

Walchand College of Engineering, Sangli
Department of Computer Science and Engineering
Class: Final Year (Computer Science and Engineering)
Year: 2022-23
Semester: 1
Course: High Performance Computing Lab

Practical No. 1

Exam Seat No.: 2019BTECS00037

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Title of practical: Introduction to OpenMP

Problem Statement 1: Difference between hardware threads vs software threads

- A hardware thread is a physical CPU or core. So, a 4-core CPU can genuinely support 4 hardware threads at once – the CPU is doing 4 things simultaneously.
 - One hardware thread can run many software threads. In modern operating systems, this is often done by time-slicing – each thread gets a few milliseconds to execute before the OS schedules another thread to run on that CPU. Since the OS switches back and forth between the threads quickly, it appears that one CPU is doing more than one thing at once, but in reality, a core is still running only one hardware thread, which switches between many software threads.
 - Software threads are threads of execution managed by the operating system.
 - Hardware threads can be thought of as CPU cores, although each core can run multiple threads. Most CPUs mention how many threads can be run on each core (on Linux, Lscpu command gives this detail). These are the number of cores that can be used in parallel.
 - Software threads are abstract to the hardware to make multi-processing possible. If you have multiple software threads but there are not multiple resources then these software threads are a way to run all tasks in parallel by allocating resources for a limited time(or using some other strategy) so that it appears that all threads are running in parallel. These are managed by the operating system. Java thread is an abstraction at the JVM level.
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Problem Statement 2: Program to print Hello world with an id of its thread.

```

F:\Academics\4th 7th\HPC practicals\Day 1\HelloWorld_Seq.exe
Hello World
CPU Time measured: 0.000000 seconds.
Wall Time measured: 0.000000 seconds.
=====
Hello(Hello(1) World(2Hello(Hello(1)
3) World(3)
) World(2)
0) World(0)
CPU Time measured: 0.000000 seconds.
Wall Time measured: 0.016000 seconds.
=====
Hello(3Hello(7) World(7)
Hello(6) World(6)
Hello(0) World(0)
Hello(8) World(8)
Hello(5) World(5)
Hello(2) World(2)
Hello(1) World(1)
Hello(4) World(4)
) World(3)
Hello(9) World(9)
CPU Time measured: 0.000000 seconds.
Wall Time measured: 0.015000 seconds.
=====

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Process exited after 0.1686 seconds with return value 0
Press any key to continue . . .

```

Attempt	Sequential Program		Default threads(4)		Custom number of Threads (50)		Custom number of Threads (100)	
	CPU time	Wall time	CPU time	Wall time	CPU time	Wall time	CPU time	Wall time
1	0	0	0	0	0.015625	0.063000	0	0.140000
2	0	0	0	0	0	0.047000	0.015625	0.141000
3	0	0	0	0	0	0.062000	0	0.110000

Problem Statement 3: Program to find squares of 1st 100 numbers followers by addition of all numbers.

Seq:

```
F:\Academics\4th 7th\HPC practicals\Day 1\square.exe
Number : 82 Square : 6724
Number : 83 Square : 6889
Number : 84 Square : 7056
Number : 85 Square : 7225
Number : 86 Square : 7396
Number : 87 Square : 7569
Number : 88 Square : 7744
Number : 89 Square : 7921
Number : 90 Square : 8100
Number : 91 Square : 8281
Number : 92 Square : 8464
Number : 93 Square : 8649
Number : 94 Square : 8836
Number : 95 Square : 9025
Number : 96 Square : 9216
Number : 97 Square : 9409
Number : 98 Square : 9604
Number : 99 Square : 9801
Number : 100 Square : 10000
sum of 1st 100 numbers 338350
CPU Time measured: 0.000000 seconds.
Wall Time measured: 0.125000 seconds.
=====
thread No. 0 Number : 0 Square : 0
thread No. 0 Number : 4 Square : 16
```

Parallel with n step

```
F:\Academics\4th 7th\HPC practicals\Day 1\square.exe
thread No. 3 Number : 99 Square : 9801
1 Number : 37 Square : 1369
thread No. 1 Number : 41 Square : 1681
thread No. 1 Number : 45 Square : 2025
thread No. 1 Number : 49 Square : 2401
thread No. 1 Number : 53 Square : 2809
thread No. 1 Number : 57 Square : 3249
thread No. 1 Number : 61 Square : 3721
thread No. 1 Number : 65 Square : 4225
thread No. 1 Number : 69 Square : 4761
thread No. 1 Number : 73 Square : 5329
thread No. 1 Number : 77 Square : 5929
thread No. 1 Number : 81 Square : 6561
thread No. 1 Number : 85 Square : 7225
thread No. 1 Number : 89 Square : 7921
thread No. 1 Number : 93 Square : 8649
thread No. 1 Number : 97 Square : 9409
sum of 1st 100 numbers 338350
CPU Time measured: 0.015625 seconds.
Wall Time measured: 0.156000 seconds.
=====
thread No. 1 Number : 26 Square : 676
thread No. 1 Number : 27 Square : 729
```

Parallel for clause

```

F:\Academics\4th 7th\HPC practicals\Day 1\square.exe
thread No. 3 Number : 93 Square : 8649
Number : 75 Square : 5625
thread No. 3
Number : thread No. 940 Square : Number : 883616 Square :
256thread No. 3
Number : thread No. 950 Square : Number : 902517 Square :
289thread No. 3
Number : thread No. 960 Square : Number : 921618 Square :
324
thread No. 0 Number : 19 Square : 361
thread No. thread No. 3 Number : 97 Square : 9409
thread No. 0 Number : 20 Square : 400
thread No. 0 Number : 21 Square : 441
thread No. 3 Number : 0 Number : 22 Square : 484
thread No. 0 Number : 23 Square : 529
thread No. 0 Number : 24 Square : 576
thread No. 0 Number : 25 Square : 625
98 Square : 9604
thread No. 3 Number : 99 Square : 9801
thread No. 3 Number : 100 Square : 10000
sum of 1st 100 numbers 338350
CPU Time measured: 0.046875 seconds.
Wall Time measured: 0.187000 seconds.
=====
-----
Process exited after 1.115 seconds with return value 0
Press any key to continue . . .

```

Attempt	Sequential Program		Parallel with n step		Parallel for	
	CPU time	Wall time	CPU time	Wall time	CPU time	Wall time
1	0	0.140000	0.015625	0.172000	0.046875	0.156000
2	0.015625	0.188000	0	0.141000	0.015625	0.140000

GitHub link: https://github.com/OnkarGavali/HPC_Lab/tree/main/Practical_No1