# COURSE OUTLINE

## (1) GENERAL

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACADEMIC UNIT</td>
<td>Department of Computer Engineering &amp; Informatics</td>
</tr>
<tr>
<td>LEVEL OF STUDIES</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>COURSE CODE</td>
<td>CEID_NY262</td>
</tr>
<tr>
<td>SEMESTER</td>
<td>4th</td>
</tr>
<tr>
<td>COURSE TITLE</td>
<td>Modern topics in Computer Architecture</td>
</tr>
</tbody>
</table>

### INDEPENDENT TEACHING ACTIVITIES

If credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits.

<table>
<thead>
<tr>
<th>Lectures and tutorials, Laboratory exercises</th>
<th>WEEKLY TEACHING HOURS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3(L)2(LE)</td>
<td>5</td>
</tr>
</tbody>
</table>

Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).

<table>
<thead>
<tr>
<th>COURSE TYPE</th>
<th>Specialized general knowledge</th>
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</table>

### PREREQUISITE COURSES:

- Introduction to Computers and Programming (NY131)
- Digital Design I (NY163)
- Digital Design II (NY164)
- Basic topics in Computer Architecture (NY261)

### LANGUAGE OF INSTRUCTION and EXAMINATIONS:

- Greek

### IS THE COURSE OFFERED TO ERASMUS STUDENTS

- No

### COURSE WEBSITE (URL)

- [https://eclass.upatras.gr/courses/CEID1014/](https://eclass.upatras.gr/courses/CEID1014/)
- [https://eclass.upatras.gr/courses/CEID1007/](https://eclass.upatras.gr/courses/CEID1007/)

## (2) LEARNING OUTCOMES

### Learning Outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area
- Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B
- Guidelines for writing Learning Outcomes

#### A. Lectures and Tutorials

Upon successful completion of the course, a student will:

1. be able to design a data path and its control unit for each one of the following cases:
   - each instruction is executed in one clock cycle
   - an instruction is executed in several clock cycles depending on its complexity
2. be able to estimate the performance of a pipeline processor considering its characteristics
3. be able to design a pipeline processor with specific given characteristics
4. understand the operation of the processor cache memory and make the correct decisions for its design
5. be able to consider the application and the organization of the processor cache memory, to organize the data in the memory in such a way that the execution time is reduced
6. be familiar with the meaning of the terms: true data dependencies, artificial data dependencies, register renaming, issue rate, in-order issue, out of order issue, sequential consistency, weak sequential consistency, strong sequential consistency, reorder buffer
7. be able to evaluate and compare superscalar processors based on their structure and their organization
8. know the advantages and disadvantages of superscalar processors compared to Very Long Instruction Word Processors
9. be familiar with multithreading at processor level, multiprocessors and multicore processors.

#### B. Laboratory Exercises

Upon successful completion of the course, a student will be able to:

1. understand the processor operation at microoperations level
2. write microprograms
(3) define an instruction set and support it by writing the necessary microprograms
(4) write programs using the instruction set that he has defined

**General Competences**

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

| Search for, analysis and synthesis of data and information, with the use of the necessary technology | Project planning and management |
| Adapting to new situations | Respect for difference and multiculturism |
| Decision-making | Respect for the natural environment |
| Working independently | Showing social, professional and ethical responsibility and sensitivity to gender issues |
| Team work | Criticism and self-criticism |
| Working in an international environment | Production of free, creative and inductive thinking |
| Working in an interdisciplinary environment | Others... |

Production of new research ideas

Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Production of new research ideas

(3) Syllabus

**A. Lectures and Tutorials**

- Data path and control unit design:
  - single-cycle implementation
  - multi-cycle implementation
- Pipelining
  - Organization
  - Performance
  - structural, data and procedural hazards
  - hazard solution techniques
    - NOP instructions
    - pipeline stages stall
    - bypassing
    - delayed branch instructions
    - branch prediction techniques
      - static prediction techniques
      - dynamic prediction techniques
  - Pipeline data path design
- Cache memory:
  - fetch policies
  - organization
  - replacing policies
  - update policies
- Virtual memory:
  - Implementation
    - paging (single level page table, multilevel page table, inverted page table)
    - segmentation
    - segmentation and paging
    - Translation Lookaside Buffer (TLB)
  - cache memory in the virtual and in the physical space
- Superscalar processors
  - true data dependencies
  - artificial data dependencies
  - register renaming
  - issue rate
    - in-order issue
    - out of order issue
  - sequential consistency
    - weak sequential consistency
    - strong sequential consistency
    - reorder buffer
- Very Long Instruction Word, VLIW, processors
- Multithreading at processor level
- Multi-core processors
**B. Laboratory**
The laboratory exercises are based on the use of a simulator of a microprogrammable computer, developed in our laboratory, running on a Windows environment. The students have the opportunity to design a machine language instruction set and then to write the necessary microprograms which implement the designed instruction set. After loading the microprograms into the control memory the students can write programs using the machine language, which they have designed and implemented, and run them in the microprogrammable computer.

### (4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<thead>
<tr>
<th>DELIVERY</th>
<th>Face-to-face, Distance learning, etc.</th>
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</thead>
<tbody>
<tr>
<td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td>
<td>Wide use of ICT. More specifically:</td>
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<tr>
<td></td>
<td>• The course is backed up by a web page for the lectures and the tutorials and a second e-class page providing all necessary documentation for the laboratory exercises.</td>
</tr>
<tr>
<td></td>
<td>• The preferred communication method with the students is email.</td>
</tr>
<tr>
<td>TEACHING METHODS</td>
<td>The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS.</td>
</tr>
<tr>
<td>Activity</td>
<td>Semester workload</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>Lectures</td>
<td>26 hours</td>
</tr>
<tr>
<td>Tutorials</td>
<td>13 hours</td>
</tr>
<tr>
<td>Laboratory exercises</td>
<td>26 hours</td>
</tr>
<tr>
<td>Laboratory exercises preparation</td>
<td>20 hours</td>
</tr>
<tr>
<td>Report preparation</td>
<td>10 hours</td>
</tr>
<tr>
<td>Study</td>
<td>50 hours</td>
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<tr>
<td>Theory exams</td>
<td>3 hours</td>
</tr>
<tr>
<td>Laboratory exams</td>
<td>1 hour</td>
</tr>
<tr>
<td><strong>Course total</strong></td>
<td><strong>149 hours</strong></td>
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</table>

### STUDENT PERFORMANCE EVALUATION

Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other

The evaluation is performed in Greek language and is based on two independent parts.

The theory evaluation is performed through a final written test that includes multiple choice questions, short-answer questions and problem solving. After the test marks are announced, the students have the opportunity to see their mistakes.

The evaluation for the laboratory part is based on:

• the correctness of the microprograms and programs developed by the students during their lab exercise

• the quality of documenting the programs that they try to develop via their reports and

• a final practical exam in which they are asked to develop in the lab a small microprogram and execute it.

### (5) ATTACHED BIBLIOGRAPHY

- **Suggested bibliography:**
  - Computer Architecture, Dimitrios Nikolos, 1st edition 2017, in Greek

- **Related academic journals:**
  - IEEE Micro
  - IEEE Transactions on Computers
  - IEEE Transactions on VLSI Systems
  - IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems