MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

MANIPAL UNIVERSITY JAIPUR

Department of Computer Science and Engineering

B Tech (Hons) Computer Science and Engineering with specialization in Artificial Intelligence & Machine Learning

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	EO2001	Economics	3	0	0	3	BB0025	Value, Ethics and Governance	2	0	0	2
	MA2101	Engineering Mathematics - III	3	0	0	3	MA2201	Engineering Mathematics - IV	3	0	0	3
	AI2101	Relational Database Management Systems	3	1	0	4	AI2201	Software Engineering & Project Management	3	1	0	4
	AI2102	Computer Organization and Architecture	3	1	0	4	AI2202	Operating Systems	3	1	0	4
	AI2103	Data Structures and Algorithms	3	1	0	4	AI2203	Principles of Artificial Intelligence	3	1	0	4
	AI2104	Object Oriented Programming	3	1	0	4	AI2204	Automata Theory	3	0	0	3
	AI2130	Relational Database Management Systems Lab	0	0	2	1	*** ***	Open Elective - I	3	0	0	3
	AI2131	Data Structures and Algorithms Lab	0	0	2	1	AI2230	Operating System Lab	0	0	2	1
	AI2132	Object Oriented Programming Lab using Python	0	0	2	1	AI2231	Web Technology Lab	0	0	2	1
	AI2170	Project Based Learning – I	0	0	2	2	AI2232	Principles of Artificial Intelligence Lab	0	0	2	1
							AI2270	Project Based Learning - II	0	0	2	2
		Total	**18**	**4**	**8**	**27**		**Total**	**20**	**3**	**8**	**28**
III	**FIFTH SEMESTER**						**SIXTH SEMESTER**					
	AI3101	Soft Computing Methods	3	1	0	4	BB0026	Organization and Management	3	0	0	3
	AI3102	Design and Analysis of Algorithms	3	1	0	4	AI3201	Machine Learning	3	1	0	4
	AI3103	Computer Networks	3	1	0	4	AI3202	Computer Vision and Pattern Recognition	3	1	0	4
	AI3104	Foundation of Data Science	3	1	0	4	AI3204	Natural Language Processing	3	1	0	4
	AI3105	Game Theory	3	1	0	4	AI32XX	Program Elective - I	3	0	0	3
	******	Open Elective - II	3	0	0	3	*** ****	Open Elective - III	3	0	0	3
	AI3130	Design and Analysis of Algorithm Lab	0	0	2	1	AI3230	Machine Learning Lab	0	0	2	1
	AI3131	Computer Networks Lab	0	0	2	1	AI3231	Computer Vision and Pattern Recognition Lab	0	0	2	1
	AI3132	Foundation of Data Science Lab	0	0	2	1	AI3270	Minor Project (Thematic projects)	0	0	6	3
	AI3170	Project Based Learning - III	0	0	2	2						
		Total	**18**	**5**	**8**	**28**		**Total**	**18**	**3**	**10**	**26**

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	SEVENTH SEMESTER						EIGHTH SEMESTER					
IV	AI4101	Deep Learning	3	1	0	4	AI4270	Major Project	-	-	-	12
	AI4102	Text Mining	3	1	0	4						
	AI4103	Recommender Systems	3	1	0	4						
	AI41XX	Program Elective - II	3	0	0	3						
	AI41XX	Program Elective - III	3	0	0	3						
	AI41XX	Program Elective - IV	3	0	0	3						
	AI4170	Industrial Training	0	0	2	1						
		Total	**18**	**3**	**2**	**22**		**Total**	**0**	**0**	**0**	**12**

3rd Year Programme Electives (PE-I)	**Programme Electives (PE-II, PE-III, PE-IV)**	**Open Electives (OE)**
AI3240: Machine Learning Applications in IOT AI3241: Reinforcement Learning AI3242: Data Mining AI3243: Compiler Construction	AI4140: Information Retrieval AI4141: Augmented & Virtual Reality AI4142: Speech Synthesis & Recognition AI4143: Artificial Intelligence in Healthcare AI4144: Social Network Analysis AI4145: AI For Cyber Security AI4146: Big Data Analytics AI4147: Data Privacy & Security AI4148: Image & Video Analytics	AI0001: Introduction to Artificial Intelligence AI0051: C For Everyone AI0052: Cybersecurity Fundamentals

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SYLLABUS

SEMESTER III

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; **Microeconomics:** Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; **Production**: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; **Cost and revenue analysis:** Cost concepts, short run and long- run cost curves, TR,AR,MR; **Various market situations:** Characteristics and types, Break-even analysis; **Macro Economics:** National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e) S. Chand Publication,2012.
2. H C Peterson et.al., *Managerial Economics*, (9e), Pearson, 2012
3. P L Mehta, *Managerial Economics*, Sultan Chand & Sons, New Delhi, 2012.
4. G J Tuesen and H G Tuesen, *Engineering Economics*, PHI, New Delhi, 2008.
5. J. L. Riggs, D. D. Bedworth and S. U. Randhawa, *Engineering Economics*, Tata McGraw Hill, 2018.

MA2101: ENGINEERING MATHEMATICS III [2 1 0 3]

Boolean Algebra: Partial ordering relations, Poset, Lattices, Basic Properties of Lattices. Distributive and complemented lattices, Boolean lattices, and Boolean Algebra. Propositional and **Predicate Calculus:** Well-formed formula, connectives, quantifications, Inference theory of propositional and predicate calculus. **Elementary configuration:** Permutations and Combinations, Generating function, Principle of inclusion and exclusion Partitions, compositions. **Ordering of permutations:** Lexicographical and Fikes. **Graph theory:** Basic definitions, Degree, regular graphs, Eulerian and Hamiltonian graphs, Trees and Properties, Center, radius and diameter of a graph, Rooted and binary trees, Matrices associated with graphs, Algorithms for finding shortest path, Algorithm. **Group theory:** Semi groups, Monoids, Groups subgroups, Normal Subgroups, Cosets, Lagrange's Theorem, Cyclic groups.

References:

1. C. L. Liu, *Elements of Discrete Mathematics, (2e)*, Mc Graw Hill, New Delhi, 2007.
2. J. P. Trembaly and R. Manohar, *Discrete Mathematics Structures with application to computer science*, Tata Mc Graw Hill, 2012.
3. E. S. Page and L. B. Wilson, *An Introduction to Computational Combinatorics*, Cambridge Univ. Press, 1979.
4. N. Deo, *Graph theory with Applications to computer science*, PHI, 2012

AI2101: RELATIONAL DATABASE MANAGEMENT SYSTEMS [3 1 0 4]

Introduction: DBMS Concepts, Database System Vs File System, Data Models, Schema & Instance, Schema architecture, Data independence, Data Base Languages and interfaces, Database system applications, Database users, Functions of DBA. **Data Modeling using the Entity Relationship Model:** ER model concepts, Entities, Attributes, Relationship & types, Relationship Constraints, Extended ER-Model Concept - Generalization, Specialization and Aggregation, Transforming ER diagram into the tables. **Relational Data models:** Domains, Tuples, Attributes, Relations, Characteristics of relations, Keys, Key attributes of relation, Relational database, Schemas, Integrity constraints. Referential

integrity, Relational Algebra and Relational Calculus, Relational algebra operators – Unary, Binary, Set Operations. Tuple oriented and domain oriented relational calculus and its operations **SQL:** Basic SQL Query, Creating Table and Views, SQL as DML, DDL and DCL, SQL Algebraic Operations, Joins, Sub-Queries, Aggregate Operations, Cursors, Dynamic SQL, Integrity Constraints in SQL, Triggers **Data Base Design:** Introduction to Normalization, Functional dependency, Normal forms, Decomposition, Armstrong's Axioms, Canonical Cover, Lossless Join & Dependency preservation Problems with null valued and dangling tuples, multivalued dependencies. **Transaction Processing Concepts:** Transaction Properties & States, Schedules, Serial & Concurrent Schedule, Serializability of schedules, conflict & view serializable schedule, Recoverability, Recovery from transaction failures, log-based recovery, checkpoints, Deadlock handling. **Concurrency Control Techniques:** Concurrency control, Concept of Locks, Concurrency Control Protocols - Two Phase Locking Protocols, Time stamping protocols, validation-based protocol, multiple granularities, Multi version schemes, Recovery with concurrent transactions. **File Structures:** File Organization, Indexing, Primary, Clustered, Secondary Indexes, Hashing, Multilevel Indexing with B-Tree, B+ Tree

References:

1. H. F. Korth, S. Sudarshan and A. Silverschatz, *Database System Concepts*, (6e), TMH, New Delhi, 2017.
2. R. Elmasri and S. Navathe, *Fundamentals of Database systems*, (7e), Pearson Education, 2017.
3. C. J. Date, *Database Systems*, (8e), Prentice Hall of India, New Delhi, 2012

AI2102: COMPUTER ORGANIZATION & ARCHITECTURE [3 1 0 4]

Basic Structure of Computers: Computer Types, Functional Units, Basic Operational Concepts, Number Representation and Arithmetic Operations, Performance, Historical Perspective. **Instruction Set Architecture:** Memory Locations and Addresses, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Encoding of Machine Instructions. **Arithmetic:** Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating Point Numbers and Operations. **Memory Hierarchy:** Basics of Caches, Measuring and Improving Cache Performance. **Pipelining:** Overview, Pipelined Datapath, Pipelined Control, Data Hazards and Forwarding, Data Hazards and Stalls, Branch Hazards. **Multicores, Multiprocessors and Clusters:** Shared Memory Multiprocessors, Clusters and other Message-Passing Multiprocessors, Hardware Multithreading, SISD, MIMD, SIMD, SPMD and Vector Processors.

References:

1. C. Hamacher, Z. Vranesic and S. Zaky, *Computer Organization and Embedded Systems*, (6e), McGraw Hill, 2017.
2. D. A. Patterson and J. L. Hennessy, *Computer Organization and Design: The Hardware and Software Interface*, (6e), Morgan Kaufmann Publishers, 2020.
3. J. P. Hayes, *Computer Architecture and Organization*, (3e), McGraw Hill, 2012

AI2103: DATA STRUCTURES & ALGORITHMS [3 1 0 4]

Introduction: algorithm specification; Performance analysis: time and space complexity, asymptotic notation; C concepts: pointers, functions, arrays, passing arrays to functions through pointers, dynamic memory allocation, **sorting:** bubble sort , insertion sort , selection sort, structures, arrays of structures, passing structures to functions; **List:** ADT, array and its types, implementation, operations, linked list and its types, implementation and operations; **Stack:** ADT, implementations using array and linked list, operations and its applications; **Queue:** ADT, implementations using array and linked list, operations and its applications; **Tree:** terminologies, different types, representation of binary tree using array and linked structure, binary search tree, different operations (recursive and non-recursive), heap, heap sort, priority queue, AVL trees, B-tree; Graph: Introduction, representation, operations and applications; Searching techniques and hashing

References:

1. Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein, *Data Structures using* C, Pearson Education, 2013.
2. M. Tenenbaum et al., *Data Structures using C*, (1e), Pearson Education, 2019
3. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, *Fundamentals of Data Structures in C*, University Press (India) Pvt. Ltd., 2014
4. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, *Data Structures and Algorithms*, Pearson Education, 2012.
5. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to algorithms*, PHI, Third Edition, 2009.
6. Seymour Lipschutz,*Data Structures with C* (Schaum's Outline Series), McGraw Hill Education Private Limited, 2011.
7. Mark Allen Weiss, Data structures and Algorithm Analysis in C, Pearson, Second edition, 2014.

AI2104: OBJECT ORIENTED PROGRAMMING [3 1 0 4]

Introduction: Programming a computer, Programming languages; **Python basics**: Getting started with Python, Essentials of a Python program; Integers, Floating-point numbers, Strings**; Variables and scope** :Variables, Modifying values, Type conversion; **Selection control statements**: Selection: if statement, Boolean values, operators and expressions; **Collections**: Lists, Tuples, Sets, Ranges, Dictionaries, Conversion, Sequences; **Loop control statements**: while, for statements, Nested loops, Iterables, iterators and generators, Comprehensions, The break and continue statements **Functions**: Input parameters, Return values, Default parameters,*args and **kwargs, Decoratorss, Lambdas. Generator functions and yield; **Object-Oriented programming:** OOP's Concepts**,** Classes: Defining and using a class, Instance attributes, Class attributes, Class decorators, inspecting an object, **Constructor, Abstraction,** Composition, Inheritance; Types of inheritance, overriding magic methods**; I/O and Errors Handling:** Errors, exceptions, Handling exceptions, Debugging programs, Logging**, Testing Packaging:** Modules, Packages, Documentation, **File Handling:** Introduction, Access Methods, Read and write operation, Working with directories. **Python Libraries:** Pandas, Matplotlib, NUMPY, Introduction to GUI programming with Tkinter.

References:

1. D. Phillips, *Python 3 Object-Oriented Programming Build robust and maintainable software with object-oriented design patterns in Python 3.8*, (3e), Packt Publishing, January 2018
2. W. J. Chun, *Core Python Applications Programming*, (3e), Prentice Hall Publishers, 2012
3. J. Grus, *Data Science from Scratch: First Principles with Python*, (1e), O'Reilly Media, 2015

AI2130: RELATIONAL DATABASE MANAGEMENT SYSTEMS LAB [0 0 2 1]

Introduction to SQL and its different command categories i.e., DDL, DML, DQL and DCL, Data Integrity Constraints and Built-in Functions, Design and implementing the data requirements of a simple DB application, Experiments on views, indexing, triggers, stored procedures, transaction.

References:

1. I. Bayross, *Teach yourself SQL & PL/SQL using Oracle 8i & 9i with SQLJ,*(3e), BPB Publications, 2010.
2. A. Silberschatz et al., *Database System Concepts*, (6e), McGraw Hill, 2013
3. R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*, (7e), Addison-Wesley, 2017

AI2131: DATA STRUCTURES & ALGORITHMS LAB [0 0 2 1]

One Dimensional Arrays and Two Dimensional Arrays: Static and Dynamic Allocation, Passing of Arrays to Functions, Stack implementation using Array, Using Structures and Pointers, Programs on Evaluation of Expressions in Infix, Prefix and Postfix Notations, Programs on Conversion from One Notation to Other**,** Implementation Linear Queue, Circular Queue, Priority Queue using Array, Using Structures and Pointers **,**Tower of Hanoi, GCD, Fibonacci Definition, Binary Search, Prefix to Postfix etc. **,** Implementation of Singly, Doubly and Circular Linked Lists Using Pointers, Polynomial Addition, Sparse

Matrices etc., Implementation of Binary Search Tree through Arrays and Pointers, Tree Traversals, Various Operations on Binary Search Tree, Huffman Algorithm, Josephus Problem etc, Implementation through Arrays and Pointers, Transitive Closure and Searching and Sorting algorithms

References:

1. E. Horowitz et al., *Fundamentals of Data Structures in C*, University Press (India) Pvt. Ltd.,2014
2. M. Tenenbaum et al., *Data Structures using C*, (1e), Pearson Education, 2019
3. V. Aho et al., (1e), *Data Structures and Algorithms*, Pearson, 2012
4. T. H. Cormen et al., *Introduction to algorithms*, (3e), PHI, 2010 .
5. S. Lipschutz, *Data Structures with C (Schaum's Outline Series)*, (1e),Tata McGraw Hill Education Private Limited, 2011

AI2132: OBJECT ORIENTED PROGRAMMING USING PYTHON LAB [0 0 2 1]

Simple Python programs using control structures and Arrays, Programs using Classes, objects, methods, Programs on Constructors and static members, Programs using Inheritance, Packages, Interfaces and Generics, Programs using Exceptions and Multithreading, GUI based programs using various Python concepts.

References:

1. D. Phillips*, Python 3 Object-Oriented Programming Build robust and maintainable software with object-oriented design patterns in Python 3.8*, (3e), Packt Publishing, January 2018
2. N. R. Ceder, The Quick Python Book, (2e), Manning Publications Co., 2013

SEMESTER IV

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case Studies*. **Governance:** Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. **Private Sector Governance:** Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. **Projects on PPP mode-relevance & prospects. CSR:** Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive **Case Studies:** Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. B.N. Ghosh, *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. S.K. Mandal, *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. C.K. Ray, *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. A. Chatterjee, *Professional Ethics* (3e), Oxford Publications, 2014.

MA2201: ENGINEERING MATHEMATICS IV [3 0 0 3]

Basic Set theory: Axioms of probability, Sample space, conditional probability, total probability theorem, Baye's theorem. One dimensional and two-dimensional random variables mean and variance, properties, Chebyschev's inequality, correlation coefficient, Distributions, Binomial, Poisson, Normal and Chisquare. **Functions of random variables:** One dimensional and Two-dimensional, F & T distributions, Moment generating functions, Sampling theory, Central limit theorem, Point estimation, MLE, Interval estimation, **Test of Hypothesis:** significance level, certain best tests; Chi square test.

References:

1. P. L. Meyer, *Introduction to probability and Statistical Applications*, (2e), Oxford and IBH publishing, 1980.
2. Miller, Freund and Johnson, *Probability and Statistics for Engineers*, (8e), PHI, 2011.
3. Hogg and Craig, *Introduction to mathematical statistics*, (6e), Pearson education, 2012.
4. S. M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Elseveir, 2010.

AI2201: SOFTWARE ENGINEERING & PROJECT MANAGEMENT [3 1 0 4]

Software Engineering – importance – emergence - Phases of software development - Feasibility study. Phases and Life cycle models of Software Development Requirement Analysis, Design, Implementation, Testing, and Maintenance phases Different Software Life Cycle Models - Classical waterfall, Iterative, prototyping, Spiral, and Agile - Compare Life cycle models **Requirements Analysis and Design** Requirement Analysis – Analysis process, Requirements specification, desirable characteristics of an SRS, structure of an SRS document, Data Flow Diagrams - Role of Software Architecture and Architecture **Software Design** - Software design concepts - Function Oriented Design and its Complexity Metrics -Object Oriented Design and its Complexity Metrics - Detailed Design. Software Implementation and Testing Software Coding - Programming principles and coding guidelines - method of incrementally developing code - managing the evolving code **Testing** - Unit testing and Code Inspection - Testing concepts and testing process - Design of Test case and Test plan - Black-box testing - White box testing **Software Project Managemen**t Software Project Management Framework - methods to estimate project time and cost, Resource. Planning for a Software Project. Management, Identification, Analysis, mitigation, and monitoring of Project Risks - Ensuring Project Quality and quality management, Configuration Management, Change management, CMMI, Quality standards -ISO.

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References:

1. B. Hughes et al., *Software Project Management*, (6e), McGraw Hill, 2017
2. P Jalote., *Software Project Management in Practice* (1e), Addison Wesley Professional,2010.
3. R. S. Pressman*, Software Engineering: A practitioner's approach*, (8e), McGraw Hill, 2014
4. S. A. Kelkar, *Software Project Management: a concise study*, (3e), PHI Learning-New Delhi, 2013
5. S. H. Kan, *Metrics and Models in Software Quality Engineering*, (2e), Pearson, 2010.

AI2202: OPERATING SYSTEMS [3 1 0 4]

Introduction: Definition of operating systems, Single and multi-processor systems, Operating system services, System commands and system calls, Interrupt, System boot, Operating system structure, Types of OS, Multi-user, Multitasking, Embedded, Real-time, Network, Distributed. **Process and Thread:** Process concept, Operations on processes, Inter-process communication, UNIX pipes, Multithreading, Multithreaded models, Programs using PThread. **Process Scheduling:** Basic concepts, Scheduling criteria, Scheduling algorithms. **Synchronization:** Critical section problem, Dekker's algorithm, Peterson solution, Synchronization hardware, Semaphores, Classical problems of synchronization, Deadlock, Methods for handling deadlock- prevention, avoidance, detection, and recovery. **Memory Management**: Address binding, Logical vs Physical address space, Swapping, Contiguous memory allocation, Paging, Structure of Page Table, Segmentation, Demand Paging, Page Replacement Policies, Allocation of Frames, Thrashing. **File System Interface and Implementation:** File Concept, Access Methods, Directory and Disk Structure, File System Mounting, File System Structure, File System Implementation, Allocation Methods, Free Space Management**. Disk Management:** Disk Scheduling Algorithms, Disk Management, Swap Space Management. **Case Studies:** Linux, Windows, iOS, Android.

References:

1. A. Silberschatz, et al., *Operating System Concepts*, (9e), Wiley, 2018
2. A.S. Tanenbaum and H. Bos, *Modern Operating Systems*, (4e), Pearson, 2015
3. W. Stallings, *Operating Systems: Internals and Design Principles*, (9e), Pearson, 2018

AI2203: PRINCIPLES OF ARTIFICIAL INTELLIGENCE [3 1 0 4]

Overview: Foundations, scope, problems, and approaches of AI; **Intelligent agents**: Reactive, deliberative, goal- driven, utility-driven, and learning agents; Artificial Intelligence programming techniques; **Problem-solving through Search**: Forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications; **Knowledge Representation and Reasoning**: Ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications; **Planning**: Planning as search, partial order planning, construction and use of planning graphs; **Representing and Reasoning with Uncertain Knowledge**: probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference, sample applications; **Decision-Making**: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications; **Machine Learning and Knowledge Acquisition**: learning from memorization, examples, explanation, and exploration. learning nearest neighbour, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications. Sample Applications of AI, student project presentations.

References:

1. S. Russell and P. Norvig, *Artificial Intelligence A Modern Approach*, (4e), Pearson 2020
2. E. Rich et al., *Artificial Intelligence*, (3e), Tata McGraw Hill, 2017
3. G. Antoniou et al., *A Semantic Web Primer*, MIT Press, 2012

AI2204: AUTOMATA THEORY [3 0 0 3]

Mathematical Preliminaries and Notation: Review of set theory, function, relation; **Finite Automata**: Deterministic Finite Automata, Design of DFA, Non Deterministic Finite Automata, Equivalence of DFA and NDFA, Reduction of the number of states in Finite Automata Regular languages; **FA with output**: Mealy and Moore machine and equivalence; **Regular Sets and Regular Grammars**: Grammar and Formal Languages, Chomsky Hierarchy, Regular Expressions, Regular Expressions and Finite Automata, Regular Grammar and Finite Automata, Properties of Regular Languages, Identifying Non-Regular Languages, Pumping Lemma for Regular Languages; **Context Free Languages and Grammars**: Derivation tree, Ambiguity, Methods for Transforming Grammars – Reduced grammar formation, null production removal, unit production removal, Chomsky Normal Form, Greibach Normal Form, Pumping lemma for CFL; **Push Down Automata**: Nondeterministic Pushdown Automata, Design of NPDA, Pushdown Automata and Context–Free Languages, Conversion between PDA and CFG, Deterministic Pushdown Automata, Deterministic Context-Free Languages; **Turing Machine and Linear Bounded Automata**: The Standard Turing Machine and variants of Turing Machine, Solving Some Problems by using Turing Machine, Problems that cannot be solved by Turing Machine, Linear Bounded Automata, Recursive and Recursively Enumerable Languages, Unrestricted Grammars, Context Sensitive Grammars and Languages.

References:

1. P. Linz*, An Introduction to Formal Languages and Automata*, (6e), Jones & Bartlett Learning, 2016
2. J. C Martin, *Introduction to Languages and the Theory of Computation*, (3e), McGraw Hill, 2010
3. M. Sipser, *Introduction to the Theory of Computation*, (3e), Cengage Learning, 2014

AI2230: OPERATING SYSTEMS LAB [0 0 2 1]

Basic Linux commands: Illustration of shell functions, wild cards, redirection, pipes, sequencing, grouping, background processing, command substitution, sub shells, Shell programming. **System Calls:** File and process, I/O Redirection, IPC using Pipe and Signals. **PThread API:** Multithreaded programs, Synchronization programs using PThreads and Semaphores, CPU Scheduling, Deadlock, Memory Management. **Creating a Virtual Machine:** Virtual Machine Files and Snapshots, Virtual Machine Cloning and Exporting.

References:

1. W. R. Stevens and S. A. Rago, *Advanced Programming in the UNIX Environment*, (3e), Addison-Wesley, 2017.
2. S. Das, *Unix Concepts and Applications*, (4e), McGraw Hill, 2017

3. K. A. Robbins and S. Robbins, *Unix Systems Programming: Communication, Concurrency, and Threads*, (2e), Prentice Hall, 2015

AI2231: WEB TECHNOLOGY LAB [0 0 2 1]

Introduction: HTML, XHTML, Java Script, Introduction to Python web Programming, Advanced Python programming concepts that include applications involving connection to databases; CGI Programming with Python; JSON and JQuery; NodeJS for client-side programming; Angular JS for server-side programming; mini project. Web/Database/XML application in python and Django web application framework.

References:

1. S. Dauzon, A. Bendoraitis and A. Ravindran,*Django: Web Development with Python,* (1e), Packt Publishing, 2016
2. H. M Deitel et al., *Internet & World Wide Web How to Program*, (5e), Pearson Education, 2011
3. C. Bates, *Web Programming: Building Internet Application*, (3e), Wiley India, 2012
4. W. J. Chun, *Core Python Applications Programming*, (3e), Prentice Hall Publishers, 2012
5. R. Connolly and R.Hoar, *Fundamentals of Web Development*, (1e), Pearson Education India, 2015.

AI2233: PRINCIPLES OF ARTIFICIAL INTELLIGENCE LAB [0 0 2 1]

Installation of gnu-prolog, Study of Prolog (gnu-prolog), its facts, and rules. Write simple facts for the statements and querying it. Write a program for Family-tree. Write Program for Monkey-banana Problem. Write a program which behaves a small expert for medical Diagnosis. Write programs for computation of recursive functions like factorial Fibonacci numbers, etc. Write program to solve 5-queens problem. Write a Program for water jug problem. Write a program for travelling salesman program. Case study of standard AI programs like Mycin and AI Shell

References:

1 . E. Rich et al., *Artificial Intelligence*, (3e), Tata McGraw Hill, 2017
2. S. Russell and P. Norvig, *Artificial Intelligence A Modern Approach*, (4e), Pearson 2020

SEMESTER V

AI3101: SOFT COMPUTING METHODS [3 1 0 4]

Introduction to Soft Computing: Concept of Computing Systems, Soft Computing Versus Hard Computing, Characteristics of Soft Computing, Some Applications of Soft Computing Techniques; Fuzzy Logic**; Introduction to Fuzzy Logic**: Fuzzy Sets and Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Rules, Propositions, Implications and Inferences, Defuzzification Techniques Fuzzy Logic Controller Design, Some Applications of Fuzzy Logic; **Artificial Neural Networks**: Biological Neurons and Its Working, Simulation of Biological Neurons to Problem Solving, Different ANNs Architectures, Training Techniques for ANNs, Applications of ANNs to Solve Some Real Life Problems; **Nature Inspired Algorithms**: Genetic Algorithms, Concept of Genetics and Evolution and its Application to Probabilistic Search Techniques, Basic GA Framework and Different GA Architectures, GA Operators-Encoding, Crossover, Selection, Mutation, etc., Solving Single-Objective Optimization Problems Using GAs, Particle Swarm Optimization- Implementation, Operators, Case Studies, Ant Bee Colony Optimization- Implementation, Operators, Case Studies.

References:

1. F. Martin et al., *Fuzzy Logic: A Practical approach*, (1e), AP Professional, 2014.
2. T J. Ross, *Fuzzy Logic with Engineering Applications*, (4e), Willey India, 2016.
3. S. Rajasekaran and G.A.V Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis, and Applications*, (1e), Prentice Hall India, 2011
4. S. Haykin, *Neural Networks and Learning Machines*, (3e), PHI Learning, 2011

AI3102: DESIGN & ANALYSIS OF ALGORITHMS [3 1 0 4]

Introduction: Algorithm Definition and Criteria of Algorithms, Iterative and Recursive algorithms, Performance Analysis: Priori and Posteriori Analysis, Asymptotic Notations, Space Complexity, Time Complexity, Performance measurement of iterative and recursive algorithms, Solving Recurrence Relations: Substitution Method, Iterative Method, Recursive Tree Method, Master Method, , **Divide and Conquer:** Introduction, Binary Search, Finding Maximum and Minimum, Merge Sort, Quick Sort, Randomized Quick Sort, Closest Pair of Points, Integer Multiplication, Fast Fourier Transforms **Graph Search Algorithm:** Graph representation, Breadth First Search and Depth First Search, **Greedy Strategy: I**ntroduction, Knapsack Problem, Job Sequencing with Deadlines, Huffman Coding, Union and Find Operation (Set and Disjoint Set), Minimum Cost Spanning Tree Algorithms (Prim's and Kruskal's), Optimal Merge Patterns, Single Source Shortest Path (Dijkstra's Algorithm), **Dynamic Programming:** Introduction, Single Source Shortest Path (Bellman and Ford Algorithm), All Pair Shortest Path (Floyd Wrashal's Algorithm), Optimal Binary Search Trees, 0/1 Knapsack Problem, Travelling Salesperson Problem, Longest Common Subsequence, Matrix Chain Multiplication, Edit distance, Viterbi algorithm **Backtracking:** Introduction, N-Queens Problem, Graph Colouring and Hamiltonian Cycles, **Branch and Bound:** Introduction, FIFO and LC Branch and Bound, 0/1 Knapsack Problem, Travelling Salesman Problem, String Matching: Naïve String Matching, Rabin Karp Algorithm, Knuth-Morris-Pratt Algorithm, Boyer- Moore Algorithm, **Complexity Classes:** NP, NP-Complete and NP-Hard Problems, Polynomial time reductions, Satisfiability, Reduction from Satisfiability to Vertex Cover, Cook's Theorem.

References:

1. E. Horowitz et al., *Fundamental of Computer Algorithms*, (2e), Universities Press, 2008.
2. T. H. Cormen et al., *Introduction to Algorithms*, (3e), MIT press, 2010.
3. T. Roughgarden, *Algorithms Illuminated (Part 2): Graph Algorithms and Data Structures (1e),*Wiley, 2018

AI3103: COMPUTER NETWORKS [3 1 0 4]

Introduction to Computer Networking Concepts: Layered Network Protocol Architectures OSI and TCP; Personal, Local, Metropolitan and Wide Area Networks; Telecommunications and Cellular Networks overview; **Physical Layer**: Data Transmission: Concepts and Terminology, Analog and Digital Data Transmission & capacity; **Transmission Media**: Guided and Wireless Transmission, Wireless Propagation, Line-of-Sight Transmission. Signal Encoding Techniques: Analog and Digital Signals; **Digital-To-Digital Conversion**: Line Coding Schemes, Block Coding, Scrambling, Analog-To- Digital Conversion: Pulse Code Modulation, Delta Modulation; **Data Link Layer and Logical Link Control (LLC) sub-layer**: Framing: Reliable transmission and Automatic Repeat Request (ARQ), Go-back-N, Selective Repeat. Performance analysis of ARQ protocols. Example protocols such as HDLC and PPP; **Medium Access Control (MAC) sub-layer**: Shared media systems: Bus, Star and Ring topologies; TDMA, FDMA, CSMA, CSMA/CD, Ethernet, CSMA/CA protocols; Shared and Switched Ethernet; Related protocols such as ICMP, NAT, ARP and RARP; **Network Layer**: Internet Protocol (IP) suite; IPv4 and IPv6 addressing and headers; Routing protocols including distance-vector and link-state approaches**; Transport Layer**: Reliable end-to-end transmission protocols; UDP header; Details of TCP header and operation including options headers and congestion control; **Application Layer:** Socket Interface and Socket programming; Example protocols such as DNS, SMTP, FTP, and HTTP.

References:

1. J.F. Kurose and K.W. Ross, *Computer Networking - A top-down approach*, (7e), Pearson, 2017.
2. A. S. Tanenbaum, *Computer Networks*, (5e), Pearson Education India, 2013.
3. W. Stallings, *Data & Computer Communications* (9e), Pearson Education Inc., Noida, 2017.
4. L. L. Peterson and B.S. Davie, *Computer Networks- A Systems approach*, (5e), Elsevier, 2016
5. B. A. Forouzan and F.Mosharraf, *Computer Networks A Top-Down Approach*, Mc-Graw Hill, 2017

AI3104: FOUNDATIONS OF DATA SCIENCE [3 1 0 4]

Introduction: Elements of Structured Data, Rectangular Data, Estimates of Location, Estimates of Variability, Exploring the Data Distribution, Exploring Binary and Categorical Data, Correlation, Exploring Two or More Variables; **Data and Sampling Distributions**: Random Sampling and Sample Bias, Selection Bias, Sampling Distribution, Bootstrap, Confidence Intervals; **Statistical Experiments and**

Significance Testing: A/B Testing, Hypothesis Tests, Resampling, Statistical Significance and p-Values, ANOVA, Chi-Square Test, **Classification**: Discriminant Analysis, Covariance Matrix, Fisher's Linear Discriminant, Evaluating Classification Models - Confusion Matrix, Rare Class Problem, Precision, Recall, and Specificity, ROC Curve, AUC. **Analysis and Visualization**: Descriptive, inferential statistics, uni-variate, and multivariate analysis. **Grouping:** Cluster Analysis- distance measures, partitioning, hierarchical, density-based methods. Market Basket Analysis, Association Analysis, Market Basket Analysis

References:

1. P. Bruce *et al*., *Practical Statistics for Data Scientists*, (2e), O'Reilly Media, Inc., May 2020
2. G.J. Myatt, *et al.*, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2019.
3. C. Douglas and C. George, *Applied Statistics and Probability for Engineers*, John Wiley and Sons, 2010.

AI3105:GAME THEORY [3 1 0 4]

Introduction: Games and decisions, Games Strategies, Costs and Payoff, Basic Solution Concepts, finding equilibria and Learning in Games. **Zero-sum games:** secure strategy, Maximin, Maximax, and Minimax Regret Solvability, value of a game. **Normal form games:** dominance, iterated dominance, Nash equilibrium. N-player games, mixed strategy nash equilibria. **Graphical Games:** Computing Nash equilibria in Tree Graphical Games, Graphical Games and correlated Equilibria. **Extensive form games:** subgame perfection, sequential equilibrium, Stackelberg Model of Duopoly, Buying Votes, Committee Decision-Making. **Bargaining:** Rubinstein bargaining, Nash bargaining. Repeated games: Folk theorem and repeated prisoner's dilemma. Tacit collusion. **Incomplete information games:** Bayesian equilibrium, higher order beliefs. **Auctions and mechanism design:** Basic auctions, voting, Vickrey-Clarke-Groves Auction.

References:

1. M. J. Osborne and A. Rubinstein *A Course in Game Theory (1e),* MIT Press,2012.
2. T. Ichiishi, A. Neyman and Y. Tauman, *Game Theory and Applications (1e)*, Elsevier,2014.
3. D. Bauso, *Game Theory with Engineering Applications*, SIAM, Philadelphia, 2016.
4. T. Roughgarden, *Twenty Lectures on Algorithmic Game Theory*, Cambridge University Press, 2016.

AI3130: DESIGN & ANALYSIS OF ALGORITHMS LAB [0 0 2 1]

Sorting & Searching Algorithm: Insertion sort, selection sort, binary search. Basic data structures: stacks and queues, graphs and trees, binary trees; Algorithmic paradigms: Recursion, divide-and-conquer, Merge sort, Quick sort. **Greedy:** Knapsack, Huffman encoding, dynamic programming, lower bounds and optimal algorithms; **Heaps:** Heaps, priority queues, min-max heaps, heap sort. Dynamic search structures, Binary search trees, height balancing, B-trees; **Algorithms on arrays:** Linear-time median finding, sorting in linear time (counting sort, radix sort, bucket sort), String matching (Rabin-Karp and Knuth-Morris-Pratt algorithms); **Graph algorithms Traversal:** (BFS, DFS, topological sort), Minimum spanning trees (Prim and Kruskal algorithms), shortest paths (Dijkstra's and Floyd-Warshal algorithms). Mini-Projects & Case Studies.

References:

1. E. Horowitz *et al*., *Fundamental of Computer Algorithms*, (2e), Universities Press, 2008
2. T. H. Cormen *et al., Introduction to Algorithms*, (3e), MIT press, 2010.
3. T. Roughgarden, *Algorithms Illuminated (Part 2): Graph Algorithms and Data Structures (1e), Wiley*, 2018

AI3131: COMPUTER NETWORKS LAB [0 0 2 1]

IPv4 addressing – Design of various protocol using GUI and command line in user and privileged mode. Configuration of Classful, CIDR, subnetting, Super netting. Understand the working of various networking devices, Configuration of Hub, Bridge, Switch, Router, Static Routing Protocol, RIPv1 and RIPv2, IGRP, EIGRP, OSPF, VLAN, NAT and DHCP.

References:

1. J.F. Kurose and K.W. Ross, *Computer Networking - A top-down approach*, (7e), Pearson, 2017.

2. A. S. Tanenbaum, *Computer Networks*", (5e), Pearson Education India, 2013.
3. W. Stallings, *Data & Computer Communications* (9e), Pearson Education Inc., Noida, 2017.
4. L. L. Peterson and B.S. Davie, *Computer Networks- A Systems approach*, (5e), Elsevier, 2016
5. B. A. Forouzan and F.Mosharraf, *Computer Networks A Top-Down Approach*, Mc-Graw Hill, 2017

AI3132: FOUNDATIONS OF DATA SCIENCE LAB [0 0 2 1]

Data Analytics & Visualization using various tools such as R, MATLAB, WEKA, RapidMiner. Experiments related to refinement of data and untimely the dataset will be elaborated in lab manual. Implement concepts of data pre-processing, data types, privacy and confidentiality, samples vs. population, comparative statistics, statistical inference, Association and clustering. Creating Visual Representations-descriptive, inferential statistics, uni-variate and multivariate analysis. Grouping – Cluster Analysis-distance measures, partitioning, hierarchical, density-based methods. Market Basket Analysis Association Analysis Suggested tools are MS Excel, Power BI, Tableau. MS Excel Pivot Tables and charts, Visualization of Groups, Volumetric Data, Case Studies in Various Perception Techniques.

References:

1. G. Shmueli, *et al.*, *Data Mining for Business Analytics: Concepts, Techniques and Applications in Python, John* Wiley & Sons, 2019
2. G. Shmueli et al., *Data Mining for Business Analytics: Concepts, Techniques, and Applications in R*, John Wiley & Sons, 2017
3. B. R. Hunt, *et al.*, *Guide to MATLAB: For Beginners and Experienced Users, (*2e), Cambridge University Press, 2011

AI2170, AI2270, AI3170: PROJECT BASED LEARNING (I, II, III) [0 0 2 2]

This course aims at developing innovative skills in the students whereby they apply in totality the knowledge and skills gained through the course work in the solution of problem or by undertaking a project. Project work, therefore, should match the strengths of students. The project assignment can be individual assignment or a group assignment. The project work identified in collaboration with industry should be preferred. Each teacher is expected to guide the project work of 5-6 students. The project assignments may consist of: Programming customer-based applications, Web page designing (Only dynamic), Database applications, Software Development etc. Execution through mentor mentee policy.

SEMESTER VI

BB0026: ORGANISATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. **Management:** Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower**. Motivation** – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. **Leadership** - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. **Entrepreneurship-Introduction**, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit**.** Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. B. Koontz, S. Harold, C. Donnell, and H. Weihrich, *Essentials of Management, (*1e) Tata McGraw-Hill, New Delhi, 1978.
2. T. Robbins, P. Stephen and M. Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. K. Aswathappa, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.

AI3201: MACHINE LEARNING [3 1 0 4]

Machine Learning Basics: Types of Machine Learning, Supervised vs. Unsupervised Learning, Parametric vs. non-parametric models. Learning theory-bias/variance tradeoff, union and Chernoff bounds, VC dimensions, Underfitting, Overfitting, Model selection, Cost functions. **Curse of Dimensionality:** Principal Component Analysis (PCA), Difference between PCAs and Latent Factors, Factor Analysis, Introduction to gradient descent. **Bayesian Models:** Bayesian concept learning, Bayesian Decision Theory, Naïve Bayesian, Zero Probability & Laplacian Correction, Bayesian Belief Networks**. Tree Models:** information theory, decision tree construction, tuning tree size; **Support Vector Machines**: kernel functions, k Nearest Neighbours. **Regression Models:** Linear Regression, Ridge and Lasso Regression, Logistic Regression, Methods of threshold determination and performance measures for classification score models**. Ensembling and Boosting Algorithms:** Concept of weak learners, bagging algorithm, Adaptive Boosting, Extreme Gradient Boosting (XGBoost), Random Forests; **Artificial Neural Networks:** Perceptron, activation functions, learning rate, Back propagation Algorithm. **Unsupervised learning:** Partitioning, Hierarchical and Density based methods.

References:

1. E. Alpaydin, *Introduction to Machine Learning*, (3e), PHI Learning 2015.
2. S Marsland, *Chapman and Hall, Machine Learning: An Algorithmic Perspective,* (2e), CRC,2014.
3. M. Bishop, *Pattern Recognition and Machine Learning*, (2e), Springer, 2013.
4. T. Mitchell, *Machine Learning,* (1e), McGraw Hill Education, 2017.
5. L.E. Sucar, *Probabilistic Graphical Models: Principles and Applications (Advances in Computer Vision and Pattern Recognition),(1e),* Springer, 2016

AI3202:COMPUTER VISION AND PATTERN RECOGNITION [3 1 0 4]

Introduction: Definition and Overview, Image Formation, Human Color Perception and Inference from color, Image Transformation. **Image Processing:** Point operation, Linear and Non-Linear Filtering, Transform Filtering Techniques, Interpolation and multi resolution. **Feature Detection and Matching:** Feature detection, descriptor, matching, Edge detection, Lines Detection, Hough transform, Object Recognition, Principal Component Analysis, SHIFT and HOG Feature. **Shape Detection and Segmentation:** Active contours, Snakes, Region Split and merge, Graph cut and Energy based methods, Medical Image Segmentation. **Motion Estimation:** Parametric Motion, Spline based motion, Optical Flow, Kalman Filtering, application of motion estimation to video stabilization, Medical Image Registration.

References:

1. R. Szeliski, *Computer Vision: Algorithms and Applications*, (2e), Springer International Publishing, 2021.
2. D. A. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, (2e), PHI learning 2012.
3. C. M. Bishop, *Pattern Recognition and Machine Learning*, (1e), Springer, 2011.

AI3203: NATURAL LANGUAGE PROCESSING [3 1 0 4]

Introduction: Stages of Natural Language Processing, Types of Ambiguities. **Preprocessing and Normalization:** Text representation in computers, encoding schemes, Regular expressions, edit distance, lemmatization, stemming. **Grammar and Language modeling:** Part of Speech, Stochastic POS tagging, parser, vocabulary, N-gram probabilities, Perplexity, Hidden Markov Modal, Transformation based tagging (TBL), multi word expressions. **Semantics**: Meaning representation using Word Embedding, semantic analysis, lexical semantics, WordNet, Word Sense Disambiguation. **Pragmatics:** Discourse, Reference Resolution, Reference Phenomena, Syntactic and Semantic

Constraints on Coreference. **Corpora and Lexicon:** characteristics of Gold Standard Corpora like Treebank, Wordnet, Sentiwordnet etc. **Feature Extraction:** Bag of word, Tf-Idf, Word Embedding using word2vec and GLOVE, Convolutional Neural Network, Recurrent neural network, Long Short-Term Memory. **Application**: Semantic Text Similarity, Sentence or Document Classification, Machine translation, Text Summarization.

References:

1. D. Jurafsky and J.H. Martin, *Speech and Language Processing* (3e), Prentice Hall,2020.
2. S.Knight, *NLP at Work: The Difference that Makes the Difference(4e),* Nicholas Brealey Publishing,2016
3. S Andreas, *NLP: New Technology (1e),* William Morrow,2011

AI3230:MACHINE LEARNING LAB [0 0 2 1]

In this course, various experiments will be performed, covering various Machine Learning techniques. Experiments covering pre-processing of data, various classifiers such as Bayesian, Decision Trees, Support Vector Machines, k-nearest neighbour; Regression Models, and data sets will be described in the laboratory manual. Measures of classification precision, enhancement of classifier efficiency by the assembly, boosting, etc.

References:

1. E. Alpaydin, *Introduction to Machine Learning*, (3e), PHI Learning 2015.
2. S Marsland, *Chapman and Hall, Machine Learning: An Algorithmic Perspective,* (2e), CRC,2014.
3. T. Mitchell, *Machine Learning,* (1e), McGraw Hill Education, 2017.
4 L.E. Sucar, *Probabilistic Graphical Models: Principles and Applications (Advances in Computer Vision and Pattern Recognition),(1e),* Springer, 2016
5. H.P. Langtangen, *Python Scripting for Computational Science*, (3e), Springer Publishers, 2014

AI3231:COMPUTER VISION AND PATTERN RECOGNITION LAB [0 0 2 1]

Introduction to Computer Vision Tools: MATLAB, OpenCV with Python. Image Processing: Colour Space Conversion, Image Transform, Linear, Non-Linear Filtering, Multi resolution. Feature Detection: Edge Detection, Principal Component Analysis, SHIFT, SURF. Shape Detection and Segmentation: Watershed Algorithm, Shape Matching. Object Tracking: Frame Differencing, Optical Flow, Background Subtraction, Object Recognition, Face Detection.

References:

1.R. C. Gonzalez *et al.*, *Digital Image Processing Using MATLAB*, (2e), Mc Graw Hill India, 2011
2.G.B García *et al.*, *Learning Image Processing with OpenCV*, (1e), Packt Publishing, 2015
3.A.F. David and J. Ponce, *Computer Vision: A Modern Approach(3e)*, PHI learning 2015.
4.K. Fukunaga, *Introduction to Statistical Pattern Recognition,* (2e), Academic press, 2013.
5.C.M. Bishop, *Pattern Recognition and Machine Learning* (1e), Springer, 2011.

PROGRAM ELECTIVE – I

AI3240: MACHINE LEARNING APPLICATIONS IN IoT [3 0 0 3]

Introduction to Internet of Things: State of the Art in IoT, Structure of the Internet, Product development Cycle, Applications, and impact of IoT on society**. IoT Communication protocol:** Basics of serial communications, HTTP protocol, MQTT protocol. **IoT Server client configurations:** Defining server and clients, defining access point and station, Web server, Point to Point communication Intranet and internet. **Setting up cloud services:** Introduction to cloud services, how to use cloud services for IoT applications; **Fog and Edge Computing Completing the Cloud:** Data Management in Fog Computing, **Predictive Analysis to Support Fog Application Deployment**: Example: Smart Building, Predictive Analysis with FogTorch: **Using Machine Learning for Protecting the Security and Privacy of Internet of Things (IoT) Systems:** Survey of ML Techniques for Defending IoT Devices, Machine Learning in Fog Computing. **Case study:** Development of Mobile robot from scratch, controlling mobile robot using smart phone over Wi-Fi, Obstacle avoidance algorithm, monitoring surrounding physical parameter using mobile phone.

References:
1. M. Makkar and N. Kumar *Machine Learning in Cognitive IoT* (1e), CRC Press, June 2020
2. R. Buyya and S. Narayana, *Fog and Edge Computing: Principles and Paradigms, (*1e), Wiley, 2019.
3. R. Karim, *Hands-On Deep Learning for IoT: Train neural network models to develop intelligent IoT applications*. Packt Publishing Limited, 2019
4. S.McEwen, *Designing the Internet of Things(1e)*, Wiley, 2014
5. J. Holler, *Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, Academic Press, 2014

AI3241: REINFORCEMENT LEARNING [3 0 0 3]

Introduction: Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning. **Markov Decision Process:** Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP), Introduction to Markov decision process (MDP), state and action value functions. **Prediction and Control by Dynamic Programming:** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions. **Monte Carlo Methods for Model Free Prediction and Control:** Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling. **TD Methods:** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD (0), TD (1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, Q-Learning, and their variants. **Function Approximation Methods:** Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD (0) algorithms, Eligibility trace for function approximation, after states, Control with function approximation, Least squares, Experience replay in deep Q-Networks; Policy Gradients.

References:
1. R.S. Sutton and A.G. Barto *Reinforcement Learning: An Introduction(2e),* A Bradford Book, 2018
2. M. Lapan, *Deep Reinforcement Learning Hands-On: Apply modern RL methods to practical problems of chatbots, robotics, discrete optimization, web automation(2e),* Expert Insight,2020.
3. D. Bertsekas*, Reinforcement Learning and Optimal Control(1e),* Athena Scientific, 2019.

AI3242: DATA MINING [3 0 0 3]

Types of data mining problems. The process of data mining, Statistical evaluation of big data: statistical prediction, performance measures, pitfalls in data-mining evaluation. Data preparation: data models, data transformations, handling of missing data, time-dependent data, and textual data. **Data reduction:** feature selection, principal components, smoothing data, case subsampling. Predictive modeling: mathematical models, linear models, neural nets, advanced statistical models, distance solutions, logic solutions, decision trees, decision rules, Association rules, model combination**. Solution analyses:** graphical trend analyses, comparison of methods. Future trends: text mining, visualization, distributed data. **Text mining:** extracting attributes, structural approaches: parsing, soft parsing. Bayesian approach to classifying text. **Web mining:** classifying web pages, extracting knowledge from the web, Sequential Pattern Mining, Pattern Mining Applications: Mining Spatiotemporal and Trajectory Patterns, Constraint-Based Mining, Graph Pattern Mining. Data Warehouse and OLAP, Data Warehouse and DBMS, Multidimensional data model, OLAP operations, loan data set.

References:
1. J. Han and M. Kamber, Morgan Kaufmann *Data Mining Concepts and Techniques (3e),* The Morgan Kaufmann Series in Data Management Systems 2016.
2. L. Bing *Web Data Mining* Springer-Verlag,2017.
3. P. Ponniah, *Data Warehousing*, (2e), Wiley India Pvt. Ltd., 2011
4. A.K. Pujari, *Data Mining Techniques* (4e), Orient Black Swan/ Universities Press 2016.
5. N.T. Pang, M. Steinbach, K. Anuj and V. Kumar., *Introduction to Data Mining*, Pearson Education (2e), Pearson 2018

AI3243:COMPILER CONSTRUCTION [3 0 0 3]

Introduction: Structure of a Compiler; The Role of the Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, The Lexical-Analyzer Generator Lex, Finite Automata, From Regular Expression to Automata, Design of a Lexical-Analyzer Generator; Context-Free Grammars, writing a Grammar, Top-Down Parsing, Bottom-Up Parsing, **Introduction to LR Parsing**: Simple LR, More Powerful LR Parsers, Using Ambiguous Grammars, Parser Generators. Syntax-Directed Definition, Construction of Syntax Trees; Variants of Syntax Trees, Three-Address Code, Types and Declarations: Type Expressions, Type Equivalence; **Translation of Expressions:** Operations within Expressions, **Type Checking:** Rules for Type Checking, Storage Organization, Stack, Allocation of Space; Issues in the Design of a Code Generator, Target Language, Addresses in the Target Code, Basic Blocks and Flow Graphs, Elements of Assembly Language Programming, A Simple Assembly Scheme, Pass Structure of Assemblers, Design of Two Pass Assemblers.

References:

1. A.V. Aho, M. S. Lam, R. Sethi and J. D. Ullman, *Compilers Principles, Techniques and Tools (2e)*, Pearson Education, 2013.
2. D.Grune et.al , *Modern Compiler Design(2e),* Springer,2014.
3.V. Raghavan, *Principles of Compiler Design(1e),* Tata McGraw Hill, 2014.

VII SEMSTER

AI4101: DEEP LEARNING [3 1 0 4]

Introduction: Feed forward Neural networks, Gradient descent and the back propagation algorithm, Unit saturation, the vanishing gradient problem, and ways to mitigate it. RelU Heuristics for avoiding bad local minima, Heuristics for faster training, Nestors accelerated gradient descent, Regularization, Dropout. Convolutional Neural Networks: Architectures, convolution / pooling layers. **Recurrent Neural Networks:** LSTM, GRU, Encoder Decoder architectures. Deep Unsupervised Learning: Autoencoders, Variational Auto-encoders, Adversarial Generative Networks, Auto-encoder and DBM Attention and memory models. Dynamic memory networks. **Applications of Deep Learning to Computer Vision:** Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models, Attention models for computer vision tasks. **Applications of Deep Learning to NLP:** Introduction to NLP and Vector Space Model of Semantics, **Word Vector Representations:** Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations. **Applications in word similarity, Analogy reasoning:** Named Entity Recognition, Opinion Mining using Recurrent Neural Networks: Parsing and Sentiment Analysis using Recursive Neural Networks: **Sentence Classification using Convolutional Neural Networks**: Dialogue Generation with LSTMs, Applications of Dynamic Memory Networks in NLP, Factoid Question Answering, similar question detection, Dialogue topic tracking, Neural Summarization.

References:

1. I. Goodfellow, Y. Bengio and A. Courville *Deep Learning(1e),* MIT Press,2016.
2. T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning(2e),* Springer,2017.
3. D. Koller, and N. Friedman *Probabilistic Graphical Models*, MIT Press,2010.
4. S. Haykin, *Neural Networks and Learning Machines*, PHI, 2016.
5. Ng's Notes on *Machine Learning* from CS229

AI4102: TEXT MINING [3 1 0 4]

Text Extraction: Introduction, Rapid automatic keyword extraction: candidate keywords, keyword scores, adjoining keywords, extracted keywords, benchmark evaluation: precision and recall, efficiency, stop list generation, Evaluation on new articles. **Clustering**: Multilingual document clustering: Multilingual LSA, Tucker1 method, PARAFAC2 method, LSA with term alignments, LMSA, LMSA with term alignments. **Classification:** Content-based spam email classification using machine-learning algorithms, utilizing nonnegative matrix factorization for email classification problems, Constrained clustering with k-means type algorithms; **Anomaly and trend detection:** Text Visualization techniques such as tag clouds, authorship and change tracking, Data Exploration, and the search for noval patterns, sentiment tracking, visual analytics and Future Lens, scenario discovery, adaptive threshold setting for novelty mining. **Text streams** Text streams: Introduction, Text streams, Feature extraction and data reduction, Event detection, Trend detection, Event, and trend descriptions, embedding semantics in LDA

Topic models: Introduction, vector space modelling, latent semantic analysis, probabilistic latent semantic analysis, Latent Dirichlet allocation, embedding external semantics from Wikipedia, data-driven semantic embedding.

References:

1. M. W. Berry and J. Kogan , *Text Mining Applications and Theory*, Wiley publications, 2010
2. C. C. Aggarwal, and C.X. Zhai, *Mining text data*. Springer Science & Business Media, 2012.
3. G. Miner, et al. *Practical text mining and statistical analysis for non-structured text data applications*. Academic Press, 2012.
4. N. Srivastava and M. Sahami, *Text mining: Classification, clustering, and applications,* Chapman and Hall/CRC, 2009.

AI4103: RECOMMENDER SYSTEMS [3 1 0 4]

Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system. **Collaborative Filtering:** User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems. **Content-based recommendation**: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms. **Knowledge based recommendation:** Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders. **Hybrid approaches:** Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies. **Evaluating Recommender System:** Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centred metrics.

References:

1. C.C. Aggarwal , *Recommender Systems: The Textbook* (1e), Springer, 2016.
2. N Manouselis, H. Drachsler, K. Verbert and E. Duval., *Recommender Systems for Learning (1e)*, Springer 2013.
3. F. Ricci, L. Rokach, D. Shapira and B.P. Kantor, *Recommender Systems Handbook (1e),* Springer ,2011.

PROGRAM ELECTIVE: II – IV

AI4140:INFORMATION RETRIEVAL [3 0 0 3]

Introduction to IR: IR Concepts, Boolean Retrievals, Inverted Index, Processing Boolean Queries. The Term Vocabulary and Postings Lists: Document Delineation and Character Sequence Decoding, Determining the Vocabulary of Terms. **Dictionaries and Tolerant Retrieval:** Search Structures for Dictionaries, Wildcard Queries, Spelling Correction, Phonetic Correction. **Index Construction:** Hardware Basics Blocked Sort-Based Indexing. Scoring, Term Weighting, and the Vector Space Model: Parametric and Zone Indexes, Term Frequency and Weighting, The Vector Space Model for Scoring. **Evaluation in Information Retrieval:** Information Retrieval System Evaluation, Standard Test Collections, Evaluation of Unranked Retrieval Sets, Evaluation of Ranked Retrieval Results. **Text Classification & Naïve Bayes:** The Bernoulli model, Properties of Naïve Bayes, Feature Selection, Evaluation of text classification. **Web Search Basics:** Web Characteristics, Advertising as the Economic Model, The Search User Experience, Index Size and Estimation, Near-Duplicates and Shingling. **Web Crawling and Indexes:** Overview, Crawling, Distributing Indexes, Connectivity Servers. Link Analysis: The Web as a Graph, Page Rank, Hubs and Authorities.

References

1. C. Manning, P. Raghavan and H. Schütze, *Introduction to Information Retrieval,* Cambridge University Press, 2011.
2. R. B. Yate and B. R.Neto*, Modern Information Retrieval,* (2e), Addison Wesley, 2012
3. S. Butcher and C.L.A. Clarke*, Information Retrieval – Implementing and Evaluating Search Engine*s (1e), The MIT Press,2016.

AI4141: AUGMENTED & VIRTUAL REALITY [3 0 0 3]

Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality; **Multiple Models of Input and Output Interface in Virtual Reality**: Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices; **Visual Computation in Virtual Reality:** Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large-Scale Environments & Real Time Rendering; **Interactive Techniques in Virtual Reality:** Body Track, Hand Gesture, 3D Manus, Object Grasp; **Development Tools and Frameworks in Virtual Reality**: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools etc.; Application **of VR in Digital Entertainment**: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR; **Augmented and Mixed Reality**, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

References:

1. A.B. Craig, *Understanding Augmented Reality, Concepts and Applications*, Morgan Kaufmann, 2013.
2. E. Lavieri, *Getting started with Unity 5*, Packt publishing, 2015.
3. D. Schmalstieg and T. Hollerer, *Augmented Reality: Principles & Practice*, (1e), Addison-Wesley, 2016
4. S. Aukstakalnis, *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability*), (1e), Addison-Wesley Professional, 2016

AI4142:SPEECH SYNTHESIS & RECOGNITION [3 0 0 3]

Introduction: Speech and Language, Speech analysis, Speech coding, speech production models, speech analysis and analysis-synthesis systems, **Mechanisms and Models of the Human Auditory System**: linear predictive coding (LPC) analysis, speech recognition, Graphical models, Hidden Markov models, Recognition and training algorithms, Language models, Search algorithms, Optimization, adaptation, Noise robustness, Digital Coding of Speech. **Message Synthesis from Stored Human Speech Components**: Phonetic Synthesis by Rule. Speech Synthesis from Textural or Conceptual Input. **Introduction to Automatic Speech Recognition:** Template Matching. Stochastic Modelling. Practical Techniques for Improving Speech Recognition and Performance. Automatic Speech Recognition for Large Vocabularies. Speaker Recognition and other Para-linguistic Technologies. Human Auditory System, Digital Coding of Speech, **Phonetics Synthesis by Rule:** Introduction Automatic Speech Recognition, Discriminative training for speech recognition, Speech recognition applications, Speech synthesis, voice conversion, Speaker recognition.

References:

1.S. Furui, *Digital Speech Processing: Synthesis, and Recognition,* (2e), CRC Press, 2018.
2.W. Holmes, *Speech Synthesis and Recognition(2e),* CRC Press,2011.
3.A. Spanias, T. Painter and V. Atti, *Audio Signal Processing and Coding(1e)*, Willey ,2017

AI4143: ARTIFICIAL INTELLIGENCE IN HEALTHCARE [3 0 0 3]

AI and Machine Learning: Application and Foundations**,** Become familiar with supervised machine learning and the types of problems it may be applied to; **Using AI for Disease Diagnosis and Patient Monitoring:** Examine real-world applications of AI for diagnosis and patient monitoring; **Natural Language Processing and Data Analytics in Healthcare:** Use AI to extract value-adding outcomes from medical literature and pathology reports; **Interpretability in Machine Leaning – Benefits and Challenges:** Appreciate the importance and benefits of interpretable algorithms.

References:
1.P. S. Mahajan, *Artificial Intelligence in Healthcare Paperback*, July 1, 2018.
2.A. Bohr and K. Memarzadeh, *Artificial Intelligence in Healthcare*, Academic Press, 2020
3.S. Dua, U. Acharya and P. Dua, *Machine Learning in Healthcare Informatics*, Springer, 2014
4.A. Panesar, *Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes, Academic* Press; (1e), 5 February 2019

AI4144:SOCIAL NETWORK ANALYSIS [3 0 0 3]
Introduction to Social Web: Nodes, Edges and Network measures, Describing Nodes and Edges, Describing Networks, Layouts; **Visualizing Network features:** The role of Tie Strength, Measuring Tie Strength, Tie Strength and Network Structure, Tie Strength and Network Propagation, Link Prediction, Entity Resolution; **Link Prediction:** Case Study Friend Recommendation, Introduction to Community Discovery, Communities in Context, Quality Functions; **Algorithms:** The Kernighan-Lin algorithm, Agglomerative Algorithms, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering, Other Approaches; **Introduction to Social Influence**: Influence Related Statistics, Social Similarity and Influence, Homophile, Existential Test for Social Influence, Influence and Actions, Influence and Interaction, Influence Maximization in Viral Marketing

References:
1. S.P. Borgatti ,M.G. Everett , J.C. Johnson, *Analyzing Social Networks (2e*) SAGE Publications Ltd, 2018
2. J. Goldbeck, *"Analyzing the Social Web",* Morgan Kaufmann Publications, 2013.
3. C. C. Aggarwal, "*Social Network Data Analytics*", Springer Publications, 2011.
4. J. Scott, *"Social Network Analysis", (3e),* SAGE Publications Limited, 2013.
5. S. Kumar, F. Morstatter and H. Liu, "*Twitter Data Analytics*", Springer Publications, 2013

AI4145: AI FOR CYBER SECURITY [3 0 0 3]
Fundamentals of Cyber Security: Identity, authentication, confidentiality, privacy, anonymity, availability, and integrity, exploring cryptographic algorithms together with major attacks (using a break-understand-and-fix approach), Exploring high-level security protocols; **Fundamentals of AI for Security:** deep learning fundamentals from a security perspective., case studies; ***Web Application Security:*** Injection, Broken authentication, Sensitive data exposure, XML External Entities (XXE), Broken access control, Security misconfiguration, Cross-Site Scripting (XSS), Insecure deserialization, Using components with known vulnerabilities, Insufficient logging, and monitoring. **Secure Web:** making websites secure using AI techniques for injection using regular expressions and identifying patterns and matching with existing scores. Case studies; **Deep learning applications:** Pattern detection and model behavior for anomalous behavior, Advanced Malware Detection Case studies; ***Secure AI Development:*** foundations of secure software design, secure programming, and security testing. The section requires a basic understanding of Application Programming Interface (API) and example APIs of companies referred to are: Darktrace, Vectra and Cylance; **Impact of AI on Cyber Security: T**hreat hunting in memory, file system and network data, analysis of malicious programs.

References:
1. A. Parisi, *Hands-On Artificial Intelligence for Cybersecurity: Implement smart AI systems for preventing cyber-attacks and detecting threats and network anomalies*, (1e) Packt Publishing, 2019
2. S. Halder, *Hands-On Machine Learning for Cybersecurity: Safeguard your system by making your machines intelligent using the Python ecosystem*, (1e), Packt Publishing, 2018
3. L.F. Sikos (Ed.), *AI in Cybersecurity*, Springer International Publishing, 2019
4. E. Tsukerman, *Machine Learning for Cybersecurity Cookbook*, Packt Publishing, 2019

AI4146: BIG DATA ANALYTICS [3 0 0 3]
Introduction to Big Data: Types of Digital Data-Characteristics of Data, Evolution of Big Data, Definition of Big Data, Challenges with Big Data, 3Vs of Big Data, Non-Definitional traits of Big Data, Business Intelligence vs. Big Data, Data warehouse and Hadoop environment, Coexistence. **Big Data Analytics:** Classification of analytics, Data Science, Terminologies in Big Data, CAP Theorem, BASE Concept. **NoSQL:** Types of Databases, Advantages, NewSQL, SQL vs. NOSQL vs NewSQL. **Introduction to Hadoop:** Features, Advantages, Versions, Overview of Hadoop Eco systems, Hadoop distributions,

Hadoop vs. SQL, RDBMS vs. Hadoop, Hadoop Components, Architecture, HDFS. **Map Reduce:** Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression. **Hadoop 2 (YARN):** Architecture, Interacting with Hadoop Eco systems. **No SQL databases:** Mongo DB: Introduction, Features, Data types, Mongo DB Query language, CRUD operations, Arrays. Functions: Count, Sort, t – Limit, Skip, Aggregate, Map Reduce. Cursors: Indexes, Mongo Import, Mongo Export. **Cassandra:** Introduction, Features, Data types, CQLSH, Key spaces, CRUD operations, Collections, Counter, TTL, alter commands, Import and Export, Querying System tables. **Hadoop Eco systems:** Hive, Architecture, data type, File format, HQL, SerDe, User defined functions.

References:

1.T. Erl , W.Khattak and P. Buhler., *Big Data Fundamentals, Concepts, Drivers & Techniques* (1e), The Prentice Hall Service Technology Series, 2016.
2. S. Acharya, *Big Data and Analytics*, Wiley India Pvt. Ltd., 2015
3. V. Prajapati, *Big Data Analytics with R and Hadoop*, Packt Publishing Ltd., 2013.
4. A. Holmes, *Hadoop in Practice*, (2e), Manning Publications, 2015
5. S. Ryza, *Advanced Analytics with Spark: Patterns for Learning from Data at Scale*, (2e), O'Reilly, 2017

AI4147: DATA PRIVACY AND SECURITY [3 0 0 3]

Introduction to Data Privacy: Types of privacy attacks, Data linking and profiling, access control models, role-based access control, privacy policies, their specifications, privacy policy languages, privacy in different domains-medical, financial, etc. Mathematical model for comparing real-world data sharing practices, computing privacy and risk measurements. Demographics and Uniqueness. Protection Models-Null-map, k-map, Wrong map. Survey of techniques-Protection models (null-map, k-map, wrong map), Disclosure control, Inferring entity identities, entry specific databases. Computation systems for protecting delimited data-Min Gen, Datafly, Mu-Argus, k-Similar. **Introduction to Security:** The OSI Security Architecture, Security Attacks, Services and Mechanisms, Model for Network Security, Number theory, Cryptographic Hash Functions, Digital Signatures, System Security, Symmetric Encryption and Message Confidentiality, Substitution ciphers, Stream ciphers, Public-key cryptography and Message Authentication, Key Distribution and Authentication, Transport Layer Security, Wireless Network Security, E-mail Security, IP Security, Security Management Systems, Need for IT Security, Intrusion Prevention and Detection Systems, Cyber Security. **Security metrics:** Design, Data sources, Analysis of security metrics data, Measuring security cost and value, Different context for security process management. **Acquisition and Duplication:** Sterilizing Evidence Media, Acquiring Forensics Images, Acquiring Live Volatile Data, Data Analysis, Metadata Extraction, and File System Analysis.

References:

1. R.Leenes , R.Brakel , S. Gutwirth, and P.De Hert, *Data Protection and Privacy: The Age of Intelligent Machines* (Computers, Privacy and Data Protection), Hart Publishing (December 28, 2017)
2. B. Raghunathan, *The Complete Book of Data Anonymization: From Planning to Implementation*, Auerbach Pub, 2016.
3. L. Sweeney, *Computational Disclosure Control: A Primer on Data Privacy Protection*, MIT Computer Science, 2017
4. W. Stallings*, Cryptography and Network Security: Principles and Practice*, 7th Edition, Pearson Education, 2017.
6. A. Kahate, *Cryptography and Network Security, 3rd Edition*, Tata McGraw-Hill Publishing Company Limited, 2013.
7. L.Hayden, *IT Security Metrics*, Tata McGraw Hill, 2016.

AI4148: IMAGE AND VIDEO ANAYSTICS [3 0 0 3]

Introduction Digital Image Processing: Characteristics of Digital Image, basic relationship between pixels, fundamental operations on image, image sampling and quantization, image transformations models; **Basic Techniques of image processing** Fundamentals of spatial filtering: spatial correlation and convolution, smoothing blurring, sharpening, basics of filtering in the frequency domain: smoothing, blurring, sharpening, histograms and basic statistical models of image; **Transformations and Segmentations**: Colour models and Transformations, image and video Segmentation, image and video demonising, image and Video enhancement- Image and Video compression; **Detection and**

Classification Object detection and recognition in image and video, texture models Image and video classification models object tracking in Video; **Applications and Case studies Industrial**-Transportation & travel, remote sensing, video Analytics: IoT Video Analytics Architectures.

References:

1. R.C Gonzalez and R.E Woods, *Digital Image Processing*, Pearson Education, 4th edition, 2018.
2. N.M. Tekalp, *Digital Video Processing,* (1e), Pearson, 2017
3. A.K. Jain, *Fundamentals of Digital Image Processing*, PHI, New Delhi, 1995
4. Rick Szelisk, *Computer Vision: Algorithms and Applications*, Springer 2011.
5. C. Shan, F. Porikli, T. Xiang and S. Gong, *Video Analytics for Business Intelligence,*(1e), Springer, 2012

OPEN ELECTIVES

AI0001: Introduction to Artificial Intelligence [3 0 0 3]

Introduction to AI, Intelligent Agents and Searching: Definition of AI, birth of AI, brief history, Turing test, Types of environments, Types of agents, PEAS (Performance measure, Environment, Actuators, Sensors), **Introduction to searching**, State Space, SAGP (State, Action, Goal test, Path cost), DFS, BFS (Completeness, Time complexity, Space complexity, Optimality), Heuristics, Local Search Algorithm, Hill Climbing. Applications of Artificial Intelligence in real word. CSP, Game Playing and Logics: Constrain Satisfaction Problems examples, Approaches to solve CSPs, Test and generate method, back tracking. Game Playing, Optimal decision in games, Min Max algorithm, Evaluation functions, **Introduction to Propositional Logic** and First Order Logic, Syntax, Substitution, Unification, Deduction, Soundness, Completeness, Consistency, Satisfiability, Expert Systems. Uncertain Knowledge, **Reasoning and Machine Learning:** Probabilistic Reasoning, Review of Probability Theory, Probabilistic Inference Rules, Bayes Theorem, examples of Bayes theorem, **Introduction to Learning**, Taxonomy of Learning Systems, Concept Learning, Find-S algorithm, Candidate Elimination Algorithm. **Introduction to Neural Networks**, Biological Neural Networks, Artificial Neural Networks, Perceptron, Perceptron Learning Rule, Delta Rule, Applications of Neural Networks, Reinforcement Learning, Introduction to Deep Learning & Deep RL.

References:

1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, (3e) PHI, 2011.
2. E. Rich, K. Knight, S. B. Nair, Artificial Intelligence, (3e), Tata McGraw Hill, 2009.
3. G. F. Luger, Artificial Intelligence-Structures and Strategies for Complex Problem Solving, (6e), Addison-Wesley Pearson Education, 2012.
4. https://archive.nptel.ac.in/courses/106/102/106102220/

AI0051: C For Everyone [3 0 0 3]

Introduction to computing: overview of the course, a history of the C language, and a first set of programming activities. **Lexical Elements and Data Types:** Lexical elements and data types, programming activities of increasing sophistication. **Flow of Control and Simple Functions:** Flow of control and simple functions, even more sophisticated programming activities, Syntax and Logical Errors in compilation, Object and executable Code. **Advanced Functions, Recursion, Arrays, and Pointers:** Modular programming and Recursive functions, 1-D and 2-D Arrays and Strings, Searching and Sorting, Structure and Pointers.

References:

1. E. Balagurusamy, Computing fundamentals and C programming (1e), McGraw-Hill, 2008.

2. W. Brian, Kernighan, M. R. Dennisie, The C Programming language (2e), Pearson Education, 1988.
3. P. J Deital, H.M. Deite, C: How to program (7e), Pearson Education, 2010.
4. https://www.coursera.org/learn/c-for-everyone

AI0052: Cybersecurity Fundamentals [3 0 0 3]

Introduction: Psychology, Usability, Thinking like a Hacker. Security Terminologies: CIA Triad, Security Protocols. **Security Policies and Management:** Multilevel and multilateral Policies, Security Mechanisms. Security Design Principles: Threat Analysis and Risk Assessment, Securing a System. Cryptography: Basic Techniques, Digital Signatures, Cryptanalysis. Software Security: Low-level attacks, Code Review and Testing, Defenses. **Network Security:** Vulnerabilities, Attacks, Defenses. **Internet and Smartphone Security:** Anonymous vs Secure Browsing. **Information Economics**: Economics of Security, Physical Protection, Biometrics. Banking Security: Cyber Forensics, Cyber Warfare, Surveillance and Privacy. **Incident Response and Mitigation:** Business Continuity, Legal issues and Ethics.

References:

1. R. Anderson, Security Engineering, 2nd Edition, John Wiley and Sons, 2008.
2. C. P. Pfleeger, Security in Computing, 5th Edition, Prentice Hall, 2015.
3. https://www.coursera.org/specializations/cyber-security