

**ECE742-001**  
**Neural Networks**  
**Spring 2011**  
**Tuesday, Thursday 2:20-3:35, Room 1226 EB2**

**Course Description:** The course provides the foundation for designing and using neural networks and other methods of machine learning. The approach of the course is to emphasize applications in signal and image processing that are typically taught in ECE departments.

**Prerequisites:** ECE301(Signals and Systems), ST371 or MA421(Probability and Statistics), The course will use elementary matrix algebra, includes matrix/vector multiplication, matrix inverses, matrix description of the solution to linear equations, eigenvalues and eigenvectors. This material is covered in ECE220. The course will heavily utilize MATLAB for homework and examples in class. MATLAB is required for ECE220 and many other courses at NCSU. The course will use elementary probability theory: means, variance, covariance, expected values/moments of linear functions, stationarity.

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**Office Hours**

Monday, Wednesday 9:30-10:30  
Other times by appointment

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Office Hours: MW 3:00-4:00

**Text:** *Neural Networks and Learning Machines*, Simon Haykin, Pearson/Prentice-Hall, 2008, ISBN 978-0-13-603219-9

**Additional References:**

M.T. Hagan, H. B. Demuth, M. Beale, *Neural Network Design*, Hagan Publishing, 2002.  
C. M. Bishop, *Neural Networks for Pattern Recognition*, Oxford University Press, 1996.  
R. C. Eberhart and Y. Shi, *Computational Intelligence: Concepts to Implementations*, Elsevier, 2007  
L. V. Fausett, *Fundamentals of Neural Networks*, Prentice –Hall, 1994

**Grading:**

Assignment	Weight
Homework (~6)	20%
Tests (2 – 3/3, 4/19)	50%
Project Proposal (3/15/11)	5%
Project	25%
Projects due 5/9/11	

Homework is available on the web site. It is the student's responsibility to check the site for the homework assignments. Homework will be assigned the first day of class. Homework should be submitted as a PDF file via the Wolfware course system. Handwritten solutions should be scanned and integrated with other work. The scanned submission should be easily read by the instructor or grader.

MATLAB solutions should be included in the PDF file. It is recommended that MATLAB scripts for problems be uploaded in a format that will permit the solution to be easily checked by running the script in MATLAB. This means that all auxiliary files and data should be included with the upload. The instructor or grader will not debug your script.

**Audit Requirements**

Auditors are required to attend 80\% of the classes and have an average grade of 70% on the homework assignments.

**Objectives:** Upon completion of the course, the student will be able to

- Describe appropriate applications of neural networks and learning methods ;
- Compare neural network solutions to other methods of modeling, approximation, simulation, classification, pattern recognition and decision making ;
- Determine which methods of learning are appropriate for a given problem;
- Combine the above abilities to create an imaging system that will achieve the near optimal performance.
- Formulate and design neural networks and other learning systems to solve realistic applications;
- Measure the performance of the neural networks and other learning methods.

**Project**

The project will be chosen individually with the aid of the instructor. The purpose of the project is to allow the student to apply some of the methods discussed in this class to an area of particular interest. The application for the project should be based upon the methods discussed in class and extended beyond the treatment in the notes and class. This extension can be either a theoretical extension to cover more general cases or methods, or the application of some method(s) to actual or simulated data. Since the project is an

extension of concepts covered in class, the relation to the material covered in the course should be *explicitly* discussed in the written and oral parts.

The student should submit a written proposal *as soon as possible* but no later than 15 March. The written proposal should be one page in length and contain *specifics* on what will be accomplished during the project. That is, project goals and objectives, tasks required to meet these objectives, expected outcomes, and a brief statement about how this project relates to the topics covered in the course. Note that the proposal is graded and counts as 5% of the total grade.

The project will take the place of the final exam. The written report, not to be in excess of 20 double-spaced pages excluding figures, will be due the day before the time scheduled for the final exam. Suggestions for projects are listed on a separate page (see web page).

### Course Outline

Lecture	Date	Topics	Text Reference
1	1/11	Goals of course, administration details, Background for course,	Chapter 0 Introduction
2	1/13	Guest Lecture: Dr. Snyder – biology, neurons and neural networks	Notes
3	1/18	Representations, architectures	
4	1/20	The basic perceptron	Chapter 1
5	1/25	The basic perceptron	Chapter 1
6	1/27	Regression, Least squares, MAP	Chapter 2
7	2/1	Regression, Least squares, MAP	Chapter 2
8	2/3	Least means square algorithm, statistical learning	Chapter 3
9	2/8	Least means square algorithm, statistical learning	Chapter 3
10	2/10	Least means square algorithm, statistical learning	Chapter 3
11	2/15	Multilayer Perceptrons – architectures	Chapter 4
12	2/17	Multilayer Perceptrons – Back-Propagation	Chapter 4
13	2/22	Multilayer Perceptrons – Generalization	Chapter 4
14	2/24	Multilayer Perceptrons – Cross-validation	Chapter 4
15	3/1	Multilayer Perceptrons – Nonlinear filtering	Chapter 4
16	3/3	Test 1	
	3/7-11	Spring Break	
17	3/15	Kernel Methods – Radial Basis Functions(RBF)	Chapter 5
18	3/17	Kernel Methods – K-means, RLS	Chapter 5
19	3/22	Kernel Methods – Regression	Chapter 5
20	3/24	Support Vector Machines	Chapter 6
21	3/29	Support Vector Machines	Chapter 6
22	3/31	Regularization Theory – Hadamard/Tikhonov	Chapter 7
23	4/5	Regularization Theory – RBF revisited	Chapter 7

24	4/7	Regularization Theory – Laplacian Regularized	Chapter 7
25	4/12	Principal-Components Analysis (PCA)	Chapter 8
26	4/14	PCA – relation to Hebbian Learning	Chapter 8
27	4/19	Test 2	
28	4/26	PCA - applications	Chapter 8
29	4/28	Review	
Final Exam/Project	5/9	Formal Exam Time is 5/10/11, Tuesday 1-4pm. There is no meeting on this day. Projects are due Monday 8:00am 5/9/11 ( I'll need time to grade the projects)	

**Students with Disabilities:** Reasonable accommodations will be made for students with verified disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653, [http://www.ncsu.edu/provost/offices/affirm\\_action/dss](http://www.ncsu.edu/provost/offices/affirm_action/dss). For more information on NC State's policy on working with students with disabilities, please see [http://www.ncsu.edu/policies/academic\\_affairs/courses\\_undergrad/REG02.20.1.php](http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.1.php) .

**Academic Integrity:** Students should refer to the University policy on academic integrity found in the Code of Student Conduct (found in Appendix L of the Handbook for Advising and Teaching). *It is the instructor's understanding and expectation that the student's signature on any test or assignment means that the student neither gave nor received unauthorized aid.*

Students must abide by the Code of Student Conduct, [http://www.ncsu.edu/policies/student\\_services/student\\_discipline/POL11.35.1.php](http://www.ncsu.edu/policies/student_services/student_discipline/POL11.35.1.php)

**Late Assignments and Missed Quizzes:**

Only the University approved reasons will be accepted for missing a quiz (See [http://www.ncsu.edu/policies/academic\\_affairs/pols\\_regs/REG205.00.4.php](http://www.ncsu.edu/policies/academic_affairs/pols_regs/REG205.00.4.php) ). There are no make-up tests. With proper documentation, the missing test grade will be the weighted average of other assignments. In all cases, signed documentation must be provided to the instructor in order to obtain credit.