**COURSE PLAN**

|  |  |
| --- | --- |
| Target | 45% (marks) |
| Level-1 | 35% (population) |
| Level-2 | 45% (population) |
| Level-3 | 55% (population) |

1. **Method of Evaluation**

|  |  |
| --- | --- |
| **UG** | **PG** |
| Quizzes/Tests, Assignments (30%) | Quizzes/Tests, Assignments, seminar (50%) |
| Mid Examination (20%) | End semester (50%) |
| End examination (50%) |  |

1. **Passing Criteria**

|  |  |  |
| --- | --- | --- |
| **Scale** | **PG** | **UG** |
| **Out of 10 point scale** | SGPA – “6.00” in each semester  CGPA – “6.00”  Min. Individual Course Grade  –  “C”  Course Grade  Point –  “4.0” | SGPA – “5.0” in each semester  CGPA – “5.0”  Min. Individual Course Grade  –  “C”  Course Grade  Point –  “4.0” |

\*for PG, passing marks are 40/100 in a paper

\*for UG, passing marks are 35/100 in a paper

1. **Pedagogy** 
   * Lectures using Board
   * Presentations over Blackboard & Video Lectures
   * Discussions & Tutorials
   * Assessments (Class Test, Quiz, Assignments)
2. **References:**

|  |  |  |  |
| --- | --- | --- | --- |
| Text Books | Web resources | Journals | Reference books |
| Book provided by IBM |  |  | <https://www.deeplearningbook.org/>  <http://neuralnetworksanddeeplearning.com/> |

**GUIDELINES TO STUDY THE SUBJECT**

**Instructions to Students:**

1. Go through the 'Syllabus' in the Black Board section of the web-site (https://learn.upes.ac.in) in order to find out the Reading List.
2. Get your schedule and try to pace your studies as close to the timeline as possible.
3. Get your on-line lecture notes (Content, videos) at Lecture Notes section.  These are our lecture notes. Make sure you use them during this course.
4. Check your blackboard regularly
5. Go through study material
6. Check mails and announcements on blackboard
7. Keep updated with the posts, assignments and examinations which shall be conducted on the blackboard
8. Be regular, so that you do not suffer in any way
9. C**ell Phones and other Electronic Communication Devices:** Cell phones and other electronic communication devices (such as Blackberries/Laptops) are not permitted in classes during Tests or the Mid/Final Examination. Such devices MUST be turned off in the class room.
10. **E-Mail and online learning tool:** Each student in the class should have an e-mail id and a pass word to access the LMS system regularly. Regularly, important information – Date of conducting class tests, guest lectures, via online learning tool. The best way to arrange meetings with us or ask specific questions is by email and prior appointment. All the assignments preferably should be uploaded on online learning tool. Various research papers/reference material will be mailed/uploaded on online learning platform time to time.
11. **Attendance:** Students are required to have minimum attendance of 75% in each subject. Students with less than said percentage shall NOT be allowed to appear in the end semester examination.

This much should be enough to get you organized and on your way to having a great semester! If you need us for anything, send your feedback through e-mail [to](mailto:abc@ddn.upes.ac.in) your concerned faculty. Please use an appropriate subject line to indicate your message details.

There will no doubt be many more activities in the coming weeks. So, to keep up to date with all the latest developments, please keep visiting this website regularly.

**RELATED OUTCOMES**

1. **The expected outcomes of the Program are:**

|  |  |
| --- | --- |
| PO1 | **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| PO2 | **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| PO3 | **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| PO4 | **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO5 | **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| PO6 | **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| PO7 | **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| PO9 | **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO11 | **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| PO12 | **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

1. **The expected outcomes of the Specific Program are: (upto3)**

|  |  |
| --- | --- |
| PSO1 | Perform system and application programming using computer system concepts, concepts of Data Structures, algorithm development, problem solving and optimizing techniques, |
| PSO2 | Apply software development and project management methodologies using concepts of front-end and back-end development and emerging technologies and platforms. |
| PSO3 | Ability to create & develop most efficient solutions by applying machine learning with analytical emphasis on industrial and research problems |

1. **The expected outcomes of the Course are: (minimum 3 and maximum 6)**

|  |  |
| --- | --- |
| CO 1 | To understand the basic concept of biological Neural Network, artificial Neural Network and its application. |
| CO 2 | Analyze the Neural network problems and learning process corresponding to different applications. |
| CO 3 | Understand the contemporary techniques and architecture of artificial neural network. |
| CO 4 | Comprehend the working of neural network and stochastic methods. |
| CO 5 | Analyze the different neural network to solve problems of moderate complexity. |

1. **Co-Relationship Matrix**

Indicate the relationships by1- Slight (low) 2- Moderate (Medium) 3-Substantial (high)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| PO/CO | PO  1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO  9 | PO  10 | PO  11 | PO  12 | PSO  1 | PSO  2 | PSO  3 |
| CO1 | 2 | 1 | 1 | 1 |  |  |  |  |  |  |  |  | 1 |  | 2 |
| CO2 | 2 | 1 | 1 | 1 |  |  |  |  |  |  |  |  | 1 |  | 2 |
| CO3 | 2 | 3 | 1 | 1 |  |  |  |  |  |  |  |  | 1 |  | 2 |
| CO4 | 3 | 3 | 1 | 3 |  |  |  |  |  |  |  |  | 1 |  | 2 |
| CO5 | 2 | 1 | 1 | 1 |  |  |  |  |  |  |  |  | 1 |  | 2 |
| Average | 2.2 | 1.8 | 1 | 1.4 |  | - | - | - | - | - | - | - | 1 | - | 2 |

1. **Course outcomes assessment plan:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **components**  **Course Outcomes** | **Assignment** | **Test/Quiz** | **Mid Semester** | **End Semester** | **Any other** |
| **CO 1** | **□** | **□** | **□** | **□** | **□** |
| **CO 2** | **□** | **□** | **□** | **□** | **□** |
| **CO 3** | **□** | **□** | **□** | **□** | **□** |
| **CO 4** | **□** | **□** | **□** | **□** | **□** |
| **CO 5** | **□** | **□** | **□** | **□** | **□** |

**BROAD PLAN OF COURSE COVERAGE**

**Course Activities:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. No.** | **Description** | **Planned** | | | **Remarks** |
| **From** | **To** | **No. of Sessions** |
| **1.** | **The Fundamentals of Deep Learning** |  |  | 8 |  |
| **2.** | **Diving to the Depths of Deep Learning** |  |  | 6 |  |
| **3.** | **Convolutional Neural Networks** |  |  | 5 |  |
| **4.** | **Recurrent Neural Networks (RNN)** |  |  | 6 |  |
| **5.** | **Generative Deep Learning** |  |  | 6 |  |
| **6.** | **Learning Process and different models in Neural networks** |  |  | 5 |  |

Sessions: Total No. of Instructional periods available for the course

**SESSION PLAN**

**UNIT-I**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Topics to be Covered** | **CO Mapped** |
| 1 | How is deep learning different from another machine learning? AI vs | CO1 |
| 2 | ML vs DL, Deep learning capabilities, Other approaches to artificial intelligence, what is special about deep learning? Relevance of deep learning | CO1 |
| 3 | How does a neural network look like? The matrix magic, | CO1 |
| 4 | Visualizing deep learning, The elephant in the room, Programmatic expression of deep learning’s math constructs, | CO2 |
| 5 | Operations with the tensors, Array broadcasting, Scalar product/Inner product of tensors, Morphing shapes of tensors, Gradient calculation. | CO2 |
| 6 | MLP Concepts, Backpropagation Algorithm, | CO2 |
| 7 | Backpropagation Algorithm Perform Better, Output Representation and Decision Rules, Feature Detection, Backpropagation and Differentiation, | CO2 |
| 8 | Approximations of Functions, Cross-Validations, Network Pruning Techniques, Virtues and Limitations of Backpropagation Learning, Accelerated Convergence of Backpropagation Learning, Supervised Learning Viewed as Optimization Problem. |  |

**SESSION PLAN**

**UNIT-II**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Topics to be Covered** | **CO Mapped** |
| 9 | Deep learning depths, Model: The molecules of DL | CO3 |
| 10 | Loss functions in neural networks, Optimizers in neural networks, Activation functions, Finding the perfect fit, | CO3 |
| 11 | Running deep learning algorithms: The frameworks, Real examples and actual schematics of building neural nets, Data preparation and label preparation | CO3 |
| 12 | Examples of neural networks at work, Readying data for neural nets, Constructing the network, ReLU, | CO3 |
| 13 | Constructing the network, Approach validation, Plotting the loss from validation & training, | CO3 |
| 14 | What experiments do we run next? An example in regression: Guess the price of the house, Processing the data, Building the network, K-fold approach for validating algorithm, K-fold approach: In code. | CO3 |

**SESSION PLAN**

**UNIT-III**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Topics to be Covered** | **CO Mapped** |
| 15 | Convolutional neural networks, What and how of ConvNets Convolution effectiveness, what is this convolution and why is it effective? | CO3 |
| 16 | Visualization of 2D convolution, Visualization of 3D convolution, Building a model without any max-pooling layers, | CO3 |
| 17 | How to train a CNN on a dataset from ground-up, Importance of deep learning when data is limited, Downloading datasets, Working on it, Building a CNN, one layer at a time, Data pre-processing: Preparing the data, Accuracy & loss: Data processing, | CO4 |
| 18 | Making the most of what’s available: Data augmentation, Accuracy & loss: Data augmentation, Using a trained CNN, How about extracting features without augmenting data? Accuracy & loss: Without data augmentation, | CO4 |
| 19 | how about extracting features with augmenting data? Accuracy & loss: With augmenting data, Tuning the CNN, what do Convolutional Neural Network (CNN, or ConvNet) see? Seeing the intermediate, Points to ponder, Visualizing the filters themselves, looking at heat maps of how filters seek details. | CO4 |

**SESSION PLAN**

**UNIT-IV**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Topics to be Covered** | **CO Mapped** |
| 20 | Recurrent Neural Network (RNN), Why recurrent networks? RNN explained, Deep RNNs, | CO1/CO2/CO5 |
| 21 | Recursive neural networks, RNN in memory, LSTMs and GRUs, Long Short Term Memory (LSTM), | CO5 |
| 22 | Working components of LSTMs, Core idea behind LSTMs, LSTM: A simple walk through, | CO5 |
| 23 | Gated Recurrent Unit (GRU), GRU design steps, Fully gated vs minimal gated architecture of GRU, | CO4 |
| 24 | Working of RNN’s, Recurrent neural networks, Backpropagation through timeline in RNN, Backpropagation through computational graphs, | CO4 |
| 25 | Complex recurrent neural networks, Over-fitting and under-fitting, Detect and avoid overfitting, Prevent of overfitting an approach on model and data, Multi-layered RNNs, Stacked LSTM, Stacked LSTM architecture, Multi-directional RNNs, Difference between LSTM and BI-LSTM, One-dimensional sequence processing, CNN and RNN. |  |

**SESSION PLAN**

**UNIT-V**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Topics to be Covered** | **CO Mapped** |
| 26 | Generative deep learning, | CO5 |
| 27 | Using LSTMs to synthesize text, Text synthetization procedures, | CO5 |
| 28 | Neural style transfer and applications, NST working principle, Content and style management in NST, NST implementation, | CO5 |
| 29 | Image synthesis with variational auto encoders, Need for image synthesis, Working models, Variational Auto Encoders (VAE), Latent space, | CO5 |
| 30 | Generative Adversarial Networks (GAN’s), Generative and discriminative algorithms, | CO5 |
| 31 | Applications using GAN, GAN working principle, Generator and discriminator, Training GAN, Implementing GAN: 1st generation. | CO5 |

**SESSION PLAN**

**UNIT-VI**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Topics to be Covered** | **CO Mapped** |
| 32 | Error-Correction Learning, Memory-Based Learning, Hebbian Learning, Competitive Learning, Boltzmann Learning, Supervised and Unsupervised Learning, Learning Tasks, | CO1/CO2 |
| 33 | Memory and Adaptations, Statistical Nature of the Learning Process, Statistical Learning Theory, Probably Approximately Correct Model of Learning. | CO1/CO2 |
| 34 | Adaptive Filtering Problems, Unconstrained Optimization Techniques, Linear Least-Squares Filters, Least-Mean-Square Algorithms, Learning Curves, Learning Rate Annealing Techniques, Perceptron, Perceptron Convergence Theorem. | CO1/CO2 |
| 35 | Cover's Theorem on the Separability of Patterns, Interpolation Problem, Regularization Theory and Regularization Networks, Generalized Radial-Basis Function Networks, Estimation of the Regularization Parameter, Approximation Properties of RBF Networks, | CO1/CO2 |
| 36 | Comparison of RBF Networks and Multilayer Perceptron, Kernel Regression and its Relation to RBF Networks, Learning Strategies in RBF Networks. Simulated Annealing, Boltzmann Machines, Deterministic Boltzmann Machine. | CO1/CO2 |