# United International University
## Department of Computer Science and Engineering
### CSE-2218 Data Structures and Algorithms II Laboratory

Practice Problemset — — Summer 2025

Total Marks:

Any examinee found adopting unfair means will be expelled from the trimester / program as per UIU disciplinary rules.

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1. You are attending your mid-term of the course "CS101". The total marks of the exam is $M$ and the total time is $T$ minutes. You have to answer $N$ questions, where the $i$-th question carries $m_i$ marks and takes $t_i$ minutes for you to answer.

   The marks you receive will be proportional to the percentage of your answer compared to the full answer. For example, if a question contains 100 marks and you complete 30% of it, you will get 30 marks.

   - Find the maximum marks you can get in this exam. Print the questions you have to answer for that.
   - Find the maximum marks you can get in this exam if you are allowed to take the same exam in a group with your one friend (as long as a question is answered, both of you get marks irrespective of who answered it) and your friend's answering capacity is exactly the same as yours.

| Sample Input | Sample Output |
|---|---|
| 120 20 5<br>20 10<br>20 5<br>30 5<br>30 6<br>20 40 | Maximum 88 marks answering alone<br>ques 3 100% done – 30 marks<br>ques 4 100% done – 30 marks<br>ques 2 100% done – 20 marks<br>ques 1 40% done – 8 marks<br>Maximum 107 marks answering with a friend |

2. You are managing a multipurpose hall of your university, where seminars, lectures, and cultural events are held. $N$ clubs have sent you booking requests for their events tomorrow. Each booking request contains the club id ($c_i$), the start time ($s_i$) and the duration ($d_i$) of the event.

   Approve the booking requests such that you can accommodate the maximum events tomorrow, without creating conflicts. Note that, after an event you need $X$ hours to clean up and prepare for the next event.

| Sample Input | Sample Output |
|---|---|
| 4<br>UIUa 2 8<br>UIUb 3 4<br>UIUd 8 1<br>UIUc 7 1<br>0 | Chosen clubs:<br>UIUb<br>UIUc<br>UIUd |
| 4<br>UIUa 2 8<br>UIUb 3 4<br>UIUd 8 1<br>UIUc 7 1<br>1 | Chosen clubs:<br>UIUb<br>UIUd |

3. Consider the problem of making an $M$-meter-long rope using smaller ropes. There are $d$ types of ropes, $C = \{c_1, c_2, \ldots, c_d\}$, each rope's value is an integer, and there are an infinite number of ropes for each rope type. Joining two ropes together costs $X$ dollars. Write an algorithm to make an $M$-meter-long rope at a minimum cost.

4. Given a rod of length $n$ inches and a table of prices $p = \{p_1, p_2, .., n\}$ determine the maximum revenue $r$, obtainable by cutting up the rod and selling the pieces. Note that if the price $p$, for a rod of length $n$ is large enough, an optimal solution may require no cutting at all. Your task is to solve the rod cutting problem using dynamic programming. Print the maximum revenue.

**Pseudocode (Tabulation method):**

```
BOTTOM-UP-CUT-ROD(p, n)
1  let r[0..n] be a new array
2  r[0] = 0
3  for j = 1 to n
4      q = -∞
5      for i = 1 to j
6          q = max(q, p[i] + r[j - i])
7      r[j] = q
8  return r[n]
```

5. You are given an array $A$ and a number $N$. You need to find out whether $N$ is a sum of any subset of $A$.

   Example: $A = \{2, 4, 5, 6, 8\}, N = 15 \rightarrow True \rightarrow \{4, 5, 6\}$
   $A = \{2, 4, 5, 6, 8\}, N = 0 \rightarrow True \rightarrow \{\}$
   $A = \{2, 4, 5, 6, 8\}, N = 3 \rightarrow False$

   Hint: similar to 0-1 knapsack. Think of A as a set of items, and N as knapsack capacity.

6. There are $n$ boxes of $n$ different items in a warehouse. Each box has a label that says the name ($m_i$), total weight ($w_i$) in kg, and the total value ($v_i$) in taka of that item ($i$). All items are divisible.

   Suppose, $k$ thieves have come to steal from the warehouse, each with a knapsack of capacity $W_i$. Given each thief wants to maximize profit, how many thieves will be needed to empty the warehouse? Solve using a greedy algorithm.

| **Sample Input** | **Sample Output** |
|---|---|
| 4<br>silver-dust 300 4<br>gold-dust 2000 8<br>salt 80 10<br>sugar 89 10<br>2<br>15 15 | Thief 1 profit: 2326.7 taka<br>Thief 2 profit: 126.3 taka<br>Total 2 thieves stole from the warehouse.<br>Still following items are left:<br>salt 2.0 kg 16.0 taka |

7. You are given a directed weighted graph with $N$ vertices and $M$ edges. Your task is to find the shortest distance from the source vertex $S$ to all other vertices.

   If the graph contains a **negative weight cycle** that is reachable from the source, print: `Negative Cycle Detected`. If a vertex is not reachable from the source, print `INF` for that vertex. Otherwise, print the shortest distance from the source to each vertex.
   Source node = Last 3 digits of your Student Id % 7.

   **Input Format:**

   - The first line contains two integers, $N$ and $M$, number of vertices and edges respectively. $0 \leq N \leq 7$
   - Each of the next $M$ lines contain $u_i, v_i, w_i$ which denotes an edge from $u_i$ to $v_i$ with weight $w_i$.

| Sample Input | Sample Output |
|---|---|
| 5 8<br>1 2 -1<br>1 3 4<br>2 3 3<br>2 4 2<br>2 5 2<br>4 2 1<br>4 3 5<br>5 4 -3 | Distance from 1 to 1: 0<br>Distance from 1 to 2: -1<br>Distance from 1 to 3: 2<br>Distance from 1 to 4: -2<br>Distance from 1 to 5: 1 |
| 4 5<br>1 2 4<br>2 3 -10<br>3 4 3<br>4 2 2<br>1 3 5 | Negative cycle detected |

- Sample input-outputs are given here considering a student ID 0112220001.

8. If all the edge weights for the previous problem are converted to non-negative(e.g. -10 will be 10), can you think of any greedy algorithm to solve the same problem?

9. Given a connected, undirected, weighted graph, find a spanning tree using edges that minimize the total weight. Use Prim's Algorithm to construct the algorithm.