Name: _____ Reg #: _____ Section: _____

National University of Computer and Emerging Sciences, Lahore Campus

Course:	**Evolutionary Computations**	**Course Code:**	**CS-566**
Program:	**MS (Computer Science)**	**Semester:**	**Fall 2018**
Duration:	**90 Minutes**	**Total Marks:**	**23**
Paper Date:	**29-Oct-18**	**Weight**	**22 %**
Section:	**N/A**	**Page(s):**	**6**
Exam:	**Midterm**		

Instruction/Notes: Attempt the examination on the question paper and write concise answers. You can use extra sheet for rough work. Do not attach extra sheets used for rough with the question paper. Don't fill the table titled Questions/Marks.

Question	1	2	3	4	Total
Marks	/ 3	/ 2	/ 3.5	/ 14.5	/ 23

Q1: [3 marks] Suppose you have 3 solutions and their objective function values are given in the table given below. Find the optimal solution using Tchebycheff approach.

$$\text{minimize } g^{te}(x|\lambda, z^*) = \max_{1 \le i \le m} \{\lambda_i |f_i(x) - z_i^*|\}$$

Weight vector (λ)	Maximize F_1	Minimize F_2	Maximize F_3
$[0.3, 0.4, 0.3]^T$	1	5	10
$[0.7, 0.1, 0.2]^T$	6	2	8
$[0.5, 0.1, 0.4]^T$	10	8	5

Q2: [2 marks] Calculate the Coverage measure for pair (A, B) of approximation sets. We have maximized all 2 objective functions (f_1, f_2).

Approximation set by **Algorithm A** is {(2, 8), (4, 6), (7, 4), (8, 3)}.

Approximation set by **Algorithm B** is { (2, 6), (5, 5), (2, 9), (6, 5), (10, 5)}.

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The formula for the coverage is given as:

$$C(A,B) = \frac{|\{b \in B; \exists a \in A : a \leq b\}|}{|B|}.$$

Calculate C(A, B) and C(B, A) in percentage.

Question 3: (3.5 mark)

Suppose you have to optimize two objectives: (i) Minimize f_1 and (ii) Minimize f_2.

a) Find out the Raw Fitness (R) for all solutions using SPEA and SPEA2.

Minimize f_1	**Minimize** f_2	**Raw Fitness using SPEA**	**Raw Fitness using SPEA2**
6	9		
2	1		
6	3		
1	2		
3	4		
5	7		

b) Using SPEA2: if the archive size is 3, which solutions will be the part of the archive?

Q4: [14.5 marks]

a) Suppose we have 10 objectives to be optimized and we need to apply MOEA/D. Given H = 5, calculate the number of sub-problems (N). **[1 mark]**

b) Suppose we have 4 objectives to be optimized and we need to apply MOEA/D. Given H = 5, generate any two possible weight vectors. **[1 mark]**

c) Can we solve 'Search Problems' without search? . Explain your choice with reason. **[1 mark]**

d) Given the fitness function $f(x) = x^2$, calculate selection probabilities for Rank-based Selection for the individuals x=1, x=2, x=10. **[2 marks]**

e) Why the performance of Evolutionary Multi-Objective Algorithms (EMO) degrades when solving problems with large number of objectives? [**1 mark**]

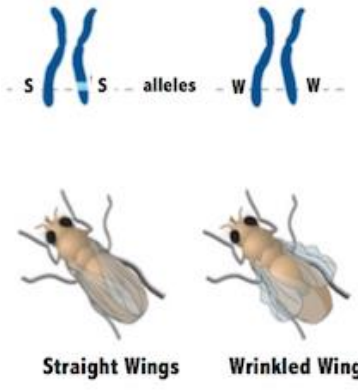
f) Why naïve implementation of Non-dominated sorting (in NSGA) has running time complexity of $O(MN^3)$? Explain with example. [**1 mark**]

g) (i) Define Exploration and Exploitation in search space. (ii) Which operator in GA helps in exploitation? (iii) Which operator in GA helps in exploration? [**2 marks**]

h) What will be the size of the Search Space for Travelling Salesman Problem for visiting 10 cities (N=10)? Is it polynomial or exponential in terms of input (N)? [**1.5 marks**]

i) Write down the main disadvantage of aggregation-based approach. What do you think which kind of fronts are difficult to handle using aggregation-based approach. [**1 mark**]

j) Genotype vs Phenotype: Flies have genes that code, or have instructions, for the shape of their wings. We have gene codes for straight wings (called **S)**, while another version of the gene codes for wrinkled wings (called **W**). In the figure below, write down which one is Genotype/Phenotype.

----------	
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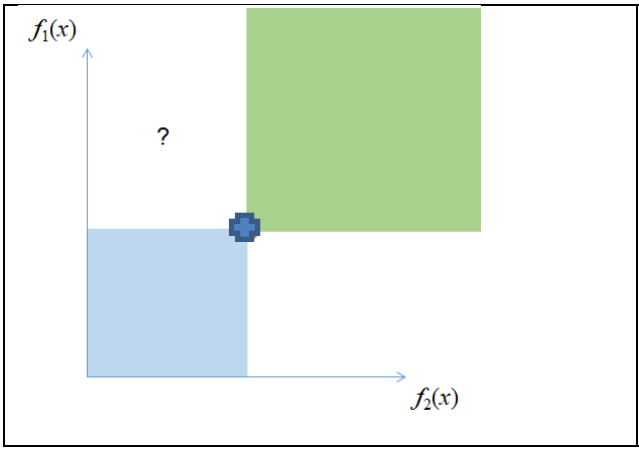
k) Which of the followings address convergence in multi-objective optimization problems? [**1 mark**]
   a. Fitness assignment (Environmental selection)
   b. Diversity preservation (density estimation)
   c. Elitism (Environmental selection)
   d. All of the above

l) In the figure below, if we look at the 4 regions with respect to a given solution '✚'. The region marked as '?' is:



a) Dominating

b) Dominated

c) Incomparable

d) None of the above

Good Luck ☺