MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	**Parallel Computing**			**Module Delivery**	
Module Type	**Elective**			☒ **Theory** ☐ **Lecture** ☒ **Lab** ☒ **Tutorial** ☐ **Practical** ☐ **Seminar**	
Module Code	**CET3107**				
ECTS Credits	**5**				
SWL (hr/sem)	**150**				
Module Level	3		**Semester of Delivery**	5	
Administering Department	CET		**College**	EETC	
Module Leader	Mahmoud Shuker Mahmoud		**e-mail**	Mahmoud.shukur@mtu.edu.iq	
Module Leader's Acad. Title	Lecturer		**Module Leader's Qualification**	Ph.D.	
Module Tutor	Asst. Prof. Dr. Dalal Abdulmohsin Hammood		**e-mail**	dalal.Hammood@mtu.edu.iq	
Peer Reviewer Name	Dr. Osama Abbas Hussein		**e-mail**	osama.abbas@mtu.edu.iq	
Scientific Committee Approval Date	13/06/2023		**Version Number**	1.0	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

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Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Aims أهداف المادة الدراسية	1. To understand the basic principles of parallel computing. 2. To demonstrate different types of parallel algorithms 3. To deal with the basic concept of parallel programming. 4. To evaluate the performance of the parallel programs. 5. To apply parallel programming for solving different problems.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	1. Understand the fundamental concepts of parallel computing and its importance in modern computing systems. 2. Demonstrate knowledge of different parallel computing architectures and their characteristics. 3. Develop an understanding of parallel algorithms for specific computational tasks, such as sorting or graph algorithms. 4. Demonstrate proficiency in using parallel computing libraries and tools, such as OpenMP or MPI. 5. Analyze and evaluate the performance of parallel algorithms and programs. 6. Design and implement parallel algorithms using parallel programming models and frameworks. 7. Identify and overcome common challenges in parallel computing, such as load balancing and synchronization. 8. Utilize parallel computing techniques to solve computationally intensive problems efficiently. 9. Apply parallelization strategies to different types of applications, such as numerical simulations or data processing tasks. 10. Optimize parallel programs through techniques like data partitioning and task scheduling. 11. Understand the impact of parallel computing on energy consumption and efficiency. 12. Explore advanced topics in parallel computing, such as parallel I/O or GPU programming.
Indicative Contents المحتويات الإرشادية	Indicative content includes the following. 1. Introduction to Parallel Computing [4] Motivation and importance of parallel computing, Taxonomy of parallel computing systems, Parallelism levels: task, data, and instruction-level parallelism 2. Parallel Architectures [6] Flynn's taxonomy: SISD, SIMD, MISD, MIMD; Shared-memory architectures: multiprocessors and multicores; Distributed-memory architectures: clusters and supercomputers; GPU architectures and programming models 3. Parallel Programming Models [12] Shared-memory programming: OpenMP, Pthreads; Message Passing Interface (MPI); GPU programming: CUDA, OpenCL; Programming shared-address space systems (OpenMP, Pthreads); Programming scalable systems (message passing: MPI, global address space languages)

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	4. Parallel Algorithms and Techniques [10] Parallelization techniques: task parallelism, data parallelism; decomposition techniques, mapping & scheduling computation, templates 5. Performance Analysis and Optimization [8] Metrics for performance evaluation: speedup, efficiency, scalability; Bottleneck identification and optimization strategies; Load balancing techniques; Memory hierarchy optimization: caching and data locality 6. Parallelization of Applications [12] Non-numerical algorithms (sorting, graphs); Numerical algorithms (dense matrix algorithms, sparse matrix algorithms) 8. Emerging Trends and Technologies [12] Cluster, Grid, and Cloud computing and parallelism; Parallel computing in edge and IoT devices; Quantum computing and its potential impact on parallelism

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	Type something like: The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials, and by considering types of simple experiments involving some sampling activities that are interesting to the students.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	74	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	5
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	76	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	5
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	150		

Module Evaluation تقييم المادة الدراسية					
		Time/Number	**Weight (Marks)**	**Week Due**	**Relevant Learning Outcome**
Formative assessment	**Quizzes**	2	10% (10)	5, 13	LO #1-4 and 5-10
	Assignments	2	10% (10)	6, 12	LO # 3-5 and 6-10
	Projects / Lab.	2	20% (20)	Continuous	All
Summative assessment	**Midterm Exam**	2 hr	10% (10)	7	LO # 1-7
	Final Exam	4hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus) المنهاج الاسبوعي النظري	
	Material Covered
Week 1	introduction of parallel computing
Week 2	Parallel Architectures
Week 3	Parallel Algorithms and Techniques
Week 4	Programming shared-address space systems
Week 5	Programming scalable systems
Week 6	Performance Analysis and Optimization
Week 7	Mid Term Exam
Week 8	Analytical modeling of program performance
Week 9	Collective communication
Week 10	Synchronization
Week 11	Non-numerical algorithms (sorting, graphs)
Week 12	Numerical algorithms (dense matrix algorithms, sparse matrix algorithms)
Week 13	Performance measurement and analysis of parallel programs
Week 14	GPU Programming
Week 15	Emerging Trends and Technologies
Week 16	**A preparatory week before the Final Exam**

هندسة تقنيات الحاسوب

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Lab 1: Introduction to Parallel Programming
Week 2	Lab 2: Implement Parallel Reduction using Min, Max, Sum, and Average operations.
Week 3	Lab 3: parallel algorithms for Vector Operations.
Week 4	Lab 4: parallel algorithms for Matrix Operations.
Week 5	Lab 5: Parallel Sorting Algorithms.
Week 6	Lab 6: Parallel Search Algorithm.
Week 7	Lab 7: Parallel Search Algorithm.

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	• An Introduction to Parallel Computing, Design and Analysis of Algorithms, 2/e. Ananth Grama, Vipin Kumar, Anshul Gupta, and George Karypis. Addison-Wesley, 2003. • Parallel Programming in C with MPI and OpenMP. Michael J. Quinn. McGraw Hill, 2004	Yes
Recommended Texts	• Using OpenMP: Portable Shared Memory Parallel Programming - Barbara Chapman, Gabriele Jost, Ruud van der Pas (2008) • Using MPI: Portable Parallel Programming with the Message-Passing Interface, 3rd Ed - William Gropp, Ewing Lusk, Anthony Skjellum (2014) • Programming Massively Parallel Processors: A Hands-on Approach, 3rd Ed. - David B. Kirk, Wen-mei W. Hwu (2016)	No
Websites	https://www.mcs.anl.gov/~itf/dbpp/	

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks (%)**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

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