AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT, IIT KHARAGPUR

End Term of Spring Semester Examination, April 2009
Subject AG60098: Food Process Modeling
M. Tech in DFE, PHE, B Tech in AgFE, Dual degree in AgFE & DFE, Research Scholar

Date: 23-04-2009 **Maximum marks: 50** **Duration: 3 Hours**

Answer ALL questions

Q.1 a) Several useful information can be derived from an empirical equation when an empirical equation is developed between the independent variables in coded form and a dependent variable. Discuss the truth behind this statement. Also discuss the type of coding to be used for (i) experimental design and (ii) empirical equation development

b) Relationship between a dependent variable and a number of independent variables is truly linear. How will you establish this fact by developing a non-linear type relationship between the variables?

c) What is similarity measure of fuzzy sensory scales? Describe the methods used for its evaluation.

d) Discuss the principle of finding neural network parameters by using the method of error backpropagation?

.. .. (16)

Q.2 **(a)** A linear type regression equation is required to be developed between five independent variables and one dependent variable. Show the procedure for developing an experimental plan which would require the minimum number of experimental observations.

(b) Saturated steam is generated inside a boiler at 12 bar (190°C saturation temperature). The steam is then superheated at the same pressure by 10°C and flows to the processing plant. Estimate the enthalpy and entropy of superheated steam by using the following data. C_{pw}=4.184 kJ kg^{-1} °C^{-1}, C_{pwv}=1.88 kJ kg^{-1} °C^{-1}, Latent heat of vaporization of water at 0°C = 2501 kJ kg^{-1}.

.. .. (10)

..... PTO

Q.3 Sensory scores of a food S1, as triplets, obtained by a number of evaluators against color & appearance, aroma, taste and mouthfeel on five point scale are given below.

S1C = (31.82 18.19 25.00)
S1A = (50.00 22.73 20.46)
S1T = (59.09 22.73 22.73)
S1M = (45.46 22.73 25.00)

Sensory scores of the quality attributes viz., color & appearance, aroma, taste and mouthfeel, as triplets, obtained by the same number of evaluators on five point scale are the following.

QC = (45.45 15.91 20.46)
QS = (65.91 25.00 15.91)
QT = (84.09 25.00 11.36)
QM = (70.46 25.00 15.91)

Find the strongest and weakest quality of the food. Also grade the quality attributes of the food in descending order

.. .. **(10)**

Q.4 A function is represented by the equation: $y = 6x_1 - 6x_2 + x_1^2 + x_2^2 - 2x_1x_2$. It is required to find out the values of x_1 and x_2 by using the Genetic algorithm, such that the value of y would be the minimum. Values of x_1 and x_2 vary in the range: $20 < x_1 < 30$ and $0.1 < x_2 < 10$. Accuracy with which the values of x_1 and x_2 are to be estimated must be greater than ± 0.5.

Following are the binary representation of the values of x_1 and x_2 as obtained by random number generation.

Sl. No.	Population string
1	11001010
2	00101010
3	01001100
4	11110000

a) Find the four population strings having the desired number of binary digits.

b) Find for each of the population strings, (i) Binary values of the strings, (ii) Values of x_1 and x_2, and (iii) values of y

c) For tournament selection, following random numbers are generated: (1,1); (2,1), (3,2) and (4,4). Arrange the elite population strings with decreasing fitness function.

d) Carry out crossover operation on the 2nd and 4th population strings at sites 4 and 3, of the elite population. Find the populations strings which are to be taken for mutation.

e) Find average fitness values of (i) initial population, and (ii) population taken for mutation

.. .. **(15)**

VALUES FOR THE EQUIVALENT DEPTH d OF HOOGHOUDT (r_o=0.1 m, d and S in m)

S→	10	15	20	25	30	35	40	45	50	75	80	85	90	100	150
d															
0.5	0.49	0.49	0.49	0.50	0.50										
1	0.80	0.86	0.89	0.91	0.93	0.94	0.96	0.96	0.96	0.97	0.97	0 97	0.98	0.98	0.99
2	1.08	1.28	1.41	1.50	1.57	1.62	1.66	1.70	1.72	1.80	1.82	1.82	1.83	1.85	1.00
3		1.45	1.67	1.83	1.97	2.08	2.16	2.23	2.29	2.49	2.52	2.54	2.56	2.60	2.72
4			1.81	2.02	2.22	2.37	2.51	2.62	2.71	3.04	3.08	3.12	3.16	3.24	3.46
5			1.88	2.15	2.38	2.58	2.75	2.89	3.02	3.49	3.55	3.61	3.67	3.78	4.12
6					2.48	2.70	2.92	3.09	3.26	3.85	3.93	4.00	4.08	4.23	4.70
7					2.54	2.81	3.03	3.24	3.43	4.14	4.23	4.33	4.42	4.62	5.22
8					2.57	2.85	3.13	3.35	3.56	4.38	4.49	4.61	4.72	4.95	5.68
9						2.899	3.18	3.43	3.66	4.57	4.70	4.82	4.95	5.23	6.09
10							3.23	3.48	3.74	4.74	4.89	5.04	5.18	5.47	6.45
12.5										5.02	5.20	5.38	5.56	5.92	7.20
15										5.20	5.40	5.60	5.80	6.25	7.77
17.5										5.30	5.53	5.76	5.99	6.44	8.20
20											5.62	5.87	6.12	6.60	8.54
25											5.74	5.96	6.20	6.79	8.99
30															9.27
35															9.44
∞	1.14	1.53	1.89	2.24	2.58	2.91	3.24	3.56	3.88	5.38	5.76	6.00	6.26	6.82	9.55

(From Wessling, 1973)

(S-spacing of drains, d thickness of aquifer below drain level and r_o-radius of the drains)