1	**Course title**	Advanced Parallel Processing
2	**Course number**	0907734
3	**Credit hours (theory, practical)**	3, 0
	Contact hours (theory, practical)	3, 0
4	**Prerequisites/co-requisites**	Advanced Computer Architecture (0907731)
5	**Program title**	MSc in Computer Engineering and Networks
6	**Program code**	0907
7	**Awarding institution**	The University of Jordan
8	**School**	School of Engineering
9	**Department**	Computer Engineering Department
10	**Level of course**	Masters Level
11	**Year of study and semester (s)**	Second Year, First Semester
12	**Final Qualification**	Passing the exams and the research project
13	**Other department (s) involved in teaching the course**	None
14	**Language of Instruction**	English and Arabic
15	**Date of production/revision**	Sep 22, 2019

16. Course Coordinator:

Instructor: Prof. Gheith Abandah
Office: CPE 406
Office hours: Sun through Thu, 12:30 – 13:30
Phone: 535-5000 ext. 22991
Email: abandah@ju.edu.jo
Home page: http://www.abandah.com/gheith

17. Other instructors:

None

18. Course Description:

Architectures for explicit parallelism. Multithreaded processors, small- and large-scale multiprocessor systems. Shared-memory coherence and consistency. Graphics processing units. Effect of architecture on communication latency, bandwidth, and overhead. Latency tolerance techniques. Interconnection networks. The development of programs for parallel computers. Basic concepts such as speedup, load balancing, latency, system taxonomies. Design of algorithms for idealized models. Programming on parallel systems such as shared or distributed memory machines, networks. Grid Computing. Performance analysis. Case studies.

19. Course aims and outcomes:

A- Aims:

The objectives of this course are:
- Introduce students to the technological changes in designing and building parallel processors
- Learn how to write shared-memory parallel programs in OpenMP and analyze their performance
- Learn how to write distributed-memory parallel programs in MPI and analyze their performance
- Study some commonly-used parallel algorithms

B- Intended Learning Outcomes (ILOs): Upon successful completion of this course students will be able to

a. Understand the fundamental concepts in modern parallel processors   [1]
b. Write and execute parallel programs   [3]
c. Analyze performance of parallel programs   [2]
d. Learn commonly-used parallel algorithms   [1]

20. Topic Outline and Schedule:

Topic	Week	Instructor	Achieved ILOs	Evaluation Methods	Reference
Introduction	1	Abandah	a	Exams and Assignments	1/1 & 3
Theoretical Background	2	Abandah	a	Exams and Assignments	1/2 & 3
Modern Architectures	4	Abandah	a	Exams and Assignments	1/3 & 3
Shared-memory programming with Pthreads and OpenMP	6	Abandah	b, d	Exams and Assignments	2/4-5 & 3
Distributed-memory programming in MPI	9	Abandah	b, d	Exams and Assignments	2/3 & 3
Parallel programs development	12	Abandah	a, c, d	Exams and Assignments	2/6 & 3

21. Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:
- The student attends the class presentations and participates in the discussions.
- The student joins the Facebook group and participates in its discussions.
- The student studies references and research papers.
- The student carries out programming assignments in parallel processing.

22. Evaluation Methods and Course Requirements:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:
- Open-book exams
- Programming assignments

23. Course Policies:

A- Attendance policies:
- Attendance is required

B- Absences from exams and handing in assignments on time:
- A makeup exam can be arranged for students with acceptable absence causes.
- The programming assignments must be handed in in time.

C- Health and safety procedures:
- All health and safety procedure of the university and school should be followed.

D- Honesty policy regarding cheating, plagiarism, misbehavior:
- All submitted work must be yours
- Cheating will not be tolerated

E- Grading policy:
- Programming assignments   30%
- Midterm Exam   30%
- Final Exam   40%

F- Available university services that support achievement in the course:
- Join the Facebook group at https://www.facebook.com/groups/695454750958228/
- Check program announcements at the Facebook group: https://www.facebook.com/Master-in-Computer-Engineering-and-Networks-in-the-University-of-Jordan-257067841079897/

24. Required equipment: (Facilities, Tools, Labs, Training….)

A classroom with whiteboard and projection facilities, library, and computer laboratory.

25. References:

Required book (s), assigned reading and audio-visuals:
1. B. Schmidt, et al. Parallel Programming: Concepts and Practice. Morgan Kaufmann, 2017. Slides on https://parallelprogrammingbook.org/ , Google Books: https://books.google.jo/books?hl=en&lr=&id=-y9HDgAAQBAJ
2. P. Pacheco. An Introduction to Parallel Programming, Morgan Kaufmann, 2011.
3. Instructor's slides at http://www.abandah.com/gheith/?page_id=2222

Recommended books, materials, and media:
4. Hennessy and Patterson. Computer Architecture: A Quantitative Approach, 6th ed., Morgan Kaufmann, Elsevier Inc., 2017.
5. D. Kirk and W-M Hwu. Programming Massively Parallel Processors: A Hands-on Approach, 3rd ed., Morgan Kaufmann, 2016. Link: https://www.elsevier.com/books/programming-massively-parallel-processors/kirk/978-0-12-811986-0
6. A. Grama, A. Gupta, G. Karypis, V. Kumar. Introduction to Parallel Computing, 2nd edition, 2010. Link: https://www-users.cs.umn.edu/~karypis/parbook/
7. Michael J. Quinn. Parallel programming in C with MPI and OpenMP, 2003.
8. D. Culler and J.P. Singh with A. Gupta. Parallel Computer Architecture: A Hardware/Software Approach, Morgan Kaufmann, 1998.

26. Additional information:

Students are assumed to have a background in the following topics:
- Basic CPU architecture: datapath design and control, pipelining, superscalars, caches
- Basic data structures: stack, queues, graphs, trees
- Writing C and C++ programs

27. Important Dates:

Date	Event
Tue 24 Sep, 2019	First Lecture
Tue 12 Nov, 2019	Midterm Exam
Tue 26 Dec, 2019	Last Lecture
Jan 5 – 13, 2020	Final Exam Period

Name of Course Coordinator: **Prof. Gheith Abandah**   Signature: ----------------- Date: -----------

Head of curriculum committee/Department: ---------------------------- Signature: --------------------------

Head of Department: --- Signature: ----------------------

Head of curriculum committee/Faculty: --------------------------------------- Signature: -------------------

Dean: -- -Signature: --

<u>Learning Outcomes for the Master's program in Computer Engineering and Networks</u>

Upon completion of the Computer Engineering and Networks program, the student is expected to be able to:

1. Discuss and analyze the basic concepts, principles, techniques and theories in the fields of computer architecture, wired and wireless networks, and security of computer network systems.

2. Employ higher-order thinking skills, critical and creative thinking, and practice scientific thinking and logical analysis in investigating, diagnosing and addressing the issues and problems related to computer engineering and networks.

3. Perfectly use the methods and techniques related to the fields of computer engineering in the design, analysis and management of systems and resources.

4. Show an interest in independent self-learning and continuous professional development, demonstrate commitment to acquire and generate unique knowledge and skills, and propose new ideas and programs that contribute to the development of the science of computer engineering and networks.

5. Demonstrate the proficiency and practice precision in achievement, work effectively in a team environment, and prepare presentation on important and modern topics that will develop the techniques used in the fields of computer engineering and networks.

6. Fulfill his/her responsibilities, exercise his/her rights and duties within the value system of the society, and properly deal with the national institutions and the local community.

7. Efficiently employ the research methodologies and the tools emerging from them, the methods for data collection, analysis and interpretation in the preparation of his/her thesis, and the preparation of different types of research related to computer engineering and networks. Accordingly, he/she prepares qualitative reports in the light of its results.

8. Assess changes that have been occurred in the field of computer engineering and networks, analyze various factors that control it domestically, regionally and globally, investigate and diagnose the network of relations and international interactions that influence it, and provide scenarios for its possible future developments.

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