Fr. Conceicao Rodrigues College Of Engineering

Father Agnel Ashram, Bandstand, Bandra-west, Mumbai-50

Department of Electronics and Computer Engineering

B.E. (ECS) (Semester VII)

(2022-23)

Course outcomes & Assessment Plan

Subject: ***Deep Learning***

Subject code: ECC DO701

Teacher-in-charge: Prof. Dipali Koshti

Academic Term: July – October 2022

Module No.	Unit No.	Contents	Hrs.
1		**Introduction**	05
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes.	
	1.2	Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning	
2		**Training, Optimization and regularization of Deep Neural Network**	08
	2.1	**Training Feedforward DNN:** Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	
	2.2	**Optimization:** Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	
	2.3	**Regularization:** Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output.	
3		**Convolutional Neural Networks (CNN): Supervised Learning**	08
	3.1	Convolution Operation, Motivation, Basic structure of a convolutional neural network: Padding, strides, pooling, fully connected layers, interleaving between layers	
	3.2	Training a convolutional network: Backpropagation through convolution, Backpropagation as convolution with inverted filter, convolution/ backpropagation as matrix multiplication	

		Modern Deep Learning Architectures: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet	
4		**Recurrent Neural Networks (RNN)**	06
	4.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Back propagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT	
	4.2	Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit	
5		**Autoencoders: Unsupervised Learning**	06
	5.1	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	
	5.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
6		**Recent Trends and Applications**	06
	6.1	Generative Adversarial Network (GAN): Architecture	
	6.2	Applications: Image Compression, Brain Tumour Detection, Fraud Detection, Expression identification.	
		Total	**39**

Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT Press book,2016.
2. Li Deng and Dong Yu, “Deep Learning Methods and Applications”, now publishers Inc (30 June 2014)
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. J M Zurada “Introduction to Artificial Neural Systems”, Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. “Algorithms for Optimization”, MIt Press.

Reference Books:

1. Jon Krohn, Grant Beyleveld, Aglae Bassens, “Deep Learning Illustrated: A Visual, Interactive
2. Guide to Artificial Intelligence”, Pearson Education.
3. Buduma, N. and Locascio, N., “Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
4. François Chollet, “Deep Learning with Python”, Manning Publications, 2018.
5. Douwe Osinga. “Deep Learning Cookbook”, O’REILLY, SPD Publishers, Delhi.
6. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc.

Course Objectives:

1. To develop mathematical concepts required for Deep Learning algorithms
2. To gain an in-depth understanding of training Deep Neural Networks.
3. To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks
4. To get familiarised with the recent trends in Deep Learning.

Course Outcomes:

After successful completion of the course, students will be able to:
DO701.1: Explain the basic knowledge of Neural Networks
DO701.2: Explain the process of training, optimization, and Regularization of Deep Neural Networks
DO701.3: Design supervised models for DNN
DO701.4: Design unsupervised model for DNN
DO701.5: Select and apply a suitable DNN model for a given application

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2
DO701.1	3													
DO701.2	3													
DO701.3	3	3	3	1	2								3	3
DO701.4	3	3	3	1	2								3	3
DO701.5	3	3	3	3	3				3	3		2	3	3

Provide a justification of PO to CO mapping

CO	PO	PI
DO701.1	**PO1**	1.1.1 Apply the knowledge of discrete structures, linear algebra, statistics, and numerical techniques to solve problems. 1.3.1 Apply engineering fundamentals. 1.4.1 Apply theory and principles of Electronics and/or computer science and engineering to solve an engineering problem.
DO701.2	**PO1**	1.1.2 Apply the knowledge of discrete structures, linear algebra, statistics, and numerical techniques to solve problems. 1.3.1 Apply engineering fundamentals 1.4.1 Apply theory and principles of Electronics and/or computer science and engineering to solve an engineering problem.
DO701.3	**PO1**	1.1.1 Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems 1.1.2 Apply the concepts of probability, statistics and queuing theory in modeling of computer-based system, data and network protocols. 1.4.1 Apply theory and principles of Electronics and/or computer science and engineering
	PO2	2.1.2 Identify Electronic Systems/components, variables, and parameters to solve the problems 2.1.3 Identify processes/modules/algorithms of a computer-based system and parameters to solve the problems 2.1.4 Identify mathematical algorithmic knowledge that applies to a given problem 2.2.4 Compare and contrast alternative solutions/methods to select the best methods

	PO3	3.1.1 Define a precise problem statement with objectives and scope. 3.2.1 Explore design alternatives. 3.2.2 Produce a variety of potential design solutions suited to meet functional requirements.
	PO4	4.1.2 Examine relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation.
	PO5	5.1.1 Identify modern engineering tools, techniques and resources for engineering activities.
	PSO1	Students design and implement supervised DNN model for real – world application. They work on real-world datasets and apply DNN models to get the desired result.
	PSO2	In order to design the supervised DNN model they need to use modern technologies like TensorFlow. Keras , PyTorch and many more.
DO701.4	**PO1**	1.1.1 Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems 1.1.2 Apply the concepts of probability, statistics and queuing theory in modeling of computer-based system, data and network protocols. 1.4.1 Apply theory and principles of Electronics and/or computer science and
	PO2	2.1.2 Identify Electronic Systems/components, variables, and parameters to solve the problems 2.1.3 Identify processes/modules/algorithms of a computer-based system and parameters to solve the problems 2.1.4 Identify mathematical algorithmic knowledge that applies to a given problem
	PO3	3.1.1 Define a precise problem statement with objectives and scope. 3.2.1 Explore design alternatives. 3.2.2 Produce a variety of potential design solutions suited to meet functional requirements.
	PO4	4.1.2 Examine relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation.
	PO5	5.1.1 Identify modern engineering tools, techniques and resources for engineering activities
	PSO1	Students design and implement unsupervised DNN model for real – world application. They work on real-world datasets and apply DNN models to get the desired result.
	PSO2	In order to design the unsupervised DNN model they need to use modern technologies like TensorFlow. Keras , PyTorch and many more.
DO701.5	**PO1**	1.1.3 Apply the knowledge of discrete structures, linear algebra, statistics, and numerical techniques to solve problems. 1.3.1 Apply engineering fundamentals. 1.4.1 Apply theory and principles of Electronics and/or computer science and engineering to solve an engineering problem.

	PO2	2.1.1 Articulate problem statements and identifies objectives 2.1.3 Identify processes/modules/algorithms of a computer-based system and parameters to solve the problems. 2.2.2 Identify, assemble and evaluate information and resources. 2.2.3 Identify existing solution/methods to solve the problem, including forming justified approximations and assumption 2.2.4 Compare and contrast alternative solution/methods to select the best methods.
	PO3	3.1.3 Review state-of-the-art literature to synthesize system requirements. 3.2.1 Explore design alternatives. 3.4.1 Refine a conceptual design into a detailed design within the existing constraints (of the resources) 3.4.2 Generate information through appropriate tests to improve or revise the design
	PO4	4.3.1 Use appropriate procedures, tools and techniques to collect and analyze data 4.3.2 Critically analyze data for trends and correlations, stating possible errors and limitations 4.3.3 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
	PO5	5.1.1 Identify modern engineering tools, techniques and resources for engineering activities
	PO9	9.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team 9.3.1 Present results as a team, with smooth integration of contributions from all individual effort 9.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
	PO10	10.1.1 Read, understand and interpret technical and non-technical information 10.3.1 Create engineering-standard figures, reports and drawings to complement writing and presentations
	PO12	12.3.1 Source and comprehend technical literature and other credible sources of information
	PSO1	Students select a suitable real-world problem and provide a solution to it. They select a suitable DNN model by exploring various DNN models used in literature and implement it for real – world application using new technologies.
	PSO2	In order to provide a feasible real-world solution, they need to use new technologies such as Keras, Pytorch, tensorflow.

CO Assessment Tools:

Course Outcome	*Direct Method (80%)*											*Indirect Method (20%)*
	Unit Tests		Assignments			Quizzes				Case study/Technical paper	End Sem Exam	Course exit survey
	1	2	1	2	3	1	2	3	4			
DO701.1	20%	--	20%	--	--	10%	--	--		--	50%	100%
DO701.2	20%	--	--	20%		--	10%	--		--	50%	100%
DO701.3	10%	10%	--	--	20%	--	--	10%		--	50%	100%
DO701.4	--	20%	--	--	20%	--	--	10%		--	50%	100%
DO701.5	20%	--	--	--		--	--	--	10%	20%	50%	100%

CO calculation= (0.8 *Direct method + 0.2*Indirect method)

Rubrics for Assignments:

Indicator	**Not satisfactory**	**Satisfactory**	**Good**	**Excellent**
Timeline (3)	More than two sessions late (0)	More than one session late (1)	One session late (2)	On time (3)
Depth of Understanding (4)	Unsatisfactory (1)	Superficial (2)	Satisfactory (3)	Adequate (4)
Completeness (3)	Not submitted (0)	Major topics are omitted or addressed minimally (1)	Most major and some minor points are covered and are accurate (2)	All major and minor points are covered and are accurate (3)

Curriculum Gap identified: (with action plan)

Transformers have revolutionized the way we process sequence–to–sequence data. Transformers are the next-generation deep neural networks and are successors of RNN and LSTM. It is essential that students have at least basic knowledge of transformer, and how to implement transformers to to solve real-world complex sequence–to–sequence problems.

Action plan:

To bridge the gap following actions have been planned.

1) Additional practicals based on Transformers will be taken in the laboratory.
2) Case study - Review 3 technical papers on any advanced topic (not covered in the syllabus) in deep learning and present the summary of it.

Modes of content delivery

Modes of Delivery	Brief description of content delivered
Class room lecture, PPT	1. Introduction 2. Optimization and Regularization 3. Convolution Neural Networks 4. Recurrent Neural networks 5. Encoders 6. GAN
Assignments	Assignment 1: Covering the basics of neural networks Assignment 2: Covering Deep network optimization and regularization Assignment 3: Covering design of supervised and unsupervised deep networks.
Quizzes	Quiz on each module
Study of Technical papers	Covering module 6 topics: Image compression, Expression identification, fraud detection
Informative videos	CNN, LeNET, AlexNET, VGGNet
Review and present technical papers	Image compression, Expression identification, fraud detection
Case study/Mini project	Content Beyond syllabus.

Lesson Plan

DEEP LEARNING

BE Electronics and Computer Science, Semester VII				
July- October 2022				
Deep Learning (DOC701)				
Lecture	***3***			
Practical	***-***			
Tutorial	***-***			
	Hours	***Marks***		
Theory examination	3	80		
Internal Assessment	--	20		
Practical Examination	--	--		
Oral Examination	--	--		
Term work	--	--		
Total	--	100		
Day	***Time***			
5				

Lecture No.	Date		Topic			
	Planned	**Actual**		**Content delivery**	**Refe**	**Remarks**
Module1 : Introduction						
1	19-7-22	19-7-22	Introduction to the course, informing course objectives and plan, Biological neuron. Mc-Culloch-Pitt Model	Classroom Teaching PPT	3,4	
2	21-7-22	21-7-22	Perceptron, perceptron learning	Classroom Teaching PPT, Lab**, Virtual Lab**	3,4,17	
3	22-7-22	22-7-22	Delta learning	Classroom Teaching PPT,	13,4	
4	26-7-22	26-7-22	Multilayer perceptron	Classroom Teaching PPT, Lab, **Virtual Lab**	3,4,17	
5	28-7-22	28-7-22	Deep Networks	Classroom Teaching PPT	1,2	Quiz1, Ass1
Module 2: Training, Optimization and regularization of Deep Neural Network						
6	29-7-22	29-7-22	Multi Layered Feed Forward Neural Network, Learning Factors,	Classroom Teaching PPT	1,2	
7	2-8-22	3-8-22	Activation functions	Classroom Teaching PPT	1,2,3	
8	3-8-22	5-8-22	Loss Functions	Classroom Teaching PPT	1,2	
9	5-8-22	10-8-22	Learning with Backpropagation	Classroom Teaching PPT	1,2	
10	10-8-22	17-8-22	Learning parameters	Classroom Teaching PPT	1,2	
11	12-8-22	24-8-22	Overview of overfitting, types of biases, Bias – variance trade off	Classroom Teaching PPT	1,2,15	

12	17-8-22	24-8-22	Regularization: L1,L2, Parameter sharing, Drop out, weight decay	Classroom Teaching, PPT **[Youtube Video]**	1,2,5,15	
13	19-8-22	26-8-22	Batch Normalization, Data augmentation, early stopping, Adding noise to input and output	Classroom Teaching PPT	1,2,5,15	Quiz2, Ass2
Module 3: Convolutional Neural Networks						
14	23-8-22	30-8-22	Convolution Operation, Motivation,	Classroom Teaching PPT **[NPTEL Video, coursera video]**	1,2	
15	25-8-22	6-9-22	Basic structure of a convolutional neural network: Padding, strides	Classroom Teaching PPT **[NPTEL Video, coursera video]**	1,2	
16	26-8-22	7-9-22	pooling, fully connected layers, interleaving between	Classroom Teaching PPT	1,2	
17	13-08-22	13-9-22	Training a convolutional network: Backpropagation through convolution,	Classroom Teaching PPT	1,2	
18	13-08-22	13-9-22	Backpropagation as convolution with inverted filter, convolution/ backpropagation as matrix multiplication	Classroom Teaching PPT	1,2	
19	25-08-22	14-9-22	LeNet, AlexNet	Classroom Teaching PPT **[Technical paper]**	1,2	
20	26-08-22	20-9-22	ZF-Net, VGGNet,	Classroom Teaching PPT **[Technical paper]**	1,2	
21	30-8-22	20-9-22	GoogLeNet, ResNet	Classroom Teaching PPT	1,2	Quiz3
Module 4: Recurrent Neural Networks (RNN)						
22	27-08-22	21-09-22	Sequence Learning Problem, Unfolding Computational graphs	Classroom Teaching PPT	1,2	31/8 - 4/9 Midterm break
23	9-9-22	21-09-22	Recurrent Neural Network	Classroom Teaching PPT	1,2	5,6,7 Sep UT1
24	13-9-22	23-9-22	Bidirectional RNN	Classroom Teaching PPT	1,2	
25	15-9-22	24-9-22	Back propagation Through Time (BTT), Vanishing and Exploding Gradients,, Truncated BTT	Classroom Teaching PPT	1,2	
26	16-9-22	27-9-22	Long Short Term Memory: Selective Read, Selective write, Selective Forget,	Classroom Teaching PPT	1,2	
27	20-9-22	28-9-22	Long Short Term Memory (continued)	Classroom Teaching PPT	1,2	Quiz, Ass3
Module 5: Encoders						
28	22-9-22	29-9-22	Introduction, linear encoder	Classroom Teaching PPT	1,2	
29	23-9-22	30-9-22	Undercomplete encoder	Classroom Teaching PPT	1,2	
30	27-9-22	30-9-22	Overcomplete encoder	Classroom Teaching PPT	1,2	
31	29-9-22	4-10-22	Regularization in encodr	Classroom Teaching PPT	1,2	
32	30-9-22	4-10-22	Denoising encoders	Classroom Teaching PPT	1,2	
33	4-10-22	7-10-22	Sparse encoders, Contractive encoders	Classroom Teaching PPT	1,2	Quiz4
Module 6: Recent Trends and Applications						
34	7-10-22	11-10-22	Generative Adversarial network:	Classroom Teaching PPT	1,2	
35	11-10-22	11-10-22	Applications: Image compression	Classroom Teaching PPT		

36	12-10-22	12-10-22	Brain tumor detection	Classroom Teaching PPT **[Technical paper]**		Flip classroom
37	14-10-22	14-10-22	Identification	Classroom Teaching PPT **[Technical paper]**		Quiz4, flip classroom

Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT Press book,2016.
2. Li Deng and Dong Yu, "Deep Learning Methods and Applications", now publishers Inc (30 June 2014),
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. J M Zurada "Introduction to Artificial Neural Systems", Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. "Algorithms for Optimization", MIt Press.

Reference Books:

6. Jon Krohn, Grant Beyleveld, Aglae Bassens, "Deep Learning Illustrated: A Visual, Interactive
7. Guide to Artificial Intelligence", Pearson Education.
8. Buduma, N. and Locascio, N., "Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
9. François Chollet, "Deep Learning with Python", Manning Publications, 2018.
10. Douwe Osinga. "Deep Learning Cookbook", O'REILLY, SPD Publishers, Delhi.
11. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc.

Online references:

12. https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
13. http://www.cse.iitm.ac.in/~miteshk/CS6910.html
14. https://nptel.ac.in/courses/106/106/106106184/
15. https://www.deeplearningbook.org/
16. http://introtodeeplearning.com/
17. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

Videos:

Video 1: L2 Regularization: L1 and L2 Regularization Methods, Explained | Built In

Video 2: Convolution Operation: Deep Learning(CS7015): Lec 11.1 The convolution operation - YouTube

Video 3: CNN: Deep Learning(CS7015): Lec 11.3 Convolutional Neural Networks - YouTube

Video 4: CNN: One Layer of a Convolutional Network - Foundations of Convolutional Neural Networks | Coursera

Video 5: How to calculate Neural network Parameters: https://www.youtube.com/watch?v=bikmA-VmSbY

Technical papers:

[1] Alex Krichevsky et al. "ImageNet Classification with Deep Convolutional Neural Networks ", NIPS'12: Proceedings of the 25th International Conference on Neural Information Processing Systems - Volume 1 December 2012 .

[2] Karen Simonyan et al. "VERY DEEP CONVOLUTIONAL NETWORKS FOR LARGE-SCALE IMAGE RECOGNITION", ICLR 2015,

[3] Asifullah Khan et al. ," A Survey of the Recent Architectures of Deep Convolutional Neural Networks", In Artificial Intelligence Review, DOI: https://doi.org/10.1007/s10462-020-09825-6.

Examination Scheme

Module		Lecture Hours	Marks distribution in Test (For internal assessment/TW)		Approximate Marks distribution in Sem. End Examination
			Test 1	Test 2	
1	Introduction	05	06 (CO1)	--	
2	Optimization and regularization	08	08 (CO2)	--	
3	Convolution Neural networks	08	06 (CO3)	05(CO3)	
4	Recurrent Neural networks	06	--	08 (CO4)	
5	Encoders	06	--	03 (CO5)	
6	Recent trends and Application	06	--	04 (CO5)	

Submitted By	**Approved By**
Prof. Dipali koshti	ii) Dr. D. V. Bhoir Sign:
Sign:	ii) Prof. K. Narayanan Sign:
	iii) Prof. Shilpa Patil Sign:
Date of Submission: 5-8-2022	**Date of Approval:**
Remarks by PAC (if any)	