Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2022-2023
Comprehensive Examination (Closed Book)
Course No: CE F 417, Time: 2:00PM-5:00PM
Course Title: Application of AI in Civil Engineering
Date: 28.12.2021, Max. Marks: 35, Duration: 3 Hours

1. Using evolutionary (or genetic) algorithms, determine the values of *x* and *y* that fulfil the equation $Sin(x) + Cos(2y) + Sin(3x) + Cos(4y) = 1$. Initially, define the objective function f(*x,y*). Set a range of 0^0 to 30^0 for the values of the two variables *x* and *y*. Initial six chromosomes are chosen at random (in degrees) as [*x; y*] = [12;5], [18;21], [10;13], [20;10], [4;19], and [5;17]. Determine the probabilities of selection. Establish the mating pairs. Utilize binary representation for x and y (5 bits each) to perform crossover on the composite or concatenated chromosomes after the fourth, sixth, and eighth bits from the left of each successive pair of composite chromosomes (each chromosome represented by "xy"). Apply the proper mutation criteria and probability of 0.05 to the composite chromosomes as well. To determine how close, you are to the correct solution, run one cycle of selection, crossover, and mutation. Do it neatly in a tabular form. **(5 Marks)**

2. A) In the reading assignment of ANNs paper Wu et al. (2005), what was ANNs used for? As per the discussion in the paper, what are the uses of learning rate and momentum factor in backpropagation algorithm? B) In the reading assignment of Fuzzy Logic paper Li et al. (2006), what was the primary objective of the paper? In the paper, which type of membership functions are used? C) In the reading assignment of Genetic Algorithms paper Burn et al. (2001), what was the primary goal of the study? As per the paper, a string consists of *NS* genes. What does *NS* stand for? And what coding is used to define treatment level? D) In the reading assignment of Expert System paper Reffat and Harkness (2001), what was the primary goal of the study? What does ESEQE stand for? What are the four categories of ESEQE knowledge base? E) In the reading assignment of SVM paper Khan and Coulibaly (2001), what was the main objective of the study? Which models were compared against SVM model?

(1+1+1+1+1 = 5 Marks)

3. A stream-site in a river basin has X1 and X2 stand for daily precipitation and agricultural land use factor, respectively, whereas Y stands for a water quality metric like nitrate content at the same place. Find the updated weights for the network in Figure 3 after one epoch using a back-propagation network. The input pattern [1, 0.6] and target output [+1] are sent to the network. Utilize a bipolar sigmoidal activation function and a learning rate of α = 0.2. **(5 Marks)**
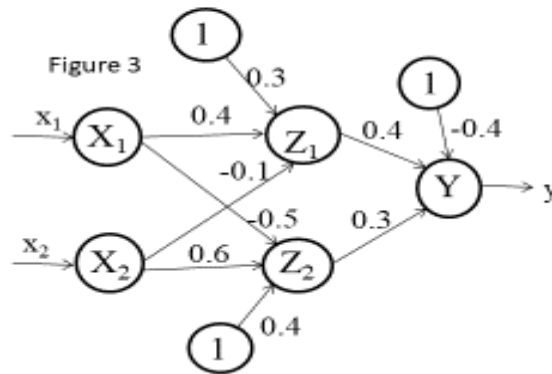
Figure 3

4. Classify the two-dimensional patterns shown in figure below using Hebb network. Verify the solution using the obtained network. **(4 Marks)**

	+		+	+		+		+		+	+		+
		+			+				+			+	
	+		+	+		+		+		+		+	
"XX" belongs to output class 1.							"XY" does not belong to output class 1.						

5. For the purpose of clustering the four vectors [1 0 1 0], [1 1 0 0], [0 0 1 1], [1 0 1 1], create a Kohonen self-organizing feature map. Use a learning rate of 0.2. A maximum of 2 clusters need to be formed. Assume that w1 = [0.1 0.2 0.7 0.9] and w2 = [0.3 0.4 0.6 0.8] are the initial clustering weights. **(4 Marks)**

6. A) Using the inference approach, find the membership values for the triangular shapes I, R, E, IR, T for a triangle with angles 40^0, 60^0, 80^0. **(4 Marks)**

7. To make concrete, the main four components are Cement, Sand, Water and Gravel. The mixture is considered to be the best if the proportions of Cement, Sand and Gravel are 1:1.5:1. An amount of 40% by volume of water is added to make concrete paste. Now, to fill the slab with concrete the constructors need the exact proportion of concrete that produces no shortage and no waste. The mix proportion for different components shown in fuzzy sets that follow: $Cement = \left\{\frac{0.4}{10} + \frac{0.3}{20} + \frac{0.9}{30} + \frac{0.6}{40} + \frac{0.4}{50}\right\}$ on a universe of cubic-feet of cement. $Sand = \left\{\frac{0.3}{15} + \frac{0.4}{30} + \frac{0.8}{45} + \frac{0.7}{60} + \frac{0.4}{75}\right\}$ on a universe of cubic-feet of sand. Then, 40% by volume of water is added to the mixture, to produce $Water =$

$\left\{\frac{0.4}{15} + \frac{0.7}{30} + \frac{0.7}{45} + \frac{0.6}{60} + \frac{0.5}{75}\right\}$ on a universe of cubic-feet of water. (a) Using fuzzy Cartesian product, find $P = C \times S$ where P represents a fuzzy set called the proportion, (b) Using max-min composition, find $Q = W \circ P$, where Q represents a fuzzy set called the overall performance of the concrete, (c) Using max-product composition, find $Q = W \star P$. **(4 Marks)**

8. Max $z_1 = 250 \ x_1 + 140 \ x_2$
   Max $z_2 = 3 \ x_1 + 3.5 \ x_2$
   Subject to
   $3.8 \ x_1 + 2.8 \ x_2 \leq 290$
   $2.1 \ x_1 + 4.8 \ x_2 \leq 320$
   $18 \leq x_1 \leq 50$
   $25 \leq x_2 \leq 75$
   Solve the problem with weightage method for weight set values (0.3, 0.7) **(4 Marks)**