School of Information Technology
Indian Institute of Technology, Kharagpur

IT 60108: Soft Computing Applications
End-Semester Examination
Spring, 2015-2016

Maximum Marks: 100 Time: 3 hours

Instructions:

1. This is a question paper cum answer script consisting of **fourteen** pages having five questions with sub-parts. You are supposed to attempt **ALL** questions in the space provided below each question.

2. Marks for each question are clearly mentioned along the right margin of the last sentence of each question. Give precise and to-the point answers to all questions taking the allotted marks into consideration.

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Name: _____Roll No: _____ Mobile: _____

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Question	1	2	3	4	5	Grand total
Marks						

Question 1 There is a factory located at each of the two places P and Q. From these locations, a certain commodity is delivered to each of the three depots situated at A, B and C. The daily requirements of the depot are a, b and c units of the commodity, respectively while the production capacity of the factories at P and Q are p and q units, respectively. Further, the cost of transportation from any factory to any depot is given below:

	A	B	C
P	c_{pa}	c_{pb}	c_{pc}
Q	c_{qa}	c_{qb}	c_{qc}

(a) Formulate the above problem as an optimization problem. **[10]**

(b) It is proposed to solve the above optimization problem using Binary coded GA. Decide the genotype for the chromosome structure to do this. **[5]**

(c) Suppose the problem needs to be adapted with m factories and n depots. What change in the chromosome structure you should devise? **[5]**

Question 2 Answer the following:

(a) What is the use of selection operation in Genetic algorithm? **[2]**

(b) Mention **four** criteria, which you should consider to judge the efficiency of a selection strategy? **[4]**

(c) Precisely state the **two** major steps in Tournament selection strategy. **[4]**

(d) It is planned to apply Roulette wheel selection strategy into Tournament selection. Give your suggestion, how the same can be realized. **[2]**

(e) How Tournament selection strategy is comparable to Roulette wheel selection strategy, if they are individually applied in Genetic algorithm? You may give your comparison in the form of a table with reference to **four** efficiency measurement criteria you have mentioned as your answer to *Problem 2(b)*. **[8]**

Question 3 Answer the following:

(a) Obtain the off spring chromosome(s), it will produce from the reproduction of three parent chromosomes P_1, P_2 and P_3 following the "Three parent crossover" technique? **[4]**

P_1:

1	1	0	1	0	0	0	1

P_2:

0	1	1	0	1	0	0	1

P_3:

0	0	1	1	0	1	1	0

(b) Two parent chromosomes in Order GA are given as under:

P_1:

1	2	3	4	5	6	7	8	9

P_2:

1	2	3	4	5	6	7	8	9

Obtain the two off spring that can be obtained following the "Partially mapped crossover" technique. **[4]**

(c) "Linear crossover" technique in Real coded GA takes the following form:

$$c_i = \alpha_i \cdot p_1 + \beta_i \cdot p_2$$

Where p_1 and p_2 are any two values and α_i, β_i are any two values chosen by the user.

Explain for the following two parent chromosomes, how two offspring chromosomes can be produced. **[4]**

P_1:

5	10

P_2:

6	9

(d) Explain the working of "Flipping" as mutation operator in Binary coded GA.

[4]

(e) Consider the following is a chromosome in Order GA encoding scheme.

Offspring:

B	H	F	G	C	E	A	D

Explain how such a chromosome can be mutated. Consider the least change in chromosomes between the offspring and the mutated offspring. **[4]**

Question 4 Each of the following question includes a statement and possibly the statements are **wrong**. You have to **rewrite** the sentence in their correct form. **[10 X 2=20]**

(a) Vector Evaluated Genetic Algorithm (VEGA) is a multi-objective evolutionary algorithm (MOEA), which is an a priori technique and Pareto based.

(b) A Pareto front is also a Pareto optimal front but the reverse is not true.

(c) Both NSGA and NSGA-II follow the "Crowding Tournament" selection strategy to create mating pool.

(d) The length of chromosome in encoding scheme while solving a multi-objective optimization problem (MOOP) is proportional to the number of objective functions in the MOOP.

(e) If c_1 and c_2 are two offspring chromosomes then according to NPGA, c_1 will be preferable to be selected for mating pool if c_1's niche count is higher than that of c_2.

(f) According to MOGA, the rank of a solution is defined as the number of solutions by which it is dominated.

(g) The a priori high level information that is required in "Lexicographic ordering" is the scalar weights of each objective function.

(h) Crowded comparison operator ($<_c$) (as defined in NSGA-II) to select between x and y is defined as $rank\ (x) < rank(y)$ or $rank\ (x) > rank(y)$ and $x_d > y_d$.

(i) A solution x_i is said to dominate another solution x_j if

1. x_j is worse than x_i and
2. x_i is strictly better than x_j.

(j) MOGA and NSGA follow their own steps to assign fitness values to all solutions in the current population whereas NPGA and NSGA-II do not require any fitness value calculation.

Question 5 Answer the following:

(a) What is niche count? What it does signify? Give an idea how niche count of a solution in a population can be calculated. **[1+1+4=6]**

(b) Explain the concept of non-dominated sorting proposed in NSGA and NSGA-II. How NSGA assigns fitness values to each solution using this non-dominated sorting output? **[3+5=8]**

(c) The non-dominated sorting GA (NSGA-II) procedure for finding multiple Pareto optimal solutions in a multi-objective optimization problem has the following three features:

(i) It uses an elitist principle

(ii) It uses an explicit diversity preserving mechanism, and

(iii) It emphasizes the non-dominated solutions.

Briefly explain how NSGA-II accomplishes the above mentioned features. You should mention the concept only instead of procedure for each. **[2+2+2=6]**