AC NO.21.02.26
Item No:4.1

# SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

## Syllabus for Approval

### B.Sc. (Artificial Intelligence)

### (WITH EFFECT FROM THE ACADEMIC YEAR 2026-2027)

| Sr. No. | Heading | Particulars |
|---|---|---|
| 1 | Title of the Programme | B.Sc. (Artificial Intelligence) |
| 4 | Passing Marks | 40% |
| 5 | Semesters | III & IV |
| 6 | Level | UG |
| 7 | Pattern | 3-4 years & 6-8 semesters Choice Based Grading System |
| 8 | Status | New |
| 9 | To be implemented from | From Academic year 2026-27 in a progressive manner |

**Date:21st Feb 2026**
**Signature:**

**Dr. Koel Roychoudhury**
**AC Chairperson**

**Dr. Sheeja Ravi**
**Head of the Department**

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# SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

**(Affiliated to University of Mumbai)**
**RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)**

**BOARD OF STUDIES**
**SYLLABUS FOR**
**B.Sc. (ARTIFICIAL INTELLIGENCE)**

**(WITH EFFECT FROM THE ACADEMIC YEAR 2026-2027)**

## OBJECTIVES OF THE PROGRAMME:

- To develop students to design robust and maintainable solutions for both simple and complex problems using Artificial Intelligence and machine learning.
- To equip students with a solid understanding of mathematics and science, essential for solving real-world problems with Artificial Intelligence technologies.
- To prepare students to analyze requirements and design engineering solutions by applying Artificial Intelligence and machine learning theory.
- To foster competency in Artificial Intelligence/Machine Learning tools and promote collaborative learning through multi-disciplinary projects.
- To ensure adherence to high ethical standards and industry codes of conduct in AI development.
- To equip students to contribute to societal progress through continuous learning and ethical application of emerging Artificial Intelligence technologies.

## PROGRAMME OUTCOMES:

- At the end of the program, students will have a strong understanding of Artificial Intelligence and machine learning algorithms, techniques, and tools, enabling them to develop effective and efficient AI-driven solutions.
- Students will possess practical experience in implementing Artificial Intelligence and machine learning models through hands-on projects and real-world applications.
- Students will be equipped with the skills to conduct research, innovate, and stay updated with the latest advancements in Artificial Intelligence technologies and methodologies.
- Students will demonstrate an understanding of the ethical implications of Artificial Intelligence technologies and apply responsible practices in developing Artificial Intelligence systems.
- Students will effectively communicate complex Artificial Intelligence concepts and solutions and collaborate in multi-disciplinary teams to achieve project goals.

## SIES(Nerul) College of Arts, Science and Commerce (Autonomous)
## NEP Credit Structure for B.SC (ARTIFICIAL INTELLIGENCE)

| Semester | Major | Minor | OE (Basket) (ANY ONE) | VSC, SEC (VSEC) | AEC, VEC, IKS | OJT,FP,CEP,CC, RP | Cum. Cr./ Sem. |
|---|---|---|---|---|---|---|---|
| III | Unsupervised Learning Techniques (3+1P) credit<br><br>Computer Vision Fundamentals (3+1P) credit<br><br>Database Systems (2 credit) | Discrete Mathematics (2) | 1. Basics of Insurance<br>2. Introduction to Indian Economy.<br>3. Social Media Marketing<br>4. Personality Development (2-credit) | VSC- Object Oriented Programming (2-credit) | AEC- Understanding Basic Form of English Literature I (2- credit) | CC- Tech Community Development , DLLE, NSS, Sports, Theatre Workshop (4- credit) | 22 |
| Total | 10 | 2 | 2 | 2 | 2 | 4 | 22 |

# SCHEME OF MODULES

| SEMESTER III | | | |
|---|---|---|---|
| **Serial No** | **Course code** | **Credits** | **Course Name** |
| **I** | **Major Department Specific Course (DSC)** | | |
| 1 | | 03 | UnSupervised Learning Techniques |
| 2 | | 01 | UnSupervised Learning Techniques Practical |
| 1 | | 03 | Computer Vision Fundamentals |
| 2 | | 01 | Computer Vision Fundamentals Practical |
| 1 | | 02 | Database Systems |
| **II** | **Minor** | | |
| 1 | | 02 | Discrete Mathematics |
| **III** | **Open Electives (OE)/ Generic Electives (Any Two)** | | |
| 1 | | 04 | 1. Basics of Insurance<br>2. Introduction to Indian Economy.<br>3. Social Media Marketing<br>4. Personality Development |
| **IV** | **VOCATIONAL COURSE (VC) & SKILL ENHANCEMENT COURSE (SEC)** | | |
| 1 | | 02 | Object Oriented Programming |
| **IV** | **ABILITY ENHANCEMENT COURSE(AEC)/VALUE EDUCATION COURSE (VEC) / INDIAN KNOWLEDGE SYSTEM (IKS)** | | |
| 1 | | 02 | Understanding Basic Form of English Literature-I |
| **V** | **Co-Curricular (CC) (Anyone)** | | |
| 1 | | 04 | Tech Community Development |
| 2 | | 04 | DLLE |
| 3 | | 04 | NSS |
| 4 | | 04 | Sports |
| 5 | | 04 | Theatre Workshop |
| **TOTAL CREDITS** | | **22** | |

## Major: Unsupervised Learning Techniques

**COURSE CODE:** **COURSE CREDIT: 03**

**1 credit - 15 lectures**
**1 lecture - 60 minutes**

### Course Objectives

After completing this course, students will be able to:

- To introduce the concepts and scope of unsupervised learning.
- To understand clustering and density-based learning techniques.
- To study dimensionality reduction and representation learning methods

### Course Outcomes

- Understand unsupervised learning concepts
- Apply clustering and dimensionality reduction techniques
- Analyze and visualize unlabeled data
- Implement real-world machine learning workflows

| Unit | Topic | No. of Lectures |
|---|---|---|
| I | Fundamentals of Unsupervised Learning: Introduction to Unsupervised Learning, Applications of Unsupervised Learning Data Transformation: Scaling, Normalization, Standardization, encoding, categorical variables Feature selection: selecting relevant feature/columns, data merging: combining multiple datasets Clustering Techniques: Clustering concept and types: K-Means Clustering: algorithm, advantages and limitations Hierarchical Clustering: Agglomerative and Divisive, Dendrograms, Density-based Clustering: DBSCAN, Core, border, and noise points, Cluster Evaluation methods: Silhouette Score, Elbow method | 15 |
| II | II Dimensionality Reduction and Advanced Methods: Dimensionality Reduction Concepts, Principal Component Analysis (PCA), Singular Value Decomposition (SVD), t-SNE (t-Distributed Stochastic Neighbour Embedding), Applications in Image, Text, and Market Segmentation, Introduction to Autoencoders (conceptual) | 15 |
| III | Semi-Supervised Learning: What is Semi-Supervised Learning? Working of semi-supervised Learning, Semi-supervised learning techniques: self-training, co-training, graph-based label propagation, challenges of semi-supervised learning, applications of semi-supervised learning. | 15 |

**TEXTBOOK**

1. "Introduction to Machine Learning with Python ", Andres C. Muller & Sarah Guido, O'reilly Publication
2. *Pattern Recognition and Machine Learning*, Bishop, C. M., Springer
3. *Data Mining: Concepts and Techniques*, Han, J., Kamber, M., & Pei, J, Morgan Kaufmann

**REFERENCES**

- The Elements of Statistical Learning, Hastie, T., Tibshirani, R., & Friedman, J., Springer
- Introduction to Machine Learning, Alpaydin, E., MIT Press
- Data Clustering: Algorithms and Applications, Aggarwal, C. C., CRC Press
- Hands-On Machine Learning with Scikit-Learn, Géron, A., O'Reilly

## Unsupervised Learning Techniques – Practical

**COURSE CODE : COURSE CREDIT: 01**

~~**1 credit - 30 lectures**~~

**1 lecture is 60 minutes**

| Sr. No | List of Practicals |
|---|---|
| 1. | Practical on Data Preprocessing and Visualisation |
| 2. | Practical on Data frames with manipulate and transform data using functions like filter, sort and group |
| 3. | Illustrate various Python libraries for unsupervised learning techniques |
| 4. | Practical on K-Means Clustering |
| 5. | Practical on the Elbow Method for Optimal K |
| 6. | Practical on Silhouette Score |
| 7. | Practical on Hierarchical Clustering |
| 8. | Practical on DBSCAN Clustering |
| 9. | Practical on PCA for Dimensionality Reduction |
| 10 | Practical on PCA visualisation |
| 11 | Implementation of Gaussian Mixture Model |
| 12 | Mini Project on Unsupervised learning Techniques |

**Major: Computer Vision Fundamentals**

**COURSE CODE:** **COURSE CREDIT: 03**

**1 credit - 15 lectures**
**1 lecture - 60 minutes**

**Course Objectives:**

- To introduce students to the fundamentals of computer vision, including image formation principles, geometric and photometric models, camera systems, and digital image acquisition concepts.
- To develop an understanding of image processing techniques in spatial and frequency domains for image enhancement, restoration, transformation, and multi-resolution representation.
- To familiarize students with techniques for detecting, describing, and matching visual features for analyzing image structure and enabling higher-level vision applications.

**Course Outcomes:**

After successful completion of the course, the student will be able to:

- Explain the concept of computer vision and analyze image formation using geometric transformations, camera models, photometric properties, sampling, color, and compression techniques.
- Apply image processing operations such as filtering, morphological processing, Fourier analysis, and multi-resolution techniques to enhance, restore, and transform digital images.
- Identify and implement feature detection, description, and matching techniques to extract meaningful structures such as edges, lines, and key points from images for vision-based applications.

| Unit | Topics | No. of Lectures |
|---|---|---|
| 01 | Introduction : What is computer vision?, A brief history<br>Image formation : Geometric primitives and transformations, Geometric primitives, 2D transformations, 3D transformations, 3D rotations, 3D to 2D projections, Lens distortions, Photometric image formation, Lighting, Reflectance and shading, Optics, The digital camera, Sampling and aliasing, Color, Compression | 15 |
| 02 | Image processing: Point operators, Pixel transforms, Color transforms, Compositing and matting, Histogram equalization, Application: Tonal adjustment, Linear filtering, Separable filtering, Examples of linear filtering, Band-pass and steerable filters, More neighborhood operators, Non-linear filtering, Morphology, Distance transforms, Connected components, Fourier transforms, Fourier transform pairs, Two-dimensional Fourier transforms, Wiener filtering, Application: Sharpening, blur, and noise removal, Pyramids and wavelets, Interpolation, Decimation, Multi-resolution representations, Wavelets, Application: Image blending, Geometric transformations, Parametric transformations, Mesh-based warping, Application: Feature-based morphing, Global optimization, Regularization, Markov random fields, Application: Image restoration | 15 |

| | | |
|---|---|---|
| 03 | Feature detection and matching: Points and patches, Feature detectors, Feature descriptors, Feature matching, Feature tracking, Application: Performance-driven animation, Edges, Edge detection, Edge linking, Application: Edge editing and enhancement, Lines, Successive approximation, Hough transforms, Vanishing points, Application: Rectangle detection | 15 |

**Text Book(s):**

1. Computer Vision: Algorithms and Applications – Richard Szeliski
2. Computer Vision: A Modern Approach – David Forsyth & Jean Ponce

**Additional Reference(s):**

1. Learning OpenCV 4 Computer Vision with Python 3 – Joseph Howse & Joe Minichino
2. Foundations of Computer Vision – Torralba, Isola & Freeman

## Computer Vision Fundamentals - Practical

**COURSE CODE : COURSE CREDIT: 01**

**1 credit - 30 lectures**

**1 lecture is 60 minutes**

| Sr. No. | List of Practical |
|---|---|
| 1 | **Introduction to Digital Images**<br>● Read and display grayscale and color images<br>● Study image properties (resolution, channels, intensity values) |
| 2 | **Image Sampling and Aliasing**<br>● Perform image resizing (upsampling & downsampling)<br>● Observe aliasing effects and apply smoothing filters |
| 3 | **Color Models and Transformations**<br>● Convert between RGB, Grayscale, HSV<br>● Analyze color channels and their applications |
| 4 | **Camera Geometry and Projections (Demo-Based)**<br>● Demonstrate 2D transformations (translation, rotation, scaling)<br>● Simple 3D-to-2D projection visualization |
| 5 | **Point and Pixel Operations**<br>● Brightness and contrast adjustment<br>● Image negative, thresholding |
| 6 | **Histogram Processing**<br>● Plot image histograms<br>● Perform histogram equalization and observe tonal improvement |
| 7 | **Linear Filtering**<br>● Apply mean and Gaussian filters<br>● Study smoothing and noise reduction |
| 8 | **Edge Detection and Non-Linear Filtering**<br>● Apply Sobel, Prewitt, and Canny edge detectors<br>● Compare results |
| 9 | **Morphological Operations**<br>● Perform erosion, dilation, opening, and closing<br>● Use morphology for noise removal and shape enhancement |
| 10 | **Frequency Domain Processing**<br>● Compute Fourier transform of images |

| | |
|---|---|
| | ● Apply low-pass and high-pass filtering |

## MAJOR- Database Systems

**COURSE CODE:** **COURSE CREDIT: 02**

**1 credit - 15 lectures**

**1 lecture is 60 minutes**

**Course Objectives:**

- To make students aware fundamentals of database system
- To experience the students working with database using SQL
- To give idea how ERD components helpful in database design and implementation

**Course Outcomes:**

- To appreciate the importance of database design
- Write simple queries using SQL
- Analyze database requirements and determine the entities involved in the system and their relationship to one another

| Unit | Topic | No of Lectures |
|---|---|---|
| 1. | **Introduction**: Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Design, Database Engine, Database and Application Architecture, Database Users and Administrators, History of Database Systems **Introduction to the Relational Model**: Structure of Relational Databases, Database Schema, Keys, Schema Diagrams. Relational Query Languages. The Relational Algebra. **Introduction to SQL**: Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database | 15 |
| 2. | **Database Design Using the E-R Model**: Overview of the Design Process, The Entity-Relationship Model, Complex Attributes, | 15 |

| | | |
|---|---|---|
| | Mapping Cardinalities, Primary Key, Removing Redundant Attributes in Entity Sets, Reducing E-R Diagrams to Relational Schemas.<br>**Relational Database Design & Normalization** - Functional Dependencies, First Normal Form (1NF),Second Normal Form (2NF), Third Normal Form (3NF), Boyce–Codd Normal Form (BCNF).<br>**Introduction to NoSQL Databases:** Need for NoSQL databases, Limitations of relational database systems, Evolution of NoSQL databases, Difference between SQL and NoSQL, Use cases of NoSQL databases. **Characteristics of NoSQL Systems:** Schema-less and flexible schema design, Horizontal scalability, Replication and partitioning. **Types of NoSQL Databases:** Key–Value databases – data model, characteristics, advantages, and applications; | |

**References:**


1. "Database System Concepts", Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw Hill, 2017
2. "Database Management Systems", Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2014


**Additional References**:


1. "Fundamentals of Database System", Elmasri Ramez, Navathe Shamkant, Pearson Education, Seventh edition, 2017
2. "Murach's MySQL", Joel Murach, 3rd Edition, 3rd Edition, 2019

## Minor: DISCRETE MATHEMATICS

**COURSE CODE:** **COURSE CREDIT: 02**

**1 credit - 15 lectures**
**1 lecture - 60 minutes**

### COURSE OBJECTIVE:

- This course provides a foundational understanding of essential concepts that are fundamental to computer science and various branches of mathematics.
- The course explores topic related to Propositional Logic, Sets and Relations, Graphs and Trees. This helps the students to equip with the analytical and problem-solving skills necessary for applications in computer science and algorithm design

### COURSE OUTCOME:

- Acquire a comprehensive understanding of propositional logic and its applications, with a focus on constructing and interpreting truth tables
- Able to proficiently define and manipulate sets, analyse relations and functions and their representation by Venn diagrams
- Acquire a basic understanding of graph theory including representations, types of graphs, their properties such as connectivity, cycles, paths and degrees
- Able to proficiently understand the tree data structures, spanning trees and associated algorithms for solving problems such as Prim's and Kruskal

| Unit | Topic | No of Lectures |
|---|---|---|
| 1 | **Mathematical Logic:**<br>Propositional Logic: Definition, Logical Operators (Negation, Disjunction, Conjunction, Implication, Biconditional), Truth Table,<br>**Law of Logic**: Tautology, Contradiction, Contingency, Logical equivalence,<br>Algebra of Propositions, Solving logic with and without truth table<br>Validity of Arguments, Logical implication, Quantifiers: Universal and Existential.<br>**Sets and Relations**: Set Theory: Definition, Concept of Set Theory, Cardinality, Types of sets Properties of Set: Subsets, Power set, Venn Diagrams, Set operations, Partition, Relation: Definition and Examples, Type of Relations with example, Equivalence relation, Equivalence Class and Di-Graph and problems, Inclusion exclusion principles, Pigeon hole principles(without proof) | 15 |
| 2 | **Graph**: Definition, Properties of Graph, Simple Graph, Regular Graph, Null Graph, Subgraph and Isomorphism, Walk, Path, Trail, Circuit, Cycle, Complete Graph, Hand-Shaking Theorem, Connected Graph, Complete Graph, Euler Graph, Hamiltonian graph, Travelling Sales Man Problem, Operations on Graph.<br>**Trees**: Definition, Properties, Pendant vertex, Distance, Eccentricity and Center of Trees, Rooted Tress, Binary Tress and Its Properties, Basic Theorems on Trees, Minimum Spanning Tree: Definition, Prim's Algorithm and Kruskal's Algorithm (Algorithm and Problem Based) Cut- | 15 |

| | | |
|---|---|---|
| | Set and Cut-Vertices, Connectivity of Graph and Weighted Graph. | |

**Text Books:**

1. C L Liu, D P Mohapatra, "Elements of Discrete Mathematics", McGraw Hill Education (India) Private Limited, 2008.
2. Seymour Lipscutz, Marc Lars Lipson, " Discrete Mathematics", Tata McGraw Hill Education Private Limited, 2015.

**References:**


1. Kenneth A Ross, Charles R B Wright, "Discrete Mathematics", 5th Edition, Pearson Education India, 2012.
2. Swapan Kumar Sarkar, "Discrete Mathematics", 9th Edition, S Chand & Co Ltd, 2016.
3. Elements of Discrete Mathematics, C. L. Liu, TMH Edition
4. Discrete Mathematical Structures with applications to Computer Science, J.K. Tremblay and R Manohar, McGraw Hill
5. Discrete mathematical Structures, Kolman, Busby, Ross, Pearson
6. Graph theory, Harry, F., Addison Wesley.
7. Finite Mathematics, S. Lipchutz, Schaum Series, MGH.

## VSC- Object Oriented Programming

**COURSE CODE:** **COURSE CREDIT:**
**02**
**1 credit - 15 lectures**
**1 lecture is 60 minutes**

**Course Objectives:**

- Understand the fundamental concepts of object-oriented programming including classes, objects, inheritance, polymorphism, abstraction, and encapsulation.
- Learn and apply basic software design principles, including modularity, reusability, coupling, cohesion, and an introductory overview of SOLID principles.
- Develop simple UML diagrams such as use case diagrams and class diagrams to model software systems.
- Understand basic design patterns and their applicability in solving common software design problems.
- Gain knowledge of software engineering fundamentals, including SDLC models (Waterfall, Agile), software testing, and software maintenance.

**Course Outcomes:**

- Apply object-oriented programming concepts to design and implement simple software solutions.
- Demonstrate the ability to design modular and reusable software components using basic software design principles.
- Create basic UML diagrams to represent requirements and structure of software systems.
- Use introductory design patterns (Singleton, Adapter, Observer) to solve common software design problems.
- Explain the software development life cycle and the role of testing and maintenance in software projects.
- Use Git version control commands to manage code, track changes, and collaborate effectively in small projects.

| Unit | Topic | No. of Lectures |
|---|---|---|
| I | **Object Oriented Programming Concepts** – Introduction to object oriented paradigm, Procedural vs object oriented approach, Class and object, Abstraction, Encapsulation, Inheritance, Polymorphism, Advantages of object oriented programming, Real-world examples of OOP concepts.<br><br>**Basic OOP Design Concepts** – Coupling and cohesion, Reusability, Modularity, Introduction to SOLID principles (overview only). **UML Basics** – Introduction to UML, Use case diagram, Class diagram, Relationships in class diagrams, Simple | 15 |

| | | |
|---|---|---|
| | UML examples. | |
| | **Design Patterns (Introduction Level)** – Introduction to design patterns, Need for design patterns, Classification of design patterns, Creational pattern – Singleton; Structural pattern – Adapter; Behavioral pattern – Observer, Simple real-world examples.**Software Engineering Basics** – Introduction to software engineering, Software characteristics, Software Development Life Cycle (SDLC), Waterfall model, Agile methodology overview, Software testing basics, Software maintenance basics.**Version Control Systems (Git – Basics)** – Need for version control, Introduction to Git, Git repository, Working directory and staging area, Basic Git commands – init, clone, add, commit, status, log, push and pull, Introduction to GitHub. | |
| **II** | | **15** |

**References:**


1. Balagurusamy, E. (2017). *Object oriented programming with Java* (2nd ed.). McGraw Hill Education.
2. Booch, G. (2007). *Object-oriented analysis and design with applications* (3rd ed.). Pearson Education.
3. Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1994). *Design patterns: Elements of reusable object-oriented software*. Addison-Wesley Professional.
4. Freeman, E., & Robson, E. (2004). *Head first design patterns*. O'Reilly Media.
5. Sommerville, I. (2016). *Software engineering* (10th ed.). Pearson Education.
6. Pressman, R. S., & Maxim, B. R. (2015). *Software engineering: A practitioner's approach* (8th ed.). McGraw-Hill Education.


**Text Books:**

1. K. Venugopal & Rajkumar, "Programming with Java: A Practical Approach" – Short, practical coverage of basic OOP concepts, simple programs, and class-object examples.
2. M. Fowler, "UML Distilled: A Brief Guide to UML" (Pocket edition) – Lightweight version focusing on essential diagrams (use case, class) for modeling.
3. S. P. Singh, "Introduction to Design Patterns" – Small book covering essential patterns (Singleton, Observer, Adapter) with simple examples.
4. Pankaj Jalote, "Software Engineering: A Concise Introduction" – Short, easy-to-read version of software engineering concepts, SDLC, and testing.
5. Chacon, S., "Pro Git Pocket Edition" – A lightweight version covering Git basics and commands for practical use.

## NEP Credit Structure for B.SC (ARTIFICIAL INTELLIGENCE)

| Semester | Major | Minor | OE (Basket) (ANY ONE) | VSC, SEC (VSEC) | AEC, VEC, IKS | OJT,FP,CEP,CC, RP | Cum. Cr./ Sem. |
|---|---|---|---|---|---|---|---|
| IV | Neural Networks (3+1P) credit<br><br>Deep Learning (3+1P) credit | 1.Multivariable Calculus (2 Credit)<br><br>2. Operating Systems (2 Credit) | 1. Financial Literacy<br>2. Photography.<br>3. Advertisement and Brand Management<br>4. Personality Development<br>5. Introduction to International Economy | SEC- Artificial Intelligence Techniques (2- credit) | AEC- Understanding Basic Form of English Literature-II (2- credit) | CEP- Community Engagement Project<br><br>(4- credit) | 22 |
| Total | 8 | 4 | 2 | 2 | 2 | 4 | 22 |

## SCHEME OF MODULES

| SEMESTER IV | | | |
|---|---|---|---|
| **Serial No** | **Course code** | **Credits** | **Course Name** |
| **I** | **Major Department Specific Course (DSC)** | | |
| 1 | | 03 | Neural Networks |
| 2 | | 01 | Neural Networks Practical |
| 1 | | 03 | Deep Learning |
| 2 | | 01 | Deep Learning Practical |
| **II** | **Minor** | | |
| 1 | | 04 | 1. Multivariable Calculus (2 Credit)<br>2. Operating Systems (2 Credit) |
| **III** | **Open Electives (OE)/ Generic Electives (Any Two)** | | |
| 1 | | 04 | 1. Financial Literacy<br>2. Photography.<br>3. Advertisement and Brand Management<br>4. Personality Development<br>5. Introduction to International Economy |
| **IV** | **VOCATIONAL COURSE (VC) & SKILL ENHANCEMENT COURSE (SEC)** | | |
| 1 | | 02 | Artificial Intelligence Techniques |
| **IV** | **ABILITY ENHANCEMENT COURSE(AEC)/VALUE EDUCATION COURSE (VEC) / INDIAN KNOWLEDGE SYSTEM (IKS)** | | |
| 1 | | 02 | Understanding Basic Form of English Literature-II |
| **V** | **Co-Curricular (CC)/CEP (Anyone)** | | |
| 1 | | 04 | Community Engagement Project |
| **TOTAL CREDITS** | | **22** | |

**Major: Neural Networks**

**COURSE CODE:** **COURSE CREDIT: 03**

**1 credit - 15 lectures**
**1 lecture - 60 minutes**

**Course Objectives:**

- To introduce students to the fundamentals of Natural Language Processing, including text preprocessing, tokenization, and the essential mathematical concepts required for computational analysis of language.
- To develop an understanding of statistical methods and probabilistic models used in Natural Language Processing for modeling and analyzing linguistic data.
- To familiarize students with core NLP tasks and applications, enabling them to apply basic machine learning techniques to real-world language processing problems.

**Course Outcomes:**

After successful completion of the course, the student will be able to:

- Explain the basic concepts of Natural Language Processing and apply text preprocessing and tokenization techniques using fundamental mathematical principles.
- Apply image processing operations such as filtering, morphological processing, Fourier Analyze linguistic data using statistical language models and interpret the performance of NLP systems using standard evaluation metrics.
- Apply appropriate NLP techniques to perform tasks such as text classification, sentiment analysis, and named entity recognition using basic machine learning approaches.

| Unit | Topic | No. of lectures |
|---|---|---|
| 01 | Introduction to Neural Networks– Biological Neuron, Artificial Neuron, Difference between Biological Neuron vs Artificial Neuron, Types of activation functions (Sigmoid, Tanh, RelU), Basic concepts of neural networks and their historical development, Properties – Different Learning Rules–Perceptron Model (Both Single &Multi-Layer) – Training Algorithm – Problems Solving Using Learning Rules and Algorithms – Linear Separability Limitation and Its Over Comings | 15 |
| 02 | Multi Layer Networks Back Propagation Networks (BPN) - Training - Architecture-Algorithm, Counter Propagation Network (CPN) - Training - Architecture, Bi-Directional Associative Memory (BAM) - Training-stability analysis, Adaptive Resonance Theory – Adaptive Resonance Theory (ART) - ART1- ART2 – Architecture -Training, Hop Field Network - Energy Function - Discrete - Continuous - Algorithm - Application – Travelling Sales Man Problem TSP | 15 |

| | | |
|---|---|---|
| 03 | SOM-Introduction - Kohonan SOM - Linear vector quantization, Probabilistic neural network, Cascade correlation, General Regression neural network, Cognitron - Application of ANN - Texture classification - Character recognition. | 15 |

**Text Book(s):**


1. Speech and Language Processing‖, Jurafsky Dan and Martin James H., 3rd Edition, Pearson, 2018.
2. Foundations of Statistical Natural Language Processing – Christopher Manning & Hinrich Schütze


**Additional Reference(s):**


1. Handbook of Computational Linguistics and Natural Language Processing‖, Martin Whitehead, Clanrye International, 2020
2. Handbook of Natural Language Processing‖, Nitin Indurkhya, and Fred J. Damerau, Pearson; 2nd edition, 2008

**Neural Networks Practical**

**COURSE CODE : COURSE CREDIT: 01**

**1 credit - 30 lectures**

**1 lecture is 60 minutes**

| Sr. No. | List of Practical |
|---|---|
| 1 | Implement the Following: a. Design a simple linear neural network model. b. Compute the output of a neural network using binary and bipolar sigmoid activation functions |
| 2 | Implement the Following: a. Generate AND / NOT logic functions using the McCulloch–Pitts neural model. b. Generate XOR function using the McCulloch–Pitts neural model |
| 3 | Implement the Following: a. Write a program to implement Hebb's Learning Rule. b. Write a program to implement the Delta Learning Rule. |
| 4 | Implement the Following: a. Write a program to implement the Backpropagation Algorithm (MLP). b. Write a program to implement Error Backpropagation with loss minimization |
| 5 | Implement the Following: a. Implement Kohonen Self-Organizing Map (SOM). b. Implement Adaptive Resonance Theory (ART1/ART2) for pattern recognition |
| 6 | Implement the Following: a. Write a program to implement a Hopfield Neural Network. b. Write a program for Radial Basis Function (RBF) Network |
| 7 | Implement the Following: a. Write a program for Linear Separation of classes using perceptron. b. Implement Hopfield Network for Associative Memory. |
| 8 | Implement the Following: a. Demonstrate Membership and Identity Operators (in, not in). b. Demonstrate Membership and Identity Operators (is, is not). |
| 9 | Implement the Following: a. Find ratios using Fuzzy Logic. b. Solve the Tipping Problem using Fuzzy Logic |
| 10 | Implement the Following: a. Implement a simple Genetic Algorithm (GA). b. Create two classes (City and Fitness) using Genetic Algorithm for optimization |

## Major – Deep Learning

**COURSE CODE:** **COURSE CREDIT: 03**

1 Credit - 15 Lectures
1 lecture - 60 minutes

**Course Objective:**

- Understand the concept and use of neural networks
- Understand the concept and use of deep learning
- Understand the tools and libraries for deep learning
- Explore the parameters of neural networks
- Have a working knowledge of neural networks and deep learning
- Identify emerging applications of deep learning

**Course Outcome:**

- Knowledge of implementing neural network architecture for deep learning.
- Skill to implement regularization and optimization of neural network.
- Ability to implement advanced networks like CNN and RNN.
- Implement deep learning applications.

| UNIT | TOPIC | No. of Lectures |
|---|---|---|
| 1 | **Neural Network Fundamentals:** Introduction to Artificial Neural Network (ANN) : History and evolution of neural networks, difference between AI, ML and DL, **Basic Structure of a Neural Network:** Artificial Neuron, Components of a neuron: input, weight, bias, summation function, activation function, Types of Neural Networks: Feed forward Networks, single-layer perceptron, multi-layer perceptron, overview of deep neural network, applications of neural networks in real-world problems. | 15 |
| 2 | **Backpropagation and optimization:** **Deep learning fundamentals:** Deep Learning applications, Popular open-source libraries for deep learning, **Backpropagation Fundamental:** Need for backpropagation, Forward pass and backward pass, Chain rule of calculus (concept and importance), **Error/Loss functions:** Mean Squared Error (MSE), Cross-Entropy Loss, Single-layer neural network, Multi-layer neural network, Weight and bias update mechanism. **Optimization Techniques:** Iterative optimization algorithm, Advanced gradient decent optimization techniques, Learning rate | 15 |

| | | |
|---|---|---|
| | selection and tuning, Problems in optimization: Local minima | |
| 3 | **Convolutional Neural Network (CNN):** Introduction to CNN, CNN architecture and working principle, Convolution operation and filters (kernels) **Regularization:** concept of regularization, Complex Network and overfitting, Hyperparameter tuning, Object detection using pre-trained models, Interception, Applications of CNN in image classification and recognition **Recurrent Neural Network (RNN):** Introduction to RNN, RNN architecture and working, Problems in RNN: vanishing and exploding gradients, Long Short-Term Memory (LSTM) networks, Applications of RNN in text, speech, and time-series analysis. | **15** |

**TEXT BOOK:**


1. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow
2. Concepts, Tools, and Techniques to Build Intelligent Systems by
3. AurélienGéron, Second Edition, O'reilly 2019
4. Deep Learning with Python by François Chollet Published by Manning 2018
5. Reinforcement Learning: An Introduction by Richard S. Sutton and
6. Andrew G. Barto, Second Edition 2014


**REFERENCES:**


1. Introduction to Machine with Python - A Guide for Data Scientists by
2. Andreas C. Müller & Sarah Guido O'reilly 2016
3. Artificial Neural Networks with TensorFlow 2 ANN Architecture Machine
4. Learning Projects Poornachandra Sarang by Apress 2021


## Deep Learning - Practical

**COURSE CODE : 01** **COURSE CREDIT:**

**1 credit - 30 lectures**

**1 lecture is 60 minutes**

| Sr. No. | List of Practical |
|---|---|
| 1 | Illustrate the various libraries for Deep Learning |
| 2 | Implement Practical on Feed-forward Neural Network. |
| 3 | Implement Practical on Regularization. |
| 4 | Implement Deep Learning recognizing classes for datasets. |
| 5 | Implement Practical on Autoencoder. |
| 6 | Implement Practical on CNN (Convolutional Neural Network) |
| 7 | Implement a Project based on Practical (1 to 6) |
| 8 | Implement a Practical on RNN (Recurrent Neural Network) |
| 9 | Implement a practical on Time-series analysis. |
| 10 | Mini Project |

## Minor: MULTIVARIATE CALCULUS

**COURSE CODE:** **COURSE CREDIT: 02**

**1 credit - 15 lectures**
**1 lecture - 60 minutes**

### COURSE OBJECTIVE:

- Understand and explain functions of two or more variables, including their graphical representations such as level curves and level surfaces.
- Analyze limits and continuity of multivariable functions using formal definitions, including the ε–δ approach.
- Apply partial differentiation techniques to functions of two or more variables, including implicit differentiation and higher-order derivatives.
- Evaluate directional derivatives and gradients to study the rate of change of multivariable functions and interpret their geometric significance.
- Construct tangent planes and normal lines to surfaces and use linear approximations for practical problems.
- Identify and classify extrema of functions of two variables using second derivative tests and optimization techniques.

### COURSE OUTCOME:

- Define and visualize functions of two and three variables using graphs, level curves, and level surfaces.
- Determine limits and continuity of multivariable functions using intuitive and ε–δ definitions.
- Compute first- and second-order partial derivatives, including applications of implicit differentiation and the chain rule.
- Calculate directional derivatives and gradient vectors and interpret their physical and geometric meanings.
- Formulate equations of tangent planes and normal lines and use linear approximations to estimate function values

| UNIT | TOPIC | No. of Lectures |
|---|---|---|
| 1 | Functions and Limits of Two or more variable: Functions of two or more variable, Graphs of Functions of Two Variables, Level Curves, Functions of Three Variables and Level Surfaces.<br>Limits and Continuity- Definition of limit, continuity of a function of two variables, functions of three or more variables, ε − δ definition of a limit(only).<br>Partial Derivatives- Partial Derivatives of Functions of Two Variables, Computing Partial Derivatives, Implicit Differentiation, Partial Derivatives of Functions of More Than Two Variables, Second order partial derivatives, The Chain Rule for Functions Involving One | 15 |

| | | |
|---|---|---|
| | Independent Variable, Linearization. | |
| 2 | Coordinate Geometry-Cartesian coordinates, vectors, lines and planes, quadric surfaces, 3D transformations, n-dimensional spaces, hyperplanes, 4D geometry basics, level surfaces, gradients, and visualization techniques for higher-dimensional data.<br>Tangent Planes and Normal Lines-Definition. Tangent Plane and | 15 |
| | Normal Line, Using the Tangent Plane of to Approximate the Surface $z = f(x, y)$<br>Extrema of Functions of Two Variables- Relative and Absolute Extrema, The Second Derivative Test for Relative Extrema, Finding the Absolute Extremum Values of a Continuous Function on a Closed Set | |

Text Books:

1. Thomas, Weir & Hass – Thomas' Calculus twelth edition.
2. George B. Thomas Jr. – Calculus and Analytic Geometry, Pearson Publisher

References

1. Erwin Kreyszig – Advanced Engineering Mathematics, Wiley publisher
2. Kreyzig & Borrelli – Advanced Mathematical Methods for Science and Engineering Wiley
3. Gilbert Strang – Calculus
4. S. L. Loney – The Elements of Coordinate Geometry

**Minor: Operating System**

**COURSE CODE:** **COURSE CREDIT: 02**

**1 credit - 15 lectures**
**1 lecture - 60 minutes**

**Course Objectives:**

- To learn basic concepts and functions of operating systems
- To learn about process and synchronization in operating system level
- To learn CPU scheduling algorithms and Memory and File system management

**Course Outcomes:**

- Work with any type of operating system
- Handle processes, process synchronization
- Understand CPU scheduling algorithms
- Understand the background role of memory management and Design file system

| Unit | Topic | No. of Lectures |
|---|---|---|
| 01 | **Introduction to Operating-Systems:** Definition of Operating System, Operating System's role, Operating-System Operations, Functions of Operating System<br>**Processes:** Process Concept, Process Scheduling, Operations on Processes, Inter process Communication<br>**Process Synchronization:** General structure of a typical process, race condition, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors<br>**CPU Scheduling:** Basic Concepts, Scheduling Criteria, Scheduling Algorithms (FCFS, SJF, SRTF, Priority, RR, Multilevel Queue Scheduling, Multilevel Feedback Queue Scheduling), Thread Scheduling | 15 |
| 02 | **Main Memory:** Background, Logical address space, Physical address space, MMU, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table<br>**Virtual Memory:** Background, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing<br>**Mass-Storage Structure:** Overview, Disk Structure, Disk Scheduling, Disk Management<br>**File-System Interface and Implementation:** File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management | 15 |

**Textbook(s):**

1. Abraham Silberschatz, Peter Galvin, Greg Gagne, Operating System Concepts, Wiley, 2021

**Additional Reference(s):**

1. Achyut S. Godbole, Atul Kahate, Operating Systems, Tata McGraw Hill, 2017
2. Naresh Chauhan, Principles of Operating Systems, Oxford Press, 2014

3. Andrew S Tanenbaum, Herbert Bos, Modern Operating Systems, 4e Fourth Edition, Pearson Education, 2016

## SEC-Artificial Intelligence Techniques

**Course Code:** **Course Credit: 02**
**1 Credit - 15 Lectures**
**1 Lecture - 60 minutes**

**Course Objectives:**

- Understand and represent knowledge and Expert System
- Model and solve planning and scheduling problems
- Apply fuzzy logic concepts

**Course Outcomes:**

- Understand and apply knowledge representation techniques
- Explain the architecture and functioning of expert systems
- Analyze and implement planning and scheduling approaches
- Design and implement fuzzy logic–based systems

| Unit | Topic | No. of Lectures |
|---|---|---|
| 01 | **Knowledge Representation and Logical Agents:**<br>**Knowledge Representation:**<br>Logical agents, Knowledge-based agents, The Wumpus World<br>**Propositional logic:** Syntax and semantics of propositional logic,<br>**Logical connectives:** AND, OR, NOT, IMPLIES, BICONDITIONAL, Well-formed formulas and truth tables,<br>**Logical inference:** Inference rules (Modus Ponens, Modus Tollens, Resolution), Soundness and completeness of inference systems, Forward chaining and backward chaining,<br>Propositional Theorem Proving and Model Checking Theorem Proving, Model Checking,<br>**Expert Systems:**<br>Definition and characteristics of expert systems, Components of expert systems: Knowledge base, Inference engine, Explanation facility, User interface, Knowledge acquisition, Rule-based expert systems,<br>Applications of expert systems (medical diagnosis, fault detection, decision support). | 15 |
| 02 | **Planning, Scheduling & Fuzzy Logic:**<br>Planning and Scheduling:<br>Planning as state-space search, Classical planning, Planning graphs, Hierarchical planning, Planning with time, resources, and uncertainty, Multi-agent planning.<br>**Fuzzy Logic:**<br>Introduction to fuzzy logic, Fuzzy sets and membership functions, Types of membership functions, Fuzzy rules and fuzzy inference system, Fuzzification and defuzzification, Applications of fuzzy logic in control systems and decision making. | 15 |

**Text Books**

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, Pearson Education, 3rd / 4th Edition.
2. Artificial Intelligence and the Design of Expert Systems, George F. Luger and William A. Stubblefield, Pearson Education, 1st Edition.
3. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Wiley India, 3rd Edition.

**Reference Books**

1. Knowledge Representation and Reasoning, Ronald J. Brachman and Hector J. Levesque,
   Morgan Kaufmann Publishers.
2. Automated Planning: Theory and Practice, Malik Ghallab, Dana Nau, and Paolo Traverso, Morgan Kaufmann Publishers.
3. Artificial Intelligence: Structures and Strategies for Complex Problem Solving, George F. Luger, Pearson Education.
4. Fuzzy Logic: Intelligence, Control, and Information,
   John Yen and Reza Langari, Pearson Education.

## SCHEME OF THEORY and PRACTICALS EXAMINATION

**MAJOR- (3 credit)**

**The scheme of examination shall be divided into two parts:**

- **Internal assessment 40% i.e. 40 marks**
- **Semester end examination 60% i.e. 60 marks**

**Internal Assessment 40 marks**

| **Description** | **Marks** |
|---|---|
| Internal test of 20 marks<br>▪ Multiple choice Questions - 20 Marks | 20 |
| One Project and Viva voce / Presentation / Case studies / Assignments Poster Making / Quiz / Role Play / Subject Specific Activities | 15 |
| Attendance and Class behavior | 05 |
| **Total** | 40 |

**Semester end examination 60 marks PAPER PATTERN**

| Duration: 2 hours | | | |
|---|---|---|---|
| Total Marks: 60 | | | |
| All Questions are Compulsory | | | |
| **Question** | **Based on** | **Options** | **Marks** |
| Q. 1 | Unit 1 | Any 3 out of 5 | 15 |
| Q. 2 | Unit 2 | Any 3 out of 5 | 15 |
| Q. 3 | Unit 3 | Any 3 out of 5 | 15 |
| Q. 4 | Unit 1,2,3 | Any 3 out of 5 | 15 |
| Total | | | 60 |

**Note**:

Q.1, 2, 3 and 4 may be divided into sub questions with internal choice if required.

Passing criteria: Minimum 40% in Internal (16 out of 40) and 40% (24 out of 60) in semester end examination.

## SCHEME OF PRACTICAL EXAMINATION (1 credit)

**The scheme of Practical examination shall be**

(A) Practical assessment carries 50 Marks : 40 marks + 05marks (journal)+ 05 marks(viva)

(B) Minimum 75 % practical are required to be completed and written in the journal.
(Certified Journal is compulsory for appearing at the time of Practical Exam)

**(A) Practical Assessment 50 marks**

| Description | Marks |
|---|---|
| Two questions of practical (20 marks each) | 40 |
| Journal | 5 |
| Viva | 5 |
| Total | 50 |

**Passing criteria: Minimum 40% in Practical (20 out of 50)**

**MINOR - (2 credit)**

**The scheme of examination shall be divided into two parts:**

- **Internal assessment 40% i.e. 20 marks**
- **Semester end examination 60% i.e. 30 marks**

**A. Internal Assessment 20 marks**

| Description | Marks |
|---|---|
| Internal test of 10 marks<br>▪ Multiple choice Questions - 10 Marks | 10 |
| One Project and Viva voce / Presentation / Case studies / Assignments Poster Making / Quiz / Role Play / Subject Specific Activities | 05 |
| Attendance and Class behavior | 05 |
| **Total** | 20 |

**B. Semester end examination: 30 marks**

**PAPER PATTERN**

| Duration: 1 hours | |
|---|---|
| Total Marks: 30 | |
| **Description** | **Marks** |
| Q.1 10 marks OR 10 marks | 10 |

| | |
|---|---|
| Q.2 10 marks OR 10 marks | 10 |
| Q.3 10 marks OR 10 marks | 10 |
| Note:<br>● Q.1, 2, 3 may be divided into sub questions if required.<br>● Q.3 May include theory (short notes) /Case Study in one of the options. | |

**Passing criteria: Minimum 40% in Internal (08 out of 20) and 40% (12 out of 30) in semester end examination.**

## VOCATIONAL COURSE (VSC) & SKILL ENHANCEMENT COURSE(SEC)

**The scheme of examination:**

- **Internal assessment 40% i.e. 20 marks**
- **Semester end examination 60% i.e. 30 marks**

**A. Internal Assessment 20 marks**

| Description | Marks |
|---|---|
| Internal test of 10 marks<br>▪ Multiple choice Questions - 10 Marks | 10 |
| One Project and Viva voce / Presentation / Case studies / Assignments Poster Making / Quiz / Role Play / Subject Specific Activities | 05 |
| Attendance and Class behavior | 05 |
| **Total** | 20 |

**B. Semester end examination 30 marks**
**PAPER PATTERN**

| | |
|---|---|
| Duration: 1 hours | |
| Total Marks: 30 | |
| **Description** | **Marks** |
| Q.1 10 marks OR 10 marks | 10 |
| Q.2 10 marks OR 10 marks | 10 |
| Q.3 10 marks OR 10 marks | 10 |

| | |
|---|---|
| Total | 30 |

Note:

- Q.1, 2, 3 may be divided into sub questions if required.
- Q.3 May include theory (short notes) /Case Study in one of the options.

**Passing criteria: Minimum 40% in Internal (8 out of 20) and 40% (12 out of 30) in semester end examination.**