School of Computing and Information Sciences

Course Title: Introduction to Parallel Computing

Date: 9/26/2019

Course Number: COP-4520

Number of Credits: 3

Subject Area:	**Subject Area Coordinator:** **email:**
Catalog Description: This course introduces the field of parallel computing. The students will be taught how to design efficient parallel programs and how to use parallel computing techniques to solve scientific problems.	
Textbook: Parallel Programming in C with MPI and OpenMP Michael J. Quinn McGraw Hill, 2004. ISBN: 0-07-282256-2	
References: An Intro to Parallel Computing, Design and Analysis of Algorithms, 2/e Ananth Grama, Vipin Kumar, Anshul Gupta, and George Karypis Addison-Wesley, 2003. ISBN 0-201-64865-2	
Prerequisites Courses: COP-3530 and (CDA-3102 or CDA-4101 or EEL-4709)	

Type: CS Elective

Prerequisites Topics:

- Programming experience in C or C++
- Basic knowledge of undergraduate level algorithms, data structures, and computer organization

Course Outcomes:

1. Be familiar with parallel algorithm design.
2. Be familiar with parallel performance analysis.
3. Master the MPI programming paradigm.
4. Be familiar with POSIX multi-threaded programming.
5. Be familiar with OpenMP programming.
6. Be exposed to parallel applications.

School of Computing and Information Sciences

COP-4520

Introduction to Parallel Computing

Outline

Topic	Number of Lecture Hours	Outcome
• Introduction to parallel computing o Parallel computers o Parallel programming paradigms o Parallel applications	7	1,6
• Principles of parallel algorithm design o Task/channel model o Foster's design methodology	3	1,3
• Analytical modeling of parallel algorithms o Speedup and efficiency o Amdahl's Law o Gustafson-Barsis's Law o Karp-Flatt Metric o Isoefficiency metric	5	1,2
• Parallel programming o Basic communication operations o Message-Passing Interface (MPI) o Multi-threading o OpenMP	6	3,4,5
• Parallel computing applications o Floyd shortest-path algorithm o Dense matrix algorithms o System of linear equations o Documentation classification o Monte Carlo methods o Sorting o Finite difference methods o Fast Fourier Transformation	15	3,6

School of Computing and Information Sciences
COP-4520
Introduction to Parallel Computing

Course Outcomes Emphasized in Laboratory Projects / Assignments

	Outcome	Number of Weeks
1	Fundamentals of parallel computing Outcomes: 1	2
2	Collective operations in MPI Outcomes: 2,3,4	2
3	Parallel algorithm design and performance analysis Outcomes: 2,3	2
4	Implementation of Cannon's matrix multiplication algorithm in MPI Outcomes: 2,3,4	3
5	Parallel application: solving linear equations Outcomes: 2,6	2

Oral and Written Communication

No significant coverage

Social and Ethical Implications of Computing Topics

No significant coverage

Approximate number of credit hours devoted to fundamental CS topics

Topic	Core Hours	Advanced Hours
Algorithms:		**1.0**
Software Design:		**1.0**
Computer Organization and Architecture:		**0.25**
Data Structures:		**0.25**
Concepts of Programming Languages		**0.25**
Other CS Topics:		**0.25**

School of Computing and Information Sciences
COP-4520
Introduction to Parallel Computing

Theoretical Contents

Topic	Class time
Performance analysis of parallel algorithms	5

Problem Analysis Experiences

1.	Parallel computing applications and performance analysis of parallel solutions

Solution Design Experiences

1.	Parallel computing applications, including parallel shortest-path algorithm, sorting, matrix multiplication, linear equations, finite difference methods, FFT, etc.

The Coverage of Knowledge Units within Computer Science Body of Knowledge[1]

Knowledge Unit	Topic	Lecture Hours
AL8	Advanced algorithm analysis; parallel algorithm performance analysis, including speedup, efficiency, Amdahl's law, Gustafson-Basis' Law, Karp-Flatt, and Isoefficiency metrics	5
AL11	Parallel algorithm design; parallel programming paradigms	3
OS3	Concurrency; mutual exclusion, process synchronization, parallel programming	3
SE3	Software tools and environments; MPI, OpenMP, and POSIX threads	6
CN4	High-performance computing; parallel applications.	19

[1]See http://www.computer.org/education/cc2001/final/chapter05.htm for a description of Computer Science Knowledge units