Rajiv Gandhi National Institute of Youth Development
(Institution of National Importance by the Act of Parliament No. 35/2012)
Ministry of Youth Affairs & Sports, Government of India
Sriperumbudur, Tamil Nadu - 602105, India

REGULATIONS, CURRICULUM & SYLLABUS FOR

MASTER OF SCIENCE (M. Sc.)
COMPUTER SCIENCE
(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

(For CBCS System in Rajiv Gandhi National Institute of Youth Development)

Effective from academic year 2022-23

REGULATIONS AND SYLLABUS FOR MASTER OF SCIENCE

COMPUTER SCIENCE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

(For CBCS System in RGNIYD)

(Effective from the Academic Year 2021-2022)

Eligibility for Admission

Candidates who have Any Computer Science Graduate / Any Information Technology Graduate/ Any UG degree with atleast 4 mathematics Papers or any other equivalent UG Computer Science Degree

Duration of the Course

The course duration shall be for two years spread over four semesters. The maximum duration to complete the course shall be 3 years.

Medium

The medium of instruction shall be English.

Passing & Classification

Passing Eligibility & Classification for the award of the Degree are as per the RGNIYD Norms

REGULATIONS AND SYLLABUS FOR MASTER OF SCIENCE

COMPUTER SCIENCE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

(For CBCS System in RGNIYD)

(Effective from the Academic Year 2021-2022)

CURRICULUM

(Effective from the Academic Year 2021 - 2022)

COURSESTRUCTURE

Course Category	Number of Credits
Minimum credits for Core and departmental electives	**73**
Soft core course (English for Communication / Buddhist Philosophy / Ethics & IPR)	**02**
Course from Online Platform (SWAYAM, MOOC, NPTEL) (Courses are suggested by the Department)	**03**
Total	**78**

Important Note: If the candidates are undergoing a six-month dedicated project during their fourth semester course of study in any of the Industries / MNCs / Organizations, then they should take an additional course from SWAYAM / MOOC / NPTEL etc., instead of their regular course offered by RGNIYD during the fourth semester

Vision

Department of Computer science aims to become the an internationally recognized center of excellence in computer science with special focus on emerging areas like Artificial Intelligence, Machine Learning, Internet of Things, Data science and Computer Vision.

Mission

The mission of the department is

- To mentor students by providing them an environment that is supportive in fostering intellectual skills
- To produce employable graduates who are trained in cutting edge technologies of Computer Science
- To train the graduates with the skillsets required for collaborative multidisciplinary research
- To develop core competencies in the field of Artificial Intelligence, Machine Learning, Internet of Things, Data science and computer vision

Learning Description:

M.Sc. in Computer science with specialization In AI & ML is a two-years masters' programme designed to train the students in cutting-edge technologies, Artificial Intelligence & Machine Learning. This programme aims to provide in-depth knowledge in AI & ML such that it can be applied in diversified domains like IoT, Data Science, & Computer Vision.

This programme has curriculum that uncovers significant techniques that can aid the students in developing AI-based solutions for real-world problems. The programme details the basic mathematical foundation of AL to Advanced Deep learning-based algorithms and its applications. Thus, the programme enables the students to try new ventures in the field of Artificial Intelligence & Machine Learning.

Programme Objective

1. To impart technical knowledge, and skills in the field of computer science with specific focus on artificial intelligence and machine learning
2. Transform the students in to technically competent industry ready graduands who can apadt to the pressing demands of the industry.
3. Encourage the students to pursue higher studies in artificial intelligence machine learning with focus on computer vision, Digital Manufacturing, Bioinformatics, Robotics and IoT, .

Course Duration

1. The course duration is of 24 months (2 years) spread over four semesters with credit hours as per the RGNIYD norms

Course Curriculum Plan

The Course Curriculum is based on comparative analysis of existing MSc. Computer science with specialization in AI & ML curriculums of other Universities, IITs and NITs. The curriculum has sufficient exposure to hands-on skills and is much more directed towards higher employability. It is also well suited for upward accommodation of computer science graduates and information technology graduates.

Eligibility

Any Computer Science Graduate / Any Information Technology Graduate/ Any UG degree with atleast 4 mathematics Papers or any other equivalent UG Computer Science Degree

FIRST SEMESTER

Course Code	Course Title	L	T	P	Credits	Core/ Specialization
MSCS 101	Data Structures & Algorithms	3	0	0	3	Core
MSCS 102	Python Programming	2	0	0	2	Core
MSCS 103	Mathematical Foundations of Computer Science	2	1	0	3	Core
MSCS 104	Database Management Systems (DBMS)	3	0	0	3	Core
MSAI 101	Artificial Intelligence	3	0	0	3	Specialization
MSCS 105	Data Structures & Algorithms Lab	0	0	4	2	Core
MSCS 106	Database Management Systems Lab	0	0	4	2	Core
MSCS 107	Python Programming Lab	0	0	4	2	Core
	Total Credits	**13**	**1**	**12**	**20**	

SECOND SEMESTER

Course Code	Course Title	L	T	P	Credits	Core/ Specialization
MSCS 201	Operating Systems	3	0	0	3	Core
MSCS 202	Web Technology	3	0	0	3	Core
MSCS 203	Object Oriented Programming Using Java	3	0	0	3	Core
MSCS 204	Machine Learning	3	0	0	3	Core
MSAI 201	Knowledge Engineering and Expert Systems	3	0	0	3	Specialization
	Elective-1	3	0	0	3	Specialization
MSCS 204	Web Technology Lab	0	0	4	2	Core
MSCS 205	Object Oriented Programming Using Java	0	0	4	2	Core
	Total Credits	**18**	**0**	**8**	**22**	

THIRD SEMESTER

Course Code	Course Title	L	T	P	Credits	Core/ Specialization
MSCS 301	Advanced Computer Networks	3	0	0	3	Core
MSAI 301	Reinforcement Learning	3	0	0	3	Specialization
MSAI 302	Natural Language Processing	3	0	0	3	Specialization
MSAI 303	Deep Learning	3	0	0	3	Specialization
	Elective - 2	3	0	0	3	Specialization
MSAI 304	Deep Learning lab	0	0	4	2	Specialization
	Total Credits	**15**	**0**	**4**	**17**	

Total credits: 73 + 5 = 78 credits

BRIDGE COURSES

COURSE CODE	COURSE TITLE	L	T	P	C
MSBC0001	Introduction to Computers	0	0	0	0
MSBC0002	Problem Solving Techniques using C	0	0	0	0

FOURTH SEMESTER

CourseCode	Course Title	L	T	P	Credits
	(MOOC/SWAYM/NPTEL/Elective as decided by the department)	2	0	0	2
MSCS 401	Project Report & Viva-Voce	0	0	24	12
	Total Credits	**2**	**0**	**24**	**14**

SOFTCORE & ONLINE COURSES

Course Code	Course Title	L	T	P	Credits
	Softcore (English Communication / Buddhist Philosophy / Ethics & IPR)	2	0	0	2
	MOOC / SWAYAM / NPTEL online courses (Minimum 12 weeks, select any one course out of a pool of subjects which are related to the branch study and the list is	3	0	0	3

	provided by the Head of the Department)				
Total Credits		5	0	0	5

LIST OF ELECTIVES – AI & ML

Course Code	Course Title	L	T	P	Credits
MSAI EL01	Computational Intelligence	3	0	0	3
MSAI EL02	Speech Processing & Synthesis	3	0	0	3
MSAI EL03	Computer Vision	3	0	0	3
MSAI EL04	Robotics	3	0	0	3
MSAI EL05	Cognitive Science	3	0	0	3
MSAI EL06	Biometric Image Processing	3	0	0	3
MSCS EL01	Information Retrieval Techniques	3	0	0	3
MSCS EL02	Operations Research	3	0	0	3
MSCS EL03	Theory of Computation	3	0	0	3
MSCS EL04	Video Processing and Analytics	3	0	0	3
MSCS EL05	Data Visualization Techniques	3	0	0	3
MSCS EL06	Cyber Security	3	0	0	3
MSCS EL07	Soft Computing	3	0	0	3
MSCS EL08	Swarm Intelligence	3	0	0	3

BRIDGE COURSES

MSBC0001	**INTRODUCTION TO COMPUTERS**	**0**	**0**	**0**	**0**
	Topics covered in this course should include but not limited to: i. Parts of a computer ii. Hardware – Software iii. System Configuration iv. Office Tools v. Internet Concepts				

MSBC0002	**PROBLEM SOLVING TECHNIQUES USING C**	**0**	**0**	**0**	**0**
	Topics covered in this course should include but not limited to: i. Summation of a set of numbers ii. Reversing the digits of an integer iii. Character to Number conversion				

	iv. Smallest Divisor of an integer v. Linear Pattern Search vi. Computing nth Fibonacci number

MSCS101	**DATA STRUCTURES AND ALGORITHMS**	**3**	**0**	**0**	**3**
Course Outcomes: **CO1:** Understand the concepts of algorithm analysis and solving recurrence relations **CO2:** Learn linear and non-linear data structures and their usage in applications **CO3:** Understand and Analyze various searching and sorting algorithms **CO4:** Applying greedy and dynamic approaches to solve challenging problems **CO5:** Understand computational complexity classes and their importance in designing algorithms					
Unit – 1	**INTRODUCTION TO ALGORITHMS AND ANALYSIS**				**9 hrs**
Overview and importance of algorithms and data structures – Fundamentals of algorithm analysis – Space and time complexity of an algorithm – Asymptotic Notations – Order of growth – Algorithm Efficiency – Best case, Worst Case, Average Case – Recurrence Relations – Solving recurrence relations using substitution method, recurrence tree method and Master Method.					
Unit – 2	**LINEAR AND NON-LINEAR DATA STRUCTURES**				**9 hrs**
Linear Data Structures: Stacks – Queues – Lists – Applications. Non-linear Data Structures: Graphs – Trees – Binary Trees – Traversal Techniques – Binary Search Tree and its operations – AVL Trees.					
Unit – 3	**SEARCHING AND SORTING ALGORITHMS, DIVIDE AND CONQUER APPROACH**				**9 hrs**

Search Problem – Linear Search – Binary Search – Sorting Problem – Bubble Sort – Insertion Sort – Heap Sort – Divide and Conquer Paradigm – Merge Sort – Quick Sort – Complexity analysis of searching and sorting algorithms.

Unit – 4	**GREEDY METHOD AND DYNAMIC PROGRAMMING APPROACH**	**9 hrs**

Greedy Method: Activity Selection Problem – Graph Traversal Algorithms. Dynamic Programming Paradigm: Knapsack problem – Matrix Chain Multiplication – All Pair Shortest Path – Single Source Shortest Path – Travelling Salesman Problem.

Unit –5	**OTHER ALGORITHM PARADIGMS AND COMPUTATIONAL COMPLEXITY CLASSES**	**9 hrs**

Backtracking: 8-Queens problem – Graph coloring. Brach and Bound: Least Cost 0/1 Knapsack problem. Tractable and Intractable problems – Decidable and Undecidable problems – P, NP and NP-Complete classes – Cook's Theorem (without proof) – NP-Hard problems.

Text Book:

1. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press February 2010

Reference Books:

1. Sanjoy Dasgupta, C.Papadimitriou and U.Vazirani , Algorithms , Tata McGraw-Hill, 2008.
2. A. V. Aho, J.E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms, Pearson, 1st edition, 2006.
3. Fundamentals of Data Structures in C -- by Horowitz, Sahni and Anderson-Freed (Silicon Press 2007).

MSCS 102	**PYTHON PROGRAMMING**	**2**	**0**	**0**	**2**

Course Outcomes:

CO1: Understand the fundamental concepts of python and its main components.

CO2: Develop (Read and Write) python programs using variables, assignments, and conditional statements using functions.

CO3: Illustrate and implement different data structures.

CO4: Demonstrate Object-oriented concepts and file handling.

CO5: Analyze and plot data using python visualization libraries.

Unit – 1	**Introduction to Python**	**6 hrs**

Introduction to a programming language – History of Python- Python environment setup – Python 2 vs. Python 3 - Comments and documentation in Python- Keywords and Identifiers - Programming Errors - Writing and Running python programs.

Unit – 2	**Variables and Conditionals in Python**	**6 hrs**

Variables – Constants- Strings - Assignment statements – Expressions-Operators – Type Conversions-Control Flow statements and Loops- Functions.

Unit – 3	**Data Structures in Python**	**6 hrs**

List Basics- List Indexing and Slicing-Appending-Sorting and Ranging-Tuples-Creation-Deletion-Converting tuple to list- Assignment- Dictionaries-Adding-Modifying and Retrieving Values-Traversing all keys in the dictionary-Operations and methods-Sets- manipulating and accessing sets.

Unit – 4	**Exception handling and File I/O**	**6 hrs**
Exception handling - Catching and Handling Exceptions-Object Orientated Concepts (Basics) – Creating python class and Objects - Object properties and methods- Inheritance- Operator overloading- Polymorphism- File handling - Opening, Reading, Writing and Deleting files		
Unit –5	**Graph Plotting**	**6 hrs**
Introduction to plotting python libraries -Plots and Graphs- Applied Visualizations – Seaborn - Matplotlib		

Text Books:

1. Python: The Complete Reference , 2018
2. Python in easy steps, McGraw Hill, 2nd Reprint , 2014

Reference:

1. Python 3 Documentation, https://docs.python.org/
2. https://www.coursera.org/learn/python

MSCS103	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**	**2**	**1**	**0**	**3**

Course Outcomes:

CO1: Apply Mathematical thinking, Mathematical proofs, and algorithmic thinking, and be able to apply them in problem-solving.
CO2: Explain the concept of Sets, Relations and Functions and their properties.
CO3: Describe mathematical induction and probability.
CO4: Describe basic properties of graphs and related discrete structures, and be able to relate these to practical examples.
CO5: Describe the use of group theory and its applications

Unit – 1	**SETS – RELATIONS – FUNCTIONS – BOOLEAN ALGEBRA**	**9 hrs**
Set Operations – Representation and Properties of Relations – Equivalence Relations – Partially Ordering**.** Functions – one-one – onto bijective – composition of relations and functions – inverse functions. Boolean Algebra and Boolean Functions and its representations – Simplifications of Boolean Functions.		
Unit – 2	**MATHEMATICAL LOGIC**	**9 hrs**
Propositional and Predicate Logic – Propositional Equivalences – Normal Forms – Predicates and Quantifiers – Nested Quantifiers – Rules of Inference.		

Unit – 3	COUNTING – MATHEMATICAL INDUCTION AND DISCRETE PROBABILITY	9 hrs

Basics of Counting – Pigeonhole Principle – Permutations and Combinations – Inclusion-Exclusion Principle – Mathematical Induction – Probability – Bayes Theorem.

Unit – 4	GROUP THEORY	9 hrs

Groups – Subgroups – Semi Groups – Product and Quotients of Algebraic Structures – Isomorphism – Homomorphism – Automorphism – Rings - Integral Domains – Fields – Applications of Group Theory – Polya's theory of counting – Introduction to Error-Correcting Codes. Discrete Geometry: Some basic definitions – Ham-Sandwich theorem.

Unit – 5	GRAPH THEORY	9 hrs

Simple Graph – Multigraph – Weighted Graph – Paths and Circuits – Shortest Paths in Weighted Graphs – Eulerian Paths and Circuits – Hamiltonian Paths and Circuits – Planner graph – Graph Coloring – Bipartite Graphs.

Text Book:

1. Rosen, K.H. and Kamala Krithivasan, "Discrete Mathematics and its Applications", 8th Edition – July 2021

Reference Books

1. Rosen, K.H., "Discrete Mathematics and Its Applications with Combinatorics and Graph Theory", 7th Edition – July 2017
2. Tremblay, J.P. and Manohar.R, " Discrete Mathematical Structures with Applications to Computer Science", McGraw Hill Education; 1st edition, July 2017
3. Grimaldi, R.P. "Discrete and Combinatorial Mathematics: An Applied Introduction", 4th Edition, Pearson Education Asia, Delhi, 2007.
4. Lipschutz, S. and Mark Lipson., "Discrete Mathematics", Schaum's Outlines, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 3rd Edition, 2010.

MSCS104	DATABASE MANAGEMENT SYSTEMS	3	0	0	3

Course Outcomes:

CO1: Identify the basic concepts and apply relational database theory and recognize and identify the use of normalization and functional dependency, indexing technique used in database design

CO2: Describe relational algebra expression, tuple and domain relation expression for queries and query processing concepts.

CO3: Apply and relate the concept of transaction, concurrency control and recovery in database.

CO4: Familiar with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.

CO5: Understand various concepts like Parallel, distributed and object-oriented databases.

Unit – 1	FUNDAMENTALS OF DBMS	9 hrs

File System versus DBMS – Advantages -Views – Data models – Database languages – Architecture – ER Model – Entities, Attributes and Entity Sets, Relationships and Relationship Sets – Features of ER Model – Conceptual design with ER – Extended E-R. Relational Model - Codd's rule – Integrity Constraints over Relations – Relational database design – Anomalies - Functional dependencies – Normalization – Normal Forms – Decomposition – Denormalization.

Unit – 2	RELATIONAL ALGEBRA AND RELATIONAL CALCULUS	9 hrs

Relational Query Languages – Relational Algebra – Tuple and Domain Relational Calculus – SQL – Query processing and optimization – Transformation of relational expressions – Evaluation Plans

Unit – 3	**TRANSACTION CONCURRENCY CONTROL AND SECURITY**	**9 hrs**
Transaction – Properties – Concurrent execution – Serializability – Concurrency control – Protocols – Recovery System – Database Security		
Unit – 4	**FILE ORGANIZATION**	**9 hrs**
File organization – Organization of records in files – Indexing – B tree and B+ tree index files – Static hashing – Dynamic hashing		
Unit –5	**ADVANCED CONCEPTS**	**9 hrs**
Parallel and distributed databases – Object-based databases - Mobile databases - XML and Web databases – Intelligent databases – Mongo DB – NOSQL – PostgreSQL		

Text Books:

1. A. Silberchatz, F. Korth, and S. Sudarshan, "Database System Concepts", 7th Edition, McGraw Hill, 2021.
2. R. Elmasri and S. B. Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson 2016

Reference Books:

1. Coronel, Carlos, and Steven Morris. Database systems: design, implementation, & management. Cengage Learning, 2016.
2. Ramakrishnan, R., Gehrke, J., & Gehrke, J. Database management systems , 3rd Edition. McGraw Hill 2006.

MSAI 101	**ARTIFICIAL INTELLIGENCE**	**3**	**0**	**0**	**3**

Course Outcomes:

CO1: Define basic terminologies of artificial intelligence

CO2: Solve simple search and decision related problems

CO3: Build intelligent agents for search and games

CO4: Learning optimization and inference algorithms for model learning

CO5: Design and develop programs for an agent to learn and act in a structured environment.

Unit – 1	**Introduction**	**9 hrs**
Introduction – Definition - Future of Artificial Intelligence – Characteristics of Intelligent Agents – Typical Intelligent Agents – Problem Solving Approach to Typical AI problems		
Unit – 2	**Problem solving Methods**	**9 hrs**
Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search - Game Playing -Optimal Decisions in Games -Alpha--Beta Pruning -Stochastic Games		
Unit – 3	**Knowledge representation**	**9 hrs**
Knowledge representation-First Order Predicate Logic – Prolog Programming - Unification - Forward Chaining -Backward Chaining - Resolution –Knowledge Representation - Ontological Engineering - Categories and Objects –Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information		
Unit – 4	**Machine learning**	**9 hrs**

Machine learning-Probability basics - Bayes Rule and its Applications - Bayesian Networks – Exact and Approximate Inference in Bayesian Networks - Hidden Markov Models - Forms of Learning - Supervised Learning - Learning Decision Trees - Regression and Classification with Linear Models - Artificial Neural Networks - Nonparametric Models - Support Vector Machines

Unit – 5	**Statistical Learning**	**9 hrs**

Statistical Learning - Learning with Complete Data - Learning with Hidden Variables- The EM Algorithm – Reinforcement Learning -AI applications – Language Models - Information Retrieval - Information Extraction – Natural Language Processing - Machine Translation – Speech recognition – Robot – Hardware – Perception – Planning – Moving

Text Books:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 3rd Edition, 2009
2. Bratko, I., Prolog Programming for Artificial Intelligence (International Computer Science Series), Addison-Wesley Educational Publishers Inc; 4th edition, 2011.

Reference Books:

1. David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.
2. 4.. M. Tim Jones, Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc; 1 edition, 2008
3. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning series), The MIT Press; second edition, 2009
4. Nils J. Nilsson, the Quest for Artificial Intelligence, Cambridge University Press, 2009.

MSCS 105	**DATA STRUCTURES AND ALGORITHMS LAB**	**0**	**0**	**4**	**2**

Course Outcomes:

CO1: Understand the fundamental concepts of python and its main components.
CO2: Develop (Read and Write) python programs using variables, assignments, and conditional statements using functions.
CO3: Illustrate and implement different data structures.
CO4: Demonstrate Object-oriented concepts and file handling.
CO5: Analyze and plot data using python visualization libraries.

Programs should include but not limited to:

Implementation of

i. Stacks and Queues
ii. Lists
iii. Linear Search and Binary Search
iv. Sorting Algorithms
v. Graph Traversal Algorithms
vi. Tree Traversal Algorithms
vii. Shortest Path Algorithms
viii. Knapsack Problem
ix. Travelling Salesman Problem

x. N-Queens's Problem

MSCS 106	DATABASE MANAGEMENT SYSTEMS LAB	0	0	4	2

Course Outcomes:

CO1: Identify the basic concepts and apply relational database theory and recognize and identify the use of normalization and functional dependency, indexing technique used in database design

CO2: Describe relational algebra expression, tuple and domain relation expression for queries and query processing concepts.

CO3: Apply and relate the concept of transaction, concurrency control and recovery in database.

CO4: Familiar with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.

CO5: Understand various concepts like Parallel, distributed and object-oriented databases.

Programs should include but not be limited to:

Exercises on

i. DDL commands
ii. DML commands- Basic Queries
iii. Aggregate Commands
iv. Nested Queries
v. Joins
vi. Views
vii. Index
viii. Functions
ix. Procedures
x. Triggers

MSCS 107	PYTHON PROGRAMMING LAB	0	0	4	2

Course Outcomes:

CO1: Understand the fundamental concepts of python and its main components.

CO2: Develop (Read and Write) python programs using variables, assignments, and conditional statements using functions.

CO3: Illustrate and implement different data structures.

CO4: Demonstrate Object-oriented concepts and file handling.

CO5: Analyze and plot data using python visualization libraries.

Programs should include but not limited to:

Experiments:

I. Test and Debug simple Python programs
II. Different datatypes in python (variables constants and strings)
III. Programs on different operators
IV. Control statements and Loops
V. Working on Functions
VI. Data structures in python (List, Tuple, Dictionary and Set)
VII. Objects and Classes manipulation using python
VIII. Open, Read and write data from/to files in Python

IX.	Different plots using Matplotlib
X.	Visualization of data using seaborn

MSCS201	OPERATING SYSTEMS	3	0	0	3

Course Outcomes:

CO1: Understand the functions, features, and concepts of operating systems.
CO2: Learn the concept of process and Analyze the Inter Process Communication methods
CO3: Analyze the scheduling algorithms and deadlocks
CO4: Understand the concept of memory management
CO5: Evaluate security mechanisms in operating computing systems

Unit – 1	OVERVIEW OF OPERATING SYSTEMS	9 hrs

Introduction to operating systems – Computer system organization, architecture – Operating system structure, operations – Process, memory, storage management – Protection and security – Distributed systems – Computing Environments – Open-source operating systems – OS services – User operating-system interface – System calls – Types – System programs – OS structure – OS generation – System Boot – Process concept, scheduling – Operations on processes – Cooperating processes – Inter-process communication – Examples – Multithreading models – Thread Libraries – Threading issues – OS examples

Unit – 2	PROCESS MANAGEMENT	9 hrs

Process Concept – Process Scheduling – Operations on Processes – Inter-Proces Communication (IPC) – IPC Examples – Client-Server Communication – Threads – Multi-core models – Multi-threading models – Threading issues – Process Synchronization – Critical Section Problem – Peterson's Solution – Synchronization Hardware – Mutex Locks – Semaphores - Monitors

Unit – 3	**CPU SCHEDULING AND DEADLOCKS**	**9 hrs**

Basic Concepts – Scheduling Criteria – Scheduling Algorithms – Thread Scheduling – Multi-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**	**9 hrs**

Main Memory Concept – Swapping – Contiguous Memory Allocation – Segmentation – Paging – Example Architectures – Virtual Memory concept – Demand Paging – Page Replacement - Frame Allocation – Thrashing – Memory Mapped Files – Kernel Memory Allocation. Secondary Storage: Disk Structure – Disk Scheduling – Disk Management – RAID structure

Unit – 5	**I/O SYSTEMS AND CASE STUDIES**	**9 hrs**

File concept – Access methods – Directory structure – File-system mounting –Protection – Directory implementation – Allocation methods – Free-space management – Protection File systems. Case Studies: Linux System – Windows 7

Text Book:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts", 10th edition John Wiley & Sons Inc., 2021

Reference Books

2. Andrew S. Tanenbaum, "Modern Operating Systems", Fourth Edition, Addison Wesley, 2016.
3. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education", 1996.
4. D M Dhamdhere, "Operating Systems: A Concept-based Approach", Second Edition, Tata McGraw-Hill Education, 2007.
5. William Stallings, "Operating Systems: Internals and Design Principles", Seventh Edition, PH, 2011

MSCS 202	**WEB TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Outcomes:

CO1: Understand the principles of www and concepts of web clients and web servers
CO2: Interpret the key responsibilities and functionalities of different internet technologies
CO3: Demonstrate Markup languages and illustrate the working of it
CO4: Analyze the different client side scripting/programming languages
CO5: Explain and demonstrate server side , presentation and database technologies

Unit – 1	**WEB ESSENTIALS**	**9 hrs**

Internet Principles – basic web concepts – Client/ server model – Retrieving data from Internet –Internet Protocols and applications

Unit – 2	**INTERNET TECHNOLOGIES**	**9 hrs**

Streaming – Networking Principles – Sockets for Clients – Sockets for Servers – Protocol Handlers – Content Handlers – Multicast sockets – Remote method Invocation.

Unit – 3	**MARKUP LANGUAGES AND STYLE SHEETS**	**9 hrs**

HTML Elements – HTML Lists – HTML Tables – HTML Forms – Links and addressing – HTML Frames and Images – DHTML – Document Object model (DOM) – XML Schemas – CSS – Text Properties – Advanced CSS

Unit – 4	**CLIENT SIDE TECHNOLOGY**	**9 hrs**

Scripts – Javascript – VB Script – JQuery and Ajax

Unit – 5	**SERVER SIDE TECHNOLOGY AND DATABASE**	**9 hrs**

Server Scripts – Servlets – Sessions – Cookies – PHP– Node.js – Java Server Pages (JSP) – Active Server pages (ASP) – Simple Applications – On-line databases – Monitoring user events – Plug-ins – Database connectivity

Text Books:

1. Web Technologies: A Computer Science Perspective , Jeffrey Jackson.
2. Harvey M. Deitel and Paul J. Deitel, "Internet & World Wide Web How to Program", 4th edition, 2008.

Reference

1. https://nptel.ac.in/courses/106/105/106105084/

MSCS203	**OBJECT ORIENTED PROGRAMMING USING JAVA**	**3**	**0**	**0**	**3**

Course Outcomes:

CO1: Understanding Object-Oriented programming concepts using basic syntaxes of control Structures, strings for developing skills of logic building activity using Java

CO2: Identification of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem

CO3: Illustration to achieve reusability using inheritance, interfaces, and packages and describes faster application development can be achieved with exception handling mechanisms

CO4: Understanding concept of multithreading for robust faster and efficient application development and applications of collection interfaces in Java

CO5: Learning of various I/O operations, connecting Java with databases using JDBC and implementation of networking with Java

Unit – 1	**OVERVIEW OF OOP AND INTRODUCTION TO JAVA**	**9 hrs**

Structured Programming and its limitation – Object-Oriented Paradigm: Basic concepts of Object-Oriented Programming (OOP) – Structured Programming vs OOP – Benefits of OOP – Object Modeling – Association – Aggregation and Generalization. Introduction to Java – Evolution of Java – Features of Java – Java Environment – JVM – Data types – variables – operators – Decision statements – Control Structures – Loops – Arrays in Java – Strings in Java – String Buffer Class – Wrapper Classes.

Unit – 2	**OBJECTS AND CLASSES**	**9 hrs**

Introducing Classes - Class Fundamentals - Declaring Objects - Object Reference Variables - Introducing Methods - Constructors - this Keyword - Garbage Collection - A Closer Look at Methods and Classes - Overloading Methods - Objects as Parameters - Returning Objects - Access control - static - final - nested and inner class - Command line arguments

Unit – 3	**INHERITANCE, PACKAGES, INTERFACES AND EXCEPTION HANDLING**	**9 hrs**

Inheritance in Java – Constructors in Inheritance – super – Multilevel Inheritance – Overriding – Dynamic Method Dispatch – final Keyword – Interfaces – Packages – JAR files – Exception Handling

Unit – 4	**MULTI THREADING AND JAVA COLLECTIONS**	**9 hrs**

Threads – Multithreading in Java – Thread Priorities – Creating Multiple Threads – Inter Thread Communication – Synchronization – Suspending, Resuming and Stopping Threads – Collections Overview – Collection Interfaces – Collection Classes – Accessing collection via Iterator.

Unit –5	**JAVA I/O, JDBC AND JAVA NETWORKING**	**9 hrs**

I/O Basics - Reading Console Input - Java I/O Classes and Interfaces - Serialization. Networking Classes and Interfaces - InetAddress - TCP/IP Client Sockets - URL - URL Connection - JDBC Driver, Database Connection Steps, DriverManager Class, Statement Interface, ResultSet Interface.

Text Book:

1. Herbert Schildt, Java: The Complete Reference, Eleventh Edition, 11th Edition December 2018, McGraw-Hill, ISBN: 9781260440249

Reference Books

1. Javin Paul, Grokking the Java Interview: Prepare for Java interviews by learning essential Core Java concepts and APIs, 2020
2. Kishori Sharan, Adam L. Davis, Beginning Java 17 Fundamentals, Springer Link, 2022
3. Herbert Schildt and Dale Skrien, Java Programming: A Comprehensive Introduction, 2013, National Edition

MSCS 204	**MACHINE LEARNING**	**3**	**0**	**0**	**3**

Course Outcomes:

CO1: Understand the fundamentals of machine learning, model preparation and evaluation
CO2: Learn ability theory and its application in data understanding
CO3: Apply supervised learning algorithms and unsupervised learning algorithms on real data
CO4: Apply ensemble classifiers on data and compare the model performance
CO5: Explore data repositories and apply Machine Learning Algorithms on case studies

Unit – 1	**INTRODUCTION – MODEL PREPARATION – EVALUATION**	**10 hrs**

Introduction to Machine Learning: Human Learning and its Types; Machine Learning and its types; Well-Posed Learning Problem; Applications of Machine Learning; Issues in Machine Learning. **Preparing To Model:** Basic Data Types; Exploring Numerical Data; Exploring Categorical Data; Exploring Relationship Between Variables; Data Issues and Remediation; Data Pre-Processing. **Modelling And Evaluation:** Selecting A Model; Training Model – Holdout, *K*-Fold Cross-Validation, Bootstrap Sampling; Model Representation and Interpretability – Under-Fitting, Over-Fitting, Bias-Variance Tradeoff – Model Performance Evaluation – Classification, Regression, Clustering – Performance Improvement.

Unit – 2	**FEATURE ENGINEERING – REVIEW OF PROBABILITY**	**6 hrs**

Feature Engineering: Feature Construction – Feature Extraction – Feature Selection. **Brief Review of Probability:** Basic Concept Of Probability – Random Variables – Discrete Distributions – Binomial, Poisson – Bernoulli - Continuous Distribution – Uniform, Normal, Laplace; Central Theorem; Monte Carlo Approximation.

Unit – 3	**CONCEPT LEARNING – SUPERVISED AND UNSUPERVISED LEARNING**	**12 hrs**

Bayesian Concept Learning: Bayes Theorem – Prior and Posterior Probability, Likelihood; Concept Learning; Bayesian Belief Network. **Supervised Learning – Regression:** Simple Linear Regression; Other Regression Techniques. **Supervised Learning – Classification:** Basics of Supervised Learning – Classification; Logistic Regression – k-Nearestneighbour – Decision Tree – Support Vector Machine. **Unsupervised Learning:** Basics of Unsupervised Learning – Clustering Techniques; Association Rules.

Unit – 4	**ENSEMBLE LEARNING**	**10 hrs**

Concept of Ensemble Learning – Bagging and Boosting and its impact on bias and variance – Random Forest – Adaboost Classifier – Gradient Boosting Machines – XG Boost

Unit –5	**PUBLIC DATASETS AND CASE STUDIES**	**7 hrs**

Exploring UCI Machine Learning Repository – Kaggle Data Sets – Analysing Data Sets – Case Studies

Text Book:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, “Machine Learning”, Pearson Publications, 2019

Reference Books

1. Tom Mitchell, —Machine Learning‖, McGraw Hill, 3rd Edition,1997
2. Christopher M. Bishop, —Pattern Recognition and Machine Learning‖, Springer 2011 Edition.
3. Ethem Alpaydin,"Introduction to Machine Learning‖, MIT Press, Prentice Hall of India, Third Edition 2014.

MSAI 201	**KNOWLEDGE ENGINEERING AND EXPERT SYSTEMS**	**3**	**0**	**0**	**3**

Course Outcomes:

CO1: Demonstrate the knowledge of fundamental elements and concepts related to Intelligent Systems

CO2: Demonstrate the fundamental and advanced modules of KEespecially with Searching methods, Representation of knowledge and different reasoningtechniques.

CO3: Ability to work with Predicate logic, back propagation with respect to the CNNs model parameters and implementing the models successfully.

CO4: Apply the higher order logics for handling uncertainty

CO5: Implement an expert system to solve critical problems of medical domain, application of business intelligence and robotics in real life problems.

Unit – 1	**Knowledge Engineering Concepts**	**9 hrs**

Definition of Knowledge Engineering – Knowledge base Systems – Knowledge base systems Vs Database systems – Rules Vs Triggers – Domain Expert – Expert Systems –Heuristic Search – A*, AO* and Mini-max algorithms - Knowledge representation – Semantic Networks – Frames- Conceptual Dependency – Scripts – Ontology – Semantic Web– Reasoning Methods

Unit – 2	**First Order Logic**	**9 hrs**

Role of Logic –Propositional logic – Predicate logic – Syntax – Semantics – Interpretations – Denotation – Satisfaction and models – Pragmatics – Explicit and Implicit Beliefs - Logical Consequence – Expressing Knowledge - Basic and Complex Facts – Terminological facts – Entailment –Abstract Individuals - Other Sorts of Facts –Resolution – The Propositional Case – Predicate Logic – Handling Variables and Quantifiers –First Order Resolution- Answer Extraction – Skolemization – Clause Form – Equality - Dealing with Computational Intractability - The First-Order Case - Herbrand Theorem - The Propositional Case - The Implications - SAT Solvers - Most General Unifiers - Other Refinements

Unit – 3	**Knowledge Representation – Using Rules**	**9 hrs**

Procedural Versus Declarative Knowledge - Logic Programming - Forward versus Backward Reasoning – Rule Matching – Rules in Production Systems- Working Memory- Conflict Resolution- Rete's Algorithm – Discriminant Networks - Control Knowledge –Reasoning with Horn Clauses – Computing Selective Linear Definite clause resolution Derivatives – Rule Formation and Search Strategy – Algorithm Design – Specifying Goal order – Committing to Proof methods – Controlling Back Tracking – Negation as Failure – Dynamic Databases

Unit – 4	**Expert Systems and Learning**	**9 hrs**

Expert Systems – Shells for Expert Systems – Inference Engine – Forward and Backward Chaining Inference – MYCIN - DENDRAL –Knowledge Acquisition - Rote Learning – Learning from Examples – Machine Learning- Neural Networks – Regression Analysis- Predictive Models - Deep Learning

Unit –5	**Applications of Knowledge Base Systems**	**9 hrs**

Factory Automation -Field and Service Robotics–AssistiveRobotics -Military Applications -Medicare–Education – Business Intelligence – Recommendation Systems – Social Network Analysis – Natural Language Processing – Information Retrieval Systems

Text Books:

Ronald Brachman, Hector Levesque, Knowledge Representation and Reasoning, 1st Edition, Morgan Kaufmann, 2004

2. Richard A Frost, "Introduction to Knowledge Based Systems", Macmillan Publishing Co, 1986.

Reference Books:

Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2010.

2. Donald A Waterman,"A Guide to Expert Systems", Addison Wesley, 1986.

3. Schall, Daniel,"Social Network-Based Recommender Systems", Springer, 2015

MSCS204	WEB TECHNOLOGY LAB	0	0	4	2

Course Outcomes:

CO1: Understand the principles of www and concepts of web clients and web servers
CO2: Interpret the key responsibilities and functionalities of different internet technologies
CO3: Demonstrate Markup languages and illustrate the working of it
CO4: Analyze the different client side scripting/programming languages
CO5: Explain and demonstrate server side , presentation and database technologies

Programs should include but not be limited to:
Implementations of

i. Demonstration of client server programming
ii. Static and Dynamic web pages creation using HTML
iii. Inline, Internal and external style sheet using CSS
iv. Creation and manipulation of XML schema
v. Scripts – Simple programs
vi. Front end development using JavaScript, VBScript
vii. Programs based on sessions and cookies
viii. Web applications (Backend) using PHP, Servlets
ix. Exercises based on database connectivity
x. Web application for event tracking and monitoring

MSCS205	OBJECT ORIENTED PROGRAMMING USING JAVA LAB	0	0	4	2

Course Outcomes:

CO1: Understanding Object-Oriented programming concepts using basic syntaxes of control Structures, strings for developing skills of logic building activity using Java
CO2: Identification of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem
CO3: Illustration to achieve reusability using inheritance, interfaces, and packages and describes faster application development can be achieved with exception handling mechanisms
CO4: Understanding concept of multithreading for robust faster and efficient application development and applications of collection interfaces in Java
CO5: Learning of various I/O operations, connecting Java with databases using JDBC and implementation of networking with Java

Programs should include but not limited to:
Programming Assignment on

i. Basic Problems
ii. Arrays
iii. Panagrams
iv. Duplicate Elements
v. Class – Objects – Constructors
vi. Access Specifiers
vii. Static and Non-static variables
viii. Packages and Interfaces
ix. Exception Handling
x. Multithreading and JDBC and Networking

MSCS301	ADVANCED COMPUTER NETWORKS	3	0	0	3

Course Outcomes:

CO1: Describe the fundamental concepts of Networking and Physical layer
CO2: Understand details and functionality of Data link layer.
CO3: Analyze switching protocols and routing algorithms
CO4: Analyze features, services and operations of various protocols of TCP/IP suite
CO5: Identify various application layer protocols and its functions

Unit – 1	FUNDAMENTAL CONCEPTS AND PHYSICAL LAYER	9 hrs

Basic Definitions - Basic Communication Models – Network Types – Protocol Layers and Service Models – OSI Model – TCP/IP protocol suite. Physical Layer: Data and Signals – Digital Transmission – Bandwidth Utilization – Transmission Media – Switching – Packet Switching – Circuit Switched Networks

Unit – 2	DATA LINK LAYER	9 hrs

Error Detection and Correction – Data Link Control – Multiple Access – Wired LANs – Wireless LAN – IEEE 802.11 – Bluetooth – Connecting Devices

Unit – 3	NETWORK LAYER	9 hrs

Circuit Switching – Packet Switching – Virtual Circuit Switching – IP – ARP – DHCP – ICMP – Routing – RIP – OSPF – Subnetting – CIDR – Interdomain Routing – BGP – IPV6 Basic Features – Multicast –Congestion Avoidance in Network Layer.

Unit – 4	TRANSPORT LAYER	9 hrs

Transport Layer Services – Port Numbers – Protocols – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Details - Flow Control – Congestion Control – Queuing Discipline - Introduction to Quality of services (QOS).

Unit – 5	APPLICATION LAYER AND INTERNET APPLICATIONS	9 hrs

Network Architecture – Layers - HTTP – DNS – E-Mail (SMTP, MIME, POP3, IMAP, Web Mail) – FTP – Telnet – SNMP.

Text Books:

1. Behrouz A. Forouzan, “Computer Networks - A top-down approach”, Tata McGraw-Hill, 2012.
2. Computer Networks -- Andrew S Tanenbaum, 6th Edition, Pearson Education

Reference Books:

1. J William Stallings, “Data and Computer Communications”, Eighth Edition, Pearson Education, 2011
2. James F. Kurose, Keith W. Ross, “Computer Networking, A Top-Down Approach Featuring the Internet”, Sixth Edition, Pearson Education, 2012.
3. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.
4. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, Computer Networks: An Open Source

Approach “, McGraw Hill Publisher, 2011.

MSAI 301	REINFORCEMENT LEARNING	3	0	0	3

Course Outcomes:

CO1: The objective of this course is to familiarize the students with the basic concepts as well as with the state-of-the-art research literature in deep reinforcement learning

Unit – 1	Reinforcement Learning (RL) Problem	9 hrs

Reinforcement Learning (RL) Problem: Reinforcement learning – examples – elements of RL. Multi-arm Bandits: Ann-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper- Confidence-Bound Action Selection, Gradient Bandits, Associative Search (Contextual Bandits)

Unit – 2	Finite Markov Decision Processes	9 hrs

Finite Markov Decision Processes: Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation

Unit – 3	Dynamic Programming	9 hrs

Dynamic Programming: Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming. Monte Carlo Methods: Monte Carlo Prediction, Monte Carlo Estimationof Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control , Importance Sampling on Truncated Returns

Unit – 4	Temporal-Difference Learning	9 hrs

Temporal-Difference Learning: Prediction, Advantages of TD Prediction Methods, Optimality ofTD(0), Sarsa: On-Policy TD Control, Q-Learning: Off-Policy TD Control , Games, Afterstates, and Other Special Cases. Eligibility Traces: n-Step TD Prediction, Forward View of TD(λ), Backward View of TD(λ), Equivalences of Forward and Backward Views, Sarsa(λ), Watkins’s Q(λ) , Off- policy Eligibility Traces using Importance Sampling .

Unit –5	Approximate Solution Methods	9 hrs

Approximate Solution Methods: On-policy Approximation of Action Values: Value Prediction with Function Approximation, Gradient-Descent Methods, Linear Methods , Control with Function Approximation; Off-policy Approximation of Action Values;

Policy Approximation: Actor–Critic Methods, Eligibility Traces for Actor–Critic Methods, R-Learning and the Average- Reward Setting.

Text Books:

1.Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, Second Edition, MIT PressCambridge, Massachusetts London, 2018

Reference Books:

1. https://nptel.ac.in/content/syllabus_pdf/106106143.pdf
2. https://cse.iitkgp.ac.in/~adas/courses/rl_aut2020/rl_aut2020.php

MSAI 302	NATURAL LANGUAGE PROCESSING	3	0	0	3

Course Outcomes:

- To learn about the concepts and principles of natural language processing.
- To explore both theoretical and practical issues of natural language processing.
- To develop skills of finding solutions and building software using natural languageprocessing techniques.

Unit – 1	Introduction to Natural Language Processing	9 hrs

Introduction: Natural Language Processing tasks in syntax, semantics, and pragmatics – Issues - Applications - The role of machine learning - Probability Basics –Information theory – Collocations -N-gram Language Models - Estimating parameters and smoothing - Evaluating language models.

Unit – 2	Morphology and part of speech tagging	9 hrs

Morphology and part of speech tagging: Linguistic essentials - Lexical syntax- Morphology and Finite State Transducers - Part of speech Tagging - Rule-Based Part of Speech Tagging - Markov Models - Hidden Markov Models – Transformation based Models - Maximum Entropy Models. Conditional Random Fields

Unit – 3	Syntax Parsing	9 hrs

Syntax Parsing - Grammar formalisms and treebanks - Parsing with Context Free Grammars - Features and Unification -Statistical parsing and probabilistic CFGs (PCFGs)-Lexicalized PCFGs.

Unit – 4	Semantic analysis	9 hrs

Semantic analysis- Representing Meaning – Semantic Analysis - Lexical semantics –Word-sense disambiguation - Supervised – Dictionary based and Unsupervised Approaches - Compositional semantics, Semantic Role Labeling and Semantic Parsing – Discourse Analysis.

Unit – 5	Applications	9 hrs

Applications- Named entity recognition and relation extraction- IE using sequence labeling- Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase- based translation – Question Answering

Text / Reference Books:

1. Daniel Jurafsky and James H. Martin Speech and Language Processing (2nd Edition), Prentice Hall; 2 edition, 2008
2. Foundations of Statistical Natural Language Processing by Christopher D. Manning and Hinrich Schuetze, MIT Press, 1999
3. Steven Bird, Ewan Klein and Edward Loper Natural Language Processing with Python, O'Reilly Media; 1 edition, 2009

4. Roland R. Hausser, Foundations of Computational Linguistics: Human- Computer Communication in Natural Language, Paperback, MIT Press, 2011
5. Pierre M. Nugues, An Introduction to Language Processing with Perl and Prolog: An Outline of Theories, Implementation, and Application with Special Consideration of English, French, and German (Cognitive Technologies) Softcover reprint, 2010
6. James Allen, Natural Language Understanding, Addison Wesley; 2 edition 1994

MSAI 303	DEEP LEARNING	3	0	0	3

Course Outcomes:

CO1: Recognize characteristics of deep learning models to solve real world problems

CO2: Understand the concepts of convolutional neural networks and its usage in classification problem

CO3: Learn deep learning supporting environments

CO4: Understand the concept of recurrent neural networks and apply them in solving real world problems

CO5: Generate auto encoders and generative models for real time applications

Unit – 1	INTRODUCTION TO DEEP LEARNING & ARCHITECTURES	9 hrs

Machine Learning Vs. Deep Learning – Representation Learning – Width Vs. Depth of Neural Networks - Activation Functions: RELU – LRELU – ERELU –Unsupervised Training of Neural Networks – Regularization – Dropout - Drop connect – Optimization methods for neural networks – Adagrad – Adadelta – Rmsprop – Adam – NAG.

Unit – 2	CONVOLUTIONAL NEURAL NETWORKS & TRANSFER LEARNING	9 hrs

Architectural Overview – Motivation - Layers – Filters – Parameter sharing – Regularization - Popular CNN Architectures: LeNet – ResNet – Vggnet – AlexNet. Transfer learning Techniques – DenseNet – PixelNet.

Unit – 3	TRAINING NEURAL NETWORKS	9 hrs

Deep Learning Hardware and Software – CPUs – GPUs – TPUs – PyTorch – TensorFlow – Dynamic vs Static computation graphs – Data Preprocessing – Data Augmentation – Batch Normalization – Transfer Learning – Deep Transfer Learning Strategies – Update Rules - Hyperparameter Tuning – Learning Rate Scheduling – Variants of CNN – ResNet – GoogleNet – Xception etc

Unit – 4	RECURRENT NEURAL NETWORKS	9 hrs

Recurrent Neural Networks – Bidirectional RNNs – Encoder-decoder sequence to sequence Architectures – Backpropagation Through Time for training RNN – Long Short Term Memory Networks.

Unit – 5	AUTO ENCODERS AND DEEP GENERATIVE MODELS	9 hrs

Under complete Autoencoders – Regulraized Autoencoders – Sparse Autoencoders – Denoising Autoencoders –Representational Power – Layer – Size and Depth of Autoencoders – Stochastic Encoders and Decoders – Contractive Encoders – Deep Belief networks – Boltzmann Machines – Deep Boltzmann Machine – Generative Adversarial Networks

Text Books:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, " Deep Learning", MIT Press, 2017.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017

Reference Books:

1. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
2. Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
3. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.

MSAI 304	DEEP LEARNING LAB	0	0	4	2

Course Outcomes:

- To understand deep learning models and make real time implementations
- To build models for object recognition systems, image classification system,segmentation systems
- To understand memory based networks

LIST OF EXPERIMENTS

- Introduction: Get your first taste of deep learning by applying style transfer to your own images, and gain experience using development tools such as Anaconda and Jupyter notebooks.
- Neural Networks: Learn neural networks basics, and build your first network with Python and NumPy. Use the modern deep learning framework PyTorch to build multi- layer neural networks, and analyze real data.
- Convolutional Neural Networks: Learn how to build convolutional networks and use them to classify images (faces, melanomas, etc.) based on patterns and objects that appear in them. Use these networks to learn data compression and image denoising.
- Recurrent Neural Networks: Build your own recurrent networks and long short-term memory networks with PyTorch; perform sentiment analysis and use recurrent networks to generate new text from TV scripts.
- Deploying a Sentiment Analysis Model: Use deep neural networks to design agents that can learn to take actions in a simulated environment. Apply reinforcement learning to complex control tasks like video games and robotics.
- Sample projects for object recognition system
- Sample project for segmentation system

	SOFTCORE (ENGLISH)	2	0	0	2

This is a Spoken English Training course offered by the department of English. There are many people who know reading and writing of English but find it difficult to speak while communicating with others. As we know, without speaking practice it's impossible to learn and speak any language.

English is the most used language in this entire world. Speaking English immediately opens doors to opportunities regardless of your race, color, and caste anywhere in this world. Not only has that, speaking fluent English had its major advantages in terms of employability.

Softcore has carefully taken into account the general mistakes and errors most commonly used by non-English speaking speakers and also aim to reduce the heavy mother tongue influence of non-native speakers.

	Intellectual Property Rights	**2**	**0**	**0**	**2**

Course Outcome:

CO1: To acquaint the learners with the basic concepts of Intellectual Property Rights.
CO2: To develop expertise in the learners in IPR related issues and sensitize the learners with the emerging issues in IPR and the rationale for the protection of IPR.

UNIT I	**Introduction**	**9 Periods**

Introduction to IPRs, Basic concepts and need for Intellectual Property **–** Meaning and practical aspects of Patents, Copyrights, Geographical Indications, IPR in India and Abroad. **Nature** of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations **–** Important examples of IPR.

UNIT II	**Intellectual Property Rights**	**9 Periods**

The IPR tool kit, Patents, the patenting process, Patent cooperation treaties: International Treaties and conventions on IPRs: Trade Related Aspects of Intellectual Property Rights Agreement, Patent Cooperation Treaty, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT III	**Intellectual Property Protections**	**9 Periods**

IPR of Living Species, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, Digital Innovations and Developments as Knowledge Assets **–** IP Laws, Cyber Law and Digital Content Protection. **Case studies: The basmati rice issue, revocations of turmeric patent, revocation of neem patent.**

UNIT IV	**Exercising and Enforcing of Intellectual Property Rights**	**9 Periods**

Rights of an IPR owner, licensing agreements, criteria for patent infringement. **Case studies of patent infringement, IPR – contract, unfair competitions and control, provisions in TRIPS,**

UNIT V	**Role of Patents in Product Development & Commercialization**	**9 Periods**

Recent changes in IPR laws impacting patents and copy rights, intellectual cooperation in the science and allied industry. Patentable and non-patentable research. **Case studies**

Text Books

1. P.B. Ganguli, *Intellectual Property Rights: Unleashing the Knowledge Economy.* Tata Mc Graw Hill, 2001.
2. Kompal Bansal and Praishit Bansal. *Fundamentals of IPR for Engineers*, 1st Edition, BS Publications, 2012.

References:

3. Prabhuddha Ganguli. *Intellectual Property Rights.* 1st Edition, TMH, 2012.
4. R Radha Krishnan & S Balasubramanian. *Intellectual Property Rights.* 1st Edition, Excel Books, 2012.
5. M Ashok Kumar & Mohd. Iqbal Ali. *Intellectual Property Rights.* 2nd Edition, Serial Publications, 2011.
6. VinodV. Scople, *Managing Intellectual Property.* Prentice Hall of India PvtLtd, 2012.
7. Deborah E. Bouchoux. *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets.* Cengage Learning, 3rd ed. Edition, 2012.
8. Prabuddha Ganguli. *Intellectual Property Rights: Unleashing the Knowledge Economy.* McGraw Hill Education, 2011.

9. Edited by Derek Bosworth and Elizabeth Webster.*The Management of Intellectual Property.* Edward Elgar Publishing Ltd., 2013.
10. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
11. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.
12. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House

MSAI EL01	COMPUTATIONAL INTELLIGENCE	3	0	0	3

Course Outcome:

CO1: To provide a strong foundation on fundamental concepts in Computational Intelligence.
CO2: To enable Problem-solving through various searching techniques.
CO3: To apply these techniques in applications which involve perception, reasoning and learning.
CO4: To apply Computational Intelligence techniques for information retrieval
CO5: To apply Computational Intelligence techniques primarily for machine learning.

UNIT I	INTRODUCTION	9 hrs

Introduction to Artificial Intelligence-Search-Heuristic Search-A* algorithm-Game Playing-Alpha-Beta Pruning-Expert systems-Inference-Rules-Forward Chaining and Backward Chaining-Genetic Algorithms.

UNIT II	KNOWLEDGE REPRESENTATION AND REASONING	9 hrs

Proposition Logic - First Order Predicate Logic – Unification – Forward Chaining -Backward Chaining - Resolution – Knowledge Representation - Ontological Engineering - Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information - Prolog Programming.

UNIT III	UNCERTAINTY	9 hrs

Non monotonic reasoning-Fuzzy Logic-Fuzzy rules-fuzzy inference-Temporal Logic-Temporal Reasoning-Neural Networks-Neuro-fuzzy Inference.

UNIT IV	LEARNING	9 hrs

Probability basics - Bayes Rule and its Applications - Bayesian Networks — Exact and ApproximateInference in Bayesian Networks - Hidden Markov Models - Forms of Learning - Supervised Learning - Learning Decision Trees — Regression and Classification with Linear Models - Artificial Neural Networks — Nonparametric Models - Support Vector Machines - Statistical Learning - Learning withComplete Data - Learning with Hidden Variables- The EM Algorithm – Reinforcement Learning

UNIT V	INTELLIGENCE AND APPLICATIONS	9 hrs

Natural language processing-Morphological Analysis-Syntax analysis-Semantic Analysis-AII applications – Language Models - Information Retrieval – Information Extraction - Machine Translation – Machine Learning - Symbol-Based – Machine Learning: Connectionist – Machine Learning.

Text Book:

1. Patrick H. Winston. "Artificial Intelligence", Third edition, Pearson Edition, 2006.

Reference Books:

1. Dan W.Patterson, —Introduction to Artificial Intelligence and Expert Systems‖, PHI, 2006.
2. Nils J. Nilsson, —Artificial Intelligence: A new Synthesis‖, Harcourt Asia Pvt. Ltd., 2000.

MSAI EL02	SPEECH PROCESSING AND SYNTHESIS	3	0	0	3

Course Outcome:

CO1: To understand the mathematical foundations needed for speech processing
CO2: To understand the basic concepts and algorithms of speech processing and synthesis
CO3: To familiarize the students with the various speech signal representation, coding and recognition techniques
CO4: To appreciate the use of speech processing in current technologies and to expose the students to real– world applications of speech processing

UNIT I	INTRODUCTION	9 hrs

Fundamentals of Speech Processing: Introduction – Spoken Language Structure – Phonetics and Phonology – Syllables and Words – Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory – Estimation Theory – Significance Testing – Information Theory.

UNIT II	KNOWLEDGE REPRESENTATION AND REASONING	9 hrs

Speech Signal Representations and Coding: Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis – Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder.

UNIT III	UNCERTAINTY	9 hrs

Speech Recognition: Hidden Markov Models – Definition – Continuous and Discontinuous HMMs – Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – OtherTechniques.

UNIT IV	LEARNING	9 hrs

Text Analysis: Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation 47

UNIT V	INTELLIGENCE AND APPLICATIONS	9 hrs

Speech Synthesis: Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation ofTTS Systems.

Text Books:

1. Joseph Mariani, —Language and Speech Processing‖, Wiley, 2009.
2. Lawrence Rabiner and Biing-Hwang Juang, —Fundamentals of Speech Recognition‖, Prentice Hall Signal Processing Series, 1993.

References:

1. Sadaoki Furui, —Digital Speech Processing: Synthesis, and Recognition, Second Edition,(Signal Processing and Communications)‖, Marcel Dekker, 2000.
2. Thomas F.Quatieri, —Discrete-Time Speech Signal Processing‖, Pearson Education,2002.

MSAI EL03	COMPUTER VISION	3	0	0	3

Course Outcomes:

CO1: To review image processing techniques for computer vision.
CO2: To understand shape and region analysis.
CO3: To understand Hough Transform and its applications to detect lines, circles, ellipses.
CO4: To understand three-dimensional image analysis techniques.
CO5: To understand motion analysis.
CO6: To study some applications of computer vision algorithms.

Unit – 1	IMAGE PROCESSING FOUNDATIONS	9 hrs

Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection – mathematical morphology – texture.

Unit – 2	SHAPES AND REGIONS	9 hrs

Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moments**.**

Unit – 3	HOUGH TRANSFORM	9 hrs

Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study: Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation.

Unit – 4	3D VISION AND MOTION	9 hrs

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion – spline-based motion – optical flow – layered motion.

Unit –5	APPLICATIONS	9 hrs

Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locatingpedestrians.

Text Books:

1. D. L. Baggio et al., —Mastering OpenCV with Practical Computer Vision Projects‖, Packt Publishing, 2012.
2. E. R. Davies, —Computer & Machine Vision‖, Fourth Edition, Academic Press, 2012.

Reference Books:

1. Jan Erik Solem, —Programming Computer Vision with Python: Tools and algorithms for analyzing images‖, O'Reilly Media, 2012.
2. Mark Nixon and Alberto S. Aquado, —Feature Extraction & Image Processing for Computer Vision‖, Third Edition, Academic Press, 2012.
3. R. Szeliski, —Computer Vision: Algorithms and Applications‖, Springer 2011.
4. Simon J. D. Prince, —Computer Vision: Models, Learning, and Inference‖, Cambridge University Press, 2012

MSAI EL04	ROBOTICS	**3**	**0**	**0**	**3**

Course Outcome:

CO1: To learn kinematics and dynamics
CO2: To devlop controllers for tracking a desired trajectory by a robot
CO3: To learn computer vision for robot motion control

UNIT I	**INTRODUCTION**	**9 hrs**

Introduction: Automation and Robotics, Basic Structure of Robots, Robot Anatomy, Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, the Wrist & Gripper Subassemblies of Robot Manipulator

UNIT II	**KNOWLEDGE REPRESENTATION AND REASONING**	**9 hrs**

Kinematics: Direct Kinematics problem, Geometry Based Direct kinematics problem, Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Problems, Composite Rotation matrix, Homogenous Transformations,, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, RollPitch-Yaw(RPY) Transformation,. D-H Representation & Displacement Matrices for Standard Configurations, Jacobian Transformation in Robotic Manipulation.

UNIT III	**UNCERTAINTY**	**9 hrs**

Trajectory Planning & Dynamics: Trajectory Interpolators, Basic Structure of Trajectory, Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories:- 4-3-4 & 3-5-3Trajectories Dynamics of Robotic Manipulators: Introduction,. Preliminary Definitions, GeneralizedRobotic Coordinates, Jacobian for a Two link Manipulator, Euler Equations, The Lagrangian Equations of motion.

UNIT IV	**LEARNING**	**9 hrs**

Controls & Applications : Application of Lagrange–Euler Dynamic Modelling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy of Arm, Potential Energy of Robotic Arm, The Lagrange , Two Link Robotic Dynamics with Distributed Mass, Control Loops of Robotic Systems,trajectory, velocity and force control, Computed Torque control, Linear and Nonlinear controllerdesign of robot, Robot Sensing & Vision:

UNIT V	**INTELLIGENCE AND APPLICATIONS**	**9 hrs**

Sensors for Robotics: Use of Sensors and Sensor Based System in Robotics, Machine Vision System,Description, Sensing, Digitizing, Image Processing and Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors, visual servo-

control, Applications of robotics in active perception, medical robotics, autonomous vehicles, and other areas

Text Book:

1. Fu, Lee and Gonzalez., *Robotics, control vision and intelligence-*, McGraw Hill International,2nd edition, 2007

Reference Book:

1. John J. Craig, *Introduction to Robotics*-, Addison Wesley Publishing, 3rd edition, 2010

MSAI EL05	Cognitive Science	3	0	0	3

Course Outcomes:

CO1: Students will be able to understand the basic concept of cognitive science

CO2: Learn and understand the learning model and apply the same to appropriate real world applications

CO3: Apply reasoning methodology to real world applications

CO4: Students will understand and apply declarativeand logic models

CO5: Envisage the concept of cognitive learning

CO6: Acquire knowledge in language processing and understanding

Unit – 1	Introduction to Cognitive Science	9 hrs

Fundamental Concepts of cognitive science – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation, semantic networks, frames, conceptual dependency, scripts, Ontology- Understanding, Common Sense Reasoning.

Unit – 2	Planning and Learning Methods	9 hrs

Planning – Situation Logic- Learning in Cognitive Systems- Rote Learning – Learning by Examples - Incremental Concept Learning – Inductive Learning - Classification Techniques – Statistical Reasoning- Bayesian Classification- Bayesian Networks- Concept Learning- Version Spaces - Discrimination Trees.

Unit – 3	Reasoning methods	9 hrs

Reasoning by analogy – Explanation based reasoning – Case based reasoning- Constraint Satisfaction- Constraint Propagation- Temporal reasoning – Temporal Constraint Networks- Spatial reasoning- Visual Spatial reasoning- Meta reasoning – Learning by correcting mistakes- AI ethics

Unit – 4	Cognitive Modeling	9 hrs

Declarative/ logic-based computational cognitive modelling - connectionist models of cognition -Bayesian models of cognition - Cognitive Models of Memory and Language - Computational models of episodic and semantic memory - modelling psycholinguistics (with emphasis on lexical semantics) - towards deep understanding - modelling the interaction of language, memory and learning.

Unit –5	Cognitive Development	9 hrs

Child concept acquisition - Child language learning - Acquisition of arithmetic skills –Distributed Cognition and Learning- Simple and Complex Decision Making – Reasoning Under Uncertainty – Natural Language Understanding – Natural Language Processing – Automated

Natural Language Generation
Text Books: 1. José Luis Bermúdez, “Cognitive Science: An Introduction to the Science of the Mind”, Cambridge University Press, New York, 2014. 2. Mallick, Pradeep Kumar, Borah, Samarjeet," Emerging Trends and Applications in Cognitive Computing”, IGI Global Publishers, 2019. **Reference Books** 1. Stuart J. Russell, Peter Norvig, “Artificial Intelligence - A Modern Approach”, Third Edition, Pearson Publishers, 2015. 2.Paul Miller, “An Introductory Course in Computational Neuroscience”, MIT Press, 2018. 3. Jerome R. Busemeyer, Zheng Wang, James T. Townsend, Ami Eidels(Ed), “The Oxford Handbook of Computational and Mathematical Psychology”,Oxford University Press (2015).

MSCS EL06	BIOMETRIC IMAGE PROCESSING	3	0	0	3

Course Outcomes:

CO1: To understand the basics of Image processing
CO2: To model and visualize the transformation of image
CO3: To understand the evolution of object detection
CO4: To mine the interest of the user

UNIT I	Image Processing Fundamentals	9 Periods

Image Processing Fundamentals: Introduction- images-sampling and frequency –Domain processing-basic image processing operations-point operators –group operations –other statistical operators –mathematical morphology

UNIT II	Feature Extraction	9 Periods

Feature Extraction: Low level Feature Extraction: Edge Detection- phase congruency-localized feature extractiondescribing image motion. High Level Extraction: Thresholding and subtraction – Template matchingfeature extraction by low level features- Hough transformation.

UNIT III	Object Detection	9 Periods

Object Detection: Object Detection- Boundary descriptors –Region descriptors –moving object detection –tracking moving features- Moving extraction and description-Texture description – classification -segmentation.

UNIT IV	3D Biometric	9 Periods

3D Biometric: Classification of 3D biometric imaging methods -3D biometric Technologies-3D palm print capturing systems-3D information in palm print- Feature Extraction from 3D palm print – matching and fusion – security applications.

UNIT V	Applications	9 Periods

Applications: Mobile Biometrics- Biometric Application Design –Biometric Technologies issues- Biometrics in society –privacy and Biometrics –Ethics and Technology usage –

human factors

Text Books:

1. Amine Nail -Ali and Regis Fournier "Signal and Image Processing for Biometrics" John wiley and sons,2012
2. David Zhang, Guangming, 3D Biometrics Systems and Applications‖ Lu, Springer 2013.

Reference Books:

1. Julian Ashbourn, Biometrics In The New World‖ , Springer 2014.
2. Mark S.Nixon, Alberto S.Aguado, Feature Extraction and image processing for computer vision, Third Edition, , Elsevier 2012.
3. Scott E Baugh "Digital Image Processing and analysis" 2nd Edition CRC Press 2010
4. Tinku Acharya and Ajoy K Ray "Image Processing Principles and Applications" John wiley and sons 2005

MSCS EL01	INFORMATION RETRIEVAL TECHNIQUES	3	0	0	3

Course Outcomes:

CO1: To understand the basics of information retrieval with pertinence to modeling, query operations and indexing

CO2: To get an understanding of machine learning techniques for text classification and clustering.

CO3: To understand the various applications of information retrieval giving emphasis to multimedia IR, web search

CO4: To understand the concepts of digital libraries

UNIT I	Introduction	9 Periods

Motivation: Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval – Retrieval Evaluation – Open Source IR Systems–History of Web Search – Web Characteristics– The impact of the web on IR —IR Versus Web Search–Components of a Search engine

UNIT II	Modeling	9 Periods

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model – Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing, Zipf's law, Porter stemmer

UNIT III	Indexing	9 Periods

Static and Dynamic Inverted Indices – Index Construction and Index Compression.
Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency

UNIT IV	Classification and Clustering	9 Periods

Text Classification and Naïve Bayes, Improved smoothing for document retrieval – Vector Space Classification – Support vector machines and Machine learning on documents. Flat Clustering – Hierarchical Clustering –Matrix decompositions and latent semantic indexing – Fusion and Meta learning 41

UNIT V	Searching the Web	9 Periods

Applications to web search and information organization, Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries, Privacy, Fairness, Fake news and disinformation, Deep Learning for IR

Text Books:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, —Introduction to Information Retrieval‖, Cambridge University Press, First South Asian Edition, 2008.
2. Implementing and Evaluating Search Engines‖, The MIT Press, Cambridge, Massachusetts London, England, 2010

Reference Books

1. Ricardo Baeza – Yates, Berthier Ribeiro – Neto, —Modern Information Retrieval: The concepts and Technology behind Search‖ (ACM Press Books), Second Edition, 2011.
2. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, —Information Retrieval

MSCS EL02	OPERATIONS RESEARCH	3	0	0	3

Course Outcomes:

CO1: Formulate various real-life problems as Operations Research models and to study methodologies to solve the problems.

CO2: Introduce Linear Programming, Transportation and Assignment problems and to discuss methods to find optimum solutions.

CO3: Study the theory of duality and sensitivity analysis in linear programming.

CO4: Learn network flow problems and their solution techniques.

CO5: Explore dynamic programming problem and its applications.

UNIT I	Introduction	9 Periods

Introduction – Models in Operations Research – Linear Programming Problems – Simplex Method – Big-M Method – Two-Phase Method – Special Cases – Degeneracy and Cycling – Unbounded Solutions – Alternative Optima.

UNIT II	Dual Linear Programs	9 Periods

Dual Linear Programs – Duality Theorems – Dual Simplex Method - Transportation Problems - Finding an Initial Basic Feasible Solution - Optimality Condition – MODI method – Degeneracy – Assignment Problems – Hungarian Method.

UNIT III	Revised Simplex Method	9 Periods

Revised Simplex Method – Sensitivity Analysis – Parametric Programming.

UNIT IV	Network Analysis	9 Periods

Network Analysis – Shortest Route Problems – Maximal Flow Problems – Critical Path Method (CPM) – Program Evaluation and Review Techniques (PERT).

UNIT V	Dynamic Programming	9 Periods

Dynamic Programming – Introduction – Principle of Optimality – Forward and Backward recursions – Discrete Dynamic Programming – Continuous Dynamic Programming – Applications.

Text Books:

1. Ravindran, Don T. Phillips and James J. Solberg, *Operations Research- Principles and Practice*, John Wiley, 2014.
2. Hamdy A. Taha, *Operations Research-An Introduction*, Prentice Hall of India, 2000.

Reference Books:

1. Frederick S. Hillier and Gerald J. Lieberman, *Introduction to Operations Research*, McGraw Hill, 2010.
2. KantiSwarup, P.K. Gupta and Man Mohan, *Operations Research*, Sultan Chand,2014.

MSCS EL03	Theory of Computation	3	0	0	3

Course Outcomes:

CO1: Use regular language and grammar for designing real world problems **CO2:** Perform computational complexity analysis **CO3**: Define Turing machines performing simple tasks. **CO4**: Understand formal languages		
Unit – 1	**Introduction to theory of computation**	**9 hrs**
Introduction to theory of computation and Finite Automata: Mathematical preliminaries – Basic concepts – Applications – DFA – NFA – Equivalence – Reduction of states.		
Unit – 2	**REGULAR EXPRESSIONS AND LANGUAGES**	**9 hrs**
Regular Language (RL) , Regular Grammar, Properties of RL: Regular Expressions (RE) – Relation between RE and RL – Regular Grammars – Properties – Context Free Grammars (CFG)		
Unit – 3	**CONTEXT FREE GRAMMAR AND LANGUAGES**	**9 hrs**
Simplification of Context Free Grammars & Normal Forms: Methods for transforming Grammars – Chomsky and Greibach Normal Forms Push Down Automata (PDA)Non-deterministic PDA – PDA and Context Free Languages (CFL) – Deterministic PDA and CFL		
Unit – 4	**PROPERTIES OF CONTEXT FREE LANGUAGES**	**9 hrs**
Properties of CFL and Turing Machines: Pumping lemma –closure properties Turing machines ™ – the standard TM – Turings' thesis – Linear Bounded Automata		
Unit –5	**UNDECIDABILITY**	**9 hrs**
Non Recursive Enumerable (RE) Language — Undecidable Problem with RE — Undecidable Problems about TM — Post Correspondence Problem, The Class P and NP.		
Text Books: 1.Peter Linz, An introduction to Formal Languages and Automata, 2012, Fifth Edition, Jones & Bartlett Learning **Reference Books** 1. Automata, Computability and Complexity: Theory and Applications, Pearson Education India; 1 edition 2012. 2. Moore, Cristopher, and Stephan Mertens. The Nature of Computation. Oxford University Press, 2011. 3. Arora, Sanjeev, and Boaz Barak. Computational Complexity: A Modern Approach. Cambridge University Press, 2009		

MSCS EL04	**VIDEO PROCESSING AND ANALYTICS**	**3**	**0**	**0**	**3**
Course Outcomes: **CO1:** To have a better knowledge about videos. **CO2:** To enrich students with data analytics. **CO3:** To understand the video content analysis.					
Unit – 1	**Video Fundamentals**				**9 hrs**

Video Fundamentals : Basic concepts and Terminology-Monochrome Analog video – Colour in Video – Analog video standards – Digital video basics – Analog to Digital conversion – Colour representation and chromasub sampling – Digital video formats and standards Video sampling rate and standards conversion.

Unit – 2	Video Segmentation and Video Features	9 hrs

Video Segmentation and Video Features : Fundamentals of Motion Estimation – Optical flow - Pixel Video Features - colour, shape features, Textural features -Feature selection and Dimensionality Reduction.

Unit – 3	Introduction to Analytics	9 hrs

Introduction to Analytics : Big-Data - Descriptive data analysis - Analytic Processes and Tools - Regression – Classification - Clustering algorithms - Validation - Multimodal approach to Image and Video data mining - Probabilistic semantic mode - Model based annotation and video mining.

Unit – 4	Video Content Analysis and Analytics :	9 hrs

Video Content Analysis and Analytics : Introduction- Detecting Shot Boundaries in Video – Parsing a Video into Semantic Segments – Video Indexing and Abstraction for Retrievals – Affective Video Content Analysis – Automatic Video Trailer Generation - Video database - Video categorization - Video query categorization.

Unit –5	Emerging Trends	9 hrs

Emerging Trends : Object Segmentation and Tracking in the Presence of Complex Background – Video In painting –Video Summarization - Forensic video analysis.

Text Book:

1. Michael Berthold, David J.Hand, Intelligent Data Analysis, Springer, 2007.

Reference Books

1. Oges Marques, Practical Image and Video Processing Using MATLAB, Wiley-IEEEPress, 2011.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, CambridgeUniversity Press, 2012.

MSCS EL05	DATA VISUALIZATION TECHNIQUES	3	0	0	3

Course Outcome:

CO1: To develop skills to both design and critique visualizations.

CO2: To introduce visual perception and core skills for visual analysis.

CO3: To understand visualization for time-series, ranking, deviation, distribution, correlation,multivariate analysis.

CO4: To understand issues and best practices in information dashboard design.

UNIT I	INTRODUCTION	9 hrs

Core Skills for Visual Analysis: Information visualization – effective data analysis – traits of meaningful data – visual perception –making abstract data visible – building blocks of information visualization – analytical interaction – analytical navigation – optimal quantitative scales – reference lines and regions – trellises and crosstabs – multiple concurrent views – focus and context – details on demand – over-plotting reduction – analytical patterns – pattern examples.

UNIT II	KNOWLEDGE REPRESENTATION AND REASONING	9 hrs

Time-Series, Ranking, and Deviation Analysis: Time-series analysis – time-series patterns – time-series displays – time-series best practices – part-to-whole and ranking patterns – part-to- whole and ranking displays – best practices – deviation analysis – deviation analysis displays – deviation analysis best practices.

UNIT III	UNCERTAINTY	9 hrs

Distribution, Correlation, and Multivariate Analysis: Distribution analysis – describing distributions – distribution patterns – distribution displays – distribution analysis best practices – correlation analysis – describing correlations – correlation patterns – correlation displays – correlation analysis techniques and best practices – multivariate analysis – multivariate patterns – multivariate displays – multivariate analysis techniques and best practices.

UNIT IV	LEARNING	9 hrs

Information Dashboard Design: Information dashboard – Introduction– dashboard design issues and assessment of needs – Considerations for designing dashboard-visual perception – Achieving eloquence.

UNIT V	INTELLIGENCE AND APPLICATIONS	9 hrs

Information Dashboard Design: Advantages of Graphics _Library of Graphs – Designing Bullet Graphs – Designing Sparklines – Dashboard Display Media –Critical Design Practices – Putting it all togetherUnveiling the dashboard.

Text Book:

1. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.

References:

1. Edward R. Tufte, "The visual display of quantitative information", Second Edition, Graphics Press, 2001.
2. Evan Stubbs, "The value of business analytics: Identifying the path to profitability", Wiley, 2011.

3. Gert H. N. Laursen and Jesper Thorlund, "Business Analytics for Managers: Taking business intelligence beyond reporting", Wiley, 2010.

MSCS EL06	CYBER SECURITY	3	0	0	3

Course Outcomes:

CO1: To understand the principles of Data warehousing and Data Mining
CO2: To be familiar with the Data warehouse architecture and its Implementation
CO3: To know the Architecture of a Data Mining system
CO4: To understand the various Data preprocessing Methods
CO5: To perform classification and prediction of data

Unit – 1	COMPUTER SECURITY CONCEPTS	9 hrs

Definitions – Threats – Harm – Vulnerabilities – Unintentional (Non-Malicious) Programming – Malicious Code – Malware Countermeasures

Unit – 2	ELECTRONIC PAYMENTS AND SAFEGUARDS	9 hrs

Concept of E-payments – ATM and Tele Banking – Immediate Payment Systems – Mobile Money Transfer and E-Wallets – Unified Payment Interface – Cybercrimes in Electronic Payments – Precautions in Electronics Money Transfer – Precautions in Electronic Money Transfer – RBI Guidelines of Customer Protection in Unauthorized Banking Transactions – KYC: Concept, cases and safeguards

Unit – 3	CYBER CRIMES AND SAFETY	9 hrs

Introdution to cybercrimes – Kinds of Cybercrimes: Phishing – Identity Theft – Cyber Stalking – Cyber Terrorism – Cyber Obscenity – Computer Vandalism – Ransomware – Identity Theft Forgery – fraud from Mobile Devices

Unit – 4	INTRODUCTION TO SOCIAL NETWORKS	9 hrs

Social Network and its contents – Blogs – Safe and Proper use of Social Networks – Inappropriate Content on Social Networks – Flagging and Reporting of Inappropriate Content – Laws regarding posting of Inappropriate Content

Unit – 5	INTRODUCTION TO INFORMATION AND TECHNOLGOY ACT, 2000 (IT ACT) AND ITS USE IN CYBER SPACE	9 hrs

Concepts as defined in IT Act – Communication Device – Computer, Cyber Security, Data Security – Secure System – Online Gaming and its Risks – Basic Concepts of Blockchain and Cryptocurrency

Text Books:

1. W.A.Coklin, G.White, Principles of Computer Security: Fourth Edition, McGrawHill, 2016
2. William Stallings, Cryptography and Network Security Principles and Practices, Seventh Edition,Pearson

Reference Books:

1. Pfleeger, C.P., Security in Computing 5th Edition, Prentice Hall, Copyright 2010,
2. ISBN 0-13-239077-9
3. Schneier, Bruce. Applied Cryptography, Second Edition, John Wiley & Sons, 1996..

4. J Michael Stewart, "Network Security, Firewalls And Vpns", Jones and Bartlett Publishers, Inc; 2nd edition, 2013
5. Charlie Kaufman and Radia Perlman, "Network Security: Private Communication in a Public World", Prentice Hall, 2002

MSCS EL07	SOFT COMPUTING	3	0	0	3

Course Outcomes:

CO1: To provide a strong foundation of fundamental concepts in Artificial Intelligence.
CO2: To provide a basic exposition to the goals and methods of Artificial Intelligence.

UNIT I	Introduction to Soft Computing	9 Periods

Introduction: Introduction to soft computing - brief description of separate theories, Introduction to biological and artificial neural network, Classification algorithms- Decision Trees, Bayesian classifier - Neural Networks and Probabilistic Reasoning

UNIT II	Neural Networks	9 Periods

Neural Networks: Basic concepts of neural networks, Neural network architectures, Learning methods, Supervised and un- supervised learning, Architecture of a back-propagation network, Applications

UNIT III	Fuzzy Sets	9 Periods

Fuzzy Sets: Fundamentals of fuzzy sets and fuzzy logic theory, fuzzy inference principle, Examples of use of fuzzy logic in control of real-world systems

UNIT IV	Optimization	9 Periods

Optimization: Derivative-based Optimization – Descent Methods – The Method of Steepest Descent – Classical Newton's Method – Step Size Determination – Derivative-free Optimization – Genetic Algorithms –Simulated Annealing – Random Search Downhill SimplexSearch

UNIT V	Applications of Computational Intelligence	9 Periods

Applications of Computational Intelligence: AI Search Algorithm-Predicate calculus- rules of interface - Semantic networks – frames – objects - Hybrid models, Applications -Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Colour Recipe Prediction

Text Books:

1. Jang J.S.R.,Sun C.T and Mizutami E - Neuro Fuzzy and Soft ComputingPrentice hall,New Jersey,1998.
2. Munakata, T.: Fundamentals of the New Artificial Intelligence, Springer-Verlag NewYork, Inc.,1998.

References:

1. Goldberg, Introduction to Genetic Algorithms.
2. Jang, Nero-Fuzzy & Soft Computing, Pearsons.
3. Cordón, O., Herrera, F., Hoffman, F., Magdalena, L.: Genetic Fuzzy systems,World Scientific Publishing Co. Pte. Ltd., 2001.
4. Kecman, V.: Learning and Soft Computing, The MIT Press, 2001

MSCS EL08	**Swarm Intelligence**	**3**	**0**	**0**	**3**

Course Outcomes:

CO1: An overview of algorithms that can be used for autonomous design and adaptation ofintelligent systems.

CO2: Insight in biologically inspired as well as traditional machine learning methods for search,optimization and classification.

CO3: An overview of the benefits and drawbacks of the various methods.

CO4: Knowledge of using the methods for real-world applications.

Unit – 1	**Introduction to Swarm Intelligence**	**9 hrs**

Introduction to Swarm Intelligence – Essence of an Algorithm, Algorithms and Self –Organization, Links between Algorithms and Self-Organization, Characteristics of Metaheuristics; Swarm Intelligence based algorithms – Ant Algorithms; Bee Algorithms; Particle Swarm Optimization and Krill Herd Algorithms; Strategies for state space search in AI-Depth First and Breadth First Search Heuristic Search- Best First Search and Hill Climbing.

Unit – 2	**Ant Colony Optimization**	**9 hrs**

Ant Colony Optimization (ACO) - Theoretical Considerations, Combinatorial optimization and meta heuristic, Stigmergy, Convergence Proofs, ACO Algorithm, ACO and Model Based Search, Variations Of ACO: Elitist Ant System (EAS), Minmax Ant System (MMAS) and Rank Based Ant Colony System (RANKAS), ACO Algorithm for Travelling Sales Person problem, ACO algorithm for feature selection.

Unit – 3	**Particle Swarm Optimization**	**9 hrs**

Particle Swarm Optimization: Principles of Bird Flocking and Fish Schooling, Evolution of PSO, Operating Principles, PSO Algorithm, Neighbourhood Topologies, Convergence Criteria, Variations of PSO.Behaviour.

Unit – 4	**Artificial Bee Colony (ABC) Optimization**	**9 hrs**

Artificial Bee Colony (ABC) Optimization - Behaviour of real bees, ABC Algorithm, Variations of ABC: Abcgbest and Abcgbestdist, Case Study: Application of ABC algorithm in solving Travelling Salesman Problem, Knapsack Problem and for feature selection.		
Unit –5	**Krill Herd Optimization**	**9 hrs**
Krill Herd Optimization - Herding Behaviour of Krill Swarms, Lagrangian Model of Krill Herding, Methodology, Application of Krill Herd Algorithm in Feature Selection.		

Text Book:

1. Xin-She Yang, Zhihua Cui, Renbin Xiao, Amir Hossein Gandomi, Mehmet Karamanoglu, "Swarm Intelligence and Bio-Inspired Computation, Theory and Applications", Elsevier 2013.
2. Marco Dorigo and Thomas Stutzle, "Ant Colony Optimization", MIT Press, Cambridge, England, 2004.

Reference Books:

1. Ben Coppin, "Artificial Intelligence Illuminated", Jones and Bartlett Publishers, 2004.
2. Kennedy J and Russel C Eberhart, "Swarm Intelligence", Morgan Kaufmann Publishers, USA, 2001.
3.Dervis Karaboga, Bahriye Akay," A comparative study of Artificial Bee Colony Algorithm" Applied Mathematics and Computation 214, Elsevier Publications, 2009.