**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – III** | |
|---|---|---|---|
| Course Name : Relational Database Management System (Paper – I) | | Course Code: (3AIT01) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**

The course will be able to define program-data independence, data models for database systems, database schema and database instances also to recall Relational Algebra concepts, and use it to translate queries to Relational Algebra, identify Structure Query Language statements used in creation and manipulation of database, identify the methodology of conceptual modeling through Entity Relationship model, identify the methodology of logical model and also identify the methodology of physical model.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Able to Implement SQL queries
2. Apply relational algebra and calculus concepts
3. Overview of database administration
4. Develop and deploy PL/SQL blocks
5. Utilize control structures, cursors, and exception handling

# B.Sc. Artificial Intelligence
## Semester – III
## Paper – I
## Relational Database Management System (3AIT01)

**UNIT – I**

Introduction to Database Management System(DBMS) - Introduction, Why a Database, Characteristic of Data in a Database, Database Management System, Why DBMS, Types of Database Management System, Object-Oriented Model, Object-Relational Model, Deductive/Inference Model, Compression Between the various Database Model. Introduction to Relational Database Management System (RDBMS)- Introduction , RDBMS Terminologies, The Relational Data Structure, Relational Data Integrity, Relational Data Manipulations, Codd's Rule. Database Architecture and Data Modeling - Introduction, Conceptual, Physical and Logical Database Model, External or Logical Level. Entity-Relationship Modeling- Introduction, E-R Model, Components of an E-R Model, E-R Modeling Symbols.

**UNIT – II**

**Data Normalization**-Introduction, First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce-Codd Normal Form (BCNF), Fourth Normal Form (4NF), Fifth Normal Form (1NF), Domain-Key Normal Form (DKNF), Renormalizations. Relational Algebra and Relational Calculus- Relational Algebra, Relational Calculus. **Introduction to Structured Query Language(SQL)** - Introduction, History of SQL, Characteristic SQL, SQL Operators, Arithmetic Operators, Compression Operators, Logical Operators, Set Operators, Operators Precedence. Tables, View and Index - Tables, View, Index. BETWEEN, LIKE and IN Condition, ALL and ANY Condition, EXITS Condition, ORDERED BY Clause.

**UNIT – III**

Query And Subqueries - Query, Subqueries. Aggregate Function - Introduction, General Rule, COUNT() and COUNT(*), SUM(), AVG(), MAX() and MIN(). Insert, Update and Delete Operation –Introduction, Insert Statement, Bulk Insert of Data, Update Statement, Delete Programming with SQL- Introduction, Query Processing, Embedded SQL, Dynamic SQL. Query-By-Example(QBL) - Introduction, Select Query in QBE, Make-Table Query, DELETE Query, UPDATE Query, APPEND Query, QBE and SQL. QUEL-Introduction, Data Definition in QUEL, Data Retrieval in QUEL, Data UPDATE Operation in QUEL.

**UNIT – IV**

**Introduction-** PL/SQL Blocks, PL/SQL Architecture, SQL Support, PL/SQL Variables, PL/SQL Data Types, PL/SQL Precompilers, Conditional And Sequential Control Statements, Control Statements, Cursors, Iterative Control Statements, PL/SQL Exceptions, PL/SQL Blocks, Statement Cursors - Introduction, Cursor Operation, Cursor Positions, Cursor Coding Guideline. Join And Union - Join, Union. **Triggers -** Introduction, What is Trigger?, Types of Triggers, Triggers Syntax, Combining Triggers Types, Setting Inserted Value, Disabling and Enabling Triggers, Replacing Triggers, Dropping Triggers, Advantages and Limitations of Triggers.

**Text Book:**

1. Alexis Leon, Mathews Leon, Database Management System, Leaon Vikas.

**Reference Books:**

1. Rini Chakrabarti, Shilbhadra Dasgupta & Subhash K. Shinde, Advance Database Management System, Dreamtech Press.
2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw-Hill.
3. G. K. Gupta, Database System Concepts, McGraw-Hill.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – III** | |
|---|---|---|---|
| Course Name : Python Programming (Paper – II) | | Course Code: (3AIT02) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**

Computer programming skills are now becoming part of basic education as these skills are increasingly of vital importance for future job and career prospects. The Python programming language which is one of the most popular programming languages worldwide. The course shows you how to use the free open-source Python to write basic programs and high level applications using concepts such as List, Tuples, functions, variables, If Else statements, For loops, While loops, iterative and recursive programs and algorithms such as the Insertion Sort algorithm. This course will be of great interest to all learners who would like to gain a thorough knowledge and understanding of the basic components of computer programming using the Python language–and might be a gentle introduction to programming for those who think they might have a longer term interest in the subject area.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Develop and Execute simple Python programs.
2. Structure a Python program into functions.
3. Using Python lists, tuples to represent compound data
4. Develop Python Programs for file processing

# B.Sc. Artificial Intelligence
## Semester – III
## Paper – II
## Python Programming (3AIT02)

**UNIT I** Introduction to Python, Python, Features of Python, Execution of a Python, Program, Writing Our First Python Program, Data types in Python. Python Interpreter and Interactive Mode; Values and Types: int, float, boolean, string, and list; Variables, Expressions, Statements, Tuple Assignment, Precedence of Operators, Comments; Modules and Functions, Function Definition and use, Flow of Execution, Parameters and Arguments Operators in Python, Input and Output, Control Statements. Boolean Values and operators, Conditional (if), Alternative (if-else), Chained Conditional (if-elif-else)

**UNIT II.** Iteration: state, while, for, break, continue, pass; Fruitful Functions: Return Values, Parameters, Local and Global Scope, Function Composition, Recursion, Arrays in Python, Strings and Characters. Strings: String Slices, Immutability, String Functions and Methods, String Module; Lists as Arrays. Illustrative Programs: Square Root, gcd, Exponentiation, Sum an Array of Numbers, Linear Search, Binary Search.

**UNIT III** Functions, Lists and Tuples. List Operations, List Slices, List Methods, List Loop, Mutability, Aliasing, Cloning Lists, List Parameters; Tuples: Tuple Assignment, Tuple as Return Value; Dictionaries: Operations and Methods; Advanced List Processing - List Comprehension; Illustrative Programs: Selection Sort, Insertion Sort, Merge sort, Histogram.

**UNIT IV:-** Files and Exception: Text Files, Reading and Writing Files, Format Operator; Command Line Arguments, Errors and Exceptions, Handling Exceptions, Modules, Packages; Illustrative Programs: Word Count, Copy File.

**TEXT BOOKS**

1. Mark Lutz, Learning Python
2. Tony Gaddis, Starting Out With Python
3. Kenneth A. Lambert, Fundamentals of Python
4. James Payne, Beginning Python using Python 2.6 and Python 3

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – III** | |
|---|---|---|---|
| Course Name : Design and Analysis of Analysis of Algorithms (Paper – III) | | Course Code: (3AIT03) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**

This course is designed to introduce the students to design and analyse algorithms in terms of efficiency and correctness. The course focuses on highlighting difference between various problem solving techniques for efficient algorithm design.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Be able to check the correctness of algorithms using inductive proofs and loop invariants.
2. To give clear idea on algorithmic design paradigms like divide and conquer, Searching approach.
3. Ability to understand and design algorithms using greedy strategy, dynamic programming,
4. Demonstrate a familiarity with major algorithms and data structures.

# B.Sc. Artificial Intelligence
## Semester – III
## Paper – IV
## Design and Analysis of Algorithms (3AIT03)

**Unit-I** : Elementary Algorithmics: Introduction- Problems and Instances- The Efficiency of algorithms- Average and worst case Analysis. Asymptotic Notation: A notation for the order of – Other asymptotic notation Conditional asymptotic notation- Asymptotic notation with several parameters- Operations on asymptotic notation. Analysis of Algorithms: Introduction- Analyzing control structures- Average case analysis- Amortized Ansalysis- Solving recurrences.

**Unit-II** : Greedy Algorithms: Making change- General Characteristics of Greedy algorithms- Minimum spanning trees and shortest paths- Knapsack Problems- Scheduling. Divide and Conquer: Introduction- Multiplying large numbers- The general template- binary search sorting- Finding the median- Matrix multiplication- Introduction to cryptography.

**Unit-III** : Dynamic Programming: The Principle of Optimality- making change the knapsack problem- shortest paths- Chained matrix multiplication- approaches using recursion- Memory functions.

**Unit- IV** : Back tracking & Brach Bound: Traversing trees- Depth first search of directed and undirected graph Breadth first search- Back tracking- Branch and bound- The minimax principle, Introduction to NPCompleteness; Classes P and NP- Polynomial reductions- NP- Complete Problems NP- Hard problems Non- Deterministic algorithms.

**Text Book** :

1. Fundamentals of Algorithms - Gilles Brassard & Paul Brately. Prentice-Hall (India)Ltd.

**Reference Books:**

1. Fundamentals of Computer Algorithms by Ellis Horowitz & Sartaj Sahani. Galgotia Publication.

2. Computer Algorithms: Introduction to Design & Analysis. Sara Baase & Alien Van Gelder. Addison Wesley Publishing Company.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – III** | |
|---|---|---|---|
| Course Name : Introduction to Artificial Intelligence (Paper – IV) | | Course Code: (3AIT04) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**

The basic exposition to the goals and methods of Artificial Intelligence along with the applications which involve perception, reasoning and learning and have an understanding of the basic issues of knowledge representation and blind and heuristic search and understanding of some of the more advanced topics of AI such as learning, natural language processing, expert systems, and planning

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Study the concepts of Artificial Intelligence.
2. Learn the methods of solving problems using Artificial Intelligence.
3. Learn the knowledge representation techniques, reasoning techniques and planning
4. Introduce the concepts of natural language processing

# B.Sc. Artificial Intelligence
## Semester – III
## Paper – IV
## Introduction to Artificial Intelligence (3AIT04)

**Unit – I**

Introduction to Artificial Intelligence, Background and Applications, Turing Test and Rational Agent approaches to AI, Introduction to Intelligent Agents, their structure, behavior and environment. **Problem Solving:** Problem Characteristics, Production Systems, Control Strategies.

**Unit - II**

**Searching Techniques :** Breadth First Search, Depth First Search, Hill climbing and its Variations, Heuristics Search Techniques: Best First Search, A* algorithm, Constraint Satisfaction Problem, Means-End Analysis, Introduction to Game Playing, Min-Max and Alpha-Beta pruning algorithms.

**Unit - III**

**Knowledge Representation:-** Representations and mappings, Knowledge Representations, Issues in Knowledge Representation, **Predicate Logic:-** Representing Instance and Isa Relationships, Computable Functions and predicates, Resolution, Natural Deduction, Logc programming, Forward versus Backward Reasoning, Matching, Control knowledge

**Unit - IV**

**Dealing with Uncertainty and Inconsistencies :** Truth Maintenance System, Default Reasoning, Probabilistic Reasoning, Bayesian Probabilistic Inference, Possible World Representations. **Understanding Natural Languages :**Parsing Techniques, Context-Free and Transformational Grammars, Recursive and Augmented Transition Nets.

**Text Books:**


1. DAN.W. Patterson, Introduction to A.I and Expert Systems – PHI, 2007.
2. Russell &Norvig, Artificial Intelligence-A Modern Approach, LPE, Pearson Prentice Hall, 2nd edition, 2005.
3. Rich & Knight, Artificial Intelligence – Tata McGraw Hill, 2nd edition, 1991.
4. Artificial Intelligence by Elaine Rich, Mcgraw hill Inc.
5. Artificial Intelligence and Expert Systems – Jankiraman, Sarukes (M)

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – III** | |
|---|---|---|---|
| Course Name : Digital Electronics and Microprocessor (Paper – V) | | Course Code: (3AIT05) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

## Learning Objectives:

The objective of this course is to provide the fundamental concepts associated with the digital logic and circuit design. To introduce the basic concepts and laws involved in the Boolean algebra and logic families and digital circuits. To familiarize with the different number systems, logic gates, and combinational and sequential circuits utilized in the different digital circuits and systems. The course will help in design and analysis of the digital circuit and system.

## Learning Outcomes:

After completion of this course successfully the students will be able to:

1. Convert different type of codes and number systems which are used in digital communication and computer systems and understand different logic gates.
2. Able to understand various laws and combinational circuits.
3. Able to analyse various flip flops and counters
4. Able to understand the basic architecture of 8086 Microprocessor and its instruction set

# B.Sc. Artificial Intelligence
## Semester – III
## Paper – V
## Digital Electronics and Microprocessor (3AIT05)

**Unit-I :**

**Number System and Data Representation - Number System :** Binary, Octal, Decimal and Hexadecimal number system and their inter conversion. **Logic gates:** Truth table, properties and symbolic representation of NOT, AND, OR, NOR , NAND, EXOR, EXNOR gates. NOR and NAND gates as a universal gates .

**Unit-II :**

**Boolean Algebra:** Laws and Identities of Boolean algebra, DeMorgan's Theorem , use of Boolean Algebra for simplification of logic expression **Combinational circuits:** Half adder, Full Adder, Half subtractor, Full Subtractor, 4-bit binary adder/subtractor, Multiplexer, Demultiplexer, Decoder, Encoder, Parity detector.

**Unit III :**

**Sequential Circuits : Flip-Flops :** Construction and working of RSFF, JKRSFF, DFF, TFF, JKFF, and JKMSFF. **Counters :** Construction and working of asynchronous, synchronous, up-down counter, shift registers and their types, Ring counter, Johnson counter with their time diagram.

**Unit-IV :**

Architecture of 8086 and Assembly Language Programming, Block diagram of 8086, Pin diagram of 8086, Addressing modes, **Instruction set:** Data transfer, Arithmetic, Logical, String manipulations, Control Transfer, Unconditional branch, Conditional branch, Flag, Processor control. Assembler directives and operators, simple assembly programs.

**Text Books:**


1. Digital Electronics by Gothman(PHI)
2. Digital and Analogue Technique by Navaneeth, Kale and Gokhale
3. Fundamental of Micropocessor by B Ram
4. Microcomputers Systems: The 8086/8088 family by Liu. Gibson
5. Modern Digital Electronics By Jain (TMH)

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester - III** | |
|---|---|---|---|
| Course Name : RDBMS Lab | | Course Code: (3AIP01) | |
| Periods per week (1 Period is 60 minutes) | | 2 | |
| Credits | | 2 | |
| | | Hours | Marks |
| Evaluation Scheme | Practical Examination | 6-8* | 50 |
| | | Total Marks | 50 |

## Practical's based on Relational Database Management System

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester - III** | |
|---|---|---|---|
| Course Name : Python Programming Lab | | Course Code: (3AIP02) | |
| Periods per week (1 Period is 60 minutes) | | 2 | |
| Credits | | 2 | |
| | | Hours | Marks |
| Evaluation Scheme | Practical Examination | 6-8* | 50 |
| | | Total Marks | 50 |

## Practical's based on Course code 3AIT02, 3AIT03 and 3AIT04

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – IV** | |
|---|---|---|---|
| Course Name : Computer Graphics (Paper – I) | | Course Code: (4AIT01) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

## Learning Objectives:

The main objective of this module is to introduce to the students the concepts of computer graphics. It starts with an overview of interactive computer graphics, two dimensional system and mapping, then it presents the most important drawing algorithm, two-dimensional transformation;
Clipping, filling and an introduction to 3-D graphics.

## Learning Outcomes:

After completion of this course successfully the students will be able to:

1. Have a knowledge and understanding of the structure of an interactive computer graphics System, and the separation of system components.

2. Have a knowledge and understanding of geometrical transformations and 3D viewing.

3. Have a knowledge and understanding of techniques for representing 3D geometrical objects.

4. Have a knowledge and understanding of interaction techniques.

# B.Sc. Artificial Intelligence
## Semester – IV
## Paper – I
## Computer Graphics (4AIT01)

**UNIT - I**

Introduction and Primitives Introduction: Application areas of Computer Graphics, overview of graphics systems, video-display devices, raster-scan systems, random scan systems, graphics monitors and work stations and input devices

**UNIT - II**

Output primitives : Points and lines, line drawing algorithms, mid-point circle and ellipse algorithms. Filled area primitives: Scan line polygon fill algorithm, boundary-fill and flood-fill algorithms.

**UNIT - III**

Basic transformation's, Translation, Rotation, Scaling, Matrix representation's & homogeneous co-ordinates, Composite transformation's, Reflection, Two dimensional viewing, The viewing pipeline, viewing coordinate reference frame, window to view-port coordinate transformation, viewing functions, Two dimensional clipping, Line, Polygon, Curve, Text Cohen-Sutherland line clipping algorithm, Sutherland –Hodgeman polygon clipping algorithm.

**UNIT - IV**

3D-transformation, Projection, Viewing, Clipping. Spline representation, Cubic spline, Bezier curve, Bezier surfaces, Beta spline, B-spline surfaces, B spline curve, Hidden surfaces, Hidden lines, Z-buffer, Computer animation.

**Reference Books**

1. "Computer Graphics Principles & practice", second edition in C, Foley, VanDam, Feiner and Hughes, Pearson Education.
2. "Computer Graphics", second Edition, Donald Hearn and M.Pauline Baker, PHI/Pearson Education.
3. Procedural elements for Computer Graphics, David F Rogers, Tata Mc Graw hill, 2nd edition.
4. "Principles of Interactive Computer Graphics", Neuman and Sproul, TMH.
5. Computer Graphics, Amrendra N Sinha,Arun D Udai TMH
6. Computer Graphics, Steven Harrington, TMH

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – IV** | |
|---|---|---|---|
| Course Name : R Programming (Paper – II) | | Course Code: (4AIT02) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**

This course introduces R, which is a popular statistical programming language. The course covers data reading and its manipulation using R, which is widely used for data analysis internationally. The course also covers different control structures and design of user-defined functions. Any scientific task without the knowledge of software is difficult to imagine and complete in the current scenario. R is a free software that is capable of handling mathematical and statistical manipulations. It has its own programming language as well as built in functions to perform any specialized task.

**Learning Outcomes:**

After completion of this course successfully the students will be able to:

1. Develop an R script and execute it
2. Install, load and deploy the required packages, and build new packages for sharing and reusability
3. Extract data from different sources using API and use it for data analysis
4. Visualize and summarize the data
5. Design application with database connectivity for data analysis

# B.Sc. Artificial Intelligence
## Semester – IV
## Paper – II
## R - Programming (4AIT02)

**UNIT I**

**Introduction** , How to run R, R Sessions, Introduction to Functions, Important R Data -Variables, Data Types, Vectors ,Conclusion , Advanced Data Structures , Data Frames ,Lists ,Matrices, Arrays , Classes.

**UNIT II**

R Programming Structures , Control Statements ,Loops ,Looping Over Non, vector Sets ,If Else, Arithmetic and Boolean Operators and values , Default Values for Argument ,Return Values, Deciding Whether to explicitly call return Returning Complex Objects ,Functions are Objective, No Pointers in R Recursion , A Quicksort Implementation Extended , Example: A Binary Search Tree.

**UNIT III**

Doing Math and Simulation in R , Math Function , Extended Example Calculating Probability Cumulative Sums and Products Minima and Maxima Calculus , Functions Fir Statistical Distribution ,Sorting , Linear Algebra Operation on Vectors and Matrices , Extended Example: Vector cross Product Extended Example: Finding Stationary Distribution of Markov Chains , Set Operation , Input /Output , Accessing the Keyboard and Monitor , Reading and writer Files.

**UNIT IV**

Graphics , Creating Graphs , The Workhorse of R Base Graphics , the plot() Function – Customizing Graphs , Saving Graphs to Files. Probability Distributions , Normal Distribution Binomial Distribution Poisson Distributions other Distribution , Basic Statistics , Correlation and Covariance.

**Reference Books**

1.The Art of R Programming, Norman Matloff, Cengage Learning
2. Cotton, R., Learning R: a step by step function guide to data analysis. 1st edition.O'reilly Media Inc.
3. R for Everyone, Lander, Pearson Siegel, S. (1956), Nonparametric Statistics for the Behavioral Sciences, McGrawHill International, Auckland.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – IV** | |
|---|---|---|---|
| Course Name : Fundamentals of IoT (Paper – III) | | Course Code: (4AIT03) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**

To grasp the concept of IoT, individuals must have a solid understanding of its fundamental components. *IoT courses* cover the basics, including the various sensors, connectivity options, and data processing methods used in IoT systems. Additionally, learners gain insight into IoT communication protocols such as MQTT, HTTP, and CoAP, which are essential for effective data exchange between devices.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Explain the definition and usage of the term ―Internet of Things‖ in different contexts
2. Understand the key components that make up an IoT system
3. Differentiate between the levels of the IoT stack and be familiar with the key technologies and protocols employed at each layer of the stack
4. Apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis
5. Discover where the IoT concept fits within the broader ICT industry and possible future trends

# B.Sc. Artificial Intelligence
# Semester – IV
# Paper – III
# Fundamentals of IoT (4AIT03)

**UNIT I**

Introduction to IoT: Overview of IoT, Types of lot frameworks, IoT Ecosystem, Design patterns for IoT, IoT architectures such as four-layer architecture, seven-layer architecture, IoT sensors and actuators: Understanding the types of sensors: Temperature, humidity, proximity, light and actuators used in IoT devices: pump, servo motor and LED and their applications.

**UNIT II**

IoT communication protocols: Learning about various communication protocols such as MQTT, CoAP, HTTP, and their usage in IoT devices.IoT platforms and cloud computing: Understanding IoT platforms: Cloud based IoT platform, Edge Based IoT Platform, On-Premises Cloud Platform. Cloud computing. IoT devices communication with cloud using Messaging, PUB/SUB, API, and their role in the deployment of IoT applications.

**UNIT III**

Data Analytics and Machine Learning for IoT: Data collection and Storage in IoT. Techniques and tools used for analyzing and processing data generated by IoT devices, including machine learning algorithms. Security and Privacy in IoT: Understanding the security and privacy challenges in IoT and techniques for securing IoT systems.

**UNIT IV**

Overview of Arduino, Introduction to programming languages and IDEs, Basic electronics concepts (resistors, capacitors, LEDs, etc.), Introduction to breadboards and circuit design, Variables, data types, and control structures, Functions and libraries, Sensors and Actuators, Introduction to sensors (e.g., temperature, humidity, light), Introduction to actuators (e.g., motors, LEDs, relays),Connecting and controlling sensors and actuators with Arduino
Case Studies on IoT Applications For Smart Homes, Cities, Environment-Monitoring and Agriculture

**Reference Books**

1. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things David Hanes, Gonzalo Salgueiro, Patrick Grossetete Robert Barton, Jerome Henry
2. INTERNET OF THINGS Architecture and Design Principles, Raj Kamal, McGraw Hill Education (India) Private Limited
3. THE INTERNET OF THINGS KEY APPLICATIONS AND PROTOCOLS Olivier Hersent Actility, France David Boswarthick ETSI, France Omar Elloumi Alcatel-Lucent, France
4. Internet of Things -Architecture, Implementation and Security by Mayur Ramgir
5. Programming Arduino™ Getting Started with Sketches Simon Monk.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – IV** | |
|---|---|---|---|
| Course Name : Data Communication and Network (Paper – IV) | | Course Code: (4AIT04) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
The objective of the course understand the basics of data communication, networking, internet and their importance, Analyze the services and features of various protocol layers in data networks. Analyze TCP/IP and their protocols. Differentiate wired and wireless computer networks, Student will be able to understand various types of transmission media, network devices; and parameters of evaluation of performance for each media and device.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Understand and Contrast the concept of Signals, OSI & TCP/IP reference models and discuss the functionalities of each layer in these models.
2. Discuss and Analyze flow control and error control mechanisms and apply them using standard data link layer protocols
3. Analyze and apply various routing algorithms to find shortest paths for packet delivery.
4. Explain the details of Transport Layer Protocols (UDP, TCP) and suggest appropriate protocol in reliable/unreliable communication.
5. Understand the basic aspects of packet-based protocol design and implementation.

# B.Sc. Artificial Intelligence
## Semester – IV
## Paper – IV
## Data Communication and Network (4AIT04)

### UNIT I

**Introduction:** Data Communications, Networks, The Internet, Protocols and Standards. **Network Models:** Layered Tasks, The OSI Model, TCP/IP Protocol Suite, Addressing. **Data and Signals:** Analog and Digital, Transmission Impairment, Performance.

### UNIT II

**Transmission Media:** Guided Media, Unguided Media, Wireless. **Switching:** Circuit-Switched Networks, Datagram Networks, Virtual-Circuit Networks. **Error Detection and Correction:** Introduction, Block Coding, Cyclic Codes, Checksum. **Data Link Control:** Framing, Flow and Error Control, Protocols, Noiseless Channel, Noisy Channels.

### UNIT III

**Connecting LANs, Backbone Networks, and Virtual LANs**: Connecting Devices, Backbone Networks, Virtual LANs. **Network Layer: Logical Addressing:** IPV4 addresses, IPV6 Addresses. **Internet Protocol:** Internetworking, IPV4, IPV6, Transition from IPV4 to IPV6.

### UNIT IV

**Transport Layer:** Process-To-Process Delivery, User Datagram Protocol (UDP), TCP. **Congestion Control and Quality of Service:** Data Traffic, Congestion, Congestion Control, Quality of Service, Techniques to improve QoS.
**Application Layer:** Domain Name System, Remote Logging, Electronic Mail, File Transfer **WWW AND HTTP:** Architecture, Web Documents, HTTP

### Textbook

1. Data Communications and Networking, Behrouz A. Forouzan, McGraw-Hill Forouzan Networking Series, Fourth Edition.

### Reference Books

1. Data and Computer Communications, William Stalling, PEARSON Prentice Hall, Eighth Edition.
2. Computer Networks, Andrew S. Tanenbum, PHI
3. Godbole, Data Communication and Network, TMH
4. Comer Internetworking with TCP/IP Vol-1, PHI Publication

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – IV** | |
|---|---|---|---|
| Course Name : Introduction to Data Science (Paper – V) | | Course Code: (4AIT05) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
To provide strong foundation for data science and application area related to information technology and understand the underlying core concepts and emerging technologies in data science

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Explore the fundamental concepts of data science
2. Understand data analysis techniques for applications handling large data
3. Understand various machine learning algorithms used in data science process
4. Visualize and present the inference using various tools
5. Learn to think through the ethics surrounding privacy, data sharing and algorithmic decision-making

# B.Sc. Artificial Intelligence
## Semester – IV
## Paper – V
## Introduction to Data Science (4AIT05)

**UNIT-I -INTRODUCTION TO DATA SCIENCE**

Definition – Big Data and Data Science Hype – Why data science – Getting Past the Hype – The Current Landscape – Who is Data Scientist? - Data Science Process Overview – Defining goals – Retrieving data – Data preparation – Data exploration – Data modeling – Presentation. Problems when handling large data – General techniques for handling large data, Steps in big data – Distributing data storage and processing with Frameworks

**UNIT-II -MACHINE LEARNING**

Machine learning – Modeling Process – Training model – Validating model – Predicting new observations –Supervised learning algorithms – Unsupervised learning algorithms. Reinforcement-The Machine Learning process. Terminologies in ML- Testing ML algorithms: Overfitting, Training,

**UNIT- III -DEEP LEARNING**

Introduction – Deep Feedforward Networks – Regularization – Optimization of Deep Learning – Convolutional Networks – Recurrent and Recursive Nets – Applications of Deep Learning. The Neuron – Activation Function – Gradient Descent – Stochastic Gradient Descent – Back Propagation

**UNIT-IV - DATA VISUALIZATION**

Introduction to data visualization – Data visualization options – Filters – Introduction to visualization tool – Evaluate the data – visualize Model's Analytical Results: hidden grouping, data classification results, outliers, decision trees, MapReduce – Dashboard development tools – Creating an interactive dashboard with dc.js-summary.

**TEXT BOOKS:**

1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Manning Publications Co., 1st edition, 2016
2. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013
3. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 1st edition, 2016
4. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O' Reilly, 1st edition, 2018

**REFERENCE BOOKS:**

1. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015
2. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1st edition, 2013
3. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Cambridge University Press, 2nd edition, 2014

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester - IV** | |
|---|---|---|---|
| Course Name : Computer Graphics Lab | | Course Code: (4AIP01) | |
| Periods per week (1 Period is 60 minutes) | | 2 | |
| Creditss | | 2 | |
| | | Hours | Marks |
| Evaluation Scheme | Practical Examination | 6-8* | 50 |
| | | Total Marks | 50 |

## Practical's based on Computer Graphics (4AIT01)

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester - IV** | |
|---|---|---|---|
| Course Name : R- Programming Lab | | Course Code: (4AIP02) | |
| Periods per week (1 Period is 60 minutes) | | 2 | |
| Credits | | 2 | |
| | | Hours | Marks |
| Evaluation Scheme | Practical Examination | 6-8* | 50 |
| | | Total Marks | 50 |

## Practical's based on Course code R- Programming (4AIT02)

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – V** | |
|---|---|---|---|
| Course Name : Introduction to Machine Learning (Paper – I) | | Course Code: (5AIT01) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
The objective of this course is to provide introduction to the principles and design of machine learning algorithms. The course is aimed at providing foundations for conceptual aspects of machine learning algorithms along with their applications to solve real world problems.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:
1. Identify various machine learning algorithms and terminologies and perform data pre-processing using standard ML library.
2. Design a predictive model using appropriate supervised learning algorithms to solve any given problem.
3. Develop an application using appropriate unsupervised learning algorithms for performing clustering and dimensionality reduction.
4. Solve complex problems using artificial neural networks and kernel machines.
5. Implement probabilistic graphical models for suitable applications.

# B.Sc. Artificial Intelligence
## Semester – V
## Paper – I
## Introduction to Machine Learning (5AIT01)

### Unit I

**Learning:** Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

### Unit II

**Multi-layer Perceptron:** Going Forwards – Going Backwards: Back Propagation Error – Multilayer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

### Unit III

**Learning with Trees**: Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

### Unit IV

**Dimensionality Reduction:** Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap –Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process. Graphical Models:Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models –Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Method

### Text Books

1. Introduction to Machine Learning (Adaptive Computation and Machine Learning Series), Ethem Alpaydin, Third Edition, MIT Press
2. Machine learning – Hands on for Developers and Technical Professionals, Jason Bell, Wiley
3. Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Peter Flach,Cambridge University Press.
4. Deep Learning , Rajiv Chopra, Khanna Publication.
5. Machine Learning, V. K. Jain, Khanna Publication.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – V** | |
|---|---|---|---|
| Course Name : Cloud Computing (Paper – II) | | Course Code: (5AIT02) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
This module aims to introduce the learner to the concept of cloud computing and how it differs from the client server model of computation that is seen on the web today. Cloud computing applications are charged on a per use basis i.e. clients only pay for what they have used. Many companies are using cloud computing to offload some of their work onto these clouds as a means of saving on software and hardware cost. Due to this new model of computation we require new methods of developing and creating software.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Learn the key and enabling technologies that help in the development of cloud.
2. Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
3. Explain the core issues of cloud computing such as resource management and security.
4. Be able to install and use current cloud technologies.
5. Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

# B.Sc. Artificial Intelligence
## Semester – V
## Paper – II
## Cloud Computing(5AIT02)

**Unit – I**

**Understanding Cloud Computing -Origins and Influences:** A Brief History, Definitions, Business Drivers: Capacity Planning, Cost Reduction, Organizational Agility, Technology Innovations: Clustering, Grid Computing, Virtualization, Technology Innovations vs. Enabling Technologies **Basic Concepts and Terminology:** Cloud, IT Resource, On-Premise, Cloud Consumers and Cloud Providers, Scaling: Horizontal Scaling, Vertical Scaling, Cloud Service, Cloud Service Consumer **Goals and Benefits:** Reduced Investments and Proportional Costs, Increased Scalability, Increased Availability and Reliability **Risks and Challenges:** Increased Security Vulnerabilities, Reduced Operational Governance Control, Limited Portability Between Cloud Providers, Multi-Regional Compliance and Legal Issues **Fundamental Concepts and Models - Roles and Boundaries:** Cloud Provider, Cloud Consumer, Cloud Service Owner, Cloud Resource Administrator, Additional Roles, Organizational Boundary, Trust Boundary **Cloud Characteristics:** On-Demand Usage, Ubiquitous Access, Multitenancy (and Resource Pooling), Elasticity, Measured Usage, Resiliency **Cloud Delivery Models:** Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Comparing Cloud Delivery Models, Combining Cloud Delivery Models, IaaS + PaaS, IaaS + PaaS + SaaS **Cloud Deployment Models:** Public Clouds, Community Clouds, Private Clouds, Hybrid Clouds, Other Cloud Deployment Models.

**Unit – II**

**Cloud-Enabling Technology - Broadband Networks and Internet Architecture:** Internet Service Providers (ISPs), Connectionless Packet Switching (Datagram Networks), Router-Based Interconnectivity, Physical Network, Transport Layer Protocol, Application Layer Protocol, Technical and Business Considerations, Connectivity Issues, Network Bandwidth and Latency Issues, Cloud Carrier and Cloud Provider Selection **Data Center Technology:** Virtualization, Standardization and Modularity, Automation, Remote Operation and Management, High Availability, Security-Aware Design, Operation, and Management, Facilities, Computing Hardware, Storage Hardware, Network Hardware, Carrier and External Networks Interconnection, Web-Tier Load Balancing and Acceleration, LAN Fabric, SAN Fabric, NAS Gateways, Other Considerations **Virtualization Technology:** Hardware Independence, Server Consolidation, Resource Replication, Operating System-Based Virtualization, Hardware-Based Virtualization, Virtualization Management, Other Considerations, **Web Technology:** Basic Web Technology, Web Applications, **Multitenant Technology, Service Technology:** Web Services, REST Services, Service Agents, Service Middleware.

**Unit - III**

**Basic Terms and Concepts:** Confidentiality, Integrity, Authenticity, Availability, Threat, Vulnerability, Risk, Security Controls, Security Mechanisms, Security Policies, **Threat Agents:** Anonymous Attacker, Malicious Service Agent, Trusted Attacker, Malicious Insider, **Cloud Security Threats:** Traffic Eavesdropping, Malicious Intermediary, Denial of Service, Insufficient Authorization, Virtualization Attack, Overlapping Trust Boundaries, **Additional Considerations:** Flawed Implementations, Security Policy Disparity, Contracts, Risk Management, Logical Network Perimeter, Virtual Server, **Cloud Storage Device**: Cloud Storage Levels, Network Storage Interfaces, Object Storage Interfaces, Database Storage Interfaces: Relational Data Storage, Non-Relational Data Storage **Cloud Usage Monitor:** Monitoring Agent, Resource Agent, Polling Agent, Resource Replication, Ready-Made Environment.

**Unit – IV**

**Specialized Cloud Mechanisms-** Automated Scaling Listener, Load Balancer, SLA Monitor, SLA Monitor Polling Agent, SLA Monitoring Agent, Pay-Per-Use Monitor, Audit Monitor, **Failover System:** Active-Active, Active-Passive, Hypervisor, Resource Cluster, Multi-Device Broker, State Management Database **Cloud Management Mechanisms -** Remote Administration System, Resource Management System, SLA Management System, Billing Management System, **Cloud Security Mechanisms** – Encryption, Symmetric Encryption, Asymmetric Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO), Cloud-Based Security Groups, Hardened Virtual Server Images.

**Text Books:**

1) Cloud Computing Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, and Ricardo Puttini

2) Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, McGraw Hill, ISBN: 978 1259029950, 1259029956

3) Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, Kai Hwang, Geoffrey C Fox, Jack G Dongarra, Morgan Kaufmann Publishers, 2012.

4) Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center, Brian J.S. Chee and Curtis Franklin, CRC Press, ISBN: 9781439806128

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – V** | |
|---|---|---|---|
| Course Name : Cyber Security (Paper – III) | | Course Code: (5AIT03) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
This course focuses on the models, tools, and techniques for enforcement of security with some emphasis on the use of cryptography. Cybersecurity has become a critical concern for individuals, businesses, and government. The ever-increasing reliance on digital technology has made us vulnerable to cyber threats and attacks. Students will learn security from multiple perspectives.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

a) Analyze and evaluate the cyber security needs of an organization.
b) Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation.
c) Measure the performance and troubleshoot cyber security systems.
d) Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.
e) Comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators

# B.Sc. Artificial Intelligence
## Semester – V
## Paper – III
## Cyber Security (5AIT03)

### Unit I

**Introduction to Cyber security:** Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

### Unit II

**Cyber crime and Cyber law:** Classification of cybercrimes, Common cybercrimes- cybercrime targeting computers and mobiles, cybercrime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cybercrimes, Remedial and mitigation measures, Legal perspective of cybercrime, IT Act 2000 and its amendments, Cybercrime and offences, Organisations dealing with Cybercrime and Cyber security in India, Case studies.

### Unit III

**Social Media Overview and Security**: Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

### Unit IV

**Digital Devices Security, Tools and Technologies for Cyber Security:** End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions

### Reference Books


1. Cyber Crime Impact in the New Millennium, by R. C Mishra , Author Press. Edition 2010.
2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011)
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform. (Pearson, 13th November, 2001)
4. Electronic Commerce by Elias M. Awad, Prentice Hall of India Pvt Ltd.
5. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers.
6. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd.
7. Fundamentals of Network Security by E. Maiwald, McGraw Hill.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – V** | |
|---|---|---|---|
| Course Name : Big Data Analytics (Paper – IV) | | Course Code: (5AIT04) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
This Course aims to equip the learner with a range of most relevant topics that pertain to contemporary analysis practices, and are foundational to the emerging field of big data analytics. Learners achieve this through developing knowledge and understanding of statistical analytics techniques and principles while applying these techniques and principles in typical real world scenarios.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Perform data gathering of large data from a range of data sources.
2. Critically analyse existing Big Data datasets and implementations, taking practicality, and usefulness metrics into consideration.
3. Understand and demonstrate the role of statistics in the analysis of large of datasets
4. Select and apply suitable statistical measures and analyses techniques for data of various structure and content and present summary statistics
5. Understand and demonstrate advanced knowledge of statistical data analytics as applied to large data sets
6. Employ advanced statistical analytical skills to test assumptions, and to generate and present new information and insights from large datasets

# B.Sc. Artificial Intelligence
# Semester – V
# Paper – IV
# Big Data Analytics (5AIT04)

**Unit I**

**Getting an Overview of Big Data:** What is Big Data, History of Data management, Structuring Big data, Elements of Big data, Big data Analytics, Advantages of Big data Analytics Exploring The Use of Big data. **Introducing Technologies for Handling Big data**: Distributed and Parallel Computing in Big Data, Introducing Hadoop, HDFS and Map reduce, Cloud computing and big data, Features of Cloud Computing. **Understanding Hadoop Ecosystem:** Hadoop Ecosystem, Hadoop Distributed file system, HDFS Architecture, HDFS Commands, Map reduce, Hadoop YARM, Introducing HBase, HBase Architecture, Combining HBase and HDFS, Hive, Pig and Pig latin, Sqoop, Zookeeper, Flume,
Oozie. **Understanding MapReduce Fundamentals and HBase:** The MapReduce Framework, Exploring the Features of MapReduce, Working of MapReduce, Techniques to Optimize MapReduce Jobs, Uses of MapReduce.

**Unit II**

**Understanding Big Data Technology Foundation:** Exploring The Big data Stack, Data Source Layer, Ingestion Layer, Storage Layer, Physical Infrastructure Layer, Platform Management Layer, Security Layer, Monitoring Layer, Visualization Layer, Big Data Applications, Virtualization and Big Data, Virtualization Approaches **Storing Data In Data Bases and Data Warehouses:** RDBMS and BigData, CAP Theorem, Issues with Relational Model, Non- Relational Database, Issues with Non-Relational Model, Integrating Big Data with Traditional Data Warehouses.

**Unit III**

**Exploring R:**Exploring Basic Features of R, Statistical Features, Packages, Graphical User Interfaces, R Console, Developing a Programme, Exploring R Studio, Basic Arithmetic in R, Variables and Functions in R, Handling Data in R Workspace **Reading Data Sets and Exporting Data from R:** Using c() Command, Using scan() Command, Reading Mutiple Data values from Large Files, Reading Data from R Studio, Exporting Data from R. **Manipulating and Processing Data In R:** Creating Data Subsets, Merging Data Sets in R, Sorting Data, Managing Data in R using Matrices, Managing Data in R using Data Frames. **Working with Functions and Packages in R**: Using Functions instead of Scripts, Using Arguments in Functions, Built in Functions in R, Introducing Packages, Working with Packages. **Performing Graphical Analysis in R**:Using Plots, Saving Graphs to External Files, Advance Features of R.

**Unit IV**

**Data Visualization**: Ways of Representing Visual Data, Techniques, Types, Applications, Visualizing Big Data, Tools used in Data Visualization **Social Media Analytics and Text Mining:** Introducing Social Media, Introducing Text Mining, Understanding Text Mining Processes, Sentiment Analysis **Mobile Analytics**: Introducing Mobile Analytics, Define Mobile Analytics, Introducing Mobile Analytics Tools, Performing Mobile Analytics, Challenges of Mobile Analytics.

**Text Books**


1. Big Data (Covers Hadoop 2, MapReduce, Hive, YARN, Pig,R and Data Visualization) Black Book, DT Editorial Services, Dreamtech Press.
2. Data Science & Big Data Analytics Discovering, Analyzing, Visualizing and Presenting Data EMC Education Services, WILEY Publication
3. Beginners Guide for Data Analysis using R Programming, Jeeva Jose, Khanna Publi.
4. Data Analytics, Maheshwari, McGraw
5. Hands-On Programming with R by Grolemund and Garrett
6. Beginning R: The Statistical Programming Language by Mark Gardener

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester - V** | |
|---|---|---|---|
| Course Name : Machine Learning Lab | | Course Code: (5AIP01) | |
| Periods per week (1 Period is 60 minutes) | | 2 | |
| Credits | | 2 | |
| | | Hours | Marks |
| Evaluation Scheme | Practical Examination | 6-8* | 50 |
| | | Total Marks | 50 |

## Practical's based on Introduction to Machine Learning (5AIT01)

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester - V** | |
|---|---|---|---|
| Course Name : Big Data Analytics Lab | | Course Code: (5AIP02) | |
| Periods per week (1 Period is 60 minutes) | | 2 | |
| Credits | | 2 | |
| | | Hours | Marks |
| Evaluation Scheme | Practical Examination | 6-8* | 50 |
| | | Total Marks | 50 |

## Practical's based on Course code Big Data Analytics (5AIT02)

## Minor Project (5AIPR01) based on Syllabus and relevant to recent trends in the field of Artificial intelligence

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Natural Language Processing (Paper – I) | | Course Code: (6AIT01) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
The objective of this course is to make students understand, the impact of Natural Language Processing (NLP) in Data Science, on society has been far-reaching and transformative. NLP applications have revolutionized communication, making it more accessible and efficient through chatbots and virtual assistants. Language barriers have been broken down with machine translation systems, fostering cross-cultural understanding and international collaboration.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Write Python programs to manipulate and analyze language data
2. Understand key concepts from NLP and linguistics to describe and analyze language
3. Understand the data structures and algorithms that are used in NLP
4. Classify texts using machine learning and deep learning

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – I
## Natural Language Processing (6AIT01)

**Unit-I**

Language Processing and Python: Computing with Language: Texts and Words, A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language, Understanding Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet

**Unit-II**

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings. Categorizing and Tagging Words: Using a Tagger, Tagged Corpora,

**Unit-III**

Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers Deep Learning for NLP: Introduction to Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks, Classifying Text with Deep Learning

**Unit-IV**

Extracting Information from Text Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction. Analyzing Sentence Structure Some Grammatical Dilemmas, What's the Use of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar

**Text Books**

1. Natural Language Processing with Python. Steven Bird, Ewan Klein, and Edward Lope, O'Reily, 2009
2. Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Akshay Kulkarni, Adarsha Shivananda, Apress, 2019
3. "Foundations of Statistical Natural Language Processing" by Manning & Schi¼tze
4. Natural Language understanding by James Allen, Pearson Education.
5. "Speech and Language Processing" by Jurafsky & Martin
6. Allen James, Natural Language Understanding, Benjamin/Cumming,1995.
7. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Reinforcement Learning (Paper – II) | | Course Code: (6AIT02) | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
The objective of this course is to make students understand Reinforcement Learning(RL) which is a type of machine learning technique that enables an agent to learn in an interactive environment by trial and error using feedback from its own actions and experiences. RL is an autonomous, self-teaching system that essentially learns by trial and error.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Model a control task in the framework of MDPs.
2. Identify the model based from the model free methods.
3. Identify stability/convergence and approximation properties of RL algorithms.
4. Use deep learning methods to RL problems in practice.

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – II
## Reinforcement Learning (6AIT02)

**Unit- I**

**Introduction**. Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning. **Probability Primer** Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

**Unit- II Markov Decision Process**

Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

**Unit- III Prediction and Control by Dynamic Programing**

Overview of dynamic programing 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.

**Unit-IV 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($\lambda$), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

**Reference Books:**


1. Reinforcement Learning: An Introduction Book by Andrew Barto and Richard S. Sutton
2. Deep Reinforcement Learning Hands-On: Apply Modern RL Methods to Practical Problems of Chatbots, Robotics, Discrete Optimization, Web Automation, and More, 2nd Edition Book by Maxim Lapan
3. Foundations of Deep Reinforcement Learning: Theory and Practice in Python Book by Laura Graesser and Wah Loon Keng
4. Hands-On Reinforcement Learning with Python: Master Reinforcement and Deep Reinforcement Learning Using OpenAI Gym and TensorFlow Book by Sudharsan Ravichandiran
5. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems Book by Aurelien Geron

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Theory of Computation (Paper – III) | | Course Code: (6AIT03) Elective - I | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
The aims of this course are to understand basic theory of computation concepts that lies at the backbone of all state-of-the-art applications and program design. Students should understand the capabilities and limits of computation, particular applications and capabilities of deterministic and non-deterministic finite automata, context-free grammars, and finally Turing machines, as well as NP-completeness and complexity classes.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Demonstrate advanced knowledge of formal computation and its relationship to languages
2. Distinguish different computing languages and classify their respective types
3. Recognise and comprehend formal reasoning about languages
4. Show a competent understanding of the basic concepts of complexity theory
5. Solve computational problems regarding their computability and complexity and prove the basic results of the theory of computation.
6. Learn about Turing Machines and Pushdown Automata and understand Linear Bound Automata and its applications

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – III
## Theory of Computation (6AIT03)
## Elective - I

**UNIT I**

**Finite Automation:** Basic Concepts of Automata theory, Finite State Machines: Introduction, Definition, Deterministic and Non-deterministic finite Automata, equivalence of NFA and DFA, Finite Automata with ε-Transitions, Finite automata with output, Two-way finite automata, Properties of limitations of Finite state machine.

**UNIT II**

**Regular Expressions:** Regular expression formalism, equivalence of regular expression and finite automata, Regular Sets and their closure Properties, The pumping lemma for Regular language, Decision Algorithms for Regular Sets. Applications of regular expression and finite automata.

**UNIT III**

**Context Free Grammars:** Formal definition, Derivation Tree, Ambiguous CFG, Simplification of context Free Grammars, Normal Forms: Chomsky Normal form, Greibach normal form, Chomsky Hierarchy, Properties of Context free languages: The pumping lemma for CFL's, Closure properties of CFL's.

**UNIT IV**

**Push Down Automata:** Formal Definition, Push – Down Automata & Context free Grammar, PDA accepting CFL's, equivalence of CFG and PDA.
Turing Machine: Introduction, The Turing Machine Model, Computable languages and functions, Techniques Turing Machine construction.

**Books**

1. Theory of Computation, by Vivek Kulkarni, Oxford Higher Education.

**Reference Books:**

1. Introduction to Automata Theory, Languages and Computation: John E. Hoperoff & Jeffery D. Ullman
2. Theory of Computer Science : E. V. Krishmamoorty. .
3. Theory of computer Science : K. L. P. Mishra.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Operation Research (Paper – III) | | Course Code: (6AIT03) Elective - I | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
Operation Research is mainly concerned with the techniques of applying scientific knowledge, besides the development of science. It provides an understanding which gives the expert/manager new insights and capabilities to determine better solutions in his decision making problems, with great speed, competence and confidence. The course aims at building capabilities in the students for analysing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained.
2. Optimize the allocation of resources to Demand points in the best possible way using various techniques and minimize the cost or time of completion of number of jobs by number of persons.
3. Model competitive real-world phenomena using concepts from game theory. Analyse pure and mixed strategy games
4. Formulate Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – III
## Operation Research (6AIT03)
## Elective - I

**UNIT - I**

Introduction to Operation Research (OR) Origin and development of OR, Nature of OR, Characteristics of OR, Linear Programming – Concepts of Linear Programming Model, Mathematical Formulation of the Problem, Graphical solution methods. Simplex Methods, Big M methods, Duality in Linear Programming – Formulation of Dual Problem, Application of Duality

**UNIT - II**

Transportation Problem, Mathematical model for Transportation Problem, Types of Transportation Problem. Assignment Problem – Zero-One Programming Model for Assignment Problem, Types of Assignment Problem, Hungarian Method, Branch and Bound Technique for Assignment Problem.

**UNIT – III**

Game Theory – Terminologies of Game Theory, Two Person Zero-Sum Games, The Maximin-Minimax Principle, Games without Saddle points-Mixed Strategies, Graphical Solution of 2x n and m x 2 games, Dominance Property. Introduction, Decision under Certainty, Decision under Risk, Decision under Uncertainty, Decision Tree.

**UNIT - IV**

Network Scheduling by CPM, Introduction, Basic Concept, Constraints in Network, Critical Path Method (CPM), Inventory Control - Introduction, Inventory Control, Selective Control Techniques, Types of Inventory, Problem of EOQ with shortage, Queuing Theory – Introduction, Terminologies in Queuing System, Characteristics of Queuing System, Definition of Transient and Steady states.

**Text Books:**


1. Operation Research by Kanti Swarup, P. K. Gupta, Man Mohan [Sultan]
2. Operation Research by R. Panneerselvam [PHI]
3. Introduction to Operation Research by Billy E. Gillet [TMH]
4. Operation Research by Hira Gupta
5. Operation Research Problems and Solutions by Sharma J. K. [MacMillan]
6. Operation Research Theory and Application by Sharma J. K., [MacMillan]

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Data Mining (Paper – III) | | Course Code: (6AIT03) Elective - I | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
It is an introduction to the field of data mining (also known as knowledge discovery from data, or KDD for short). It focuses on fundamental data mining concepts and techniques for discovering interesting patterns from data in various applications It emphasizes techniques for developing effective, efficient, and scalable data mining tools.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Ability to understand the role of data mining in knowledge discovery process.
2. To familiarize with various data mining functionalities and how it can be applied to various real-world problems.
3. To learn about finding data characteristics and evaluating the outcome of data mining process.
4. To familiarize with various machine learning algorithms used in data mining.

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – III
## Data Mining (6AIT03)
## Elective - I

**Unit I**

Introduction to Data Mining: What is Data Mining? Motivating Challenges, Definitions, Origins of Data Mining, Data Mining Tasks, Data: Types of Data- Attributes and Measurement and Types of data sets, Data Quality-Measurement and Data Collection Issues, Issues Related to Applications, Data Preprocessing- Aggregation, Sampling, Dimensionality Reduction, Feature subset selection, Feature creation, Discretization and Binarization, Variable Transformation.

**Unit II**

**Exploring Data:** The Iris Data Set, Summary Statistics- Frequencies and Mode, Percentiles, Measures of Location: Mean and Median, Measures of Spread: Range and Variance, Multivariate Summary Statistics, Visualization: Representation, Arrangement, Selection, Visualization Techniques: Histograms, Box Plots, Scatter Plots, Contour Plots, Matrix Plots, Parallel Coordinates, Visualizing Higher-Dimensional data, OLAP and Multidimensional data Analysis, Classification: Basic Concepts, Decision Trees, and Model Evaluation: Preliminaries, General Approach to Solving Classification Problem, Decision Tree Induction, Evaluating the Performance of a Classifier, Methods for Comparing Classifiers.

**Unit III**

Classification: Alternative Techniques: Rule-Based Classifier, Rule Ordering Schemes, Building Rules-Based Classifier, Nearest Neighbor Classifiers, Bayesian Classifiers, Naive Bayes Classifier, Artificial Neural Networks (ANN), Support Vector Machines. Association Analysis: Basic Concepts and Algorithms: Problem Definition, Frequent Itemset Generation- Apriori Principle, Candidate Generation and Pruning, Support Counting, Computational Complexity, Rule Generation, Compact Representation of Frequent Itemsets, Alternative Methods for Generating Frequent Itemsets, FP-Growth Algorithm, FP-Tree Representation.

**Unit IV**

Cluster Analysis: Basic Concepts and Algorithms: What is Cluster Analysis? Different Types of Clustering, Types of Clusters, Clustering Algorithms: K-means and its variants, Hierarchical clustering, Density based clustering. Graph-Based Clustering, Shared Nearest Neighbor Approach, Jarvis Patrick Clustering, SNN Density-Based Clustering, Anomaly Detection: Causes of Anomaly Detection, Approaches to Anomaly Detection, Statistical Approaches, Proximity-Based Outlier Detection, Density-based Outlier Detection, Clustering-Based Techniques.

**Books**

1. Introduction to Data Mining, Tan, Steinbach, Kumar.
2. Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber, Morgan Kaufmann
3. Data Mining: Practical Machine Learning Tools and Techniques by Ian H. Witten and Eibe Frank, Morgan Kaufmann
4. Principles of Data Mining: David Hand, HeikkiMannila and Padhraic Smyth, PHP

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Parallel Computing (Paper – III) | | Course Code: (6AIT03) Elective - I | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
In a parallel computation, multiple processors work together to solve a given problem. These are exciting times in parallel computing. The largest parallel machine has over a hundred thousand processors, and it is believed that machines with over ten thousand processors will be commonly available by the end of the decade. Furthermore, with most chip manufacturers moving toward multicore processors, most machines will soon be parallel ones. It is, therefore, essential to learn to use parallel machines effectively. Parallel programming is ubiquitous in today's multi-core era and solves many real-world scientific problems. Massive parallelism entails significant hardware and software challenges.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. To understand the concepts Parallel Computers, Data and Temporal Parallelism.
2. To learn Structures of Parallel Computers.
3. To understand the concepts of Operating Systems for Parallel Computers.
4. To acquire knowledge on CUDA.
5. To learn Parallel Programming with CUDA C.

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – III
## Parallel Computing (6AIT03)
## Elective - I

**UNIT I Introduction:**
Why do we Need High Speed Computing, How do we Increase the Speed of Computers , History of Parallel Computers. **Solving problems in parallel:** Utilizing Temporal Parallelism , Utilizing Data Parallelism , Comparison of Temporal and Data Parallel Processing , Data Parallel Processing with Specialized Processors.

**UNIT II Structure of parallel computers:**
A Generalized Structure of a Parallel Computer, Classification of Parallel Computers, Vector Computers, A Typical Vector Super Computer, Array Processors, Shared Memory Parallel Computers, Distributed Shared Memory Parallel Computers, Message Passing Parallel Computers.

**UNIT III Operating systems for parallel computers:**
Resource Management , Process Management , Process Synchronization , Inter-process Communication , Memory Management , Input/output (Disk Arrays) , Basics of Performance Evaluation , Performance Measurement Tools.

**UNIT IV Computer unified device architecture:**
The age of parallel processing, The rise of GPU computing, CUDA, Applications of CUDA, Development Environment-CUDA Enabled Graphics Processors, NVIDIA Device driver, CUDA Development Tool kit, Standard C compiler. CUDA C: Introduction to CUDA C: First program, Querying Devices, Using Device Properties, Parallel Programming in CUDA C: CUDA Parallel Programming- Summing Vectors program

**Text Books**
1. Parallel Computers Architecture and Programming, V. Rajaraman, C. Siva Ram Murthy,PHI.
2. CUDA By Example, Jason Sanders, Edward Kandrot, Addison_Wesley.

**References**
1. Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Pearson Education.
2. Parallel Computing Theory and Practice, Michel j.Quinn

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Cryptography and Network Security (Paper – IV) | | Course Code: (6AIT04) Elective - II | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
To make the student learn different encryption techniques along with hash functions, MAC, digital signatures and their use in various protocols for network security and system security. To develop the student's ability to understand the concept of security goals in various applications and learn classical encryption techniques.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Understand basics of Cryptography and Network Security and classify the symmetric encryption techniques.
2. Understand, analyze and implement the symmetric key algorithm for secure transmission of data.
3. Acquire fundamental knowledge about the background of mathematics of asymmetric key cryptography and understand and analyze asymmetric key encryption algorithms and digital signatures.
4. Analyze the concept of message integrity and the algorithms for checking the integrity of data.
5. Understand various protocols for network security to protect against the threats in the networks.

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – IV
## Cryptography and Network Security (6AIT04)
## Elective - II

### Unit I

Introduction : Attributes of security, OSI Security Architecture, Model for network security. Mathematics of cryptography: modular arithmetic, Euclidean and extended Euclidean algorithm. Classical encryption techniques: substitution techniques-Caesar cipher, Vigenere's ciphers, Hill ciphers, Playfair ciphers and transposition techniques.

### Unit II

Symmetric key cryptography: Block Cipher Principles, Data Encryption Standard (DES), Triple DES, Advanced Encryption Standard (AES), RC4, Key Distribution.

### Unit III

Asymmetric key cryptography: Euler's Totient Function, Fermat's and Euler's Theorem, Chinese Remainder Theorem, RSA, Diffie Hellman Key Exchange, ECC, Entity authentication: Digital signature.

### Unit IV

Message Integrity and authentication: Authentication Requirements and Functions, Hash Functions, MD5, Kerberos, Key Management, X.509 Digital Certificate format.Network Security: PGP, SSL, Firewalls, IDS, Software Vulnerability: Phishing, Buffer Overflow, SQL Injection, Electronic Payment Types,

### Text Books:

1. William Stallings,"Cryptography and Network Security: Principles and Standards", Prentice Hall India, 7th Edition, 2017.

2. Bernard Menezes, 'Network Security and Cryptography", Cengage Learning, 2010.

### References:

1. Nina Godbole, "Information System Security", Wiley India Publication, 2008.
2. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network security, private communication in a public world", Second Edition, Prentice Hall, 2002.
3. Christopher M. King, Curtis Patton and RSA press, "Security architecture, Design Deployment and Operations", McGraw Hill Publication, 2001.
4. Robert Bragge, Mark Rhodes, Heithstraggberg "Network Security, The Complete Reference", Tata McGraw Hill Publication, 2004.
5. Behrouz A. Forouzan, "Cryptography and Network Security", McGraw-Hill publication, 2nd Edition, 2010.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Information Security and Cyber Law (Paper – IV) | | Course Code: (6AIT04) Elective - II | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
The course is designed to make the participants capable of solving industry standard problems in information Security. After completing the course, the participants will be capable of doing the following. They will be able to design countermeasures against common Information Security Attacks.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Demonstrate knowledge and understanding of the policies and stakeholders involved in the internet governance debate and the technical, social, financial, and legal impact of cybercrime, cyberwarfare, and cyber power on global commerce

2. Able to develop strategies for risk management.

3. Will design, develop and test policies and procedures to manage enterprise security risks.

4. Able to evaluate and communicate the human role in security systems with an emphasis on ethics.

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – IV
## Information Security and Cyber Law (6AIT04)
## Elective - II

**Unit I: Information Security**

Need of Information Security, Attributes of Information Security, Authentication, Confidentiality, Integrity, Availability, Non Repudiation.

**Security Services, mechanism and attacks:** Access Control, Threats and Vulnerabilities, Security Attacks, Unauthorized Access, Impersonation, Denial of Service, Malicious Software, Viruses, Worms, Trojan Horses. Definitions, Types of authentication, Password Authentication, Password Vulnerabilities &Attacks: Brute Force & Dictionary Attacks. Password Policy & Discipline, Single Sign-on – Kerberos, Alternate Approaches, Biometrics: Types of Biometric Techniques: False Rejection, False Acceptance, Cross over Error Rates.

**Unit II: Physical and System Security:**

Function of Operating system , Types of OS ( Real time OS, Single User Single task OS, Single User-Multi tasking System, Multiuser System), Task of OS , Process, Memory Management, Device Management, Storage Management, Application Interface, User Interface, Security Weakness, Operating System, Windows Weakness, Hardening OS during Installation, Secure User Account Policy, Strong User Password Policy, Creating list of Services and Programs running on Server, Patching Software, Hardening Windows, Selecting File System, Active Directory / Kerberos, General Installation Rules.

**Unit III: Internet and Web security:**

Web Servers and Browsers, HTTP, Cookies, Caching, Plug-in, ActiveX, Java, JavaScript, Secure Socket Layer (SSL), Secure Electronic Transaction (SET).E-mail Risks, Spam, E-mail Protocols, Simple Mail Transfer Protocol (SMTP), Post office Protocol (POP), Internet Access Message protocol (ICMP). Secured Mail: Pretty Good Privacy (PGP), S/MIME(Secure/Multipurpose Internet MailExtensions)

**Unit IV: Network security Fundamentals:**

Network Devices: Switches, Routers, Firewalls, VPN Concentrators, Load Balancers, Proxies. Network Protocol: Overview of IPV4 and IPV6, OSI Model, Maximum Transfer Unit, Internet Protocol (IP), Transport Control Protocol (TCP), User Datagram Protocol (UDP), Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address ResolutionProtocol (RARP), Domain Name System (DNS). Network Design: Network Address Translation (NAT), Demilitarized Zone (DMZ), Subnetting, Switching, Virtual Local Area Network (VLAN). Network Attack: Buffer Overflow, TCP Session, Hijacking, Sequence Guessing, Network Scanning. IP Security overview and architecture. **IT acts and Cyber Laws:** Salient Feature of IT Act 2000, Legal Provisions under the Information Technology Act, Recent amendments by the IT (Amendment Act) 2008, ActSection66(A, B, C, D, E, F), ITActSection67(A,B,C)

**Text Book**

1. Cryptography & Network Security by William Stallings

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Text Analytics (Paper – IV) | | Course Code: (6AIT04) Elective - II | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
Investigates linguistic, statistical, and machine learning techniques for modeling the information in textual sources. Includes information retrieval, natural language processing, text classification, and sentiment analysis and the software systems for performing these analyses.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. Understand the basics of Natural language processing
2. Analyze the text syntactically
3. Analyze the text content semantically
4. Implement recurrent network for language models
5. Implement a sentiment classification and chatbot systems

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – IV
## Text Analytics (6AIT04)
## Elective - II

**UNIT I: INTRODUCTION**

Introduction to NLP, Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit distance, N gram Language Models, Evaluating Language Models

**UNIT II: SYNTACTIC ANALYSIS**

English Word Classes, The Penn Treebank Part-of-Speech Tagset, Part-of-Speech Tagging, HMM Part- of-Speech Tagging, Maximum Entropy Markov Models, Grammar Rules for English, Treebanks, Grammar Equivalence and Normal form, Lexicalized Grammar.

**UNIT III: SEMANTIC ANALYSIS**

Representation of Sentence Meaning: Computational Desiderata for Representations, Model-Theoretic Semantics, First-Order Logic, Event and State Representations, Description Logics, Semantic roles, Semantic role labeling.

**UNIT IV: SEQUENCE PARSING WITH RECURRENT NETWORKS**

Simple Recurrent Networks, Applications of RNNs, Deep Networks: Stacked and Bidirectional RNNs, Managing Context in RNNs: LSTMs and GRUs, Words, Characters and Byte-Pairs. Sentiment Classification, Dialog Systems and Chatbots.

**TEXT BOOKS**

1.Dan Jurafsky and James H. Martin. Speech and Language Processing (3rd ed. draft), 2019.

**REFERENCE BOOKS**

1. Steven Bird, Ewan Klein, and Edward Loper, Natural Language Processing with Python, FirstEdition, O'reilly, 2009
2. Yoav Goldberg, University of Toronto, Neural Network Methods for Natural language Processing, Morgan & Claypool, 2017

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**
**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**
**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** | |
|---|---|---|---|
| Course Name : Data Visualization (Paper – IV) | | Course Code: (6AIT04) Elective - II | |
| Periods per week (1 Period is 60 minutes) | | 4 | |
| Credits | | 4 | |
| | | Hours | Marks |
| Evaluation Scheme | Theory Examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | | Total Marks | 100 |

**Learning Objectives:**
Data Visualization is designed to provide best knowledge of Data Visualization tools and techniques.The student will be able to create Interactive data visualization software desktop workspace and to connect data and creating calculations to enhance the data visualisation.

**Learning Outcomes:**
After completion of this course successfully the students will be able to:

1. The student will be able to identify and use Interactive data visualization software desktop tools and will also be able to create Interactive data visualization software desktop workspace
2. The student will be able to connect data and will also be able to use Interactive data visualization software's File Types effectively.
3. The student will be able to create analytics pane and will also be able to use Sort, Filters, Sets, Groups and Hierarchy functions
4. The student will be able to create calculations to enhance the data visualisation

# B.Sc. Artificial Intelligence
## Semester – VI
## Paper – IV
## Data Visualization (6AIT04)
## Elective - II

**UNIT -I**

Creating Visual Analytics with Interactive data visualization software Desktop – Shortcomings of Traditional Information Analysis, Business Case for visual analysis, The Interactive data visualization software Software Ecosystem, Introducing Interactive data visualization software Desktop Workspace

**UNIT II**

Connecting Data – How to connect Data, What are generated values, Use of Data Connection and Data Extract, Joining Database Table with Tableau, Blending different Data sources in single Worksheet, Data Quality Problem

**UNIT III**

Building Visualisation – Fast and Easy Analysis via "Show me", how "Show Me" works, Trendlines and Reference Lines, Sorting Data in Interactive data visualization software, Enhancing views with Filters, Sets, Groups and Hierarchies

**UNIT IV**

Creating Calculations to Enhance Data- Aggregation, Calculated Values and Table Calculations, Using Calculation Dialogue box, Binding Formulas using Table Calculations, Table Calculation Functions, Flexibility to Calculation Parameters

**Text Book:**

1. Tableau 10 Complete Reference: Transform your business with rich data visualizations and interactive dashboards with Tableau 10, Joshua MilliganPackt Publishing Limited, ISBN-13: 978-1789957082

2. Visual Analytics with Tableau, Alexander Loth, John Wiley & Sons, ISBN-13: 978-1119560203

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**

**THREE YEAR BACHELOR OF SCIENCE (B. Sc.) ARTIFICIAL INTELLIGENCE DEGREE COURSE**

**(C B S)**

| **B. Sc. (Artificial Intelligence)** | | **Semester – VI** |
|---|---|---|
| Course Name : Major Project | | Course Code: (6AIPR01) |
| Periods per week (1 Period is 60 minutes) | | 4 |
| Credits | | 4 |
| Evaluation Scheme | | |
| Internal Evaluation | | External Evaluation |
| ` | Marks | Marks |
| Two Seminar | 40 | - |
| Project Report | 60 | 60 |
| Viva | - | 40 |
| Total | 100 | 100 |

**Major project based on the B.Sc. Artificial Intelligence Syllabus and relevant to recent trends in the field of Artificial intelligence**