



**c) Professional and Practical Skills:**

At the end of the course, the student will be able to:

- c1- Build a simple neural network with Mat-Lab tool and try to perform simple training to his network with a small dataset.
- c2- Interact with the activation function the weight matrix for a given neural network.

**d) General and Transferable Skills:**

At the end of the course, the student will have:

- d1- The ability to use the neural networks in some applications like pattern recognitions and classification.
- d2- The ability to adapt the weight matrix of a given neural network during the training process in a small dataset.

**3. Content of Course**

Topic	No. of Hrs	Lecture	Tutorial/ Practical
Fundamentals: - Introduction - A framework for distributed representation - Processing units - Connections between units - Activation and output rules - Network topologies - Training of artificial neural networks - Paradigms of learning - Modifying patterns of connectivity - Notation and terminology - Notation - Terminology	6	4	2
Perceptron and Adaline: - Networks with threshold activation functions - Perceptron learning rule and convergence theorem - Example of the Perceptron learning rule - Convergence theorem - The original Perceptron - The adaptive linear element (Adaline) - Networks with linear activation functions: the delta rule - Exclusive-OR problem - Multi-layer perceptrons can do everything	6	4	2
Back-Propagation: - Multi-layer feed-forward networks - The generalized delta rule - Understanding back-propagation - Working with back-propagation - An example	12	8	4

<ul style="list-style-type: none"> <li>- Other activation functions</li> <li>- Deficiencies of back-propagation</li> <li>- Advanced algorithms</li> <li>- How good are multi-layer feed-forward networks?</li> <li>- The effect of the number of learning samples</li> <li>- The effect of the number of hidden units</li> <li>- Applications</li> </ul>			
<p>Recurrent Networks:</p> <ul style="list-style-type: none"> <li>- The generalized delta-rule in recurrent networks</li> <li>- The Jordan network</li> <li>- The Elman network</li> <li>- Back-propagation in fully recurrent networks</li> <li>- The Hopfield network</li> <li>- Description</li> <li>- Hopfield network as associative memory</li> <li>- Neurons with graded response</li> <li>- Boltzmann machines</li> </ul>	6	4	2
<p>Self-Organizing Networks:</p> <ul style="list-style-type: none"> <li>- Competitive learning</li> <li>- Clustering</li> <li>- Vector quantization</li> <li>- Kohonen network</li> <li>- Principal component networks</li> <li>- Introduction</li> <li>- Normalized Hebbian rule</li> <li>- Principal component extractor</li> <li>- More eigenvectors</li> <li>- Adaptive resonance theory</li> <li>- Background: Adaptive resonance theory</li> <li>- ART1: The simplified neural network model</li> <li>- ART1: The original model</li> </ul>	12	8	4
<p>Reinforcement learning:</p> <ul style="list-style-type: none"> <li>- The critic</li> <li>- The controller network</li> <li>- Barto's approach: the ASE-ACE combination</li> <li>- Associative search</li> <li>- Adaptive critic</li> <li>- The cart-pole system</li> <li>- Reinforcement learning versus optimal control</li> </ul>	6	4	2
<p>Robot Control:</p> <ul style="list-style-type: none"> <li>- End-effector positioning</li> <li>- Camera {robot coordination is function approximation</li> <li>- Robot arm dynamics</li> <li>- Mobile robots</li> <li>- Model based navigation</li> <li>- Sensor based control</li> </ul>	6	4	2

<p>Vision:</p> <ul style="list-style-type: none"> <li>- Introduction</li> <li>- Feed-forward types of networks</li> <li>- Self-organizing networks for image compression</li> <li>- Back-propagation</li> <li>- Linear networks</li> <li>- Principal components as features</li> <li>- The cognition and neocognitron</li> <li>- Description of the cells</li> <li>- Structure of the cognition</li> <li>- Simulation results</li> <li>- Relaxation types of networks</li> <li>- Depth from stereo</li> <li>- Image restoration and image segmentation</li> <li>- Silicon retina</li> </ul>	12	8	4
<p>General Purpose Hardware:</p> <ul style="list-style-type: none"> <li>- The Connection Machine</li> <li>- Architecture</li> <li>- Applicability to neural networks</li> <li>- Systolic arrays</li> </ul> <p>Dedicated Neuro-Hardware:</p> <ul style="list-style-type: none"> <li>- General issues</li> <li>- Connectivity constraints</li> <li>- Analogue vs. digital</li> <li>- Optics</li> <li>- Learning vs. non-learning</li> <li>- Implementation examples</li> <li>- Carver Mead's silicon retina</li> <li>- LEP's LNeuro chip</li> </ul>	6	4	2

#### 4. Teaching and Learning Methods

- Lectures
- Tutorials
- Computer-lab Sessions
- Practical lab work
- Class discussions
- Independent Work

#### 5. Student Assessment

##### a) Assessment Methods

- Assignments and Quizzes
- Midterm written exam
- Oral exam
- Practical exam
- Final written exam

##### b) Assessment schedule

Midterm examination	Week 7
Practical examination	Week 13
Oral examination	Week 14
Final examination	Week 15

**c) Weighting of assessments**

Assignments and Quizzes	0 %
Mid-Term Examination	10%
Oral Examination	10%
Practical Examination	15%
Final-term Examination	65%
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<b>Total</b>	<b>100 %</b>

**6. List of References**

**a) Recommended Books:**

- Principe, Euliano, and Lefebvre, "Neural and Adaptive Systems: Fundamentals through Simulations", John Wiley and Sons, ISBN: 0471351679.
- Christopher M. Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, USA; 1 edition, ISBN-10: 0198538642, 1996.

**7. Facilities Required for Teaching and Learning**

- Computer lab supported by MATLAB software.
- Data show device.

**Course coordinator:**

**Head of Department:**

Date: / /