1. (30%) Assume you have a system with a static priority CPU scheduler. Assume the scheduler supports preemption. Describe what the program below prints in sequence, where the priorities are set such that T2 has a high priority, T1 has the middle priority, and T0 has the low priority. Assume the system starts with only T0 executing. Assume the semaphore mutex is initialized to 1.

```
void T0 ( )   {              void T1 ( )   {              void T2 ( )   {
   printf ( "T0-Start \n" );    printf ( "T1-Start \n" );    printf ( "T2-Start \n");
   StartThread (T1);            P (mutex);                   P (mutex);
   printf ( "T0-End \n" );      printf ( "T1-A \n" );        printf ( "T2-A \n" );
}                               StartThread ( T2 );          V (mutex);
                                printf ( "T1-B \n" );        printf ( "T2-End \n" );
                                V (mutex);                }
                                printf ( "T1-End \n" );
                             }
```

2. (20%) Are the following statements true or false? For each statement, you will get 4 points for correct answer, zero point for blank, or -2 point for incorrect answer.
   (a) The system call pipe() provides reliable, bidirectional communication between processes on the same host.
   (b) If the valid-invalid bit for a page is set, it is required to write the memory page to the disk for page replacement.
   (c) Internet standards are developed by the Internet Engineering Task Force.
   (d) The goal of Web 3.0 is to enable a more decentralized internet.
   (e) The BGP protocol is an intra-AS routing protocol.

3. Consider the following figure that illustrates the layout of a process' virtual address space.

(a) (10%) The process is executing a recursive function that continuously adds a new data node to a long linked list. Explain how the memory is updated/changed during the time that the process is executing the recursion.

(b) (10%) Then, the process creates three threads to perform parallel computing. Explain how the memory layout will become after the three threads have been created.

(c) (10%) What will happen to the memory layout after the process finishes a fork( ) function call?

(d) (10%) Some systems, such as Java, support automatic garbage collection. Please explain:
● What memory region(s) will be affected by the garbage collection mechanism?
● How the garbage collection mechanism works?

4. (10%) Consider the C-SCAN algorithm for disk drive head scheduling. The request queue of the disk contains the following requests for moving the disk head to several positions:

98, 188, 37, 128, 17, 137, 97, 47

The disk head starts at position 40 and the address space is 0-199. List the movement sequence of the disk head if C-SCAN is used.