

i Information

Written Exam in IN3030/IN4330

2023 Spring Semester

Duration: 4 hours

Date: May 31st, 2023

General information:

- IN4330 students are given the same questions as IN3030 students but are expected to give better and more in-depth answers.
- Your answer should reflect your own independent work and should be a result of your own learning and work effort.
- Concerning Answers that involve Java Programming: the prime concern is what the program does; it is a secondary concern that the program is entirely syntactically correct, so good pseudo-code where boring or less relevant Java details are missing is acceptable: Spend your time on getting the algorithms right rather than the syntax.

Support material:

All written materials.

The answer must be written with an academic standard.

You can answer in English, Norwegian (bokmål or nynorsk), Danish or Swedish. Or a mixture of these languages.

1 Selection Sort

Selection sort

Given the selection sort algorithm below, describe how you would parallelize it.

```
void sort(int arr[])
{
    int n = arr.length;

    // One by one move boundary of unsorted subarray
    for (int i = 0; i < n-1; i++)
    {
        // Find the minimum element in unsorted array
        int min_idx = i;
        for (int j = i+1; j < n; j++)
            if (arr[j] < arr[min_idx])
                min_idx = j;

        // Swap the found minimum element with the first
        // element
        int temp = arr[min_idx];
        arr[min_idx] = arr[i];
        arr[i] = temp;
    }
}
```

Write your suggestion here:

Maximum marks: 20

2 Implementation of parallel Selection Sort

Implement your suggested parallel version of Selection Sort.

Write the code for your parallel version of selection sort

1

Maximum marks: 16

3 Speed of Light in Vacuum

What is the speed of light in vacuum? Choose the most precise answer to get two points (an approximate answer that is within 1 percent of the correct value will be given one point).

Choose ONE alternative:

- ☐ 300 000 m/s
- ☐ 299 792 458 m/s
- ☐ 299 458 792 m/s
- ☐ 299 458 792 km/s
- ☐ 300 000 000 km/s
- ☐ 300 000 km/s

Maximum marks: 2

4 Effects of the speed of light

The slow speed of light:

Select one alternative:

- ☐ Causes significant latency when transferring data from main memory
- ☐ The latency it causes can be overcome by using optical cable
- ☐ Is not important because the latency it causes over short distances (less than 10 meters) is insignificant.
- ☐ Causes overheating of optical cable

Maximum marks: 2

5 Latency hiding

The latency caused by the slow speed of light can be partially hidden from the programmer by

Select one alternative:

- ☐ Increasing the clock cycle of each core
- ☐ Replacing optical connections by copper based electric wires
- ☐ Using caching
- ☐ Placing memory on chips separate from the CPU chip

Maximum marks: 2

6 One meter - how long is it?

How long does it take light in vacuum to travel 1 meter? Choose the best answer.

Select one alternative:

- ☐ About 1 microsecond
- ☐ About 33 nanoseconds
- ☐ About 3 nanoseconds
- ☐ About 333 nanoseconds
- ☐ About 1 nanoseconds

Maximum marks: 2

7 WaitNext

WaitNext

This question is about a new synchronization mechanism that you are to implement.

Write a Java class, **WaitNextC**, that has a single method:

`waitnext()`

that does the following:

if no one is waiting, the calling thread waits.

if there already is one waiting, the calling thread unblocks the waiting thread and itself then waits.

Your solution MUST ONLY use semaphores for synchronization.

Write the class below:

Write your WaitNextC Java Class here:

1	
---	--

Maximum marks: 18

8 Test Program for WaitNextC

Write a Java test program that demonstrates the representative unit testing for the implemented your **WaitNextC**. Ensure that the output of the test explains the steps of the execution.

Explain the test that you chose and why it gives good test coverage.

Submit the program, its output and any comments that you might have.

Write your Java test program here:

1

Maximum marks: 12

9 Amdahl's Law

If a program has an initial sequential part taking 25% of the execution time, what is the maximum achievable speedup according to Amdahl's Law?

Select one alternative:

☐ 2.5

☐ 3

☐ 2

☐ 3

Maximum marks: 3

10 Max Speedup

If all parts of a program are easily parallelizable, what is the maximum achievable speedup on an 8 core machine?

Select one alternative:

☐ 4

☐ 8

☐ 16

☐ 2

Maximum marks: 2

11 Caching Speedup

On a machine with a single level of cache where a cache line can be fetched in 4 machine cycles from the cache and in 32 machine cycles when fetched from the main memory, what is the maximum speedup that we can achieve by making a program extremely cache-friendly?

Select one alternative:

- ☐ 8
- ☐ 32
- ☐ 4
- ☐ 16

Maximum marks: 3

12 Cache-friendliness of Selection Sort

Consider Selection Sort (as shown below - same as in an earlier question). Comment on its cache-friendliness (sequential version only):

```
void sort(int arr[])
{
    int n = arr.length;

    // One by one move boundary of unsorted subarray
    for (int i = 0; i < n-1; i++)
    {
        // Find the minimum element in unsorted array
        int min_idx = i;
        for (int j = i+1; j < n; j++)
            if (arr[j] < arr[min_idx])
                min_idx = j;

        // Swap the found minimum element with the first
        // element
        int temp = arr[min_idx];
        arr[min_idx] = arr[i];
        arr[i] = temp;
    }
}
```

Fill in your comments here

Maximum marks: 16