**COURSE PLAN**

III-TRIMESTER (2023-24)

**SECTION I**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Trimester** | | III | | **Class** | II1MSAIM |
| **Course Code** | | MAI371 | | **Course title** | Deep Learning |
| **Hours** | | 75 | | **Hours per week** | 7 |
| **Credits** | | 5 | | **Course Type** | Theory and Practical (Full CIA) |
| **Faculty name** | | Dr Prabu P | | **Contact details** | [prabu.p@christuniversity.in](mailto:prabu.p@christuniversity.in)  8883773120 |
| **Class policies and guidelines** | | * Please ensure strict compliance with the class policies of the University/Department as outlined in the following link:<https://christuniversity.in/general-regulations>. * Students must adhere to the timetable and be present in their designated classrooms. * Dress code is compulsory. * A student who is not able to attend any classes due to unavoidable reasons, is expected to inform the faculty handling the session/class teacher via email or WhatsApp Message, along with reason for absence. * All communication will be conducted through Google Classroom/Github. * All the programs must be uploaded to the GitHub account, and the GitHub account must be associated with your official Christ ID. * Cell phones, pagers, iPods/MP3 players should be kept in your bag and turned off, as these items cause disruptions during valuable class time. * All students are required to bring their laptops with necessary software installed. Laptops should only be used when instructed in class. * It is expected that students will employ genuine, sincere, and fair methods to complete tests, tasks, or projects, which will be used to evaluate their progress. Any instances of plagiarism, copying, or cheating will result in automatic zeros. | | | |
| **Teaching methodologies** | | **1.Concept Visualization:**  Live demonstration employing tools to enhance understanding of key concepts in Deep Learning Algorithms  **Experiential and Participative Learning**  **2.Project Based Learning:**  Implement projects requiring teams to apply neural network knowledge to real-world challenges, emphasizing teamwork and experiential learning.  **3.Peer Review:**  Encourage collaborative peer code reviews on GitHub to evaluate neural network implementations. Enhance code quality, promote best practices, and deepen understanding of implementation details. | | | |
| **Course Description/Objectives** | | The main objective of this course is to make students comfortable with the tools and techniques required to handle large datasets. Several libraries and datasets publicly available will be used to illustrate the application of these algorithms. This will help students develop the skills required to gain experience of doing independent research and study. | | | |
| **Course Outcomes** | | **CO1:**Recognize the basic concepts and techniques of deep learning.  **CO2:**Evaluate and prepare to apply deep learning algorithms.  **CO3:**Apply deep learning models for applications.  **CO4:**Identify appropriate tools to implement the solutions to problems related for deep learning. | | | |
| **SECTION II** | | | | | |
| Module/ Unit/ Topic number and title | Module/ Unit/ Topic details | Week (starting and end dates) | Hours per week | Pedagogy (teaching learning methods used)/ activities and or class trips/ dates for assessment | Resource/ Reference details |
| Introduction  Unit-1 | Discussion on Course Plan, Introduction to DL, An overview of ANN, Back Propagation Neural Networks, Deep Feedforward Networks | Week 1  (05/2/2024 To  10/2/2024) | 7 | Interactive Lectures and  PPT | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016. |
| Unit-1 | Deep network for Universal Boolean function representation, classification and Approximation, perceptron Learning  **Lab Exercises:**  1. Demonstrate MLP in Keras/Tensorflow  2. Demonstrate Deep Feedforward Network | Week 2  (12/2/2024  To  17/2/2024) | 7 | Interactive Lectures,  PPT and Demo  **CIA Component**  **-I**  **MCQ** | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016. |
| Unit-1 | Perceptron with activation functions | Week 3  (19/2/2024  To  24/2/2024) | 7 | Interactive Lectures and Demo | [2] Introduction to Deep Learning by Eugene Charniak. The MIT Press 2019 |
| Unit-2 | Regularization for Deep models: L2 and L1 Regularization  **Lab Exercises:**  1. Demonstrate Regularization L1 for Deep learning model |
| Unit-2 | Constrained Optimization and Under- Constrained, Early Stopping, Parameter Tying and Parameter Sharing  **Lab Exercises:**  2. Demonstrate Regularization L2 for Deep learning model | Week 4  (26/2/2024  To  02/3/2024) | 7 | Interactive Lectures, Case Studies and Demo  **CIA Component**  **-II**  **Lab Test** | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [2] Introduction to Deep Learning by Eugene Charniak. The MIT Press 2019 |
| Unit 2 | Sparse representations, Dropout | Week 5  (04/3/2024  To  (9/3/2024) | 6 | Interactive Lectures, Case Studies and Demo | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [2] Introduction to Deep Learning by Eugene Charniak. The MIT Press 2019 |
| Unit 3 | The Convolution Operation, Pooling, Structured Outputs |
| Unit 3 | Variants of convolution, Variants of CNN – ImageNet, Alexnet, VGG16  **Lab Exercises:**  1.Demonstrate Convolution Neural Network  2. Demonstrate VGG16 | Week 6  (11/3/24)  To  (16/3/24) | 7 | Interactive Lectures, Case Studies and Demo | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [2] Introduction to Deep Learning by Eugene Charniak. The MIT Press 2019 |
| Unit 3 | ResNet, Applications in Computer Vision  **Lab Exercises:**  1. Demonstrate ResNet | Week 7  (18/3/24)  To  (23/3/24) | 7 | Interactive Lectures, Case Studies and Demo  **ETE Component**  **-IV**  **Lab Test** | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [2] Introduction to Deep Learning by Eugene Charniak. The MIT Press 2019 |
| Unit 4 | Sequence Processing, Unfolding Computational Graphs |
| Unit 4 | Training recurrent networks  The Long Short-Term Memory (LSTM), Optimization for Long  **Lab Exercises:**  1. Demonstrate Recurrent Neural Network | Week 8  (25/3/24)  To  (30/3/24) | 7 | Interactive Lectures, Case Studies and Demo | [2]Introduction to Machine Learning, E. Alpaydin, 3rd Edition, MIT Press, 2014.  [3]Machine Learning with R: Expert techniques for predictive modeling, Brett Lantz, 3rd Edition, Packt Publishing, 2019 |
| Unit 4 | Term Dependencies, Encoder-Decoder Sequence-to-Sequence processing  **Lab Exercises:**  2. Demonstrate Short-Term Long Memory (LSTM) | Week 9  (01/4/24)  To  (06/4/24) | 7 | Interactive Lectures, Case Studies and Demo  **ETE Component**  **-V**  **Theory**  **Test** | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [3] Dive into Deep Learning by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola. 2019 |
| Unit 5 | The architecture of autoencoders |
| Unit 5 | relationship between the Encoder, Bottleneck, and Decoder | Week 10  (08/4/24)  To  (13/4/24) | 3 | Interactive Lectures, Case Studies and Demo | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [3] Dive into Deep Learning by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola. 2019 |
| Unit 5 | how to train autoencoders- Types of autoencoders: Undercomplete autoencoders, Sparse autoencoders, Contractive autoencoders, Denoising autoencoders  **Lab Exercises:**   1. Demonstrate Sparse Autoencoders | Week 11  (15/4/24)  To  (20/4/24) | 7 | Interactive Lectures, Case Studies and Demo | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [3] Dive into Deep Learning by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola. 2019 |
| Unit 5 | Denoising autoencoders, Variational Autoencoders  **Lab Exercises:**  Demonstrate Contractive Autoencoders  **Revision** | Week 12  (22/4/24)  To  (27/4/24) | 7 | Interactive Lectures, Case Studies and Demo  **ETE Component**  **-VI**  **Group Project Presentation** | [1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [3] Dive into Deep Learning by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola. 2019 |
|  | **Revision** | Week 13 | 1 | Group Discussion | [[1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.  [3] Dive into Deep Learning by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola. 2019 |

**SECTION III**

**Mapping:**

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| --- | --- | --- | --- | --- | --- |
| Course Outcomes | Programme Outcomes (please take up the strength mapping here, map your COs to POs at -, 1, 2, and 3) | | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 |
| **CO1:** Recognize the basic concepts and techniques of deep learning. | 1 | 2 | 2 | - | 1 |
| **CO2:** Evaluate and prepare to apply deep learning algorithms. | 2 | 1 | 3 | 1 | - |
| **CO3:** Apply deep learning models for applications. | 3 | 2 | 2 | 2 | 2 |
| **CO4:** Identify appropriate tools to implement the solutions to problems related for deep learning. | 2 | 2 | 3 | - | 1 |

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| --- | --- | --- | --- | --- | --- | --- |
| Course Outcomes | Components of assessment (with the break up of marks) | | | | | |
| CIA  Comp-1  **MCQ** | CIA  Comp-2  **Lab Test** | CIA  Comp-3  **Regular Lab Exercises** | ETE  Comp-1  **Lab Test** | ETE  Comp-2  **Theory Test** | ETE  Comp-3  **Group Project** |
| CO 1 | 10 | 10 | 10 | 10 | - | - |
| CO 2 | 10 | 10 | 10 | 10 | 5 | 5 |
| CO 3 | - | 10 | 10 | 10 | 15 | 10 |
| CO 4 | - | - | 10 | - | 10 | 25 |

**Assessment outline:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Components of assessment | | | | | |
| Components | CIA I  (Comp-1) | CIA II  (Comp-2) | CIA III  (Comp-3) | Attendance | ETE  (Comp-1) | ETE  (Comp-2) | ETE  (Comp-3) |
| Marks  /Percentage | 20 | 30 | 40 | 10 | 30 | 30 | 40 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Weightage** | **Component** | **Marks** | **Description of the CIA component** | **Schedule** |
| CIA  75 Marks | Component – I | 20 | MCQ | Week 2 |
| Component – II | 30 | Practical Test would be conducted during the regular class hours.  Duration: 1:30 Hours  Total Marks: 30 marks  No of questions: 2 Scenario based questions | Week 4 |
| Component – III | 40 | Regular Lab exercises evaluations |  |
| Attendance | 10 | Regularity and Punctuality |  |
|  | **Total** | **100** | The total mark will be converted to 75 |  |
| ETE  75 Marks | Component – IV | 30 | Practical Test would be conducted during the regular practical hours.  Duration: 2:00 Hours  Total Marks: 30 marks  No of questions: Scenario based questions based on the 50% of the prescribed regular lab exercises. | Week 6 |
| Component – V | 30 | Theory Written Test would be conducted in a common schedule proposed by the department.  Duration:2 hours  No of questions: 5 with internal choices  Each question is for 10 Marks  Total Marks: 50 marks and reduced to 30 Marks | Week 8 |
|  | Component – VI | 40 | Group Project Demonstration and Presentation and would be deployed in the GitHub / Cloud repositories. | Week 10 |
|  | **Total** | **100** | The total mark will be converted to 75 |  |

**SECTION IV**

**Assessment Description: CIA Component-1**

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| --- | --- |
| **Nature of Assignment** | MCQ |
| **Submission Mode** | Online (Moodle) |
| **Date of Exam** | Week 2 |
| **Duration** | 35 Mins |
| **Total Marks** | 20 Marks |
| **Assignment Description** | The evaluation includes 40 multiple-choice questions (MCQs) centered on topics such as Artificial Neural Networks, Back Propagation Neural Networks, and Deep Feedforward Networks. Each question holds a value of 1 mark, and there are no deductions for incorrect responses. The cumulative score will be converted into a maximum of 20 marks. The examination will be conducted using the Moodle platform. |

**Learning outcomes:**

**LO1:Analyze neural network architectures for effective representation and approximation.**

**LO2:Demonstrate proficiency in implementing and assessing Deep Feedforward Networks using Keras/Tensorflow.**

**Evaluation Rubric/s:**

|  |  |  |
| --- | --- | --- |
| Score | Impression | Description |
| 16-20 | Proficient | Demonstrates an excellent understanding and comprehensive knowledge of neural network architectures for effective representation and approximation. Provides clear, accurate, and detailed answers to the MCQs, showcasing a high level of proficiency in analyzing and implementing deep feedforward networks. |
| 11-15 | Good | Displays a good understanding of neural network architectures, specifically in implementing and assessing Deep Feedforward Networks using Keras/Tensorflow. Answers most MCQs correctly, with a few minor errors or omissions. |
| 6-10 | Satisfactory | Exhibits a fair understanding of neural network architectures for representation and approximation. Provides partially correct answers to some MCQs, but may lack clarity or make significant errors in understanding specific concepts. |
| 1-5 | Need to  Improve | Demonstrates a limited understanding of neural network architectures, particularly in implementing Deep Feedforward Networks using Keras/Tensorflow. Answers are incorrect or incomplete, indicating a need for improvement in knowledge of the topics covered. |

**Mapping the Learning Outcomes of the assignment with components of the evaluation rubrics:**

|  |  |  |
| --- | --- | --- |
| Learning Outcome of the assignment | Method of assessment | Components of the evaluation rubrics |
| **LO1: Analyze neural network architectures for effective representation and approximation.** | Online MCQ Test | Impression |
| **LO2: Demonstrate proficiency in implementing and assessing Deep Feedforward Networks using Keras/Tensorflow.** |

**Assessment Description: CIA Componet-2**

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| --- | --- |
| **Nature of Assignment** | Lab Test |
| **Date of Exam** | Week 5 |
| **Duration** | 2 Hours |
| **Total Marks** | 30 Marks |
| **Assignment Description** | * The lab assessment comprises two scenario-based questions designed to evaluate students' comprehension of regularization techniques in deep learning models. Each student is required to implement the corresponding code for the scenarios and submit their completed code on GitHub. Thorough code descriptions, elucidating the purpose and application of each function or package, are anticipated. Students are encouraged to utilize GitHub's description option for this purpose. * Following the test, all students code will be shared, facilitating a collaborative environment for code review. Students will have the opportunity to review and evaluate their peers code, offering constructive feedback and assigning ratings based on the quality of their work. There will be a total of seven groups, with each group comprising ten students. As a student, you are responsible for reviewing and providing feedback on the code submissions within your assigned group. |

**Learning outcomes:**

**LO1:** Apply regularization techniques in deep learning models through code implementation, demonstrating practical understanding.

**LO2:** Evaluate and critique peers code submissions, offering constructive feedback and assigning ratings based on the quality of regularization implementations.

**Evaluation Rubric/s:**

|  |  |  |  |
| --- | --- | --- | --- |
| Category | Coding Proficiency  (15 Marks) | Documentation and Communication  (10 Marks) | Collaboration and Peer Review  (5 Marks) |
| Excellent | 13-15 Marks | 8-10 Marks | 5 Marks |
| Good | 9-12 Marks | 6-7 Marks | 4 Marks |
| Satisfactory | 5-8 Marks | 4-5 Marks | 3 Marks |
| Need to Improve | 0-4 Marks | 0-3 Marks | 2 Marks |

Mapping the Learning Outcomes of the assignment with components of the evaluation rubrics:

|  |  |  |
| --- | --- | --- |
| Learning Outcome of the assignment | Method of assessment | Components of the evaluation rubrics |
| **LO1:** Apply regularization techniques in deep learning models through code implementation, demonstrating practical understanding. | Practical test | Impression |
| **LO2:** Evaluate and critique peers' code submissions, offering constructive feedback and assigning ratings based on the quality of regularization implementations. | Practical test | Impression |

**Assessment Description: CIA Componet-3**

|  |  |
| --- | --- |
| **CIA Assessment Component – III** | Regular Lab Exercises |
| **Portion** | All 5 Units |
| **Dates for Evaluation** | All Practical Hours allotted in the time table |
| **Technology tool used** | Keras,Tenserflow and Jupiter Notebook |
| **Maximum marks** | 40 |
| **Duration** | 4 Hours / Week |
| **General Instructions** | * Students should design a conceptual model and relational model for the identified domain and upload the same in Google Classroom * Students should execute the queries for the given question and upload the same in Google Classroom * Consolidated marks scored will be converted to out of 40 * Each lab exercises will be evaluated out of 10 marks and the Evaluation Rubrics for each program would be   Timely Submission (2 marks)  Correctness and Demonstration (5 marks)  Concept Clarity (Viva) (3 marks)   * Absenteeism is not be entertained |

**Mapping the Learning Outcomes with components of the evaluation rubrics:**

|  |  |  |
| --- | --- | --- |
| Learning Outcomes of the assignment | Method of assessment | Evaluation Rubrics |
| CO1:Recognize the basic concepts and techniques of deep learning. | Each program will be assessed based on the following:  Timely Submission Correctness of the code  Model Performance and Concept Clarity | Impression |
| CO2:Evaluate and prepare to apply deep learning algorithms. |
| CO3:Apply deep learning models for applications. |
| CO4:Identify appropriate tools to implement the solutions to problems related for deep learning. |

**Evaluation Rubrics:**

|  |  |
| --- | --- |
| **Score** | **Impression** |
| 31-40 | Proficient |
| 21-30 | Good |
| 11-20 | Satisfactory |
| 1-10 | Need to improve |

**Assessment Description: ETE Component-4**

|  |  |
| --- | --- |
| **Nature of Assignment** | Lab Test |
| **Date of Exam** | Week 7 |
| **Duration** | 2 Hours |
| **Total Marks** | 30 Marks |
| **Assignment Description** | * Complete two scenario-based coding tasks that assess your understanding of the Convolution Operation, Pooling, Structured Outputs, Variants of convolution, and prominent CNN architectures (ImageNet, Alexnet, VGG16, ResNet) in the context of Computer Vision. * Submit your code on GitHub, ensuring to provide comprehensive descriptions specifying the purpose and usage of each function or package. Use GitHub's description option for clarity. * Post-assessment, engage in a collaborative code review. Review and evaluate peers' code submissions, offering constructive feedback and assigning ratings based on the quality of their work. * There will be seven groups, each with ten students. As part of your responsibility, review and provide feedback on the code submissions within your assigned group. |

**Learning outcomes:**

**LO1:** Apply Convolutional Neural Network (CNN) concepts and deep learning architectures in coding tasks related to Computer Vision, showcasing practical expertise.

**LO2:** Assess and provide constructive feedback on peers' coding submissions,

demonstrating critical analysis and understanding of CNN concepts in Computer Vision.

**Evaluation Rubric/s:**

|  |  |  |  |
| --- | --- | --- | --- |
| Category | Coding Proficiency  (15 Marks) | Documentation and Communication  (10 Marks) | Collaboration and Peer Review  (5 Marks) |
| Excellent | 13-15 Marks | 8-10 Marks | 5 Marks |
| Good | 9-12 Marks | 6-7 Marks | 4 Marks |
| Satisfactory | 5-8 Marks | 4-5 Marks | 3 Marks |
| Need to Improve | 0-4 Marks | 0-3 Marks | 2 Marks |

**Mapping the Learning Outcomes of the assignment with components of the evaluation rubrics:**

|  |  |  |
| --- | --- | --- |
| Learning Outcome of the assignment | Method of assessment | Components of the evaluation rubrics |
| **LO1:** Apply Convolutional Neural Network (CNN) concepts and deep learning architectures in coding tasks related to Computer Vision, showcasing practical expertise. | Practical Test | Impression |
| **LO2:**Assess and provide constructive feedback on peers' coding submissions, demonstrating critical analysis and understanding of CNN concepts in Computer Vision. | Practical Test | Impression |

**Assessment Description: ETE Component-5**

|  |  |
| --- | --- |
| **Nature of Assignment** | Theory Test |
| **Date of Exam** | Week 9 |
| **Duration** | 2 Hours |
| **Total Marks** | 50 Marks (Converted to 30 Marks) |
| **Assignment Description** | * **Test Duration:** The theory test for RECURRENT NEURAL NETWORKS and AUTOENCODERS will be conducted within a time frame of two hours. * **Test Format:** The theory test will consist of 5 questions with internal choice, including Descriptive and problem-solving questions. * **Content Coverage:** The test will cover the following topics:   + **RECURRENT NEURAL NETWORKS:**     - Sequence Processing     - Unfolding Computational Graphs     - Training Recurrent Networks     - Long Short-Term Memory (LSTM)     - Optimization for Long-Term Dependencies     - Encoder-Decoder Sequence-to-Sequence Processing   + **AUTOENCODERS:**     - Architecture of Autoencoders     - Relationship between Encoder, Bottleneck, and Decoder     - Training Autoencoders     - Types of Autoencoders: Undercomplete, Sparse, Contractive, Denoising     - Variational Autoencoders |

**Learning outcomes:**

**LO1:** Demonstrate the practical implementation of Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) architectures, emphasizing sequence processing and network training.

**LO2:** Evaluate the architecture and training strategies of Autoencoders, showcasing understanding of the Encoder, Bottleneck, and Decoder relationship

**Evaluation Rubric/s:**

|  |  |
| --- | --- |
| **Score** | **Impression** |
| 26-30 | Proficient |
| 21-25 | Good |
| 15-20 | Satisfactory |
| Below 15 | Need to  Improve |

**Assessment Description: ETE Componet-6 Group Project**

Team Size: 3

Mode of Submission: Online (Github)

Date of Presentation:Week12

Total Marks:40 Marks

Assignment description: The group project should include the following components:

In this deep learning project, the focus is on selecting a domain (e.g., computer vision,NLP ,Speech Recognition etc.,) with datasets relevant to MLP, Deep Feedforward Networks, L2/L1 Regularization, CNN, VGG16, ResNet, LSTM, and Autoencoders. The project involves proposing objectives, datasets, and a plan with detailed timelines. Data preprocessing emphasizes relevant attributes for deep learning concepts, followed by the implementation of MLP, Deep Feedforward Networks, and various regularization and network architectures. The evaluation phase assesses performance metrics, facilitating the identification of the most effective approach. Result analysis delves into findings, discussing strengths, limitations, and implications. Collaborative efforts extend to documentation, utilizing tools like GitHub for efficient sharing, while reflections cover challenges, lessons learned, and potential future directions.

**Learning outcomes:**

**LO1:** Apply deep learning concepts (MLP, CNN, LSTM) to solve real-world problems in a chosen domain.

**LO2:** Demonstrate project management skills, outlining objectives, proposing timelines, and creating detailed plans.

**LO3:** Exhibit proficiency in exploring and pre-processing datasets for effective application of deep learning concepts.

**LO4:** Analyze project results, discussing strengths, limitations, and broader implications. Reflect on challenges, lessons learned, and future directions.

**Evaluation Rubric/s:**

1. Data Pre-processing and Exploration (5 marks)
2. Algorithm Implementation (15 marks)
3. Model Evaluation and Performance Analysis (5 marks)
4. Presentation and Communication (10 marks)
5. Collaboration and Teamwork (5 marks)

**Mapping the Learning Outcomes of the assignment with components of the evaluation rubrics:**

|  |  |  |
| --- | --- | --- |
| Course Outcome of the assignment | Method of assessment | Components of the evaluation rubrics |
| **CO1:** Apply deep learning concepts (MLP, CNN, LSTM) to solve real-world problems in a chosen domain. | Practical Exercises, Project Implementation | Data Pre-processing and Exploration |
| **CO2:** Demonstrate project management skills, outlining objectives, proposing timelines, and creating detailed plans. | Coding Assessment, Model Evaluation and comparison | Algorithm Implementation |
| **CO3:** Exhibit proficiency in exploring and pre-processing datasets for effective application of deep learning concepts. | Result Analysis | Model Evaluation and Performance Analysis |
| **CO4:** Analyze project results, discussing strengths, limitations, and broader implications. Reflect on challenges, lessons learned, and future directions. | Project report assessment, presentation assessment | Project Report and Documentation |