PROPOSAL SCC #99/00-406

CURRICULUM PROPOSAL FORM 1999-2000

NON-GENERAL EDUCATION PROCESS A

DEADLINES: Deadline dates for 1999/2000 submissions: Regular proposals: October 22, 1999 to be implemented in Fall 2000; Short-Term proposals: December 10, 1999 to be implemented in Fall, 2000; Regular proposals February 18, 2000 to be implemented in Spring 2001; March 24, 2000 for short-term courses to be implemented in Spring 2001

0909.454

PROPOSAL TITLE: Introduction to Artificial Neural Networks (0909.454)

SPONSOR(S): S. Mandayam, J. Schmalzel

DEPARTMENT: Electrical and Computer Engineering

COLLEGE: Engineering

IF LAS CHECK ONE:_____History/Humanities _____Math/Science _____Social/Behavioral Sciences

Check one: __X__Undergraduate _____Graduate

THE ATTACHED *NON-GEN-ED* PROPOSAL IS BEST DESCRIBED BY THE ITEM(S) CHECKED.

- __X__New non-gen-ed course
- _____Short-term non-gen-ed course
- _____Minor curricular changes (fewer than three) to:
  - _____existing non-gen-ed course
  - _____non-gen-ed degree requirements
  - _____major
  - _____minor, specialization, concentration, track certificate program

DEPARTMENT
(Signature indicates approval) [signature] 10/25/99

Dept. Curriculum Chair/Date [signature] 25 OCT 1999

Dept. Chairperson/Date

ACADEMIC DEAN

Approved ✓ Not Approved_____ Comments:

Dean's Signature/Date [signature]

COLLEGE CURRICULUM COMMITTEE

Date of open hearing (if necessary) 12/8/99 Approved ✓ Not Approved____
Comments:

Signature of College Chair/Date: Ravi [illegible] Ramachandran

UNIVERSITY CURRICULUM COMMITTEE
Date Received/Processed 2/[illegible]
Comments:

Curriculum Chair Signature: [illegible] Date Announced At Senate [illegible]

EXECUTIVE VICE PRESIDENT/PROVOST
Approved ✓ Not Approved______ If no, reasons are as follows:

Student Credit Hours:________ Faculty Load Hours:_________ Equalized Credit Hours_________

Official Copy & Approval Sheet Filed (Date): _______ Executive VP/Proved Signature/Date [illegible] 2/21/00

REGISTRAR
Date Approved Course Description Required__________
Hegis Taxonomy & Course Number Assigned 0909.454
Registrar Signature/Date Robert A. Zubot 2/15/00

NOTIFICATION FORWARD

_____Senate Curriculum Committee Chairperson _____Academic Dean(s)

_____Department Chairpersons _____Registrar _____Sponsor(s)

Course Proposal

1. Details:

a) Course Title:	Introduction to Artificial Neural Networks (0909.454)
b) Sponsor:	Dr. Shreekanth Mandayam and Dr. John L. Schmalzel, Electrical Engineering
c) Credit Hours:	3 credit hours
d) Course Level:	Senior Elective
e) Curricular Effect:	Senior Elective Course
f) Prerequisites:	Mathematics of Engineering Analysis II (1701.242) or Linear Algebra (1701.210) or permission of instructor
g) Suggested Time/ Scale of Implementation	Spring 2000 One section
h) Resources	Faculty will be hired and laboratory equipment obtained consistent with Engineering School multi-year budget. Library acquisitions will be required.

2. Rationale:

The proposed course is a senior level elective available to students in engineering.

Artificial neural networks have emerged as viable computational models for a variety of problems, including automatic pattern classification, signal and image interpretation, forecasting and prediction, combinatorial optimization, non-linear systems modeling and process control. The recent developments of an array of commercial artificial neural network-based software, along with dedicated neural network IC chips, portend that this technology is here to stay and may be at the frontiers of future developments in science and technology. Furthermore, a flurry of research activity in this area has contributed significantly to diminish the "black-box" heuristic aspect of traditional neural network paradigms of the 70s. Artificial neural networks can be viewed as special cases of digital filters, amenable to design and analysis using "respectable" classical filter design techniques. They are fast becoming the method of choice for analyzing and controlling systems which are associated with vast amounts of data.

In this course, students will gain familiarity with both established and emergent paradigms for artificial neural network architectures. Artificial neural network techniques will be employed for analysis and control in a variety of contemporary engineering applications (speech, face, fingerprint recognition, process control, machine vision, etc.). State-of-the-art software tools will be used for accomplishing these tasks.

3. Essence of the Course:

a) Objectives:

The proposed course has a number of objectives:

(i) Provide a comprehensive foundation in the various artificial neural network paradigms.

(ii) Provide a comprehensive foundation in various neural network achitectures – in particular, the multilayer perceptron, radial basis function and Hopfield neural networks.

(iii) Provide a working knowledge of the mathematical tools and software packages for designing artificial neural networks.

(iv) Provide a working knowledge of the state-of-the-art algorithms for training artificial neural networks.

(v) Continually demonstrate the applications of artiticial neural networks, for example, in signal and image processing (speech/face recognition, nondestructive evaluation, handwriting recognition), process control, robotics, machine vision, etc.

b) Topical Outline:

The general topical outline is described below; however, prior to each semester's offering, the instructor will assess any technology advances in the course subject matter or in teaching resources prior to the course and make changes deemed appropriate to maintain requisite content and currency.

Introduction to Neural Networks
Neuron models
Feedback
Network architectures
Representation of knowledge
Artificial intelligence

Learning Paradigms

Error-Correction
Hebbian learning
Boltzmann learning
Supervised and unsupervised learning
Statistics of learning

The Perceptron
Maximum-likelihood Gaussian classifier

LMS algorithms
Wiener-Hopf equations

Multilayer Perceptrons
Backpropagation and variations
Engineering applications

Radial basis function networks
Regularization theory
Fuzzy neural networks
Engineering applications

Hopfield networks
Stochastic neurons
Engineering applications

Self organizing systems
Hebbian learning
Competitive learning
Information theoretic models
Engineering applications

Modular networks
Temporal processing
Neurodynamics
Engineering applications

VLSI Implementations
Design considerations
Neurocomputing hardware

c) Evaluation and Grading Procedures:

Student grades will be based on projects, examinations, homework, and written and oral technical communication.

d) Course Evaluation:

The proposed course will be evaluated based on student evaluations and critical review by engineering faculty.

4. Results of Consultations:

a) Consulted Departments:
b) Consultants and Consultant Statements:
c) Written Consultations:

5. Additional Supporting Information:

<u>Example textbooks that could serve as primary or supplemental references for this course</u>:

1. Simon Haykin, *Neural Networks: A Comprehensive Foundation*, Macmillan College Publishing /IEEE Press, 1994.
2. Robert Schalkoff, *Artificial Neural Networks*, Mc Graw-Hill, 1997.
3. Sied Mehdi Fakhraie, *VLSI-Compatible Implementations for Artificial Neural Networks*, Kluwer Academic Publisher, 1997.

<u>Example software that could be used in conjunction with the course</u>:

1. *Matlab Neural Network Toolbox*, The MathWorks Inc., Natick, MA.

6. Catalog Description:

Introduction to Artificial Neural Networks (0909.454)

This course covers the design of a variety of popular neural network architectures and their contemporary engineering applications. Neural network architectures that will be studied in detail include the multilayer perceptron, radial basis function and the Hopfield networks. State-of-the-art software will be used for network design. VLSI implementations of neural networks will be discussed.

Prerequisites: Mathematics of Engineering Analysis II (1701.242) or Linear Algebra (1701.210) or permission of instructor.