

**Course Title: Neural Network**

**Credit: 3**

**Course : CSIT.416.4**

**Number of period per week: 3+3**

**Nature of the Course: Theory + Lab**

**Total hours: 45+45**

**Year: Fourth, Semester: Seventh**

**Level: B. Sc. CSIT**

## 1. Course Introduction

This course introduces the fundamental concepts of neural networks and essentials of artificial neural networks with single layer and Multilayer Networks. The course covers the basics and applications of neural networks, including design of neural network, learning processes, perceptron model, radial basis function and neuro-fuzzy systems.

## 2. Objectives

The main objective of the course is to introduce concepts of artificial neural networks. The general objectives are to:

- introduce the neural networks as means for computational learning
- present the basic neural network architectures
- give design methodologies for artificial neural networks
- introduce learning theories used in neural networks
- demonstrate neural network applications on real-world tasks.
- explore use of fuzzy system in neural networks

## 3. Specific Objectives and Contents

Specific Objectives	Contents
<ul style="list-style-type: none"><li>• Understand Biological Neural Network</li><li>• Understand analogy between biological neural network and artificial network</li><li>• Explore real world applications of neural networks</li></ul>	<b>Unit I: Introduction (6 Hrs)</b> 1.1. Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological Neuron Model, Artificial Neuron Models, Artificial Network Networks (ANN) 1.2. History of neural network research, characteristics of neural networks, Applications of ANN
<ul style="list-style-type: none"><li>• Understand mathematical foundations of neural network</li><li>• Explore different neuron models</li><li>• Understand different neural network architectures</li></ul>	<b>Unit II: Basics of Artificial Neural Networks (8 Hrs)</b> 2.1. Artificial Neuron Model and its Mathematical model 2.2. Activation Function, Types of Neuron Activation Function: Linear, Threshold, Sigmoid, Tangent 2.3. Models of neuron Mc Culloch –Pitts model, Perceptron, Adaline model, Madaline Model

	<p>2.4. ANN Architectures: Single-layer, Multilayer Feed Forward, Recurrent</p> <p>2.5. Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic)</p>
<ul style="list-style-type: none"> <li>• Understand the learning strategies</li> <li>• Explore different learning approaches</li> </ul>	<p><b>Unit III: Learning Process (7 Hrs)</b></p> <p>3.1. Learning, Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application</p> <p>3.2. Error-Correction Learning, Memory-Based Learning, Hebbian Learning, Competitive Learning, Boltzman Learning</p>
<ul style="list-style-type: none"> <li>• Understand perceptron model</li> <li>• Explore theories and algorithms for perceptron networks</li> <li>• Determine applications of perceptrons</li> </ul>	<p><b>Unit IV: Single Layer Perceptrons (8 Hrs)</b></p> <p>4.1. Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks</p> <p>4.2. Least Mean Square Algorithm</p> <p>4.3. Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications</p>
<ul style="list-style-type: none"> <li>• Understand feed forward and feedback networks</li> <li>• Construct multilayer neural networks</li> <li>• Explore the Hopfield network</li> <li>• Understand and analyze delta rule and back propagation algorithm with its use</li> </ul>	<p><b>Unit V: Single and Multilayer Feed forward Neural Networks (8 Hrs)</b></p> <p>5.1. Basic Concepts of single layered networks, Hopfield Networks</p> <p>5.2. Multilayer Feed Forward Networks, Feedback Networks,</p> <p>5.3. Discrete Hopfield Network</p> <p>5.4. Gradient Descent, Delta Rule</p> <p>5.5. Derivation of Back-propagation (BP) Training, Summary of Back-propagation Algorithm, Selection of tuning parameters in Back-propagation</p>
<ul style="list-style-type: none"> <li>• Understand Radial function networks</li> <li>• Understand regularization theory</li> <li>• Construct Radial Basis Function Networks</li> </ul>	<p><b>Unit VI: Radial Basis Function Networks (5 Hrs)</b></p> <p>6.1. Pattern separability and Interpolation</p> <p>6.2. Regularization Theory</p> <p>6.3. Regularization and Radial Basis Function (RBF) Networks</p> <p>6.4. RBF network design and training</p> <p>6.5. Approximation properties of RBF</p>
<ul style="list-style-type: none"> <li>• Understand basics of fuzzy systems and fuzzy neural Networks</li> </ul>	<p><b>Unit VII: Fuzzy Neural Networks ( 3 Hrs)</b></p> <p>7.1. Neuro-fuzzy systems</p> <p>7.2. Background of fuzzy sets and logic, Design of fuzzy systems</p> <p>7.3. Design of fuzzy neural networks, applications of neuro-fuzzy systems</p>

## Evaluation System

Undergraduate Programs							
External Evaluation	Marks	Internal Evaluation	Weight age	Marks	Practical	Weight age	Mark
End semester examination	60	Assignments	20%	20	Practical Report copy	25%	20
(Details are given in the separate table at the end)		Quizzes	10%		Viva	25%	
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

### External evaluation

#### 1. End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

#### 2. External Practical Evaluation:

After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Full Marks: 100, Pass Marks: 45, Time: 3 Hrs

Nature of question	Total questions to be asked	Total questions to be answered	Total marks	Weightage
Group A: multiple choice*	20	20	20×1 = 20	60%
Group B: Short answer type questions	7	6	6×8 = 48	60%
Group C: Long answer type questions	3	2	2×16 =32	60%
			100	100%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

## **Internal evaluation**

**Assignment:** Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

**Quizzes:** Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

**Attendance in class:** Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

**Presentation:** Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

**Mid-term examination:** It is a written examination and the questions will be asked covering all the topics in the session of the course.

**Discussion and participation:** Students will be evaluated on the basis of their active participation in the classroom discussions.

**Instructional Techniques:** All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam. Unless and until the student clears one semester he/she will not be allowed to study in the following semesters.

## **Laboratory Work**

Student should have practical session for constructing artificial neural networks. The students should simulate different programs constructing neural networks for solving real world problems. The environments can be decided by the instructor, however it is highly recommended to use MATLAB, Java. The lab work should be practiced for minimum of 3 lab hours per week.

## Prescribed Text

1. **S. Haykin**, *Neural Networks – A Comprehensive Foundation*, Prentice Hall

## References

1. **C. M. Bishop**, *Neural Networks for Pattern Recognition*, Clarendon Press Oxford
2. **B.Yegnanarayana**, *Artificial Neural Networks*, Prentice Hall of India
3. **Satish Kumar**, *Neural Networks – A Classroom Approach*, Tata McGraw-Hill
4. **Robert J. Schalkoff**, *Artificial Neural Networks*, McGraw-Hill International Editions
5. **Jeff Heaton** , *Introduction to Neural Networks for Java*, Heaton Research
6. **S N Sivanandam, S. Sumathi**, *Introduction to Neural Networks Using MATLAB* , Tata McGraw-Hill