



Rayat Shikshan Sanstha's
Sadguru Gadage Maharaj College,
Karad (An Empowered Autonomous)
Accredited by NAAC with 'A' grade (3.63 CGPA) Grade, ISO 9001:2015 Certified
Affiliated to Shivaji University, Kolhapur

Bachelor of Science

Part - II

Artificial Intelligence (Entire)

Syllabus

**To be implemented
w.e.f. June, 2024**

NEP 2024

Rayat Shikshan Sanstha's
Sadguru Gadage Maharaj College, Karad (Autonomous)
Department of Artificial Intelligence (Entire)
Syllabus for Bachelor of Science Part-II

1. TITLE: ARTIFICIAL INTELLIGENCE (ENTIRE)

2. YEAR OF IMPLEMENTATION: New Syllabus for the B.Sc. I Artificial Intelligence (Entire) will be implemented from June 2023 onwards.

3. PREAMBLE:

Bachelor of Science is an integrated academic degree in the faculty of science. The revision of existing syllabus of Artificial Intelligence subject in Science Faculty is essential. This is a humble endeavor to initiate the process towards an era of knowledge. Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It is the branch of computer science that emphasizes on creating intelligent machines that work and reacts like humans. This course is designed to span a wide variety of topics in computer science research, including machine learning, Game playing, Expert Systems etc.

4. GENERAL OBJECTIVES OF THE COURSE:

- 1) To undertake industry careers involving innovation and problem-solving using software and other information technologies.
- 2) To undertake research careers in Computer Sciences and allied areas.
- 3) To contribute to society by becoming a model professional who can communicate effectively and observes ethical behavior
- 4) To inculcate the software development attitude and generate interest in the field of Technology.
- 5) To develop programming skills, management skills, writing skills, Project Analysis skill among students.

5. PROGRAM SPECIFIC OUTCOMES (PSO's):

- 1) Ability to contribute to problem identification, analysis, design, and development of systems using principles and concepts of Artificial Intelligence and Machine Learning.
- 2) Apply the concepts and practical knowledge in analysis, design and development of computing systems and applications to multi-disciplinary problems.
- 3) To provide a concrete foundation and enrich their abilities to qualify for Employment, Higher studies and Research in Artificial Intelligence and Data science with ethical values.
- 4) Ability to use Artificial Intelligence and Machine Learning models on data for enabling better decision making.

6. DURATION:

- The course shall be a full-time course.

7. PATTERN: Semester

8. MEDIUM OF INSTRUCTION: ENGLISH

Course Structure for B.Sc. II (Semester-III)

Theory				Practical				
Course Title	Course Code	Lecture per week	Credits	Course	Course Title	Course Code	Lecture per week	Credits
Introduction to Machine Learning	BAIT 24 - 301	5	2	Practical -2	Machine Learning and Data Science Lab	BAIP 24-303	4	2
Data Science-I	BAIT 24-302		2					
Data Structure	BAIT 24 - 304	5	2	Practical -2	Data Structure Lab	BAIP 24-306	4	2
Software Engineering (Agile Methodologies)	BAIT 24-305		2					

Course Structure for B.Sc.II. (Semester-IV)

Theory				Practical				
Course Title	Course Code	Lecture per week	Credits	Course	Course Title	Course Code	Lecture per week	Credits
Advanced Machine Learning	BAIT 24-401	5	2	Practical –2	Advanced Machine Learning and Data Science- II Lab	BAIP24-403	4	2
Data Science-II	BAIT 24-402		2					
Image Processing in Machine Learning	BAIT 24-404	5	2	Practical –2	Image Processing in Machine Learning and Advanced Python Programming Lab	BAP24-406	4	2
Advanced Python Programming	BAIT 24-405		2					

Structure and Title of Courses of B. Sc. Course:***B.Sc. II Semester III***

Course Number	Course Code	Course Name
Subject-I DSCI:	BAIT24-301	Introduction to Machine Learning
Subject-I DSCII	BAIT24-302	Data Science-I
Subject-I Practical-I	BAIP24-303	Practical based on DSCI and DSCII
Subject-II DSCI:	BAIT24-304	Data Structure
Subject-II DSCII	BAIT24-305	Software Engineering(Agile Methodologies)
Subject-II Practical-I	BAIP24-306	Practical based on DSCI

Structure and Title of Courses of B.Sc II. Course:***B.Sc. II Semester IV***

Course Number	Course Code	Course Name
Subject-I DSCIII:	BAIT24-401	Advanced Machine Learning
Subject-I DSCIV	BAIT24-402	Data Science-II
Subject-I Practical-II	BAIP24-403	Practical based on DSCI and DSCII
Subject-II DSCIII:	BAIT24-404	Image processing in Machine Learning
Subject-II DSCIV	BAIT24-405	Advanced Python Programming
Subject-II Practical-II	BAIP24-406	Practical based on DSCIII and DSCIV

Major Syllabus

B.Sc.II

Semester III

Theory: Course- I: BAIT301: Introduction to Machine Learning

Course Objectives: Students should be able to...

- 1) Develop a solid understanding of the fundamentals of machine learning, including its types and applications.
- 2) Apply various machine learning techniques such as linear regression, logistic regression, and decision trees to train models and make predictions.
- 3) Gain proficiency in using support vector machines (SVM) for classification and regression tasks.
- 4) Acquire practical skills in implementing machine learning algorithms.
- 5) Analyzing performance measures for model evaluation.

Credits=2	SEMESTER-III Course- I: BAIT24-301 Introduction to Machine Learning	No. of hours per unit/ credits
Unit I	Overview of machine learning concepts	(15)
	Introduction to Machine learning, Types of Machine learning, Real World applications and Ethics. Programming for ML : Python libraries , Numpy , Pandas , Matplotlib, Foundations for ML, ML Techniques overview , Validation Techniques (Cross-Validations) Supervised learning: Introduction to supervised learning, types of problems, Linear models Linear regression , logistic regression, Decision trees & random forests , Support vector machines (SVM) , Instance based learning - K-Nearest Neighbors (KNN), regularization techniques : Ridge , Lasso	
Unit II	Unsupervised learning:	(15)
	Introduction to clustering, Clustering techniques -K-means clustering, Hierarchical clustering, DBSCAN , Model evaluation ,Gaussian mixture models (GMM) & Expectation- maximization(EM) , Anomaly detection techniques Dimensionality reduction techniques: Principal component analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE): Uniform Manifold Approximation and Projection (UMAP): Self-Organizing Maps (SOMs), Forecasting models trend analysis , cyclical and seasonal analysis	

Course Outcomes: Students will be able to...

- 1) Remember the foundational concepts and historical developments in Machine Learning.
- 2) Understand the principles of SVM.
- 3) Apply search strategies effectively, distinguishing between uninformed and informed methods to solve ML problems.
- 4) Analyze different approaches to knowledge representation in ML.

Reference Books:

- 1) Ameet V. Joshi(2019),Machine Learning and Artificial Intelligence, Springer, Cham.
- 2) Zsolt Nagy(2018),Artificial Intelligence and Machine Learning Fundamentals.
- 3) Andreas C. Müller, Sarah Guido (2016), Introduction to Machine Learning with Python ,First Edition Publisher – O'Reilly Media, Inc.
- 4) Machine Learning in Action, Peter Harrington (2012), April, Manning publications, Jiawei Han and Micheline Kamber(2012) Data Mining Concepts and Techniques, Elsevier Inc.

B.Sc. II - Semester-III
Theory: Course II: BAIT24-302: Data Science

Course Objectives: Students should be able to...

- 1) To provide the knowledge on Data Mining concepts and techniques.
- 2) To study the basic concepts of cluster analysis.
- 3) To study a set of typical clustering methodologies, algorithms, and applications.

Credits=2	SEMESTER-III Course II: BAIT24-302: Data Science	No. of hours per unit/ credits
UNIT I	Data Mining Fundamentals	(15)
	Data Mining–Knowledge Discovery from Databases–Foundation in Data science– Data Objects and Attribute Types–Mean, Median, and Mode–Range, Quartiles, and Interquartile Range – Outliers–Variance and Standard Deviation–Data Preprocessing–Major Tasks in Data Preprocessing – Forms of Data Preprocessing –Data Cleaning –Missing Values –Noisy Data – Data Cleaning as a Process- Discretization, Concept Hierarchy for Nominal Data.	
UNIT II	Mining Frequent Patterns, Associations, and Correlations	(15)
	Market Basket Analysis–Frequent Itemsets, Closed Itemsets, and Association Rules – Apriori Algorithm – Pattern-Growth Approach for Mining Frequent Itemsets –Mining Frequent Itemsets Using the Vertical Data Format – Mining Closed Classification – General Approach to Classification Decision Tree Induction – Basic Algorithm for Inducing a Decision Tree from Training Tuples – Attribute Selection Measures: Information Gain – Gain Ratio – Gini Index. Cluster Analysis: Cluster Analysis Requirements - Clustering Methods - Evaluation of Clustering - Outlier Analysis - Data Mining Trends: Other Methodologies of Data Mining - Data Mining Applications and Data Mining Trends.	

Course Outcomes: - Students will be able to...

- 1) Apply the basics of databases and data management.
- 2) Evaluate various theoretical and practical principles involved in the design and use of databases systems with the help of database.
- 3) Design and implement databases for various scenarios.

Reference Books:

- 1) K.P. Soman, Shyam Diwakar, V. Ajay “Insight into Data Mining Theory and Practice “,Prentice Hall of India Pvt. Ltd, New Delhi
- 2) Parteek Bhatia, „Data Mining and Data Warehousing: Principles and Practical Techniques“, Cambridge University Press, 2019
- 3) Berson and Smith S.J. (1997) : Data warehousing, Data Mining, and OLAP, McGraw-Hill.
- 4) Breiman J.H Friedman, R.A. Olshen and stone C.J. (1984) : Classification a Regression Trees, Wadsworth and Brooks / Cole.
- 5) Han, J. and Kamber, M. and Pei, J. (2012) : Data Mining: Concepts and Techniques. MorganGaufmann.3rd Edition.
- 6) Chattamvelli, R. (2015). Data mining methods. Alpha Science International.

Web, E-content from open-source libraries.

Practical-I

Lab Course I: BAIP24-303: Lab based on BAIT24-301 and BAIT24-302

Course Objectives: Students should be able to...

- 1) Study of awareness of fundamental understanding of various applications of AI techniques.
- 2) Understand the various steps in program development.
- 3) Learn different types of database systems and their applications in different scenarios.
- 4) Identify the process of drawing the ER-Diagrams.
- 5) Study of the importance of database analysis and learn any database application.
- 6) Identify and handle missing values.
- 7) Study to Deal with duplicate records.
- 8) Learn about Handle outliers.
- 9) Understand the Correct inconsistent data.
- 10) Study the Standardize formats (e.g. dates, text) Fix data types.

Credits= 2	SEMESTER-III Course II: BAIP24-303: Practical ML and Data Science
1	Introduction to Machine Learning Concepts <ul style="list-style-type: none">● Implement a basic linear regression model using Python (scikit-learn).● Explore a data set, visualize relationships using Matplotlib and Seaborn.
2	Validation Techniques <ul style="list-style-type: none">● Implement K-fold cross-validation on a dataset.● Compare Leave-One-Out Cross-Validation (LOOCV) with K-fold cross-validation.
3	Feature Reduction & Dimensionality Reduction <ul style="list-style-type: none">● Apply Principal Component Analysis (PCA) and visualize transformed data.● Implement feature selection using Lasso and Ridge regression.
4	Supervised Learning – Classification <ul style="list-style-type: none">● Build a logistic regression classifier for binary classification.● Implement K-nearest neighbor (KNN) regression and evaluate performance● Implement Decision Trees and Random Forest classifiers.
5	Unsupervised Learning – Clustering <ul style="list-style-type: none">● Implement K-means clustering and visualize clusters.● Apply Hierarchical clustering and plot a dendrogram.
6	Support Vector Machines (SVM) <ul style="list-style-type: none">● Train a Linear SVM for classification.● Apply Soft Margin SVM for handling non-linearly separable data. Decision Trees <ul style="list-style-type: none">● Train a Decision Tree classifier and visualize it using Graphviz.
7	Dimensionality Reduction Techniques <ul style="list-style-type: none">● Implement Multidimensional Scaling (MDS) on a dataset.● Apply PCA for reducing dimensionality in high-dimensional datasets.

Credits=2	<p style="text-align: center;">SEMESTER-III Course II: BAIP24-303: Practical Data Science(Mining)</p>
1	<p>Data Mining Fundamentals:</p> <ul style="list-style-type: none"> ● What is Data Mining? ● Key Steps in Data Mining Process ● Popular Data Mining Techniques
2	<p>Data Preprocessing Practical's (with Python)</p> <ul style="list-style-type: none"> ● Libraries to Import ● Loading Data ● Handling Missing Data ● encoding Categorical Variables
3	<p>Data Cleaning Practical in Data Mining</p> <ul style="list-style-type: none"> ● Load the Dataset ● Missing Value Handling ● Remove Duplicates ● Outlier Detection & Removal ● Fix Inconsistent Data ● Standardize Date Formats
4	<p>Market Basket Analysis (MBA):</p> <ul style="list-style-type: none"> ● Load or Create a Transaction Dataset ● Find Frequent Itemsets ● Generate Association Rules ● Filter Strong Rules
5	<p>Apriori Algorithm:</p> <ul style="list-style-type: none"> ● Required Libraries ● Sample Transaction Dataset ● Apply Apriori Algorithm ● Generate Association Rules

Reference Books:

- 1) Tom Mitchell. Machine Learning. McGraw Hill, 1997.
- 2) Gupta, Brij B., and Quan Z. Sheng, eds. Machine learning for computer and cyber security: principle, algorithms, and practices. CRC Press, 2019.
- 3) Artificial Intelligence and Data Mining Approaches in Security Frameworks Editor(s):Neeraj Bhargava, Ritu Bhargava, Pramod Singh Rathore, Rashmi Agrawal, 2021.
- 4) Tsai, Jeffrey JP, and S. Yu Philip, eds. Machine learning in cyber trust: security, privacy, and reliability.

B.Sc. II - Semester-III
Theory: Course II: BAIT24-304: Data Structure

Course Objectives: Students should be able to...

- 1) Implement and manipulate fundamental data structures like arrays, linked lists, stacks, queues, trees, and graphs.
- 2) Analyze algorithm efficiency using asymptotic notations such as Big O, Big Omega, and Big Theta.
- 3) Apply sorting and searching algorithms including Bubble Sort, Merge Sort, Quick Sort, Linear Search, and Binary Search.
- 4) Understand and implement hashing techniques for efficient data retrieval and collision resolution.
- 5) Solve real-world problems by selecting and applying appropriate data structures and algorithms.

Credits=2	SEMESTER-III Course II: BAIT24-304: Data Structure	No. of hours per unit/ credits
UNIT I	Overview of Data Structures	(15)
	Introduction to Data Structures, Types of data structures, Abstract Data Types (ADT), Arrays : one and multidimensional , Operations of Arrays, linked lists: singly , doubly and circular linked lists. Stacks :Implementing using array and linked lists, push, pop, peek and isEmpty operations, Simple queues , circular queue, Deque, Operations of Queues, Scheduling , buffering. Sorting and Searching algorithms : Bubble sort, insertion sort , Merge sort ,selection sort , Searching algorithms.	
UNIT II	Data structure Algorithms	(15)
	Binary trees, Balanced tree , Heap trees , Applications of trees : Priority queues and sorting ,Types of Graphs , Graph traversal algorithms, applications of graphs, Hash functions, structure and operations of hash tables , collision resolution techniques.	

Course Outcome: After completion of the course, students will be able to:

- 1) Demonstrate the different types of data structures
- 2) Understand the concept of recursive algorithms.
- 3) Able to understand the operations on linear data structures.
- 4) Summarize searching and sorting techniques.
- 5) Comprehend Data Structure and Their real-time applications- Stack, Queue, Trees, Graphs.

Reference Books:

- 1) Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
- 2) The Art of Computer Programming by Donald E. Knuth
- 3) The Algorithm Design Manual by Steven S. Skiena
- 4) Algorithms by Robert Sedgewick and Kevin Wayne
- 5) Data Structure and Algorithm Analysis in C – Mark Allen Weiss – Second Edition, Addison Wesley publishing company, 1997
- 6) C and C++ Programming Concepts and Data Structures -P.S. Subramanyam - BS Publications, 2013.
- 7) Data Structures and Algorithms- Alfred V.Aho, John E.Hopcraft and Jeffrey D.Ullman - Pearson Education - Fourteenth Impression -2013

B.Sc. II - Semester-III

Theory: Course II: BAIT24-305: Software Engineering (agile methodologies)

Course Objectives: Students should be able to...

- 1) Understand Software Development Models: Learn about traditional and modern software development life cycle models, including Waterfall, V-Model, Spiral, and Agile methodologies.
- 2) Apply Agile Practices: Gain practical experience in implementing agile frameworks such as Scrum, Kanban, and Extreme Programming (XP) to manage software projects effectively.
- 3) Master Software Design Principles: Develop skills in modular design, abstraction and user interface design principles to create maintainable and user-friendly software systems.
- 4) Implement Testing and Quality Assurance: Learn various testing levels (unit, integration, system, and acceptance) and techniques (black-box, white-box, regression) to ensure software quality.

Credits=2	SEMESTER-III Course- I: BAIT24-305 Software Engineering (agile methodologies)	No. of hours per unit/ credits
Unit I	Basics of Software Engineering Importance of software engineering, Waterfall, V-Model, Spiral SDLC , Software requirements gathering techniques, functional and nonfunctional requirements, Software design principals and patterns , modular design and abstraction, user interface design principals. Software testing : Levels of testing : unit , integration , system , acceptance , testing techniques : black-box , white-box , regression , test planning and case design , bug tracking & reporting	(15)
Unit II	Agile Methodologies Agile Manifesto and Principles, Comparison with Traditional Software Development Models , Waterfall vs. Agile, Benefits and challenges of Agile adoption, Scrum framework: Scrum Roles, Scrum Artifacts Sprint Planning, Daily Scrum, Sprint Review, Sprint Retrospective. Kanban, system, lean principals , real world examples , and Extreme Programming (XP) frameworks: Core practices of XP, XP values Agile project Management : planning & estimation , monitoring & reporting , risk management , Jira and Trello	(15)

Reference Books:

- 1) Software Engineering (10th Edition) Author: Ian Sommerville.
- 2) Agile Estimating and Planning Author: Mike Cohn
- 3) The Art of Software Testing (3rd Edition) Author: Glenford J. Myers
- 4) Agile Software Development, Principles, Patterns, and Practices Author: Robert C. Martin

Practical-I
Lab Course I: BAIP24-306: Lab based on BAIT24-304

Course Objectives: Students should be able to...

- 1) This course will introduce the concepts of Abstract data type (ADTs), linear data structures which includes lists, stacks, and queues
- 2) The course covers various sorting, searching and hashing algorithms and applications of linear data structures.

Credits= 2	SEMESTER-III Course II: BAIP24-303: Data Structure
1	Implementing Stack as an array.
2	Implementing Stack as a linked list.
3	Convert Infix expression to Postfix expression using stack.
4	Convert Infix expression to Prefix expression using Stack
5	Implementing Queue as an Array.
6	Implement Queue as a linked list.
7	Implement Binary tree traversals.
8	Implementation of Binary Search Tree. Create a binary search tree.
9	Traverse the above binary search tree recursively in pre-order, post-order and in- order
10	Implement Bubble sort as a searching algorithm.
11	Implementation of Insertion sorting.
12	Implement the Merge sort and selection sort.

Course Outcomes: completion of the course the student should

- 1) Understand the need for Data Structures when building applications.
- 2) Design and develop algorithms using relevant data structure operations.
- 3) Appreciate the need for an optimized algorithm.

Recommended Reading:

- 1) Aho- Hopcraft- Ullman- "The Design and Analysis of Computer Algorithms" Pearson Education- 2008.
- 2) Horowitz- Sahni- Rajasekaran- Fundamentals of Computer Algorithms-Silicon Pr- 2nd Edition- November 2012.

B.Sc. II - Semester-III
Theory: OE: BAIT24-307: Computer Organization

Course Objectives: Students should be able to...

- 1) To introduce the fundamental principles and concepts of computer organization, architecture, and digital electronics.
- 2) To provide solid understanding of how computers are designed and how digital circuits operate, enabling them to comprehend the interactions between hardware and software components.

Credits=2	SEMESTER-III Course- I : OE: BAIT24-307: Computer Organization	No. of hours per unit/ credits
Unit I	<p>MEMORY ORGANISATION: Introduction, Characteristics of memory systems, Main memory design, Memory hierarchy, Cache memory, Memory mapping, Virtual Memory, Memory management concepts (paging and segmentation).</p> <p>CONTROL UNIT: Introduction, Hardware control-design methods, Micro programmed control unit, Microinstruction addressing and architecture of typical micro programmed control unit.</p>	(15)
Unit II	<p>I/O ORGANISATION Peripheral devices, Input output Interface, IO mapped IO, Memory mapped IO, Asynchronous data transfer, Modes of transfer, Priority Interrupts, Direct memory access, Input output Processor, serial communication.</p> <p>CPU ORGANISATION: Introduction, General register organization, Stack Organization, Instruction formats, Addressing modes Program Control, Arithmetic and Logic Unit (One bit and multiplebit), Bit processor.</p>	(15)

Course Outcomes:

- 1) Understand various components of computer and their interconnection
- 2) Understand basic components and design of the C.P.U
- 3) Compare and select various Memory devices as per requirement.
- 4) Compare various types of IO mapping techniques

Reference Books:

- 1) Computer Organization - J.P. Hays TMH
- 2) William Stallings, "Computer Organization and Architecture- Designing for Performance," Pearson Education, 10th Edition, 2016.
- 3) Anrew S. Tanenbaum, "Structured Computer Organization," Pearson Education, 6th Edition, 2016.
- 4) John P. Hayes, "Computer Architecture and Organization," McGraw-Hill, 3rd Edition, 2017

B.Sc. AI - II - Semester-III
Practical: Course I: BAIP24-309-SEC-I-Introduction to R

Course Objectives:

- 1) **Understand the basics of R programming** – including installation, R Studio interface, and script execution.
- 2) **Work with data types and structures** – such as vectors, lists, matrices, data frames, and factors.
- 3) **Implement control structures** – such as loops, conditional statements, and user-defined functions.
- 4) **Read and write data** – including CSV, Excel, and other common formats.
- 5) **Understand and use packages** – install, load, and apply R packages for extended functionality.
- 6) **Develop basic data analysis projects** – to apply R programming in real-world contexts.

Credits=2	SEMESTER-III BAIP24-309-SEC-I - Introduction to R	No. of hours per unit/credits
Unit I	Introduction	(15)
	1.1 Installation and introduction to R, History and features of R, Why R?, data input / output variables in R: Numeric, character, logical and complex 1.2 Class (), Object identification: is.na, is.numeric, is.character, is.matrix, is.vector, is.null, is.factor, as. functions, Creation of vector using commands: combine, scan, seq, rep, edit, sort, length, which, order 1.3 Operations on data: Assignment operators in R, leftwards assignments(<-<<-, =) rightwards assignments (->, ->>, =), Listing and deleting the objects: matrix, data.frame, cbind, rbind ,converting objects, 1.4 Arithmetic and simple functions: sum, prod, sort,	
Unit II	Control Structure in R, Data visualization & interpretation	(15)
	2.1 Matrix computation: addition, multiplication, determanant, inverse, rank, Import and export data: read.table, read.csv, file.choose, write.table, write.csv. 2.2 Data Visualization: -Diagramatic representation: simple bar diagram, sub-divided bar diagram, multiple bar diagram. -Graphical representation: Scatter plot, histogram, frequency polygon, ogive curve. 2.3 Control structure: for loop, while loop, if else statement, break statement, switch case. 2.4 Installation of packages, Exploratory data analysis: mean, quantiles, aggregate function from apply family, functions.	

Course Outcomes: At the end of this course students will be able to:

- 1) Understand basics of R programming.
- 2) Know various built-in functions in R.
- 3) Understand the control structure in R.
- 4) Understand the data visualization in R.

Reference Books:

- 1) Crawley, M. J. (2006): Statistics - An introduction using R. John Wiley, London 32
- 2) Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015): Statistics using R, second edition. Narosa Publishing House, New Delhi.
- 3) Verzani, J. (2005): Using R for Introductory Statistics, Chapman and Hall /CRC Press, New Yor

Practical

Sr.No	Practical Name
1	R tools for statistical computing- Some basic operations
2	R tools for statistical computing- Creating a vector, Repeat Function
3	R tools for statistical computing- Class Function, Sequence function
4	R tools for statistical computing-Operators using vectors, Accessing vectors
5	R tools for statistical computing- Some common built in functions
6	R tools for statistical computing : Data frame
7	R tools for statistical computing: Graphical Representation
8	R tools for statistical computing : Matrix
9	R tools for statistical computing : Control Statement-1
10	R tools for statistical computing : Control Statement-2

B.Sc. II - Semester-IV
Theory: Course II: BAIT24-401: Advanced Machine Learning

Course Objectives: Students should be able to...

- 1) Understand and implement advanced neural network architectures including MLPs, CNNs and RNNs with a strong grasp of activation functions and back propagation.
- 2) Apply reinforcement learning techniques like Q-Learning and Deep Q-Networks using Markov Decision Processes for sequential decision-making problems.
- 3) Analyze and forecast time series data using statistical models like ARIMA and machine learning-based Forecasting methods.
- 4) Deploy machine learning models into production environments using tools like Flask and Fast API while addressing ethical concerns and ensuring fairness.

Credits=2	SEMESTER-III Course II: BAIT24-401: Advanced Machine learning	No. of hours per unit/ credits
UNIT I	<p>Advanced Machine Learning:</p> <p>Introduction to Neural Networks – NLP , Biological Neural Networks vs. Artificial Neural Networks, Typs of Neural Networks, Feed forward Networks, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Natural Language Processing (NLP), Activation functions: Sigmoid, ReLU, Tanh, Back propagation algorithm, Application.</p> <p>Natural Language Processing (NLP): Definition, Applications(Chatboat,search engine ,transaltion,Chatboat) ,Text Pre-processing ,(Tokenization, stop words, stemming, lemmatization) Text Representation Bag of Words (BoW), TF-IDF, word frequency matrix.Text classification. ML based text classification spam detection or sentiment analysis</p>	(15)
UNIT II	<p>Reinforcement Learning:</p> <p>Markov Decision Processes (MDPs), Q-Learning and Deep Q- Networks (DQN), Time Series Analysis : ARIMA models, Forecasting techniques, Model Deployment and Product ionization: Model serialization and deserialization, Flask, FastAPI , Ethics and Fairness in Machine Learning</p>	(15)

Course OutComes:

- 1) Demonstrate the ability to build and train deep neural networks using MLPs, CNNs, and RNNs for various machine learning tasks.
- 2) Apply reinforcement learning algorithms to solve real-world problems involving decision-making and control systems.
- 3) Perform time series analysis and forecasting using ARIMA models and evaluate model Performance effectively.
- 4) Deploy machine learning models as APIs using Flask or FastAPI and explain ethical implications in AI systems.

Reference Books:

- 1) Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville
- 2) Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron
- 3) Reinforcement Learning: An Introduction – Richard S. Sutton, Andrew G. Barto
- 4) Speech and Language Processing – Daniel Jurafsky, James H. Martin
- 5) Deep Reinforcement Learning Hands-On – Maxim Lapan
- 6) Natural Language Processing with Python (NLTK Book)

B.Sc. II - Semester-IV
Theory: Course II: BAIT24-402: Data Science-II

Course Objectives:

- 1) Introduce the foundations of data warehousing and its role in analytics.
- 2) Teach data modeling techniques and the basics of ETL pipelines.
- 3) Demonstrate how to analyze data using simple BI and data science tools.
- 4) Provide hands-on experience with a cloud-based data warehouse and Python.

Credits=2	SEMESTER-IV Course II: BAIT24-402: Data Science-II	No. of hours per unit/ credits
UNIT I	Introduction to Data Warehousing	(15)
	Difference between databases and data warehouses, real life examples , OLTP VS OLAP, Data modeling: Star schema vs Snowflake schema, fact & dimension tables, ER diagrams, Use of ETL (Extract, Transform , load), Talend , ETL operation using python, Use of SQL in warehousing, Filtering , joins , aggregation, Writing queries on fact & dimension tables	
UNIT II	Cloud Data Warehousing& basic DS on warehouse data	(15)
	Intro to Big Query or Snowflake (GUI and simple queries), Uploading data to a cloud warehouse, Connecting Python or BI tools to the cloud warehouse, Using Python (pandas, matplotlib) to explore warehouse data, Simple prediction using Linear Regression or Decision Trees	

Course Outcomes: Students will be able to...

- 1) Understand the purpose and structure of a data warehouse.
- 2) Design basic star and snowflake schemas for a business case.
- 3) Perform basic ETL tasks and data cleaning using GUI tools and Python.
- 4) Analyze warehouse data using SQL, visualization tools, and basic ML models.

Recommended Resources:

- 1) The Data Warehouse Toolkit (Beginner-Friendly Sections) – Ralph Kimball
- 2) Data Science for Business – Provost & Fawcett
- 3) Google BigQuery Tutorials (free)
- 4) YouTube Channels: Alex The Analyst, Data School
- 5) Optional: Datacamp / Coursera beginner SQL and Python courses

Practical-II
Lab Course I: BAIP 24-403: Lab based on BAIT24-401 and BAIT24-402

Course Objectives:

- 1) Understand neural network fundamentals by training and evaluating models on real-world datasets like MNIST and Fashion-MNIST.
- 2) Learn the impact of activation functions (Sigmoid, Tanh, ReLU) on model performance through experimentation on classification tasks.
- 3) Implement and evaluate CNNs and RNNs for image and text classification, utilizing datasets like CIFAR-10 and IMDB.
- 4) Apply time series analysis (e.g., ARIMA) to forecast future trends such as temperature or sales data.
- 5) Work with cloud data warehousing, SQL, and Python to clean, analyze, and visualize warehouse data, creating dashboards and reports.

Credits=2	SEMESTER-IV Course II: BAIP24-403: Machine Learning and Data Science
1	Train a neural network to recognize handwritten digits using the MNIST dataset.
2	Compare how accuracy changes when using Sigmoid vs Tanh vs ReLU in a small neural network on the Fashion-MNIST dataset.
3	Classify images from the CIFAR-10 dataset using a CNN with two convolutional layers, ReLU activation, and max pooling.
4	Build a character-level RNN that predicts the next character in a word. Use a small dataset like names or movie titles.
5	Classify movie reviews (positive/negative) using an LSTM on the IMDB dataset. Use word embeddings and basic text preprocessing.
6	Use the ARIMA model to forecast the next 10 days of daily temperature from a given dataset (e.g., Weather dataset from Kaggle).
7	Create a Flask app to serve a trained digit classification model. Take an image as input and return the predicted digit.
8	Examine the "Adult Income" dataset for gender bias in predictions. Train a model to predict income and check if it treats genders equally.

9	Create a star schema for a retail store with a fact table for sales and dimension tables for product, customer, and time. Draw the schema diagram and explain the relationships.
10	Load raw CSV data (e.g., sales data) and clean it by handling missing values and removing duplicates using Python (pandas) or an ETL tool.
11	Write SQL queries to analyze a sales data warehouse, including queries for total sales, top products, and monthly revenue trends using JOIN and aggregation.
12	Build an interactive dashboard to visualize sales data, including charts for total sales, top products, and trends over time using a BI tool like Power BI or Google Data Studio.
13	Upload a CSV file to a cloud data warehouse (e.g., BigQuery or Snowflake) and run a query to summarize the data, visualizing the results if applicable.
14	Use Python to load warehouse data and apply a basic linear regression model to predict future sales trends based on historical data.

Course Out comes:

- 1) Build and train neural networks to classify images and text, optimizing performance with different architectures and activations.
- 2) Design and implement data preprocessing and ETL workflows to clean and prepare real-world data for analysis or machine learning.
- 3) Create interactive visualizations and dashboards using BI tools to explore sales data, trends, and predictions.
- 4) Perform time series forecasting and evaluate the performance of ARIMA models in predicting future trends.
- 5) Deploy machine learning models using Flask and cloud platforms, ensuring their integration into real-world applications for prediction tasks.

Reference Books:

- 1) "Deep Learning with Python" by François Chollet
- 2) "Python Data Science Handbook" by Jake VanderPlas
- 3) "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
- 4) "SQL for Data Scientists" by Renee M. P. Teate
- 5) Google Cloud Training (BigQuery & Data Studio) - Google Cloud

B.Sc. II - Semester-IV

Theory: Course II: BAIT24-404: Image processing in Machine Learning

Course Objectives:

- 1) Explain the basics of image formation and image processing techniques.
- 2) Apply filtering, enhancement, and transformation techniques on images.
- 3) Implement edge detection, segmentation, and morphological operations.
- 4) Analyze image features for pattern recognition and AI-based applications.
- 5) Build simple image processing pipelines using Python.

Credits=2	SEMESTER-IV Course II: BAIT24-404: Image processing in Machine Learning	No. of hours per unit/ credits
UNIT I	<p>Introduction to Image Processing:</p> <p>Digital image fundamentals, Image representation: Binary, grayscale, color, Human visual system vs computer vision, Image file formats (JPEG, PNG, BMP, TIFF), Image acquisition and sampling, Color models (RGB, HSV, CMY)</p> <p>Image Enhancement and segmentation:</p> <p>Introduction to Image Enhancement, Image histograms: Equalization and contrast stretching, Point processing: Brightness and contrast adjustment, Spatial filtering: Smoothing (mean, Gaussian), Sharpening (Laplacian), Noise removal techniques: Median filter, Gaussian blur, Image resizing, rotation, affine and perspective transformations</p>	(15)
UNIT II	<p>Introduction to Image Processing Sobel, Prewitt, Canny, Region-based segmentation, Thresholding: Global, adaptive, Contour detection</p> <p>Feature Extraction and Applications in AI :</p> <p>Feature descriptors: Corners, blobs, HOG, Pattern recognition using extracted features, Introduction to object detection, Haar Cascade, object tracking and Face detection. Real-world applications: Medical imaging, OCR, surveillance.</p> <p>Models: Deep CNN, VGG16, ResNet50, MobileNet, YOLO</p>	

Course Outcomes: Students will be able to...

- 1) Explain the fundamentals and applications of digital image processing.
- 2) Explain the fundamentals and applications of digital image processing.
- 3) Enhance images using spatial domain techniques.
- 4) Apply frequency domain methods for filtering and enhancement.
- 5) Perform image restoration using various filtering techniques.

Recommended Books:

- 1) Gonzalez & Woods, Digital Image Processing, 4th Ed., Pearson, 2018.
- 2) Anil K. Jain, Fundamentals of Digital Image Processing, PHI, 1989.
- 3) Bernd Jähne, Digital Image Processing, 6th Ed., Springer, 2005.
- 4) William K. Pratt, Digital Image Processing, 4th Ed., Wiley, 2007.
- 5) S. Jayaraman et al., Digital Image Processing, TMH, 2011

B.Sc. II - Semester-IV
Theory: Course II: BAIT24-405: Advanced Python Programming

Course Objectives:

- 1) To Gain familiarity with Python syntax, data types, and control structures to write simple programs.
- 2) To Apply Python to solve computational problems, manipulate data, and automate tasks effectively.
- 3) To develop proficiency in writing Python scripts and programs for various applications, such as web development, data analysis and automation.

Credits=2	SEMESTER-IV Course II: BAIT24-405: Advanced Python Programming	No. of hours per unit/ credits
UNIT I	<p>Classes and objects: Creating a class, the self-variable, types of variables, namespaces, types of methods, instance methods, class methods, static methods, passing members of one class to another class, inner classes.</p> <p>Inheritance and polymorphism: Inheritance in python, types of inheritance- single inheritance, multilevel inheritance, hierarchical inheritance, multiple inheritance, constructors in inheritance, overriding super class constructors and methods, the super() method, method resolution order (mro), polymorphism, duck typing, operator overloading, method overloading, method overriding , Creating a GUI in python, Widget classes, Working with Fonts and Colors, working with Frames, Layout manager, Event handling</p>	(15)
UNIT II	<p>Working with files:</p> <p>Files, opening and closing a file, working with text files containing strings, knowing whether a file exists or not, working with binary files, with statement, the seek() and tell() methods, random accessing of binary files, zipping and unzipping files, working with directories, running other programs from python program.</p> <p>Regular expressions and Threads in python: What is a regular expression?, sequence characters in regular expressions, quantifiers in regular expressions, special characters in regular expressions, using regular expression on files, Difference between process and thread, types of threads, benefits of threads, creating threads, single tasking and multitasking, thread synchronization, deadlock in threads, daemon threads.</p>	(15)

Course Out comes: Students will be able to...

- 1) Understand the purpose and structure of a Python.
- 2) Perform basic tasks with data handle using GUI tools and Python.
- 3) Analyze warehouse data using SQL, visualization tools, and basic ML models.

Recommended Resources:

- 1) Hetland, Magnus Lie, "Beginning Python from Novice to Professional," Apress, 2nd Edition, 2017.
- 2) Lutz, M., "Learning Python: Powerful Object-Oriented Programming," O'Reilly Media, Inc. 5th Edition, 2013.

Practical-II

Lab Course I: BAIP24-406: Lab based on BAIT24-404 and Lab based on BAIT24-405

Credits= 2	SEMESTER-III Course II: BAIP24-406: Advanced Python Programming and Image processing in Machine Learning
1	Write a Python Program to Print a Multiplication Table for the given number
2	Write a Python Program to check whether the given number is prime or not.
3	Write a Python Program to display the Fibonacci series for a given number
4	Write a menu driven program to convert the given temperature from Fahrenheit to Celsius and vice versa depending upon user's choice.
5	Write a Python Program to implement List Operations (Nested List, Length, Concatenation, Membership, Iteration, Indexing and slicing).
6	Write a Python Program to Transpose the Matrix.
7	Write a Python Program to implement the simple Calculator.
8	Write a Python Program to Generate the Calendar for the Given Month and Year
9	Write a Python Program to implement the List Methods (Add, Append, Extend & Delete)
10	Write a Python Program to implement the Breadth first Search Traversal.
11	Write a Python Program to implement the Hangman game
12	Write a Python Program to sort the sentence in the alphabetical order.
13	Write a Python Program to Find factorial of the given number to implement the simple chat bot.

Credits= 2	SEMESTER-III Course II: BAIP24-406:Image processing in Machine Learning
1	Display and basic manipulation using OpenCV , Hands-on: Convert RGB to grayscale
2	Apply different filters using Python Compare original vs enhanced images
3	Resize and transform images in real-time, Visualize DFT spectrum of an image
4	Segment handwritten digits or simple objects
5	Apply Canny edge detection on real images
6	Face detection using OpenCV
7	Medical image classification Model using image augmentation

B.Sc. II - Semester-IV

Theory: OE: BAIT24-407: Computer Networking

Course Objectives:

- 1) Build an understanding of the fundamental concepts of computer networking.
- 2) Familiarize the student with the basic taxonomy and terminology of the computer networking area.
- 3) Introduce the student to advanced networking concepts, preparing the student for entry Advanced courses in computer networking.
- 4) Allow the student to gain expertise in some specific areas of networking such as the design and maintenance of individual networks.

Credits=2	SEMESTER-IV Course II: BAIT24-407:Computer Networking	No. of hours per unit/ credits
UNIT I	Physical and Data link Layer:	(15)
	Physical layer: -Digital-to-analog conversion: concept, Amplitude Shift Keying, Frequency Shift Keying, Analog-to digital conversion:- Pulse Code Modulation (PCM),Delta Modulation (DM), Data link layer , Design issues, Framing, error detection and correction, Protocols:- Sliding window protocol: one bit sliding window protocol, protocol using go back, protocol using selective repeat. Network and Transport Layer: Network layer: - Design issue, Concept of routing, Routing algorithm (shortest path, Flooding, distance vector) , Congestion control algorithms (Leaking bucket, Token Bucket) , Transport layer: Services: Connection oriented and connection less services, Transport Layer Primitives: listen, connect, send, receive, disconnect , Protocols: TCP, UDP.	
UNIT II	Session layer: Services: dialog management synchronization, activity management, exception handling Remote procedure calls Presentation layer: Services: Translation, compression, encryption Cryptography: concept, symmetric key & asymmetric key cryptography. Application layer and network security: Application layer: Function Domain name system (DNS),Hypertext Transfer Protocol (HTTP), Simple Mail Transfer Protocol (SMTP) ,Telnet, File Transfer Protocol (FTP) Network security: Security concept and services Message Authentication, Digital Signatures, Entity authentication.	(15)

Course Outcomes:

- 1) Identify the different types of network topologies and protocols.
- 2) Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.
- 3) Identify the different types of network devices and their functions within a network
- 4) Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation

Recommended Books:

- 1) Computer Networks, Andrew. S. Tanenbaum, 4/e, Prentice Hall of India Private Ltd, 2003.
- 2) Data Communications and Networking, Behrouz A Forouzan, 4/e, Tata McGraw Hill Education Private Limited.
- 3) Data Communications & Networks, Achyut S. Godbole, Tata McGraw Hill Education Private Limited, 2002.
- 4) Data and Computer Communication, William Stalling, 7/e, Prentice Hall of India Private Ltd, 2007.

B.Sc. AI - II - Semester-IV
Practical: Course II: BAIP24-408-SEC-II- Statistical Methods Using R

Course Objectives:

- 1) Conduct basic statistical analysis – such as mean, median, correlation, regression, and hypothesis testing.
- 2) To introduce fundamental concepts of statistics and their practical applications using R.
- 3) To understand and apply descriptive statistics and probability distributions.
- 4) To analyze relationships using correlation and regression techniques.
- 5) To design and conduct experiments, and analyze the results statistically using R.

Credits=2	SEMESTER-III BAIP24-408-SEC-II - Statistical Methods Using R	No. of hours per unit/ credits
Unit I	Sampling and descriptive statistics	(15)
	1.1 Simple random sampling (SRSWR, SRSWOR, Stratified sampling and Systematic sampling) 1.2 Mean, Median and Mode. 1.3 Range, quartile deviation, mean deviation, (Relative measures) Standard deviation, Variance, C.V. 1.4 Karl Pearson's coeff. of skewness, Bowley's coeff. of skewness, Pearsonian coeff. of skewness, Kurtosis	
Unit II	Correlation, Regression, Probability distribution and Design of Experiment	(15)
	2.1 Scatter diagram, Karl Pearson's coefficient of correlation, Spearman's Rank Correlation coefficient 2.2 lines of regression. 2.3 Probability and Probability Distributions (Uniform distribution, Binomial distribution, Geometric distribution, poison distribution), Plots to check normality: Box plot, Q- Q plot. shapiro.test(x) 2.4 Design of experiment (One-way ANOVA, Two-way ANOVA).	

Course Out comes: At the end of this course students will be able to:

- 1) Evaluate various Sampling methods.
- 2) Evaluate various descriptive statistics measures using R.
- 3) Apply correlation and regression.
- 4) Apply different parametric tests using R.

Reference Books:

- 1) Crawley, M. J. (2006): Statistics - An introduction using R. John Wiley, London 32
- 2) Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015): Statistics using R, second edition. Narosa Publishing House, New Delhi.
- 3) Verzani, J. (2005): Using R for Introductory Statistics, Chapman and Hall /CRC Press, New York

Practical

Sr. No	Practical Name
1	R tools for statistical computing- Sampling methods
2	R tools for statistical computing- Measures of central tendency
3	R tools for statistical computing- Measures of Dispersion
4	R tools for statistical computing- Skewness and Kurtosis
5	R tools for statistical computing- Correlation
6	R tools for statistical computing :Regression
7	R tools for statistical computing: Discrete probability Distributions
8	R tools for statistical computing : Check for Normality (Box plot, Q-Q plot, Shapiro Wilk test)
9	R tools for statistical computing : Designs of experiment-1 One-Way ANOVA
10	R tools for statistical computing : Designs of experiment-2 Two-Way ANOVA

B.Sc. AI - II - Semester-IV
Practical: Course II: CEP-BAIP24-411-CEP- PHP

Course Objectives:

- 1) To introduce the fundamentals of PHP programming and basic web development concepts including variables, constants, operators, and data types.
- 2) To provide knowledge of database connectivity by using SQL with MySQL, PDO, and SQLite for storing and managing application data.

Credits=2	SEMESTER-III CEP-BAIP24-411-CEP- PHP	No. of hours per unit/ credits
Unit I	Introducing PHP	(15)
	<p>Basic development Concepts – Creating first PHP Scripts – Using Variable and Operators – Storing Data in variable – Understanding Data types – Setting and Checking variables Data types – Using Constants – Manipulating Variables with Operators.</p> <p>Controlling Program Flow: Writing Simple Conditional Statements – Writing More Complex Conditional Statements – Repeating Action with Loops – Working with String and Numeric Functions.</p> <p>Working with Arrays: Storing Data in Arrays – Processing Arrays with Loops and Iterations – Using Arrays with Forms – Working with Array Functions – Working with Dates and Times-</p>	
Unit II	PHP Working with Database and SQL	(15)
	<p>Using Functions and Classes- Working with Files and Directories: Reading Files – Writing Files – Processing Directories.</p> <p>Introducing Database and SQL – Using MySQL – Adding and modifying Data – Handling Errors – Using SQLite Extension and PDO Extension.</p> <p>Introduction XML – Simple XML and DOM Extension.</p>	

Course Out comes: At the end of this course students will be able to:

- 1) Understand the basic concepts of web development and create simple PHP scripts using variables, constants, operators, and data types.
- 2) Design and interact with databases using SQL and MySQL, including inserting, updating, retrieving data, and handling errors using PDO and SQLite.
- 3) Use arrays, string functions, numeric functions, and date/time functions to manipulate and process data effectively.
- 4) Work with XML data using SimpleXML and DOM extensions to read, manipulate, and integrate structured data in PHP applications.

Reference Books:

- 1) PHP A Beginner's Guide – Vikram Vaswani, Tata McGraw-Hill .
- 2) PHP Complete Reference – Steven Holzner, Tata McGraw-Hill Edition.

Practical

Sr. No	Practical Name
1	Write a PHP program using controls and functions.
2	Develop a PHP program and check message passing mechanism between pages.
3	Design a PHP program using String function and Arrays.
4	Develop a PHP program using parsing functions (use Tokenizing).
5	Write a PHP program and check Regular Expression, HTML functions, Hashing functions.
6	Develop a PHP program and check File System functions, Network functions, Date and time functions.
7	Develop a PHP program using cookie and session.