**GOVERNMENT POLYTECHNIC, NAGPUR.**

**(An Autonomous Institute of Govt. of Maharashtra)**

**COURSE CURRICULUM**

**PROGRAMME : DIPLOMA IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

**COURSE CATEGORY : PROGRAMME CORE COURSE**

**COURSE CODE : AI301G$**

**COURSE TITLE : INTRODUCTION TO DEEP LEARNING**

**TEACHING SCHEME : TH: 03; TU: 00; PR: 02(CLOCK Hrs.)**

**TOTAL CREDITS : 04 (1 TH/TU CREDIT = 1 CLOCK HR., 2 PR CREDIT = 1 CLOCK HR.)**

**TH. TEE EXAM : 03 HRs**

**PR. TEE EXAM : 01 HRs**

**PT. EXAM : 01 HR**

* **RATIONALE:**

Deep Learning is one of the most exciting and promising segments of Artificial Intelligence and machine learning technologies. This course will help the students to understand and build neural networks using the deep learning framework PyTorch. The students will be familiar with the significant technological trends driving the rise of deep learning, build, train, and apply fully connected deep neural networks, identify key parameters in a neural network’s architecture and apply deep learning to their own applications.

* **COURSE OUTCOMES:**

After completing this course students will be able to–

* Apply the basic concepts related to deep learning.
* Apply the concepts of PyTorch its main functions, operations and the execution pipeline.
* Build and train a simple neural network using the PyTorch.
* Build a simple Convolutional Neural Network (CNN) in PyTorch.
* Implement Recurrent Neural Network with Pytorch.
* Use CNN and RNN to develop the applications of object detection, Image captioning

**COURSE DETAILS:**

1. **THEORY :**

| **Units** | **Specific Learning Outcomes (Cognitive Domain)** | **Topics and Subtopics** | **Hrs.** |
| --- | --- | --- | --- |
| **1. Introduction to Neural Network and Deep Learning** | 1. Describe the use of Deep Learning in given application domain. 2. Differentiate Machine Learning and Deep learning on the basis of given points. 3. Demonstrate the Perceptron Learning Algorithm on the basis of given data, and given initial weight values. 4. Identify the most commonly used Activation Function from given below & why? 5. Calculate the output of the network for the given input pattern & given activation function. | * 1. Deep Learning   2. Differentiate between Machine Learning and Deep Learning   3. The Perceptron   4. Multilayer Perceptron(MLP)   5. Feedforward algorithm   6. Artificial Neural Network – Architecture, notations   7. Activation Functions- linear, Sigmoid, ReLU, Hyperbolic tangent, Softmax, etc | **08** |
| **2.** **Introduction to PyTorch** | 1. Identify essential elements of PyTorch. 2. Create tensors from given Python lists. 3. Compare PyTorch and TensorFlow on the basis of given points. 4. Write the steps to find the derivatives of the function in PyTorch? 5. Illustrate the PyTorch Deep Learning Model Life-Cycle. | * 1. PyTorch: An open source machine learning framework:   2. Major features of PyTorch, TensorFlow vs. PyTorch   3. Tensors, Datasets and DataLoaders,   4. Transforms, Build Model, Automatic Differentiation, Optimization Loop, Save, Load and Use Model   5. PyTorch Deep Learning Model Life-Cycle: Prepare the Data, Define the Model, Train the Model, Evaluate the Model, And Make Predictions. | **10** |
| **3.**  **Training the deep Neural network** | 3a. Difference between Epoch,  Batch, and Iteration in Deep  Learning?  3b Illustrate when training a  Neural Network by  Backpropagation, what  happens if the Learning Rate is  too low? What happens if it is  too high?   1. Identify ways to deal with the vanishing gradient problem in a deep neural network. 2. Illustrate the steps for using a gradient descent algorithm. | * 1. Gradient Descent- working ,   2. Types of Gradient Descent   3. Loss function, cost function   4. Training a Neural Network with Backpropagation   5. The Vanishing and Exploding Gradient Problem   6. Overfitting – Early stopping, regularization , dropout | **10** |
| **4.**  **Convolutional Neural Networks** | 1. Demonstrate why do we prefer Convolutional Neural networks (CNN) over Artificial Neural networks (ANN) for image data as input? 2. Justify why do we use a different Layer in a CNN 3. Determine the size of the convoluted matrix for a given input image and given filter size with stride. 4. Describe the characteristics of given type of Pooling | * 1. The convolution operation   2. Convolutional Neural networks Architecture   3. The Basic Structure of a Convolutional Network - Padding ,Strides , Typical Settings , The ReLU Layer , Pooling , Fully Connected Layers , The Interleaving Between Layers   4. Case Study – AlexNet, GoogLeNet | **08** |
| **5.** **Recurrent Neural Networks** | 1. Identify the Issues of Standard RNNs. 2. Identify the need a Recurrent Neural Network. 3. Describe the steps in implementation of a full Recurrent Neural Network. | * 1. Introduction to Recurrent Neural Networks   2. The Architecture of Recurrent Neural Networks   3. Working of Recurrent Neural Networks ,   4. Echo-State Networks , Long Short-Term Memory (LSTM) | **06** |
| **6.** **Applications of Deep Learning** | 1. Illustrate how CNN used in given real-life applications. 2. Illustrate the use of Recurrent Neural Networks in given application domain. | * 1. Applications of Convolutional Networks , Content-Based Image Retrieval , Object Localization , Object Detection , Natural Language and Sequence Learning , Video Classification   2. Applications of Recurrent Neural Networks - Application to Automatic Image Captioning , Sequence-to-Sequence Learning and Machine Translation, Question-Answering Systems , Application to Sentence- Level Classification , End-to-End Speech Recognition , Handwriting Recognition | **06** |
|  | **Total Hrs** | | **48** |

1. **LIST OF EXPERIMENTS:**

| **Practi-**  **cals** | **Specific Learning Outcomes (Psychomotor Domain)** | **Units** | **Hrs.** |
| --- | --- | --- | --- |
| **1** | Setup a Python Environment for Deep Learning and Install Deep Learning Libraries. | 1. Introduction to Neural Network and Deep Learning | **02** |
| **2** | Install  PyTorch popular deep learning framework and work with   1. Datasets & DataLoaders 2. Datasets | 2. Introduction to PyTorch | **02** |
| **3** | Implement a simple linear regression model using PyTorch. | **02** |
| **4** | Implementation of Perceptron Algorithm for AND Logic Gate with 2-bit Binary Input | 1. Introduction to Neural Network and Deep Learning | **02** |
| **5** | Implement Neural Network in Python using Iris flower dataset. | **04** |
| **6** | Implement backpropagation Algorithm using MNIST data set | 3.  Training the deep Neural network | **04** |
| **7** | Implement Gradient Descent in PyTorch to reduce the loss of the linear regression model build in experiment no 3. | 3.  Training the deep Neural network |  |
| **8** | Implement back propagation algorithm showing overfitting. | **04** |
| **9** | Implement CIFAR 10- CNN using PyTorch. | 4. Convolutional Neural Networks | **04** |
| **10** | Implement Recurrent Neural Network with Pytorch. | 5. Recurrent Neural Networks | **04** |
| **11** | Develop any application of Deep Learning | 6. Applications of Deep Learning | **04** |
| **Total Hrs.** | | | **32** |

* **SPECIFICATION TABLE FOR THEORY PAPER:**

| **Unit No.** | Units | **Levels from Cognition Process Dimension** | | | **Total Marks** |
| --- | --- | --- | --- | --- | --- |
| **R** | **U** | **A** |
| **1** | Introduction to Neural Network and Deep Learning | 02(00) | 03(03) | 00(00) | **05(03)** |
| **2** | Introduction to PyTorch | 02(02) | 03(03) | 03(00) | **08(05)** |
| **3** | Training the deep Neural network | 02(00) | 03(03) | 09(06) | **14(09)** |
| **4** | Convolutional Neural Networks | 02(00) | 03(03) | 09(06) | **14(09)** |
| **5** | Recurrent Neural Networks | 02(02) | 03(00) | 06(03) | **11(05)** |
| **6** | Applications of Deep Learning | 02(02) | 03(00) | 03(03) | **08(05)** |
|  | Total | **12(06)** | **18(12)** | **30(18)** | **60 (36)** |

R – Remember U – Understand A – Analyze / Apply

* **QUESTION PAPER PROFILE FOR THEORY PAPER**

T-Unit/Topic Number L- Level of Question M- Marks

R-Remember U-Understand A-Analyze/ Apply

1 R 2 means Unit/Topic Number No- 1, Level of Question –Remember, Marks – 2 Marks

| **Q.**  **No** | **Bit 1** | | | **Bit 2** | | | **Bit 3** | | | **Bit 4** | | | **Bit 5** | | | **Bit 6** | | | **Options** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | R | 2 | 2 | R | 2 | 3 | R | 2 | 4 | R | 2 | 5 | R | 2 | 6 | R | 2 | 6/9 |
| 2 | R | 2 | 5 | R | 2 | 6 | R | 2 |  |  |  |  |  |  |  |  |  |
| 2 | 1 | U | 3 | 2 | U | 3 | 3 | U | 3 | 4 | U | 3 | 3 | U | 3 |  |  |  | 3/5 |
| 3 | 4 | U | 3 | 5 | U | 3 | 6 | U | 3 | 1 | U | 3 | 2 | U | 3 |  |  |  | 3/5 |
| 4 | 2 | A | 3 | 3 | A | 3 | 3 | A | 3 | 4 | A | 3 | 6 | A | 3 |  |  |  | 3/5 |
| 5 | 4 | A | 3 | 3 | A | 3 | 6 | A | 3 | 5 | A | 3 | 4 | A | 3 |  |  |  | 3/5 |
| 6 | 4 | A | 6 | 5 | A | 6 | 3 | A | 6 |  |  |  |  |  |  |  |  |  | 2/3 |

* **ASSESSMENT AND EVALUATION SCHEME:**

|  | **What** | | **To Whom** | **Frequency** | **Max Marks** | **Min Marks** | **Evidence Collected** | **Course Outcomes** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Direct Assessment Theory** | **CA**  (Continuous Assessment) | PT | Students | Two PT (average of two tests will be computed) | 25 | -- | Test Answer Scripts | 1, 2, 3,4,5,6 |
| Class Room Assignments | Assign-  ments | 15 | -- | Assignment Book | 1, 2, 3,4,5,6 |
| **TEE**  (Term End Examination) | End Exam | Students | End of the Course | 60 | 24 | Theory Answer Scripts | 1,2,3,4,5,6 |
|  |  |  |  | **Total** | **100** | **40** |  |  |
| **Direct Assessment Practical** | **CA**  (Continuous Assessment) | Continuous Assessment of Practical | Students | End of Every Practical | 20 | -- | Journal | 1, 2, 3,4,5,6 |
| Journal Writing | Assign-  ments | 05 | -- | Journal | 1, 2, 3,4,5,6 |
|  | Total | **25** | **10** |  |  |
| **TEE**  (Term End Examination) | End Exam | Students | End of the Course | **50** | **20** | Practical Answer Scripts | 1,2,3,4,5,6 |
| **Indirect Assessment** | Student Feedback on course | | Students | After First PT | Student Feedback Form | | | 1, 2, 3, 4,5,6 |
| End of Course Survey | | End of The Course | Questionnaires | | |

* **SCHEME OF PRACTICAL EVALUATION:**

| **S.N.** | **Description** | **Max. Marks** |
| --- | --- | --- |
| **1** | Identification of Framework-installation. | **10** |
| **2** | Build Save Load Use, Model. | **20** |
| **3** | Accuracy of Model | **10** |
| **4** | Viva Voce | **10** |
|  | **TOTAL** | **50** |

* **MAPPING COURSE OUTCOMES WITH PROGRAM OUTCOMES:**

| **Course Outcomes**  **(COs)** | **Program Outcomes (POs)** | | | | | | | **Program Specific Outcomes (PSOs)** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** |
| **1** | 3 | -- | -- | 3 | -- | -- | -- | -- | 3 |
| **2** | 3 | -- | -- | 3 | -- | -- | -- | -- | 3 |
| **3** | 3 | -- | -- | 3 | -- | -- | -- | -- | 3 |
| **4** | 3 | 3 | 3 | 3 | -- | -- | -- | -- | 3 |
| **5** | 3 | 3 | 3 | 3 | -- | -- | -- | -- | 3 |
| **6** | 3 | 3 | 3 | 3 | -- | -- | -- | -- | 3 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

* **REFERENCE & TEXT BOOKS:**

| **S.N** | **Title** | **Author, Publisher, Edition and Year of Publication** | **ISBN Number** |
| --- | --- | --- | --- |
| **1** | Deep Learning | Aaron Courville (Author), Ian Goodfellow (Author), Yoshua Bengio (Author)  MIT Press, 2016 | ISBN 9780262035613 |
| **2** | Programming PyTorch for Deep Learning | Ian Pointer Released September 2019  Publisher(s): O'Reilly Media, Inc. | ISBN: 9781492045359 |
| **3** | Deep Learning: A Practitioner's Approach 1st Edition | by Josh Patterson (Author), Adam Gibson (Author ) Kindle Edition | ISBN-13: 978-1491914250 |
| **4** | Neural Networks and Deep Learning | Charu C. Aggarwal (Author), Springer International Publishing AG, part of Springer Nature 2018 | ISBN-13 ‏ : ‎ 978-3-030-06856-1 |

* **E-REFERENCES:**
* https://www.simplilearn.com/tutorials/deep-learning-tutorial/what-is-deep-learning accessed on 10/03/2022
* https://pytorch.org/ accessed on 10/03/2022
* https://www.tutorialspoint.com/python\_deep\_learning/index.htm accessed on 10/03/2022
* **LIST OF MAJOR EQUIPMENTS / INSTRUMENTS WITH SPECIFICATION:**

1. PyTorch-open source machine learning framework
2. Anaconda -The World's Most Popular Data Science Platform
3. Colaboratory

* **LIST OF EXPERTS & TEACHERS WHO CONTRIBUTED FOR THIS CURRICULUM:**

| **S.N.** | **Name** | **Designation** | **Institute / Industry** |
| --- | --- | --- | --- |
| **1** | Dr.A R Mahajan | HoD, Information Technology and Course Expert | Government Polytechnic, Nagpur. |
| **2** | Dr. Paresh Kamble | Machine Learning Specialist, OZ Sports Nagpur. | Industry Expert |
| **3** | Dr. Gopal Sakarkar | Assistant Professor, A.I., G. H. Raisoni College of Engineering, Nagpur. | Member from Academics(External) |
| **4** | Mr. Pravin Malve | Lecturer in C.O., G.P.Arvi | MSBTE Nominee |
| **5** | Mr. M.N.Gawande | Lecturer in Electrical Engg. | CDC In Charge and Member Secretary |
| **6** | Mrs.Shifa Sayyed | Lecturer in IT | Member (Internal) |
| **7** | Mr.L D Vilhekar | Lecturer in IT | Member (Internal), Reviewer |

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
 (Member Secretary PBOS) (Chairman PBOS)**