# IIT Mandi
# CS671: Deep Learning and Applications
**Credits:** 3-1-0-4 (L-T-P-C)

**Prerequisites**: IC252-Data Science 2 (Probability, Statistics and Random Variables) or Equivalent, IC111-Linear Algebra or Equivalent

1. **Basics of artificial neural networks (ANN)**: Artificial neurons, Computational models of neurons, Structure of neural networks, Functional units of ANN for pattern recognition tasks [3 Lectures]

2. **Feedforward neural networks**: Perceptron model, Multilayer feedforward neural networks (MLFFNNs), Backpropagation learning, Empirical risk minimization, Regularization [5 Lectures]

***Programming Assignment 1***

3. **Deep neural networks (DNNs)**: Difficulty of training DNNs, Greedy layerwise training, Optimization for training DNNs, Newer optimization methods for neural networks (AdaGrad, RMSProp, Adam), Second order methods for training, Regularization methods (dropout, drop connect, batch normalization) [12 Lectures]

4. **Autoencoders:** Autoencoder architecture, dimension reduction using autoencoders, denoising autoencoders, visualization of weights [5 Lectures]

***Programming Assignment 2***

5. **Convolution neural networks (CNNs)**: Introduction to CNNs – convolution, pooling, Deep CNNs, Different deep CNN architectures – LeNet, AlexNet, VGG, PlacesNet. Training a CNNs: weights initialization, batch normalization, hyperparameter optimization, Understanding and visualizing CNNs. [8 Lectures]

***Programming Assignment 3***

6. **Recurrent neural networks (RNNs)**: Sequence modeling using RNNs, Back propagation through time, Long Short Term Memory (LSTM), Gated RNN Architecture [12 Lectures]

***Programming Assignment 4***

7. **Attention mechanism and Generative models**: Encoder-decoder architecture, attention mechanism, transformers. Introduction to generative models - generative adversarial networks (GANs). [5 Lectures]

***Programming Assignment 5***

8. **Applications**: Applications in vision, speech and natural language processing [6 Lectures]

**Textbooks:**

[1] Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep learning*, In preparation for MIT Press, Available online: http://www.deeplearningbook.org, 2016

[2] Charu C. Aggarwal, *Neural Networks and Deep Learning*, Springer, 2018

**Reference books:**

[3] S. Haykin, *Neural Networks and Learning Machines,* Prentice Hall of India, 2010
[4] Satish Kumar, *Neural Networks - A Class Room Approach*, Second Edition, Tata McGraw-Hill, 2013
[5] B. Yegnanarayana, *Artificial Neural Networks*, Prentice- Hall of India, 1999
[6] C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
[7] Research papers in related area.

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| Week 1 | Basics of artificial neural networks (ANN) [3, 4, 5] |
| Week 2-3 | Feedforward neural networks [3, 4, 5] |
| Week 3-7 | Deep neural networks (DNNs) and Autoencoders [1, 2] |
| Week 8-9 | Convolution neural networks (CNNs) [1, 2], Some papers |
| Week 10-12 | Recurrent neural networks (RNNs) [1, 2], Some papers |
| Week 13-14 | Attention mechanism and Generative models [1, 2, 3], Some papers |
| Week 14 | Applications [1, 2], Some papers |

**Instructor**:

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**Evaluation**: Midsem exam (20), Endsem exam (30), Programming assignments (5 assignments) (50)

**Programming Assignments:** These must be submitted as reports and code on Moodle. Please register on the Moodle course page. Assignments are done strictly in pairs of two or three (depending on class size).

**Class Hours and Slot:** A slot **-** Monday (08:00 – 08:50 AM), Tuesday (02:00 – 02:50 PM), Wednesday (10:00 – 10:50 AM), Friday (09:00 – 09:50 AM)

**Exam Dates:**

- **Mid Sem Exam**: **Monday 20 March 2023**
- **End Sem Exam: Sunday 21 May 2023**