

High Performance Computing (3-0-0-6)

Theme: Mobile Cloud Computing/FoG Computing/Edge Computing

Instructor : A. Sahu **TAs :** Suvarthi Sarkar and Vasantha Reddy

Lecture time and Venue: Time slot B1 (Monday 3-4PM, Thursday/Friday 2.00-3.00PM), 5G4

Rules: Mid Sem Exam 35%, End Sem Exam 35%, four pre-declared quizzed with 25% weightage and 5% for class participation.

There will not be any programming assignments or programming projects. No coding and plug-play technology buzz word business in this course.

Lecture Notes:

1. Jan 06 : Introduction to HPC [No Slide](#)
2. Jan 09 : Introduction to HPC [Lec01.pdf](#)
3. Jan 12 : Multiprocessor/SoC [Lec02.pdf](#)
4. Jan 13 : Serial Code Optimization (SCO) [Lec03.pdf](#) [[Ref: [HagerBook.pdf](#), Chapter 2 and Chapter 3]]
5. Jan 16 : SCO and Scalar Profiling (gprof, gcov, valgrind, cloc_t) [Lec04.pdf](#) [GcovExample.tgz](#), and [GProfExamples.tgz](#), [CallGraphValgrind.tgz](#)
6. Jan 19 : SCO (C++, SIMD, Float, GCC Opt) [Lec05.pdf](#)
7. Jan 23 : C++Opt, Roof Line Model, Code Intensity/Balance [Lec06.pdf](#) [MicroStress.tgz](#)
8. Jan 27 : Quiz I [Q1 Model Solution PDF](#)
9. Jan 30 : Data Access Optimization [Lec07.pdf](#)
10. Feb 09 : Caching and APP Classification [Lec08.pdf](#) [MatrixMulJK-MissCall-Valgrind.tgz](#)
11. Feb 10 : PThread and OpenMP [Lec09.pdf](#) [PthreadExamples.tgz](#), [openmp-Ex.tgz](#), [thread-pool.cpp](#)
12. Feb 11-1 : (Makeup classes of 2nd and 6th Feb): MPI [Lec10.pdf](#) [MPI-Example.tgz](#)
13. Feb 11-2 : (Makeup classes of 2nd and 6th Feb): MPI [Lec10Cntd.pdf](#)
14. Feb 13 : Interconnection Network (static/dynamic, Diameter, Bisection) [Lec11.pdf](#)
15. Feb 16 : Amdahl's Law and Cilk [Lec12.pdf](#) [[Ref: **Chap 27 of CLR Algorithm Book CLR-3dEd-Chap27.pdf**]]
16. Feb 17 : Cilk and Work Stealing Scheduler: Span, Work, Parallelism, Speed Up [Lec13.pdf](#)
17. Feb 20 : Work Stealing (Optimality), Cilk Examples (VecAdd, MatMul, Tableau Const.): T_1, T_{inf}, S_p Analysis [Lec14.pdf](#)
18. Feb 22 : Quiz 2 [Quiz2ModelSolution](#)
19. Feb 23 : Classification of Task Scheduling Problems [Lec15.pdf](#) [[Ref: **Scheduling Algorithm By Brucker BruckerSchedulingAlgorithms_Full.pdf**]]
20. Feb 24 : Scheduling of Independent Tasks [Lec16.pdf](#)
21. Feb 27 : MidSemExam [QMS-ModelSolutionV2.pdf](#)
22. Mar 13 : Scheduling of Dependent Tasks [Lec17.pdf](#)
23. Mar 16 : Power/Energy Aware Scheduling : Top500 and Green500 [Lec18.pdf](#)
24. Mar 17 : Power/Energy Aware Scheduling, Real Time System : [Lec19.pdf](#)
25. Mar 20 : Introduction to Cloud System, Pro/Cons of Cloud from User Point of View [Lec20.pdf](#)
26. Mar 23 : Introduction to Cloud System [Lec21.pdf](#)
27. Mar 24 : Virtualization [Lec22.pdf](#)
28. Mar 27 : Virtualization, Cloud Economic Model: CAPEX and OPEX [Lec23.pdf](#)

29. Mar 27 : Data Center Energy Modeling [Lec24.pdf](#) [[Ref:[DC-EnergyModel-By-Dayaratna.pdf](#)]]
 30. Mar 31 : Quiz 3 [Quiz3ModelSolution](#)
 31. Apr 03 : Data Center Energy Modeling [Lec25.pdf](#)
 32. Apr 06 : Data Center Energy/Power Aware Scheduling [Lec26.pdf](#)
 33. Apr 10 : Green Cloud Framework, DPM, DVFS, VM Migration [Lec27.pdf](#)
 34. Apr 13 : Energy Aware Real time Task Scheduling in Virtualized Data Center [Lec28.pdf](#) [[[RollingsHorizon.pdf](#)]]
 35. Apr 17: Dynamic Resource Allocation Using VM Usage Predictions [Lec29.pdf](#) [[[Skewness.pdf](#)]]
 36. Apr 20 : Energy Aware VM Consolidation in Cloud using Prediction Model [Lec30.pdf](#) [[[EA-VMC-PM.pdf](#)]]
 37. Apr 21 : Scheduling Scientific Workflow in cloud under Budget Constraints [Lec31.pdf](#) [[[MED-CC.pdf](#)]]
 38. Apr 24 : Q4 Model Solution [Q4Sol.pdf](#)
 39. Apr 27 : Robust Scheduling of Workflows with Deadline and Budget Constraints, Intro to reliability [Lec32.pdf](#) [[[RobustSched.pdf](#)]]
 40. Apr 28 : Reliability Aware Scheduling, Intro to IoT and Edge Computing [Lec33.pdf](#) [[[MinRedun.pdf](#)]]
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Text/reference Book:

1. George Hager and Gerhard Wellein. *Introduction to High Performance Computing for Scientists and Engineers* CRC Press, India, 2010.
Very good HPC web link by George Hager [HPC course by Hager](#)
 2. [Online HPC Book](#)
 3. PAPER: A survey on Cloud Resource Scheduling [ACM Survey Cloud Scheduling](#)
 4. PAPER: Energy Efficiency Techniques in Cloud Computing A Survey and Taxonomy [PDF](#)
 5. PAPER: A Taxonomy and Survey of Energy-Efficient Data Centers and Cloud Computing Systems [PDF](#)
 6. PAPER: Cloud Computing Survey on Energy Efficiency [PDF](#)
 7. PAPERS: [Load balancing](#), power management, [Energy Aware Scheduling](#), [Energy Efficiency of Large System](#), [Data Center Energy Model](#)
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Other resources and materials:

- [Pthread](#) and [OpenMP](#)
 - Resources for Cilk: cilktool [cilk-5.4.6.tar.gz](#), How to Install Cilk [HowtoInstallCilk.txt](#) Test program and Makefile for cilk [cilkmatmultest](#) and Cilk Manual And Resources at [Cilk@MIT](#), PowerPoint: [lecture-1.ppt](#), [lecture-2.ppt](#), [lecture-3.ppt](#)
 - C++ thread References [C++ Multithreading](#)
 - Optimization of Computer Programs in C : [Optimizing C Code](#)
 - Optimization of C/C++ : [Optimizing C/C++ Code](#)
 - MPI installation in PC/Laptop:
Fedora (\$sudo dnf install openmpi openmpi-devel; \$module load mpi/openmpi-x86_64;)
Ubuntu (\$sudo apt-get install openmpi openmpi-dev; \$module load mpi/openmpi-x86_64;)
Ubuntu 18: sudo apt-get install openmpi-bin openmpi-common openssh-client openssh-server libopenmpi-dev
 - John L. Hennessy and David A. Patterson. *Computer Architecture: A Quantitative Approach (5th ed.)* Elsevier India Pvt. Ltd. 2011.
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