**INDIAN INSTITUTE OF TECHNOLOGY**

**GOA**

**COMPUTER ARCHITECTURE LAB (CS 211)**

Faculty : Dr. Sharad Sinha

Teaching Assistant: Prachi Kashikar & Pavitra P. Bhade

**LAB 06**

In this course, you will learn the concept of **Dynamic Memory Allocation** and **Data Structures** using QtSpim simulator. This lab exercise will be split in two parts. In part A, you will be introduced in brief to the concepts. In part B, you will be asked to write assembly programs to understand the same.

**Part A:**

**Dynamic memory allocation** is when an executing program requests that the operating system give it a block of main memory.

Following instructions will illustrate dynamic memory allocation:

li $a0,xxx

li $v0,9

syscall

In the first instruction, number of bytes needed should be stored in $a0 register. This number has to be a multiple of 4.

The syscall code for memory allocation is 9. This has to be entered in $v0 before making the syscall.

After the syscall is executed, register $v0 will hold the address of the location that is dynamically allocated.

A **Data Structure** is a collection of data that includes the structural relationships between the data.

For example, a linked list is a data structure, which is just a collection of nodes such that, each node consists of two items:

1. The data
2. The address of the next node.

This can be pictorially represented as shown in Fig 1. Each node has integer data as well as a link to the next node.

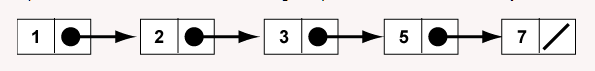


Fig 1

In assembly language, this can be achieved by assuming each node to be of 8 bytes, such that first 4 bytes hold the data part and the next 4 bytes hold the address of the next node. The last node will hold 32 zero bits in the next address part, which represents NULL.

A **Record** or a **Structure** is a block of memory that contains several data items. Each data item will require specific number of bytes for storage. The memory required for the entire structure will be the cumulative memory of all individual data items.

**Part B:**

Write Mips assembly programs for the following exercises. Execute in single stepping mode and check the updates in data memory and other registers during dynamic memory allocation process.

**Exercise:**

1. Dynamically allocate memory to store a structure ‘Date’, which has three variables of integer type, namely date, month and year. The values for the same have to be entered by the user. Place the next date in next memory location and also display it on the screen.
2. Create a linked list of integers entered by user. Sort the list and print the same. Take user input initially for the total number of nodes.