Program: ECE
Degree Level: Master

Faculty/College: TGGS

Course 090245351

Hardware and System Software Architectures

King Mongkut's University of Technology North Bangkok

The Sirindhorn International Thai-German Graduate School of Engineering

Electrical and Computer Engineering Program

Section 1: General Information

1. **Course code and course title**

   090245351 Hardware and System Software Architectures

2. **Total credits**

   3 credits ☐ (2-2-5) ☑ (3-0-6) ☐ (3-0-9) ☐ (2-3-7)

3. **Curriculum and course category**:

   Curriculum: *Master of Engineering in Electrical and Computer Engineering*

   Course category: Required Courses

   ☐ Core Course ☑ Specific Core Course

   ☐ Industrial Internship ☐ Master Thesis

   Elective Courses

   ☐ General Elective ☐ Specific Elective ☐ Other Elective

4. **Course coordinator/ Instructors**

   Course Coordinator: _____

   Instructor(s): Rachata Ausavarungnirun

5. **Semester/ year of study**

   ☑ Semester 1 (Aug. to Dec.) ☐ Semester 2 (Jan. to May) Academic Year: 2021

6. **Pre-requisite** (**if any**)

   ☑ No ☐ Yes, please provide: .....

7. **Co-requisites** (**if any**)

   ☑ No ☐ Yes, please provide: .....

8. **Venue of study**

   Lecture Day/Time: Monday at 13.00-16.00

   ☑ On-site: Lecture Room No.:……11……. Floor:…1102….

   ☑ TGGS, KMUTNB ☐ Faculty of Engineering, CU ☐ RWTH

   ☑ On-line*: Teaching Media: ☑ Microsoft Teams ☐ Google Meet

   ☐ Zoom ☐ Webex

   ☐ Other (specify) …… ……..…..

Remark: * *During COVID-19, the teaching can be on-site and/or on-line according to TGGS Policy*.

9. Information for quality assurance in education

This course shows evidence of:

- Integration of research or creative activities with instruction; use of research-based learning management; knowledge management practices for learning improvement
- Integration of academic services and course implementation

10. Date of latest revision:

July 2021

Section 2: Course Description and Implementation

1. Course Description (*As written in the Official Approved Curriculum*)

Translation from a high-level language to hardware operations, processor design, pipelining, out-of-order processing, branch prediction, caching, memory subsystem, concurrency, locality, virtual memory, software subsystems, system software, the design of software systems, programming paradigms, hardware-software co-optimizations.

2. Number of hours per semester

Lecture	Practice	Self-study
45 hours/ semester (*3 hours/week**)	*30 hours* (*2 hours/week**)	*75 hours/ semester* (*5 hours/week**)

Remark: * *Based on 15 weeks of lecture*

Course Category: ☑ Lecture ☐ Practice ☐ Laboratory

Course Evaluation: ☑ A-F ☐ S/U ☐ P

3. Number of hours per week for academic guidance to individual students

☐ 1. Giving academic advice (minimally number hour per week) during the office hour

☑ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ .....

The student can arrange the time via email for the meeting date/time.

☐ 2. Adopting information technology-based academic advising

☑ Email: rachata.a@tggs.kmutnb.ac.th

☐ Phone:

☐ Communication Apps: Line ID:

(Please notify the lecturer when adding the line.)

☑ Meeting Online: The platform will be informed to students upon the request.

☑ Other (specify) TGGS Discord Server .....

☐ 3. .....

4. Course Learning Outcomes (CLOs): Students should be able to:

CLO 1. To understand a fundamental concept of computer architecture

CLO 2. To demonstrate proficiency with designing microarchitectural components

CLO 3. To design simple microprocessors

CLO 4. To apply architectural techniques to solve problems in real-world context and communicate the result effectively

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5. The mapping between Expected Learning Outcomes (ELOs) from the curriculum and Course Learning Outcomes (CLOs)

Table 5.1 ELOs-CLOs Consistency *(for a subject-specific course/ a specific curriculum)*

ELOs/CLOs consistency	CLO 1	CLO 2	CLO 3	CLO 4
ELO1				
ELO2	✓			
ELO3		✓	✓	✓
ELO4				
ELO5		✓	✓	✓
ELO6				✓
ELO7				✓
ELO8				
ELO9				
ELO10				

Remark: All ELOs and ELOs for the course (highlighted row) are as written in the Official Approved Curriculum.

Table 5.2 Mapping desirable characteristics of KMUTNB graduates and CLOs *(for non-specific courses designed for various curriculums)*

Consistency between desirable characteristics of KMUTNB Graduates- CLOs	CLO 1	CLO 2	CLO 3	CLO 4
1. **Professional credentials with critical thinking skills**			✓	✓
2. **Integrity and social responsibility**				
3. **Innovative and technopreneur mindset**				✓
4. **Global Competence**			✓	

Section 3: Student Improvement in relation to Course Learning Outcomes (CLOs)

Organizing learning to develop skills/ knowledge; evaluation of CLOs in accordance with the ones identified in Section 2.4

Course Learning Outcomes (CLOs)	Teaching Methods compliant with CLOs	Evaluation Methods compliant with CLOs
CLO 1	• Lecture* • Individual assignment	• Assignment evaluation • Exam****
CLO 2	• Lecture* • Individual assignment	• Assignment evaluation • Exam****
CLO 3	• Lecture* • Individual assignment • Case studies	• Assignment evaluation • Exam****
CLO 4	• Lecture* • Individual assignment • Case studies • Group or individual project	• Assignment evaluation • Exam**** • Presentation

*Remark: * Lecture on the concept of the topic is introduced with basic or fundamental definitions, visualization and correlations. For the complicated equation, the derivation from the basic laws can be shown to students. So, the students do not memorize the equations but understand the basic concept and basic equation. The lecturer will introduce the advanced and new concepts, technologies, and findings to students from publications such as journals and websites and from the research and industrial experiences.*

*** Active learning by asking questions related to the topic in the lecture and encouraging the students to response to the questions. If the students cannot response with answers, then the lecturer will give some guidance until the students can response.*

**** Quiz in the closed-book format on the basic concepts and equations with simple problem solving to evaluate their learning. The solution will be given to students after grading, so they can identify their mistakes and weakness.*

***** Exam on the basic concepts and equations with simple problem solving in the closed-book format as a review, whereas the complicated/integrated problem solving will be worked in the open-book format.*

Section 4: Lesson Plan and Evaluation

1. **Lesson Plan**

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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
1	Introduction to Computer Architecture	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
2	Assembly, ISA and Single-cycle Architecture	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
3	Multi-cycle Architecture	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
4	Data Dependency, Pipelining and Superscalar Processors	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
5	Branch Prediction	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
6	Precise Exception and Out-of-order Execution	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
7	Issues with Out-of-order Execution	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
8	Midterm Exam		3.0	Paper-based examination	
9	Memory Hierarchy, Caching and Introduction to Virtual Memory	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata

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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
10	Virtual Memory, DRAM and Memory Scheduling	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
11	Project Checkout Meeting	CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
12	Emerging Memory Technology, Techniques to Tolerate Memory Latency and SIMD	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
13	- GPUs, Multiprocessors and Multithreading,	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A • Assignment	Rachata
14	- Memory Consistency and Coherency	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A	Rachata
15	Accelerator and Modern-day Architectural Techniques	CLO 1 CLO 2 CLO 3 CLO 4	3.0	• Lecture presentation slides • Q&A	
16	*Final Exam*		3.0	• Paper-based examination	
		Total	48.0		

2. **Evaluation Plan** (**in accordance with OBE** 2 **mapping framework**)

Course Learning Outcomes (CLOs)	Evaluation Methods	Week of Evaluation	Percentage of Evaluation
CLO 1, 2, 3, 4	Assignments	4, 7, 14	40%
CLO 1, 2, 3, 4	Exams	9, 16	20%
CLO 3, 4	Project	16	40%

Section 5 Teaching/Learning Resources

Textbooks and materials

[1] J. Hennessy and D. Patterson, "Computer Architecture: A Quantitative Approach,"Morgan Kaufmann, 5th edition, 2011.

Section 6 Course Evaluation and Improvement

1. **Course evaluation by students**

The students will have an opportunity to evaluate the effectiveness of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including the grading will be reviewed by the curriculum meeting to evaluate the course's effectiveness.

2. **Strategies for assessing learning management**

The students will have an opportunity to evaluate the teaching of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including the grading will be reviewed by the curriculum meeting to evaluate the teaching as well as returning to the lecturer for further improvement.

3. **Improvement schemes of course implementation**

The evaluation from the students including the grading will be submitted to the curriculum meeting for reviewing and brainstorming to improve teaching of each course. Comments and suggestions given by the curriculum meeting will be informed to the responsible lecturer of each course.

4. **Verification of students' learning outcomes, referred to OBE 2 and 3**

The grading of this course will be evaluated and reviewed by the Department meeting and the TGGS executive board meeting in order to verify its appropriateness before the final approval.

5. **Course review and improvement plans**

The results of the grading evaluation and student evaluation will be submitted to the curriculum meeting for reviewing and brainstorming to improve the effectiveness of the offered courses. Comments and suggestions will be informed to the responsible lecturer of each course.

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