



Sri Lanka Institute of Information Technology

B.Sc. Honors Degree in Information Technology

Specialized in Cyber Security

Final Examination

Year 2, Semester 1 (2022)

IE2032 – Secure Operating Systems

Duration: 2 Hours

June 2022

Instructions to Candidates:

- ◆ This paper has 4 questions.
- ◆ Answer all questions in the booklet given.
- ◆ The total mark for the paper is 100.
- ◆ This paper contains 6 pages, including the cover page.
- ◆ Electronic devices capable of storing and retrieving text, including and mobile phones are not allowed.
- ◆ Calculators are allowed.

**Question 1****(25 marks)**

1. You wish to implement the P() and V() semaphore operations using the atomic operations above. Clearly explain why the original synchronization functions (the non-combination functions) are not sufficient for implementing the semaphore operations. (5 marks)
2. We explore the so-called barbershop problem. A barbershop consists of a n waiting chairs and the barber chair. If there are no customers, the barber waits. If a customer enters, and all the waiting chairs are occupied, then the customer leaves the shop. If the barber is busy, but waiting chairs are available, then the customer sits in one of the free chairs. Here is the skeleton of the code, without synchronization. (20 marks)

```

extern int N;    /* initialized elsewhere to value > 0 */
int customers = 0;

void* customer() {

    if (customers > N) {

        return NULL;
    }

    customers += 1;

    getHairCut();

    customers -= 1;

    return NULL;
}

void* barber() {
    while(1) {

```

```
cutHair();
```

```
}  
}
```

- I. Indicate the initial values for the three semaphores. (5 marks)
- II. Complete the code above filling in as many copies of the following commands as you need, but no other code. (15 marks)
  - P(&mutex);
  - V(&mutex);
  - P(&customer);
  - V(&customer);
  - P(&barber);
  - V(&barber);

## **Question 2**

**(25 marks)**

1. What do we understand by a deadlock? (5 Marks)
2. Is it possible to implement a deadlock detection? (5 Marks)
3. For single unit resources, we can model resource allocation and requests as a directed graph connecting processes and resources. Given such a graph, what is involved in deadlock detection. (3 Marks)
4. I. Is the following system of four processes with 2 resources deadlocked? (6 Marks)

Current allocation matrix

P1	1	3
P2	4	1
P3	1	2
P4	2	0

1 2  
4 3  
1 7  
5 1

Current request matrix

P1	1	3
P2	4	3
P3	1	7
P4	5	1

Availability Vector

1	4
---	---

- II. If the availability vector is as below, is the system above still deadlocked? (6 Marks)

2	3
---	---

### Question 3

(25 marks)

1. I have just invented a new scheduling algorithm that I claim gives the highest priority to processes that have just entered the system but is fair to all processes. The algorithm works like this: There are two queues, one for new processes and one for old processes. When a process enters the system, it is put at the end of the new queue. After 2 milliseconds on the new queue, whether a process has been scheduled or not, it is moved to the end of the old queue. When it is time to schedule a process, the system schedules the process at the head of one of the queues, alternating between the two queues. Each process runs to completion before the next process is scheduled. Assume that processes enter the system at random times and that most processes take much longer than 2 milliseconds to execute.
  - i. Does this algorithm give the highest priority to new processes? Explain your answer. (5 Marks)
  - ii. Is this algorithm starvation free? Explain your answer. (3 Marks)

- iii. Discuss whether this algorithm is fair to all processes. By “fair” we mean every process has a wait time approximately equal to the average wait time, assuming all processes have close to the same execution time. (5 Marks)

2. Shown below is the workload for 5 jobs arriving at time zero in the order given below –

Job	Burst Time
1	10
2	29
3	3
4	7
45	12

- i. Now find out which algorithm among FCFS, SJF And Round Robin with quantum 10, would give the minimum average time. (12 Marks)

#### Question 4 (25 marks)

- What are the differences between paging and segmentation? (5 Marks)
- Consider a user program of logical address of size 6 pages and page size is 4 bytes. The physical address contains 300 frames. The user program consists of 22 instructions a, b, c, . . . u, v. Each instruction takes 1 byte. Assume at that time the free frames are 7, 26, 52, 20, 55, 6, 18, 21, 70, and 90. Find the following? (10 marks)
  - Draw the logical and physical maps and page tables?
  - Allocate each page in the corresponding frame?
  - Find the physical addresses for the instructions m, d, v, r?
  - Calculate the fragmentation if exist?
- How can systems that implement the principle of least privilege still have protection failures that lead to security violations? (5 Marks)

4. Brandy Is Using A Computer At A Hotel Business Center And She Is Concerned That The Operating System On The Device May Be Compromised. What Is the Best Way For Her To Use This Computer In A Secure Fashion? (5 Marks)

**End of the paper**