AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
SPECIALIZED CREDIT HOURS ENGINEERING PROGRAMS
Mechatronics Engineering PROGRAM

Fall 2022 | Course Code: *CSE473* | *Time allowed: 2Hrs.*

Computational Intelligence

The Exam Consists of **FOUR** Questions in Two Pages. *Maximum Marks: 60 Marks* 1 / 2

Important Rules:
- Having a (mobile - Smart Watch- earphones) inside the examination hall is forbidden and is considered as a cheating behavior.
- It is forbidden to have any references, notes, books, or any other materials even if it is not related to the exam content with you in the examination hall.

Try All Questions and Assume Any Missing Information

Question (1): **[15 Marks]**

Given the following dataset which contains labelled vectors: -

$$D = \{([-1\ -1]^T, 1), ([-1\ +1]^T, 2), ([+1\ -1]^T, 2), ([+1\ +1]^T, 2)\}$$

a- Use a MCSM to design and train classifier. Write an expression for the loss function.
b- Use the batch training criterion to find the parameters of your classifier.
c- Visualize the classification boundaries together with the training data vectors.

Question (2): **[15 Marks]**

a- For a closed loop control system, design a fuzzy controller. In your design, assume that the inputs of the fuzzy system are the error and error change rate with negative, zero, and positive membership functions. You may assume that the control signal has 5 membership functions distributed overs its range. Justify in detail how you derive the nine control rules.
b- In your designed system of (a), if the error value is 0.5 and its change is -0.4, find the control signal value using the center of shape approach.
c- In some cases, the performance of the controller needs some improvement. One way is that the error and its change rate are multiplied respectively by k_1 and k_2 to be used as inputs to the fuzzy controller. Suggest a criterion for tunning k_1 and k_2.

Question (3): **[10 Marks]**

The genetic algorithm is used to minimize the function $f(x, y) = \exp(|x| + |y|)$. Each variable is binary encoded in 8 bits. Generate randomly a population of 5 points to start the following: -

a- Calculate the fitness function value for each chromosome.
b- Carry out a tournament selection and cross over to get the new generation individuals.
c- Mutate the resulting chromosomes. Assume a proper mutation probability.
d- Compute the new chromosomes fitness values. Is there any improvement?

$[1\ 1\ 1]\begin{Bmatrix}1\\1\\1\end{Bmatrix}$ $x=1$ $y=2$ $[0\ 0\ -2]/[1\ 1\ -1]$