



Faculty of Engineering, Built Environment and Information Technology

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DEPARTMENT OF COMPUTER SCIENCE

COS 122 OPERATING SYSTEMS

Assignment 2

Due: 05 October 2023 @ 23:00

PLAGIARISM POLICY

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The Department of Computer Science considers plagiarism as a serious offence. Disciplinary action will be taken against students who commit plagiarism. Plagiarism includes copying someone else's work without consent, copying a friend's work (even with consent) and copying material (such as text or program code) from the Internet. Copying will not be tolerated in this course. For a formal definition of plagiarism, the student is referred to <http://www.ais.up.ac.za/plagiarism/index.htm> (from the main page of the University of Pretoria site, follow the *Library* quick link, and then click the *Plagiarism* link). If you have any form of question regarding this, please ask one of the lecturers, to avoid any misunderstanding. Also note that the OOP principle of code re-use does not mean that you should copy and adapt code to suit your solution.

Objectives

This assignment evaluates the understanding and application of various key concepts and functions found in computer and operating systems. It covers chapters 3,4 and 5 of the prescribed textbook. This assignment has 4 tasks for a total of 20 marks.

Upload Instructions

You need to provide written answers to the tasks in this assignment. You are then required to submit a document containing these answers in order for them to be marked. Show all the intermediate and calculation steps in your answers (excluding the multiple choice task). Some marks will be awarded for intermediate steps.

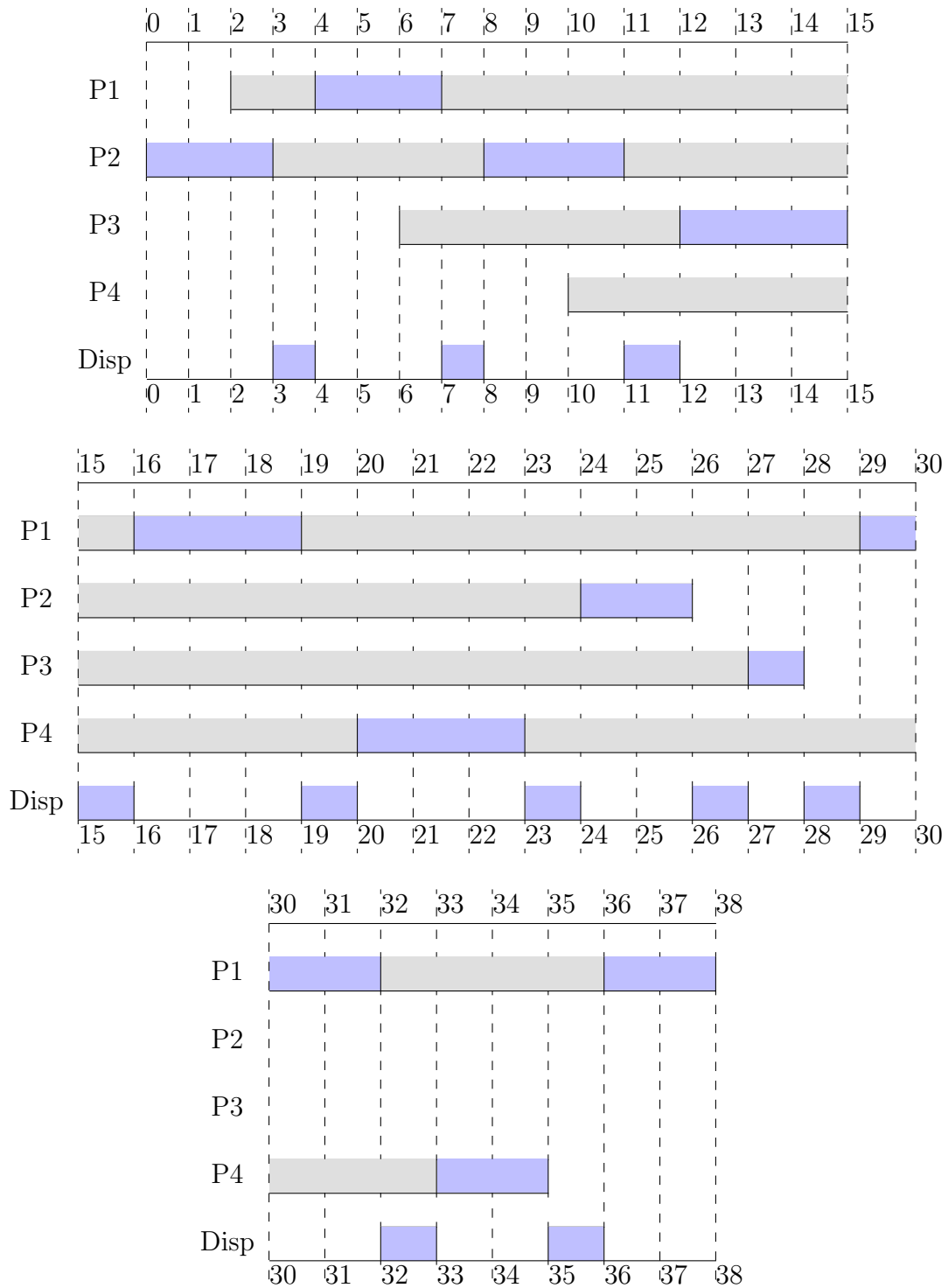
- Upload your document to the Assignment 2 assignment slot on COS 122 ClickUP before 23:00 on 05-Oct-2023. **No late submissions will be accepted!**
- All documents must be in either text, Word or PDF format (typed not handwritten) as **no other formats** will be marked.
- **Failure to upload your answers will result in 0 marks being awarded for your assignment!**

Task 1 (5 marks)

- 1.1 Which of the following is NOT a reason for process termination: (1)
- A. Arithmetic Error
 - B. Timing
 - C. Privileged Instruction
 - D. Parent Termination
- 1.2 Which portion of a process image contains executable code? (1)
- A. User Data
 - B. User Program
 - C. Stack
 - D. Process Control Block
- 1.3 What are the units of resource allocation and management referred to? (1)
- A. Processes
 - B. User-level Threads
 - C. Kernel-level Threads
 - D. Programs
- 1.4 Which situation occurs when multiple threads or processes read and write a shared data item, and the final result depends on the relative timing of their execution? (1)
- A. Race Condition
 - B. Critical Section
 - C. Atomic Operation
 - D. Mutual Exclusion
- 1.5 Which locking mechanism has threads executing in an infinite loop waiting for lock release? (1)
- A. Semaphore
 - B. Spinlock
 - C. Condition Variable
 - D. Readers/Writer Lock

Task 2 (8 marks)

A system adopts a round-robin scheduling approach, where every process gets the same amount of execution time. In a recorded timespan, the system has four processes P1, P2, P3 and P4, none of which perform any I/O. They are shown in the following sequence diagram:



Running **Ready**

- 2.1 What is the dispatch time for the given system? (1)
- 2.2 What execution timeslice is given to each process? (1)
- 2.3 What is the average time spent waiting by a process? Show all calculations. (2)
- 2.4 Explain how the execution would change for process P3 if it instead did have an I/O operation. (1)

2.5 Find the turnaround time for each process. Show all steps. (2)

2.6 Find the total execution time for each process. (1)

Task 3 (3 marks)

You are replacing your current gaming PC which has an Intel Core i7 Extreme with 4 processor cores with a new PC that contains an AMD Ryzen Threadripper with 12 processor cores. Your favourite game has 40% of code that is inherently serial. Theoretically, what will be the **change** in speedup if you only consider the change from four processor cores to twelve processors cores (ignore any speedup obtained due to the newer CPU architecture etc.)? Show all calculations and intermediate steps. Round all your results to three decimal places.

Task 4 (4 marks)

Consider the following implementation of the producer/consumer problem using counting semaphores:

```
/* program producer/consumer */
semaphore items = 0, free = 1;
void producer()
{
    while (true) {
        produce();
        semWait(free);
        append();
        semSignal(items);
        semSignal(free);
    }
}
void consumer()
{
    while (true) {
        semWait(free);
        semWait(items);
        take();
        semSignal(free);
        consume();
    }
}
void main()
{
    parbegin (producer, consumer);
}
```

4.1 What problem can occur with this implementation? (1)

4.2 Give an execution sequence that shows the problem and provide an explanation. (2)

4.3 What would you change in the code to fix the identified problem? (1)