

## Knight Foundation School of Computing and Information Science

**Course Title:** Applied Parallel Computing

**Date:** 10/18/2019

**Course Number:** COT 4431

**Number of Credits:** 3

<b>Subject Area:</b> Computer Applications	<b>Subject Area Coordinator:</b> Gregory Reis <b>email:</b> <a href="mailto:gmuradre@fiu.edu">gmuradre@fiu.edu</a>
<b>Catalog Description:</b> This course teaches advance undergraduate and graduate students to solve problems from scientific, social and financial domains using parallel computing principles and techniques.	
<b>Textbook:</b> None. We will distribute reading materials throughout the semester.	
<b>References:</b> 1) Petascale Computing: Algorithms and Applications, Edited by David A. Bader, Chapman & Hall/CRC Computational Science Series, 2007 2) Big Data: Algorithms, Analytics, and Applications; ISBN 9781482240559 3) Multicore Computing: Algorithms, Architectures, and Applications (Chapman & Hall/CRC Computer and Information Science Series) 1st Edition 4) Techniques and Environments for Big Data Analysis: Parallel, Cloud, and Grid Computing (Studies in Big Data) 1st ed. 2016 Edition 5) Networking for Big Data (Chapman & Hall/CRC Big Data Series) Hardcover August 3, 2015	
<b>Prerequisite Courses:</b> ( <a href="#">COP 3530</a> and ( <a href="#">CDA 3102</a> or <a href="#">CDA 4101</a> or <a href="#">EEL 4709</a> ))	
<b>Corequisite Courses:</b> None	

**Type:** Elective (Systems group)

**Audience:** Both undergraduate and graduate student will be exposed to the course materials listed in the course outline. The graduate students will have additional work assigned to them such as reading additional materials, research papers and executing a small project in the context of the course.

**Prerequisite Topics:**

- Calculus, Basic Programming, and Data Structures

**Course Outcomes:**

Students who successfully complete this course will be able to:

1. Describe a selection of concepts, algorithms, and models used in parallel computing for solving complex real-world problems.
2. Identify a class of parallel computing techniques and algorithms that might be applied to a specific task for a given parallel architecture

Knight Foundation School of Computing and Information Sciences  
COT 4431  
Applied Parallel Computing

3. Explain the basic understanding of sources of parallelism and locality and how to identify enough parallelism and reduction in data movement costs for given parallel architectures
4. Identify, understand, and apply the concept of programming "patterns" and how to identify the "7 basic dwarfs" of high-performance computing and how these dwarfs can be parallelized for big data problems in manufacturing, medicine, scientific and financial domains
5. Identify and explain the metrics for measuring performance and be able to identify bottlenecks in parallel algorithms and architectures and be able to describe dynamic and static load balancing techniques for a given architecture.

**Outline:**

<b>Topic</b>	<b><i>Hours (Total: 37.5 hours = 15 weeks * 2 lectures/week * 1.25 hrs/lecture)</i></b>	<b><u>Outcome</u></b>
1. Introduction: Why Parallel Computing?	<b>1</b>	<b><u>1,2</u></b>
2. Single processor machines: Memory hierarchies and processor features	<b>1</b>	<b><u>1,2,3</u></b>
3. Introduction to parallel machines and programming models	<b>1</b>	<b><u>1,2,3</u></b>
4. Sources of parallelism and locality in simulation and Algorithms: part 1	<b>1</b>	<b><u>1,2,3,4</u></b>
5. Sources of parallelism and locality in simulation and Algorithms: part 2	<b>1</b>	<b><u>1,2,3,4</u></b>
6. Shared memory machines and programming: OpenMP and Threads	<b>1</b>	<b><u>1,2,3,4,5</u></b>
7. Distributed memory machines and programming in MPI	<b>2</b>	<b><u>1,2,3,4,5</u></b>
8. Partitioned Global Address Space Programming with Unified Parallel C UPC	<b>1</b>	<b><u>1,2,3,4,5</u></b>
9. GPUs, and programming with CUDA and OpenCL	<b>1</b>	<b><u>1,2,3,4,5</u></b>
10. Performance and Debugging Tools	<b>1</b>	<b><u>3,4,5</u></b>
11. Dense Linear Algebra Algorithms: Part 1	<b>1</b>	<b><u>1,2,3,4,5</u></b>
12. Dense Linear Algebra: Part 2	<b>1</b>	<b><u>1,2,3,4,5</u></b>
13. Graph Partitioning: Part 1	<b>1</b>	<b><u>1,4,5,</u></b>
14. Graph Partitioning: Part 2	<b>1</b>	<b><u>1,4,5</u></b>
15. Sparse-Matrix-Vector-Multiply: Part 1 and 2	<b>2</b>	<b><u>1,3,4,5</u></b>
16. Particle (N-Body) methods: Efficient Data Race Detection for Distributed Memory Parallel Programs	<b>1</b>	<b><u>1,2,3,4,5</u></b>

Knight Foundation School of Computing and Information Sciences  
COT 4431  
Applied Parallel Computing

17. Structured grids and multigrid	1	<u>4,5</u>
18. Cloud computing paradigms with MapReduce and Hadoop	1	<u>3,4,5</u>
19. Patterns of Parallel Programming	2	<u>4,5</u>
20. Structured grids	1	<u>4,5</u>
21. Exascale Computing	1	<u>1,2,3,4,5</u>
22. Parallel Graph Algorithms	1	<u>1,2,3,4,5</u>
23. Parallel Climate Modeling	1	<u>1,2,3,4,5</u>
24. Parallel Fast Fourier Transform (FFT)	1	<u>1,2,3,4,5</u>
25. Static and Dynamic Load Balancing	1	<u>1,2,3,4,5</u>
26. Parallel Algorithms and Architectures for Machine-Learning and Deep-Learning Solutions	2	<u>1,2,3,4,5</u>

**Assessment Plan for the Course & how Data in the Course are used to assess Program Outcomes**

Student and Instructor Course Outcome Surveys are administered at the conclusion of each offering, and are evaluated as described in the School's Assessment Plan:  
<https://abet.cs.fiu.edu/csassessment/>