UNIVERSITI TEKNOLOGI MARA

CSC773: PARALLEL COMPUTING

Course Name (English)	PARALLEL COMPUTING APPROVED
Course Code	CSC773
MQF Credit	3
Course Description	This course introduces the parallelism fundamentals and parallel algorithm design for improving computational performance. It emphasizes the decomposition and mapping techniques in constructing parallel algorithms. The parallel programming paradigms, namely, the shared address space and message passing are applied to implement parallel programs. Other topics include the analytical modeling and parallel algorithms.
Transferable Skills	parallel programming
Teaching Methodologies	Lectures, Lab Work, Discussion
CLO	CLO1 Apply the parallel programming models and algorithm design techniques in designing a parallel program. CLO2 Design a parallel program based on the existing parallel programming models and parallel algorithm design techniques. CLO3 Build a parallel program to solve a computational problem based on specific performance requirements.
Pre-Requisite Courses	No course recommendations

Topics
1. Parallel Computing Fundamentals 1.1) Motivating Parallelism 1.2) Scope of Parallel Computing 1.3) Parallel Computing Platforms 1.4) Setting up Parallel Computing Environment
2. Parallel Programming Models 2.1) Shared Address Space 2.2) Distributed memory 2.3) Data Parallelism 2.4) Hybrid 2.5) SPMD and MPMD
3. Parallel Algorithm Design 3.1) Methodical Design 3.2) Problem Understanding 3.3) Partitioning 3.4) Communication 3.5) Synchronization 3.6) Dependencies 3.7) Mapping
4. Shared Address Space Programming Paradigm 4.1) Thread Lifecycle 4.2) Low-level APIs 4.3) Synchronization Construct 4.4) Liveness problems 4.5) High-level APIs

5. Message Passing Programming Paradigm 5.1) MPI: Message Passing Interface 5.2) Basic Operations 5.3) Communication Protocols 5.4) Point-to-point communication using API 5.5) Collective communication using API
6. Performance Analysis 6.1) Source of Overhead 6.2) Performance Metrics 6.3) Scalability 6.4) Analysis Techniques
7. Emerging Topics 7.1) N/A

Assessment Breakdown	%
Continuous Assessment	100.00%

Details of Continuous Assessment

Assessment Type	Assessment Description	% of Total Mark	CLO
Assignment	Assignment 2	10%	CLO2
Assignment	Assignment 3	10%	CLO2
Assignment	Assignment 4	10%	CLO3
Assignment	Assignment 5	10%	CLO3
Assignment	Assignment 1	10%	CLO1
Group Project	n/a	30%	CLO3
Test	n/a	20%	CLO1

Reading List

Reference Book Resources

- **Jin, H., Jespersen, D., Mehrotra, P., Huang, L., & Chapman, B. 2011, *High performance computing using MPI and OpenMP on multi-core parallel systems***
- **Norman Matloff 2012, *Parallel Computing for Data Science: With Examples in R, C++ and CUDA***
- **Peter S. Pacheco 2011, *An Introduction to Parallel Programming*, Morgan Kaufmann Pub**
- **Baños, R., Ortega, J., Gil, C., de Toro, F., & Montoya, M. G. 2016, *Analysis of OpenMP and MPI implementations of meta-heuristics for vehicle routing problems***
- **Khaitan S. K., McCalley, J. D 2014, *SCALE: A hybrid MPI and multithreading based work stealing approach for massive contingency analysis in power systems***
- **Tomar, A., Bodhankar, J., Kurariya, P., Anarase, P., Jain, P., Lele, A., Bhavsar, V. C. 2013, *Parallel implementation of machine translation using MPJ Express***
- **Amer, A., Lu, H., Balaji, P., & Matsuoka, S. 2015, *Characterizing MPI and Hybrid MPI+Threads Applications at Scale: Case Study with BFS***
- **Sabri Pllana and Fatos Xhafa 2017, *Programming Multicore and Many-core Computing Systems*, 1 Ed., Wiley**

Article/Paper List	This Course does not have any article/paper resources
Other References	This Course does not have any other resources