Course Syllabus

1	**Course title**	Advanced Computer Architecture
2	**Course number**	0907731
3	**Credit hours (theory, practical)**	3, 0
	Contact hours (theory, practical)	3, 0
4	**Prerequisites/co-requisites**	None
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)**	First 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**	Oct 7, 2021

16. Course Coordinator:

Instructor: Prof. Gheith Abandah
Office: CPE 406
Office hours: Sun through Wed, 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:

Review of computer design principles, processor design, RISC processors, pipelining, and memory hierarchy. Instruction level parallelism (ILP), dynamic scheduling, multiple issue, speculative execution, and branch prediction. Limits on ILP and software approaches to exploit more ILP. VLIW and EPIC approaches. Thread-level parallelism, multiprocessors, chip multiprocessors, and multi-threading. Cache coherence and memory consistency. Advanced memory hierarchy design, cache and memory optimizations, and memory technologies. Advanced topics in storage systems. Designing and evaluating I/O systems.

19. Course aims and outcomes:

A- Aims:

The purpose of this course is to introduce advanced computer architecture topics to the graduate student. It is designed to achieve the following objectives:

- Provide awareness about current trends in computer architecture research
- Introduce advanced processor design approaches
- Introduce advance memory hierarchy design approaches
- Introduce various techniques used to exploit parallelism in various levels

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

a.	Research current solutions for a problem in computer architecture and report and present the results of this research.	[4, 5, 8]
b.	Ability to evaluate performance of alternative processor, memory, and system designs.	[2]
c.	Demonstrate a sound, in-depth, and up-to-date technical knowledge of memory hierarchy designs	[1]
d.	Demonstrate a sound, in-depth, and up-to-date technical knowledge of processor designs	[1]
e.	Demonstrate a sound, in-depth, and up-to-date technical knowledge of computer system designs	[1]

20. Topic Outline and Schedule:

Topic	Week	Instructor	Achieved ILOs	Evaluation Methods	Reference
Fundamentals of Quantitative Design and Analysis	1	Abandah	b	Exams and Reports	1 & 2
Memory Hierarchy Design	2	Abandah	c	Exams and Reports	1 & 2
Instruction-Level Parallelism and Its Exploitation	5	Abandah	d	Exams and Reports	1 & 2
Data-Level Parallelism in Vector, SIMD, and GPU Architectures	8	Abandah	d	Exams and Reports	1 & 2
Multiprocessors Thread-Level Parallelism	10	Abandah	d	Exams and Reports	1 & 2
The Warehouse-Scale Computers	12	Abandah	e	Exams and Reports	1 & 2
Domain Specific Architectures	13	Abandah	e	Exams and Reports	1 & 2
Project Presentations	14	Students	e	Presentations	1-7

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 a research project in computer architecture that surveys original and recent research papers where the student studies basic ideas, state-of-the-art solutions, and expected future directions.
- The student develops a professional report for the research report.
- The student presents the research project in class.

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
- Report for the Research Project
- Presentation for the Research Project

23. Course Policies:

A- Attendance policies:

- Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard.

B- Absences from exams and handing in assignments on time:

- A makeup exam can be arranged for students with acceptable absence causes.
- The project report must be handed in in time.

C- Health and safety procedures:

- Covid-19 vaccination or valid PCR test is required to join the classes.
- All health and safety procedure of the university and school should be followed.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

- Open-book exams.
- All submitted work must be of the submitting student.
- Other text or code must be properly quoted with clear source specification.
- Cheating will not be tolerated.

E- Grading policy:

- Term Project's Report and Presentation 30%
- Midterm Exam 30%
- Final Exam 40%
- Total 100%

F- Available university services that support achievement in the course:

- Join Microsoft Teams team at this link
- Check program announcements at the Facebook group

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. Hennessy and Patterson. Computer Architecture: A Quantitative Approach, 6th ed., Morgan Kaufmann, Elsevier Inc., 2017.
2. Instructor's slides at http://www.abandah.com/gheith/?page_id=2756.

Recommended books, materials, and media:

3. Patterson and Hennessy. Computer Organization & Design: The Hardware/Software Interface, RISC-V ed., Morgan Kaufmann, Elsevier Inc., 2018.
4. J. P. Shen and M. H. Lipasti. Modern Processor Design: Fundamentals of Superscalar Processors, Mc Graw Hill, 2005.
5. D. Culler and J.P. Singh with A. Gupta. Parallel Computer Architecture: A Hardware/Software Approach, Morgan Kaufmann, 1998.
6. J. Hayes. Computer Architecture and Organization, 3rd ed., McGraw-Hill, 1998.
7. Readings in Computer Architecture, Mark Hill (Editor), Norman Jouppi (Editor), Gurindar Sohi (Editor), Morgan Kaufmann Publishing Co., Menlo Park, CA. 1999.

26. Additional information:

Students are assumed to have a background in the following topics:

- Digital Logic Design
- Computer Organization
- RISC Instruction Set Architectures, preferably RISC-V

27. Important Dates:

Date	Event
Mon 11 Oct, 2021	First Lecture
Mon 29 Nov, 2021	Midterm Exam
Mon 5 Dec, 2021	Term project proposal is due
Mon 10 Jan, 2022	Term project report is due and project presentations
Mon 10 Jan, 2022	Last Lecture
Jan 18 – 30, 2022	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: ----------

Learning Outcomes for the Master's program in Computer Engineering and Networks

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.