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
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 te3chniques*	-	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 n 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	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)*	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*

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

Learning Resources	
	1. JohnL. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann. *2. John Paul Shen and MikkoH. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hil* *3. Parallel programming with Intel parallel studio by Stephen Blair-Chappell, Andrew Stokes* *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:*
CLR-1:	*understand autonomous navigation technology and autonomous driving algorithms*
CLR-2:	*study of various sensor and actuator and to relate their functionalities*
CLR-3:	*predict the route and control the motion, path and speed of autonomous vehicles*
CLR-4:	*illustrate client system requirements, cloud platform and GNSS system of autonomous navigation system*
CLR-5:	*analyse tasks of autonomous vehicle in complex traffic environment*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
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		
	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. Senthamilarasu, Applied Deep Learning and Computer Vision for Self-Driving Cars, build autonomous vehicles using deep neural networks and behavior-cloning techniques, Packt Publishing, 2020.*	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*

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:*
CLR-1:	*understand the solid foundation in software engineering for mobile games*
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:*	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
CO-1:	*acquire the knowledge on the fundamentals of game development techniques*	-	-	*3*	-	*3*	-	-	-	-	-	-	*3*	-	*3*	-
CO-2:	*acquire the ability to apply the tools and plugins*	-	-	*3*	-	*3*	-	-	-	-	-	-	*3*	-	*3*	-
CO-3:	*utilize the design and mobile usability on various problems*	-	-	*3*	-	*3*	-	-	-	-	-	-	*3*	-	*3*	-
CO-4:	*acquire the ability to prototype the game project*	-	-	*3*	-	*3*	-	-	-	-	-	-	*3*	-	*3*	-
CO-5:	*apply the knowledge gained on larger game projects*	-	-	*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* 2. *Sanjay Madhav, "Game Programming Algorithms and techniques", Addidon-Wesley, 2013*	3. *Jonathon Manning, Paris Buttfield-Addison, "Mobile Game Development with Unity: Build Once, Deploy Anywhere", O'Reilly Media Inc., 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*	*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:*
CLR-1:	*understand time series analysis, trends and characteristic of stochastic component of time series*
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:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
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.* 2. *Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, Introduction to Time Series Analysis and Forecasting, Second Ed., Wiley, 2016.* 3. *Brockwell & Davis (2016) Introduction to Time Series and Forecasting, 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.* 5. *Cryer & Chan (2008) Time Series Analysis with Applications in R, 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:*
CLR-1:	*discuss the fundamentals of distributed systems and its architecture*
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:*	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
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.* 2. *Kshemkalyani, Ajay D., and Mukesh Singhal. Distributed computing: principles, algorithms, and systems. Cambridge University Press, 2011.* 3. *Pradeep K Sinha, "Distributed Operating Systems: Concepts and Design", Prentice Hall of India, 2007.*	4. *George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed Systems Concepts and Design", Fifth Edition, Pearson Education, 2012.* 5. *Tanenbaum A.S., Van Steen M., "Distributed Systems: Principles and Paradigms", Pearson Education, 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, Standarad 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:*
CLR-1:	*understand the basics of Big data and Hadoop architecture*
CLR-2:	*analyze the Hadoop and Map Reduce technologies associated with big data analytics*
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:*	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
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 Iublinsky, Kevin t. Smith, AlexeyYakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.* 2. *Chris Eaton,Dirk derooset al. , "Understanding Big data ", McGraw Hill, 2012. BIG Data and Analytics, Sima Acharya, Subhashini Chhellappan, Willey.*	3. *MongoDB in Action, Kyle Banker,Piter Bakkum , Shaun Verch, Dream tech Press* 4. *Tom White, "HADOOP: The definitive Guide", O Reilly 2012.* 5. *VigneshPrajapati, "Big Data Analyticswith R and Haoop", 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	BIOINFORMATICS	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:	*adapt basic knowledge on different forms of biological data acquisition*
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:*	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
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. *Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press, May 2019.* 2. *Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press,2010* 3. *Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by Durbin, S.Eddy, A.Krogh, G.Mitchison,2012*	4. *Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press,2004* 5. *Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O"Reilley Media, 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*	*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.Sansthosh C, Senior Consultant, Infosys*	1. *Mr.Yuvaraj D, Assistant Professor, BIT, Sakimangalam*	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:*
CLR-1:	*understand the basics of Computational Neuroscience*
CLR-2:	*apply the concept of Neuron, Associations and learning*
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:*	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
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.* 2. *Paul Miller, an Introductory Course in Computational Neuroscience, MIT Press ISBN: 9780262038256, October 2018.*	3. *Hans Peter A.Mallot, "Computational NeuroScience: A First Course" Springer 2013.* 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*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	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
CO-1:	*acquire the knowledge on basics of biometric traits*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-2:	*ability to identify pattern recognition system and its features*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-3:	*understand about multi model biometric traits*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*1*	-
CO-4:	*apply the knowledge of biometrics on developing authentication system*	*3*	-	*1*	*2*	-	-	-	-	-	-	-	-	-	*1*	-
CO-5:	*apply the knowledge for designing biometric systems*	*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, smoothening, 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, DavideMaltoni, Dario Maio, Biometric Systems, Technology Design and Performance Evaluation, Springer, 2005.* 2. *James wayman, Anilk.Jain, ArunA.Ross, Karthik Nandakumar, ―Introduction to. Biometrics‖, Springer, 2011* 3. *Mark S.Nixon, Alberto S.Aguado, Feature Extraction and image processing for computer vision, Third Edition, , Elsevier 2012*	4. *Digital Image Processing using MATLAB, By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2019* 5. *Guide to Biometrics, By: Ruud M. Bolle, SharathPankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell, Springer 2009* 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 applications‖, 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:*	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
CO-1:	*gain the knowledge of robot building system*	*2*	*2*	-		-	-	-	-	-	-	-	-	*1*	-	-
CO-2:	*create the program for robot*	-	*2*	-	*3*	-	-	-	-	-	-	-	-	*2*	-	-
CO-3:	*gain knowledge on the sensor signal calibration, and actuator control for interfacing with Robot*	-	*2*	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-4:	*obtain the insights of Robot Operating system*	-	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-5:	*design and program the robot for its intelligent operation*	-	-	-	*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:

1. *Study the anatomy of Robot and create a Robot structure for pick and place operation.*
2. *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:

1. *Understanding file system and using IDE.*
2. *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*

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 Juypter 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:*	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
CO-1:	*distinguish the different components in GPU systems*	-	*1*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*create environments to work with different NGC container packages*	-	*2*	*3*	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-3:	*implement codes using jupyter notebook and pytorch*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	*3*
CO-4:	*develop and work with CUDA*	-	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*
CO-5:	*visualize different DL deployments for various scientific applications*	-	*2*	-	-	*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***
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- MLOps: 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.* 2. *Sanders, J. and Kandrot, E., 2010. CUDA by example: an introduction to general-purpose GPU programming. Addison-Wesley Professional.*	3. *Christopher Love, Jay Vyas, Core Kubernetes, 2022* 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, SRMIST*

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:*
CLR-1:	*learn the different GPU Components*
CLR-2:	*know to work with GPUs for Accelerated Data Sciences*
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:*	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
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 pratical 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	
	1. *Goodfellow, I., Bengio, Y. and Courville, A., 2017. Deep learning (adaptive computation and machine learning series). Cambridge Massachusetts, pp.321-359.*
	2. *Ng, A., 2017. Machine learning yearning. URL: http://www. mlyearning. Org/ (96), 139.*
	3. *Christopher Love, Jay Vyas, Core Kubernetes, 2022*
	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. *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:***
CLR-1:	*provide a broad understanding about evolutionary computing*
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:***	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
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. 2. Benjamin Doerr, Frank Neumann, "Theory of Evolutionary Computation, Recent Developments in Discrete Optimization", Springer International Publishing, 2020.	3. T Back, D B Fogel and T Michalewicz, "Evolutionary Computation 1, Basic Algorithms and Operations", CRC Press, Taylor& Francis Group, 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	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:***
CLR-1:	*learn to build brand architecture on brand value*
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:***	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
CO-1:	*analyse user Generated Contents*	-	-	-	-	-	-	-	*3*	-	*3*	-	-	*1*	-	-
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	1. *Seema Gupta, Avadhoot Jathar," Marketing Analytics", ISBN: 9789354242625* 2. *Brea Cesar (2014), "Marketing and Sales Analytics: Proven Techniques and Powerful Applications from Industry Leaders", FT Press, ISBN-0133761711* 3. *Emmett Cox (2012), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1*	4. *Fok Dennis (2003), "Advanced Econometric Marketing Models", ERIM, ISBN 90–5892–049-6* 5. *Mireles Carlos Hern´andez (2010), "Marketing Modeling for New Products", ERIM, ISBN 978-90-5892-237-3* 6. *Rackley Jerry (2015), "Marketing Analytics Roadmap: Methods, Metrics, and Tools", Apress, ISBN-1484202597*

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:*
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:*	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
CO-1:	*exhibit knowledge on basics of Cloud Computing*	*2*	*1*	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*identify then type of services for various applications*	*1*	*3*	*1*	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-3:	*predict the type of security to be applied for various cloud services*	*1*	-	*2*	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-4:	*examine the concept of virtualization and capacity planning*	*2*	*1*	-	-	*2*	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*recommend the service provider for specific requirement*	*2*	-	-	*1*	*2*	-	-	-	-	-	-	-	*2*	-	-

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

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 ManagerKyndryl India Pvt Ltd.	2. Dr. S. Gopika, Kristu Jayanti College, Bangalore.	2. Dr. J. D. DorathiJayaseeli, 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:***	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
CO-1:	*illustrate the basic concepts of Swarm Intelligence processes*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*1*
CO-2:	*examine the principle of Immune computing techniques*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	*1*
CO-3:	*manage the scope changes of nature inspired techniques which influence computing*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-4:	*identify optimization Techniques to provide functionality and value*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-5:	*understand the needs and familiarize the DNA Computing*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	*3*

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 Resources	1. *"Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman &Hall/CRC, Taylor and FrancisGroup, 2007.* 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*	4. *AlbertY.Zomaya,"Handbook of Nature-Inspired and Innovative Computing ", Springer, 2006 4. Marco Dorrigo, Thomas Stutzle,‖ Ant Colony Optimization‖, PHI,2005.* 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. JothiBasu Kamaraj, jothibasu.kamaraj@gmail.com*	1. *Dr.D.Paulraj, Professor, RMKCET,kingrajpaul@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:***
CLR-1:	*gain knowledge on propositional logic and First order logic*
CLR-2:	*understand the concept of description logic and reasoning methods*
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:***	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
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.* 2. *Handbook of Knowledge Representation. Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). Foundations of Artificial Intelligence, 2008.*	3. *Boolos, G. S., Burgess, J. P., Jeffrey, R. C. Computability and logic. – Cambridge university press, 2002.* 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:*
CLR-1:	*generate knowledge about biological macromolecules and bioinformatics*
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:*	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
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 Resources	1. *Krane, D. E., Raymer, M. L. "Fundamental Concepts of Bioinformatics", Benjamin Cummings, (2003).* 2. *Federico Divina, Francisco A. Gómez Vela, Miguel García-Torres. "Computational Methods for the Analysis of Genomic Data and Biological Processes", MDPI (AG) (2021).* 3. *Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th Reprint, Pearson Education. 2005.* 4. *Adam Bohr and Kaveh Memarzadeh. Artificial Intelligence in Healthcare. 1st Edition. Academic publishers. Elsevier Science. 2020*	5. *Christophe Lambert, Darrol Baker, George P. Patrinos. "Human Genome Informatics - Translating Genes into Health", Elsevier Science, (2018).* 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.* 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.*

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@datalorelabs.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:***
CLR-1:	*generate knowledge about macromolecules and their structural importance*
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:***	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
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 Resources	1. *Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th 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.*	4. *Online Sources: https://wiki.python.org/moin/BeginnersGuide/Programmers.* 5. *Mount D., "Bioinformatics: Sequence and Genome Analysis", 2 nd Edition, Cold Spring Harbor Laboratory Press, New York. 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*	*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):	***The purpose of learning this course is to:***
CLR-1:	*outline the basic concepts, requirements, principles, and techniques in emerging cyber physical systems*
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:***	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
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* 2. *Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015* 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* 4. *P.Ashok, G. Krishnamoorthy, and D. Tesar, "Guidelines for managing sensors in cuber physical systems with multiple sensors," J. Sensors, vol.2011, 2011.* 5. *P.Marwedel, Embedded System Design:Embedded system foundations of Cyber-Physical Systems,vol.16.2010.*	6. *Wolf, Marilyn. High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing. Elsevier, 2014.* 7. *Guido Dartmann, Houbing song, Anke schmeink, "Big data analytics for Cyber Physical System", Elsevier, 2019* 8. *Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press, 2019* 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*

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:*	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
CO-1:	*gain knowledge on Business Intelligence, Analytics and Decision Support*	-	-	-	-	-	-	-	-	-	-	-	-	*1*	-	-
CO-2:	*understand the technologies for Decision making*	-	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-3:	*apply predictive modeling techniques*	-	-	-	-	-	-	-	*3*	-	*3*	-	-	*2*	-	-
CO-4:	*apply sentiment analysis techniques*	-	-	-	-	-	-	-	*3*	-	*3*	-	-	-	-	*2*
CO-5:	*gain knowledge on Decision-making systems*	-	-	-	-	-	-	-	*3*	-	*3*	-	-	-	*1*	-

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	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*

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):	*The purpose of learning this course is to:*
CLR-1:	*illustrate the fundamentals concepts of VR*
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:*	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
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 Resources	1. *Virtual Reality Systems, By John Vince, Pearson Education 2002* 2. *Virtual Reality Technology, 2nd, by Grigore C. Burdea (Author), Philippe Coiffet (Author), Wiley Publications. June 2003* 3. *Augmented Reality: Principles & Practice Paperback – 12 Oct 2016 by Schmalstieg/Hollerer (Author)* 4. *Virtual & Augmented Reality for Dummies 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.*	6. *Steve Aukstakalnis , "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR" 2016, Publisher(s): Addison-Wesley Professional* 7. *Course on Virtual Reality, IIT Madras ttps://nptel.ac.in/courses/106/106/106106138/* 8. *Foundation Course on Virtual Reality and Augmented Reality, IIT Madras, NPTELhttps://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual-reality-and-augmented-reality/,3rd ed, Pearson,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*	*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.Veningston 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*

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

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