AMERICAN UNIVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

EECE 664 – Fuzzy Sets, Logic and Applications
Midterm Exam
FALL TERM 2009-2010
DECEMBER 3, 2009
TIME: 1 ½ HOURS
CLOSED BOOK EXAM
ALL PROBLEMS ARE EQUALLY WEIGHTED IN GARDING
INSTRUCTOR: DR. JEAN J. SAADE

NAME:_____ **ID #:** _____

Problem # 1

Give a brief (approximately 5 lines) definition of an intelligent system or machine. In this definition, include a statement related to "task execution or performanee" and another one related to "human experts."

Problem # 2

When a human expert executes a task requiring a high level of intelligenee he or she uses most often an approximate rather than a precise type of reasoning. Explain briefly what is meant by approximate reasoning using the car driving example and then tell how this type of reasoning can be represented mathematically by fuzzy sets and fuzzy logic (do not exceed 10 lines in all).

Problem # 3

For a human being to become able to perform or execute appropriately a task requiring a high level of intelligence, he or she usually needs to be trained by a supervisor or expert in order to gain the needed expertise. Is it possible to train a machine? If so, explain how.

Problem # 4

Fuzzy set theory can be used to model uncertainty in a manner similar to the theory of probability. Furthermore, the theory of digital communications is usually referred to as the "statistical theory of communications." Is it possible to rebuild the theory of digital communications using fuzzy sets so that it may then be called the "fuzzy theory of communications?" Whether your answer is positive or negative explain it and give justifications.

Problem # 5

Explain the difference between artificial neural networks and fuzzy sets and logic in the setting of intelligent machine design.

Problem # 6

Specify the reason for which not all elements in a space over which a fuzzy set is defined can be classified as complete elements or no elements in the fuzzy set. In your answer consider the manner by which a fuzzy set is defined and also the manner by which the grades of membership are assigned. Do not consider any type of formula for membership functions.

Problem # 7

Explain the reason for which a crisp set has a sharply defined boundary while a fuzzy set does not.

Problem # 8

Consider the set $A=\{1,2,4,5\}$ and the crisp relation R from A into A defined by $xRy \Leftrightarrow x \leq y$. Give a matrix representation of this relation where the entries of the matrix are the characteristic values of R considered as a crisp subset of $A \times A$.

Problem # 9

Consider the function $y=f(x) = x^2$ mapping the set of real numbers $\Re$ into $\Re$ and the fuzzy set A defined over $\Re$ such that:

$$\mu_A(x)=\begin{cases}\frac{1}{3}x+\frac{2}{3}, -2\le x\le 1\\ -\frac{1}{3}x+\frac{4}{3}, 1\le x\le 4\\ 0, \text{elsewhere.}\end{cases}$$

Are the conditions needed to make $B_\alpha=[f(A)]_\alpha=f(A_\alpha)$ satisfied by f and A in this problem? State these conditions and tell if they are satisfied or not.

Problem # 10

Consider again Problem # 9 and determine B_α for all $\alpha\in(0, 1]$ by assuming that $B_\alpha=f(A_\alpha)$.

Problem # 11

Use B_α you obtained in Problem # 10 and draw an approximate plot of the membership function of fuzzy set B induced from A by function f. You do not need to determine $\mu_B(y)$.

Problem # 12

Addition of real numbers is known to be a continuous binary operation (function) from $\Re\times\Re$ into $\Re$, where $\Re$ is the set of real numbers. Consider fuzzy numbers A and B such that these numbers satisfy the properties required under the extension principle to make $C_\alpha=A_\alpha+B_\alpha$ where C=A+B.

(a) What are these properties? State them clearly.
(b) What other properties are required to be satisfied by A and B so as to be able to perform their addition using their α cuts? State these properties clearly as well.