Catholic University Institute of Buea (CUIB)
2020/2021 ACADEMIC YEAR
First Semester Examinations – February/March 2021

EoC

School	INFORMATION TECHNOLOGY				
Course Code	SIT 333	Course Title	Systems Programming		
Status	C	Credit Value	6	Dept	Software Engineering
Date	24/02/2021	Venue	LH 2/ LH 5/6	Time	1:30PM – 3:30PM
Course Instructor(s)	Mr. Achankeng Peter				

Instructions: ***Answer All Questions in Section A, and C and Any Three (3) in Section B.***

SECTION A: (20 Marks)

(Answer ALL Questions in this section)

1) State and explain any three aspects of computing involved in Systems Programming. **(3 marks)**

2) Following technology trends, state and explain any two reasons why Linux system programming is more relevant than Windows system programming. **(2 marks)**

3) Define the following terminologies:
   a) Kernel b) Shell c) Interrupt d) Multi-threading e) Socket (1 x 5 = **5 marks)**
4) Assume that the terminal on a Linux PC starts with the prompt: **abcd@mylinux-box:/$**. Explain all the components of the prompt above. **(2 marks)**
5) Propose the GNU Linux command(s) you will use to achieve the following on a terminal.
   a) Create a directory **exam** and give it a read and write permission for the owner only. **(1 mark)**
   b) Enter into the **exam** directory, and create a hidden file with any name that you choose. **(1 mark)**
   c) Change current terminal user session to **newuser.** **(1 mark)**
   d) List all files in the directory **etc/bin** and append the results to a file called **binaries.txt (1 mark)**

6) Automated Teller Machines (ATM) have become very common in most of our banks today. They help to dispense cash to authenticated clients. Categorize, list and explain all the major system components of a standard ATM machine, and indicate how systems programming comes into play here. **(4 marks)**

SECTION B: (Answer ANY three (3) Questions in this Section)

7) ABC Consulting firm is a startup IT company which wants to start developing computer firewall software to prevent attack on a PC. Study carefully, the C codes in Figure 1 below.

```
1   #include <ncurses.h>
2   int main(){
3       int ch;
4       initscr();
5       cbreak();
6       noecho();
7       keypad(stdscr, TRUE);
8       ch = getch();
9       endwin();
10      printf("The key pressed is %d\n", ch);
11  }
```

Figure 1: Screenshot for a C program in an IDE editor

Modify the program above, so that we have an infinitely running program method called **Firewall()**, which is called every 10s, and should only stop when the **F2** function key is pressed. You must comment all functions used. Assume that the Firewall() function is predefined in a c file called firewall.c.

(5 marks)

8) The syscall() function can be exploited heavily in a C program to execute some shell commands and other non-standard commands. Assume that the parameters for the calls to initialize, capture, and close a thumbprint scanner are respectively as follows:

```
syscall(SYS_thumbprint, _INIT);
syscall(SYS_thumbprint, _CAPTURE, "<filepath>", "<photoname>");
syscall(SYS_thumbprint, _TERMINATE);
```

where the C library file **thumbprint.c** has the implementation of these calls, and these calls return 1 if successful, and -1 if an error is encountered.

Write a C program which prompts a user to swipe their finger on the thumbprint scanner, captures the finger's contours, and stores a vector image of it in the home directory of the PC with a given name. If the thumbprint scanner cannot be initialized or the fingerprint could not be captured for any reason, the program displays the system error message, and then terminate.

(5 marks)

9) Ntarikon Microfinance Inc. for the past 10 years creates just one type of account called "**Basic Account**" for all her customers, which contains an account number, account holder, telephone, currency, and balance in the account, and offers a simple interest free savings and withdrawal functionalities.

a) Using Object Oriented Programming (OOP) concepts, propose a JAVA or C++ class for this Basic Account. **(3 marks)**

b) If a new kind of account is introduced in this bank called "**Premium Account**", similar to the Basic account but with a flat interest of 6% for savings, and charge of 1% for withdrawals. Quickly exploit the paradigms of OOP to produce a new class for Premium Accounts. **(2 marks)**

10). A HTTP RESTful API is running on CUIB's webserver with the url http://api.cuib.com. This API provides a student's Fee Balance when provided with the student's Regnum, password, and academic year. This API captures data from the user using the GET method, and expects to receive values in the variables: **regnum**, **pwd** and **ayear**.

a. What is a RESTful API ? **(1 mark)**

b. Write a C program which uses this API (assume it is already implemented) to request for the fee balance of a student with regnum: 17SI-003544, password: 12345A@ and academic year: 2020. **(3 marks)**

c. Which two output formats are commonly used for such types of API responses. **(1 mark)**

SECTION C: (*Answer all questions in this section. All codes are in Java*)

11. Threads play a vital role in system programs especially in multiprogramming environments where **concurrency** is possible or **parallelism** may be explored.

a) What is a thread, and how is it different from a process? **(2 marks)**

b) Distinguish between the words: concurrency and parallelism? **(2 marks)**

c) A certain encryption algorithm to be developed with Java requires that we use the factorial of numbers from 1 to 20 to generate a random key. Assuming that we can generate a maximum of 4 threads in our Java program, propose a Java class file called **MyRandomKey,** which will call a factorial method (to be implemented by you), and in the main class (called **MyRandomKeyThread**), which rapidly generates a random key, by using 4 instances of the MyRandomKey algorithm, and then concatenates the results to produce a random encryption key. **(5 marks)**

d. Explain any issue that may occur in general, when running multiple threads, like in the Java class in c) above. **(1 mark)**

12. Study carefully the two JAVA files in Figure 2a and Figure 2b.

```
1  import java.io.*;
2  import java.net.*;
3
4  public class MyClient {
5  public static void main(String[] args) {
6  try{
7  Socket s=new Socket("localhost",6666);
8
9  DataOutputStream dout=new DataOutputStream(s.getOutputStream());
10
11 dout.writeUTF("Hello Server");
12 dout.flush();
13
14 dout.close();
15 s.close();
16
17 }catch(Exception e){System.out.println(e);}
18 }
19 }
20
```

Figure 2a: A Java File for a program

```
21  import java.io.*;
22  import java.net.*;
23
24  public class MyServer {
25  public static void main(String[] args){
26  try{
27  ServerSocket ss=new ServerSocket(6666);
28  Socket s=ss.accept();//establishes connection
29
30  DataInputStream dis=new DataInputStream(s.getInputStream());
31
32  String  str=(String)dis.readUTF();
33  System.out.println("message= "+str);
34
35  ss.close();
36
37  }catch(Exception e){System.out.println(e);}
38  }
39  }
```

Figure 2b: Another Java File for an application

i. What is the use of Lines 7, 11, 27 ? **(3 mark)**
ii. Which layer of the OSI Reference Model is this program operating at? **(1 mark)**
iii. What really are the codes in Figure 2a and b trying to achieve? **(1 mark)**