
School of Computing and Information Technology

ASSIGNMENT 1 (Individual)

CSIT113 – Problem Solving

Session 1, January – March 2024

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Total No of Questions: Eight (8) questions

Total Marks: 100 marks

Weightage: 8% of total subject mark

Objective

In this assignment, students are assessed on the understanding of the materials from Unit 1 to Unit 4 in the lecture notes. Students are required to apply the appropriate strategies and methods discussed in these units for each of the problems stated for the questions in this assignment.

Question 1 [10 marks]:

In applying **pure brute force** to arrange the numbers in a sequence in non-decreasing order, in the worst case, in total what are the number of possible solutions we have to consider for the following cases:

- (a) when sequence-size = 4 [2 mark]
- (b) when sequence-size = 5 [2 mark]
- (c) when sequence-size = 6 [2 mark]
- (d) when sequence-size = n [4 mark]

Question 2 [20 marks]:

A swimming team consists of 4 swimmers. The following table tabulates the time it took for each swimmer to swim a standard length (50 meter) with different technique at practice.

Technique Swimmer	Free style (1)	Breast stroke (2)	Butterfly (3)	Back stroke (4)
Andrew	44	44	41	43
Bernard	41	47	42	42
Chester	40	43	44	46
Daniel	46	44	45	48

The team is entering a relay team contest, where in a team each of the swimmers must swim 50 meters using a different technique listed in the table. Using **brute force** strategy, assign the four techniques to the 4 swimmers such that the total time for the team is optimal.

- (a) How many possible assignments (solutions) in total in using **pure brute force** (that is, brute force without considering any constraint).

[5 mark]

- (b) How many possible assignments (solutions) in total in using **brute force** with the constraint that each swimmer must use a different technique taken into consideration

[5 mark]

- (c) Show all the possible combinations of assigning the techniques to the four swimmers according to Q1(b) and indicate the total time for each of the assignments.

[5 mark]

- (d) Which combination(s) of swimming technique yields the lowest (optimal) total team time?

[5 mark]

Question 3 [10 marks]:

Alice, Bob, Carol and Dave want to cross a river. They have a boat with a capacity of 100Kg. Alice weighs 46Kg, Bob 49Kg, Carol 52Kg and Dave 100Kg. Except Bob, all of them can row. Using abstraction and invariants to find a way to get all of them across the river with the minimum number of rows.

Question 4 [10 marks]:

Prove or disprove that $p \wedge (q \equiv r) \equiv ((p \wedge q) \equiv (p \wedge r))$.

Question 5 [10 marks]:

Prove that $(p \Rightarrow q) \wedge (q \Rightarrow r) \Rightarrow (p \Rightarrow r)$.

Question 6 [15 marks]:

On Knights and Knave Island, all natives are either knights, who always tell the truth, or knaves, who always tell lies.

You meet five islanders, Alice, Bob, Carol, Steven and John, who make the following statements:

Alice: "Bob and Carol are of the same type."

Bob: "Carol is a knave."

Answer the following questions;

- (a) Is Alice a knight or a knave?
(b) What question can you ask Steven to identify exactly what John is?

Question 7 [10 marks]:

Let A be a sequence with n nonzero numbers. Design an algorithm by using induction to compute the sum of the reciprocal of the numbers in A. Specify your algorithm using recursive implementation.

Note that for a number x, its reciprocal is $1/x$.

Question 8 [15 marks]:

Prove by Mathematical Induction that for all $n \geq 1$, $1^3 + 2^3 + 3^3 + \dots + n^3 = n^2(n+1)^2/4$.