Menoufia University **Faculty of Electronic Eng.** **Dep. of Ind. Electronics and Control Eng.**	**Final Term Exam – 4th year (2018/2019)** **Intelligent Control Systems – ACE 423** **Time Allowed: 3 Hours** **2-6-2019**

Answer the following questions:

Question No. (1): [15 Degree]

Consider ***a temperature controller*** with two inputs; *temperature* ($^{\circ}C$) and *humidity (%)* and one output; *fan speed (%)*. The input (temperature) is divided into three fuzzy sets as COOL, WARM and HOT. The input (humidity) is divided into three fuzzy sets as LOW, MEDIUM and HIGH. The output (fan speed) is divided into three fuzzy sets as ZERO, MEDUIM and HIGH. The fuzzy sets for input temperature are defined as $\mu_{COOL} = trapezoid\,(0,0,20,30)$, $\mu_{WARM} = triangular\,(20,30,40)$ and $\mu_{HOT} = trapezoid\,(30,40,50,50)$.

The fuzzy sets for humidity input are defined as $\mu_{LOW} = trapezoid\,(0,0,30,40)$, $\mu_{MEDUIM} = trapezoid\,(30,40,60,80)$ and $\mu_{HIGH} = trapezoid\,(60,80,100,100)$.

The fuzzy sets for the output fan speed are defined as $\mu_{ZERO} = triangular\,(0,0,50)$, $\mu_{MEDUIM} = triangular\,(10,50,70)$ and $\mu_{HIGH} = triangular\,(60,100,100)$. The fuzzy rule-base system is summarized in the following table:

	COOL	***WARM***	***HOT***
LOW	ZERO	ZERO	MEDUIM
MEDUIM	ZERO	MEDUIM	HIGH
HIGH	MEDUIM	HIGH	HIGH

Note that: The fuzzy inference is based on the **individual rule based** (***Mamdani implication method***). Use the **approximated COA** defuzzification method.

Find the value of the fan speed if the temperature equals 32 $^{\circ}C$ and the humidity equals 62 %? Show graphically the inference, the fuzzy output for each fired rule and total fuzzy output?

Question No. (2): [20 Degree]

A) Draw the block diagram for the various structures of the PID-like fuzzy logic controller. Which one is the best? And why?

B) Consider a system, which is described by the following difference equation:

$$y(k+1) = 0.5\,y(k) - 0.25\,y(k-1) + 0.01u(k) + 0.1u(k-1)$$

A PI-like fuzzy logic controller is designed to regulate this system around a set-point $R = 3$. Five fuzzy sets are used to represent the linguistic variables ***NB, NS, Z, PS*** and ***PB*** for controller variables. ***Symmetrical triangular membership functions with 50 % overlap*** are used and defined on the normalized domain [-1, 1]. The fuzzy rule-base system is summarized in the following table. Using

the initial conditions as $y(0)=0.1$, $y(1)=0.85$, $u(0)=20$ and $u(1)=25$. Find $u(2)$ and $y(3)$ if the actual domain for the input variables is [-10, 10] and for the output variables is [-30, 30]. Use the ***Mamdani inference method and* approximated *COA method***.

ΔE/E	NB	NS	Z	PS	PB
NB	NB	NB	NB	NS	Z
NS	NB	NB	NS	Z	PS
Z	NB	NS	Z	PS	PB
PS	NS	Z	PS	PB	PB
PB	Z	PS	PB	PB	PB

Question No. (3): [15 Degree]

A) Write short notes about supervised and unsupervised learning in a neural network.

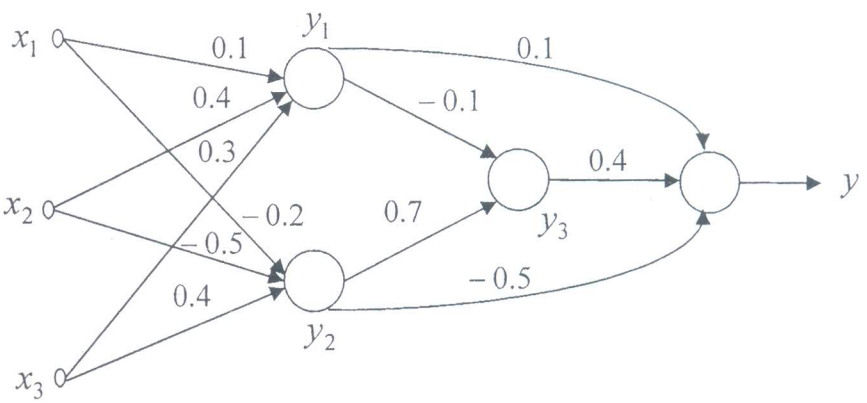
B) ***Mention only*** the names of the learning rules of the neural networks.

C) Two steps of ***Hebbian learning rule*** of a single-neuron network with four inputs have been implemented starting with $\mathbf{w}^1=[1 \quad -1 \quad 0 \quad 0.5]^T$. The learning constant $c=0.65$ and the inputs as: $\mathbf{x}_1=[1 \quad -2 \quad 1.5 \quad 0]^T$ and $\mathbf{x}_2=[1 \quad -0.5 \quad -2 \quad -1.5]^T$. Find the final weight vector for **unipolar continuous activation function** where $\lambda=5$.

Question No. (4): [20 Degree]

A) Draw the block diagram of a direct adaptive neural control and an indirect adaptive neural control.

B) For the network shown in the following Figure, **Find only the update weights for the output layer** using the ***Back Propagation method***. Where the input vector is $\mathbf{x}=[0.4 \quad 0.6 \quad 0.1]^T$, desired output $d=0.7$, learning constant $\eta=0.4$, and **unipolar continuous activation function** where $\lambda=1$.



With our best wishes.....Prof. Nabila El-Rabaie and Dr. Ahmad M. El-Nagar