4.8: Provide two programming examples in which multithreading does not provide better performance than a single-threaded solution.

1. simple program: If the workload to be performed by the individual threads is small, the overhead of context-switching can outweigh any performance benefits of a multi-threaded solution.
2. sequencial data dependency: If the multiple threads are sequentially dependent on each other, there will be no performance benefit to multi-threading.

4.10: Which of the following components of program state are shared across threads in a multithreaded process?

(a) Register values

(b) Heap memory

(c) Global variables

(d) Stack memory

(b), (c)

4.16: A system with two dual-core processors has four processors available for scheduling

- A CPU-intensive application is running on this system
- All input is performed at program start-up, when a single file must be opened
- Similarly, all output is performed just before the program terminates, when the program results must be written to a single file
- Between start-up and termination, the program is entirely CPU-bound
- Your task is to improve the performance of this application by multithreading it
- The application runs on a system that uses the one-to-one threading model (each user thread maps to a kernel thread)

How many threads will you create to perform the input and output? Explain

One. The file should be accessed sequentially or it may caused race condition.

How many threads will you create for the CPU-intensive portion of the application? Explain.

Four. Since the thread is one-to-one mapping, four processors indicates that there are at most four threads can run parallelism.

5.14: Most scheduling algorithms maintain a run queue, which lists processes eligible to run on a processor. On multicore systems, there are two general options:

(1) each processing core has its own run queue, or

(2) a single run queue is shared by all processing cores.

What are the advantages and disadvantages of each of these approaches?

(1)
advantages: no race condition will happen on a single run queue
disadvantages: hard to schedule all processes to different queue

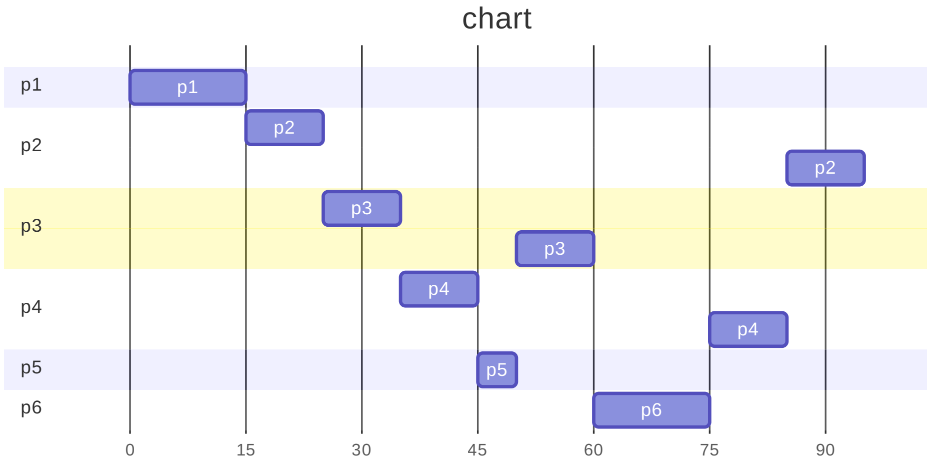
(2)
advantages: easy to manage processes
disadvantages: there might be race condition since multiple threads have to access the same queue

5.18: The following processes are being scheduled using a preemptive, priority-based, round-robin scheduling algorithm.

- Each process is assigned a numerical priority, with a higher number indicating a higher relative priority.
- For processes with the same priority, a round-robin scheduler will be used with a time quantum of 10 units.
- If a process is preempted by a higher-priority process, the preempted process is placed at the end of the queue

Thread	Priority	Burst	Arrival
P1	8	15	0
P2	3	20	0
P3	4	20	20
P4	4	20	25
P5	5	5	45
P6	10	15	55

(a) Show the scheduling order of the processes using a Gantt chart.



(b) What is the turnaround time for each process?

p1 = 15
p2 = 70
p3 = 35
p4 = 50
p5 = 5
p6 = 15

(c) What is the waiting time for each process?

p1 = 0
p2 = 50
p3 = 15
p4 = 30
p5 = 0
p6 = 0

5.22: Consider a system running ten I/O-bound tasks and one CPU-bound task. Assume that the I/O-bound tasks issue an I/O operation once for every millisecond of CPU computing and that each I/O operation takes 10 milliseconds to complete. Also assume that the context-switching overhead is 0.1 millisecond and that all processes are long-running tasks. Describe the CPU utilization for a round-robin scheduler when:

(a) The time quantum is 1 millisecond

11 / (11 + 1.1) = 91%

(b) The time quantum is 10 millisecond

20 / (20 + 1.1) = 94%

5.25: Explain the differences in how much the following scheduling algorithms discriminate in favor of short processes:

(a) FCFS

If a short process arrive after of a long process, it have to wait for a long time until the long process is done.

(b) RR

Round-Robin treats all process equally, no process will wait longer than (n-1)*(time quantum) of time.
But if the time quantum is very long, it will cause the same result as FCFS.

(c) Multilevel feedback queues

Multilevel feedback queue scheduling is more adaptive and dynamic compared to FCFS and RR, since each queue have different strategy.

6.7: The pseudocode of Figure 6.15 illustrates the basic push() and pop() operations of an array-based stack. Assuming that this algorithm could be used in a concurrent environment, answer the following questions:

```
push(item) {
   if (top < SIZE) {
      stack[top] = item;
      top++;
   }
   else
      ERROR
}

pop() {
   if (!is_empty()) {
      top--;
      return stack[top];
   }
   else
      ERROR
}

is_empty() {
   if (top == 0)
      return true;
   else
      return false;
}
```

(a) What data have a race condition?

top

(b) How could the race condition be fixed?

Let `pop` and `push` function be critical section, only one process can access the function.

6.15: Explain why implementing synchronization primitives by disabling interrupts is not appropriate in a single-processor system if the synchronization primitives are to be used in user-level programs.

For security consideration, it is very dangerous if user-level program can disable interrupt, since the process might be last very long.

6.18: The implementation of mutex locks provided in Section 6.5 suffers from busy waiting. Describe what changes would be necessary so that a process waiting to acquire a mutex lock would be blocked and placed into a waiting queue until the lock became available

1. Modify Mutex Structure
    - Including waiting queue in mutex structure
2. Implement Blocking
    - When a process attempt to acquire a lock, the process will be placed into a waiting queue.
3. Release Lock
    - When a lock is released, dequeue the process