

In this project, you are required to implement some procedures in MIPS assembly language. You will use SPIM simulator [1] to develop and test your code. There will be three questions in the project which are unrelated.

**QUESTION 1.** (10 points) In this program you are required to implement a number series based on given inputs. Your program should take three inputs: a starting index, a number of integers in the list and the distance between two successive numbers in the list. After taking inputs, it should display the series and the summation of them. Please consider only positive numbers in the series! All the numbers in the series should fit in a word!

An example run:

Enter the first number in the series: 7

Enter the number of integers in the series: 5

Enter the offset between two successive integers in the series: 4

The series is: 7 11 15 19 24

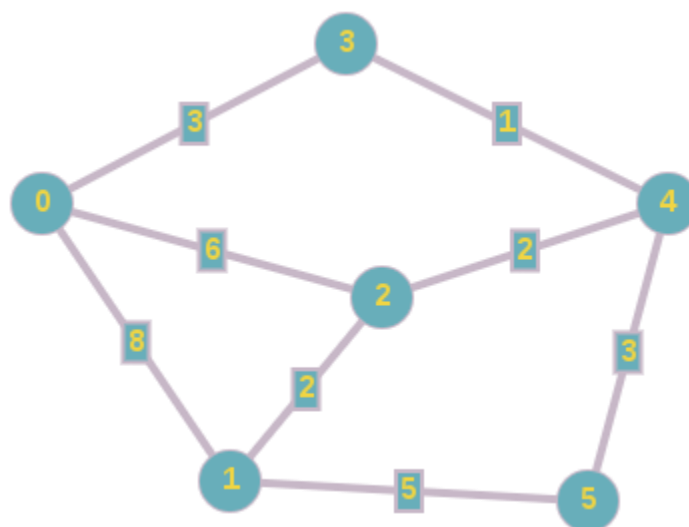
The summation of the numbers is 76

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**QUESTION 2.** (25 points) In this question, you are required to implement Prim's Minimum Spanning Tree Algorithm [2]. Given undirected graph with weighted edges, Prim's algorithm initially selects a random root node and adds unexplored vertices by sorting edge weights. Algorithm terminates when all the vertices are connected and the main constraint is that there is no cycle between vertices (For more information check a textbook on algorithms [2]). Your graph inputs will be in the following format:

[NodeID] [NodeID] [Edge1] [NodeID] [NodeID] [Edge2] ..... [NodeID] [NodeID] [EdgeN]  
emphasizing edges in the graph.

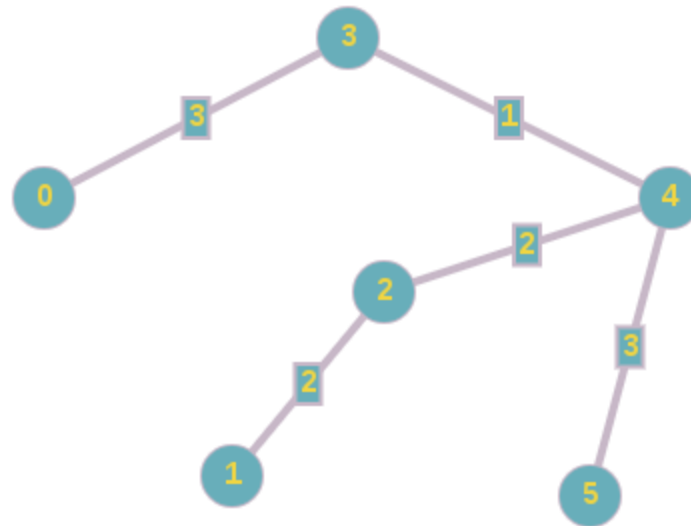
Example graph is given below:



Values in the graph indicating vertex id and edge weights. Input for the graph above given as follows:

0 1 8 0 2 6 0 3 3 1 2 2 1 5 5 2 4 2 3 4 1 4 5 3

Assuming that initially vertex 2 selected, Minimum Spanning Tree output of the Prim's algorithm would be as follows:



Output of the program must list only the selected edges in the graph and total weight as follows:

0 3 3  
1 2 2  
2 4 2  
3 4 1  
4 5 3

An example run:

Enter the graph: 0 1 8 0 2 6 0 3 3 1 2 2 1 5 5 2 4 2 3 4 1 4 5 3

Minimum Spanning Tree:

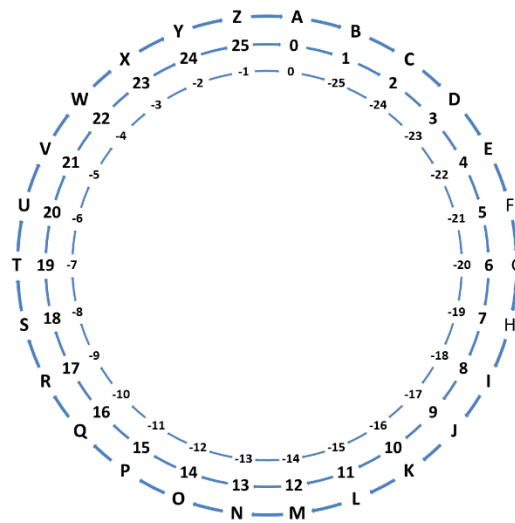
0 3 3  
1 2 2  
2 4 2  
3 4 1  
4 5 3

Total weight is 11

Vertex id and weights can be 2 digits: 12, 19 etc.

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**QUESTION 3.** (12 points) Write a MIPS program that performs string encryption or decryption based on taken arguments. Your program should take an input string and an integer offset value, then it should encode or decode input string based on a shift offset. It will take an integer offset and it will perform encryption if the value is positive and it will perform decryption if it is negative. The value of offset must be -25 to -1 (inclusive) and 1 to 25 (inclusive). Encoding/decoding scheme is given in the following figure:



Example Runs:

Enter an input string: I am an engineer!

Enter an offset value: 25

SOURCE: I AM AN ENGINEER!

PROCESSED: H ZL ZM DMFHMDDQ!

Enter an input string: I am an engineer!

Enter an offset value: -1

SOURCE: I AM AN ENGINEER!

PROCESSED: H ZL ZM DMFHMDDQ!

Enter an input string: Vdkbnld sn Lzqlzqz Tmhudqrhsx :)

Enter an offset value: -25

SOURCE: VDKBNLD SN LZQLZQZ TMHUDQRHSX :)

PROCESSED: WELCOME TO MARMARA UNIVERSITY :)

Enter an input string: Vdkbnld sn Lzqlzqz Tmhudqrhsx :)

Enter an offset value: 1

SOURCE: VDKBNLD SN LZQLZQZ TMHUDQRHSX :)

PROCESSED: WELCOME TO MARMARA UNIVERSITY :)

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**MENU** (8 points): Your program should support a *Menu* including all questions above. A sample execution scenario given below:

Welcome to our MIPS project!

Main Menu:

1. Prim's Algorithm

2. Number Series

3. Encrypt/Decrypt

4. Exit

Please select an option: 1

These options must be printed inside a loop until "Exit" option is selected.

When the user select option 1, you should print the followings:

Enter the graph: 018026033122155242341453

Total weight is 11

Main Menu:

1. Prim's Algorithm

2. Number Series

3. Encrypt/Decrypt

4. Exit

Please select an option: 2

Enter the first number in the series: 7

Enter the number of integers in the series: 5

Enter the offset between two successive integers in the series: 4

The series is: 7 11 15 19 24

The summation of the numbers is 76

Main Menu:

1. Prim's Algorithm

2. Number Series

3. Encrypt/Decrypt

4. Exit

Please select an option: 3

Enter an input string: I am an engineer!

Enter an offset value: 25

SOURCE: I AM AN ENGINEER!

PROCESSED: H ZL ZM DMFHMDDQ!

Main Menu:

1. Prim's Algorithm
2. Number Series
3. Encrypt/Decrypt
4. Exit

Please select an option: 4

Program ends. Bye :)

## **References**

- [1] <http://spimsimulator.sourceforge.net/>

[2] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. 2009. Introduction to Algorithms, Third Edition (3rd ed.). The MIT Press.