



Artificial Intelligence and Computer Engineering Program

AI Engineering Institute, CMKL University

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WELCOME TO THE ARTIFICIAL INTELLIGENCE ENGINEERING INSTITUTE

The AI Engineering Institute (AIEI) is a collaboration among leading Thai universities to advance AI Engineering education and research in Thailand. AIEI was established to make it easier for participating universities to share curriculum and teaching resources among the members and to take advantage of the particular strengths of individual institute members.

AIEI is based on curriculum concepts and content originally developed for the Bachelors in Artificial Intelligence and Computer Engineering (AiCE) program at CMKL University. The AiCE program was designed to provide an individualized, self-paced learning experience for each student that considers his or her goals, passions, learning styles and prior experience. Both fundamental and advanced topics are integrated into a framework that emphasizes the active acquisition of skills required to function as an AI Engineer – a committed, quality focused professional who can apply AI and computer engineering to build practical systems and solve real world problems.

The AiCE program at CMKL builds upon the lessons learned from our graduate program experience while having the mission to pursue new frontiers in AI, computer engineering, and innovation. Our competency-based learning program provides a well-rounded foundation of knowledge that can be put to immediate use to help people and organizations solve their real-world problems. Moreover, through artificial intelligence, computer engineering and an entrepreneurial perspective, AiCE graduates can assist our society in tackling challenges that will propel the future development of Thailand and Southeast Asia.

Through the AI Engineering Institute, students at universities other than CMKL University will be able to participate in the same competency-based learning experiences. This can occur in two contexts. First, their home university may borrow and adapt curriculum material from the AiCE curriculum for use within their own programs. Second, a student may enroll as a virtual or exchange student at another university (the “host” university), participating in the learning activities offered at that university and receiving credits that can be transferred back to the home university.

As AIEI matures, we also expect that universities other than CMKL University will actively contribute curriculum modules and learning materials. Over time we will create a common digital repository providing benefits to all AIEI members, to help all member universities develop exceptional graduates who are prepared to tackle the technological, societal, and ethical challenges of the twenty-first century.

In this manual, you will find more information about the AIEI and its collaborating programs. If you have questions or concerns not covered in this manual, please do not hesitate to reach out to us. I am looking forward to seeing our graduates making positive impact in the field, enabling future possibilities for our economy and society.

Sincerely,



Akkarit Sangpetch, PhD
AiCE Program Director, CMKL University

BRIEF OVERVIEW OF PROGRAM

Thailand's first integrated degrees in artificial intelligence and computer engineering!

The AI Engineering Institute (AIEI) was established as a collaboration among leading Thai universities to advance AI Engineering education and research. Founding members of AIEI include CMKL University, King Mongkut's Institute of Technology Ladkrabang, Mahidol University, Khon Kaen University, Chiang Mai University and Prince of Songkla University.

AIEI brings together organizations with great depth and breadth of expertise in AI Engineering, allowing us to connect research communities, institutions, businesses, and wider society, in Thailand and around the world. The Institute aims to enrich the quality of teaching and learning in Competency-based AI Engineering curriculum, advance research, and support knowledge exchange.

The Artificial Intelligence and Computing Engineering (AiCE) program at CMKL university is considered to be a pilot program for AI Engineering curriculum and educational management that uses on competency-based approach. The AiCE competency-based curriculum is intended to move beyond the limits of traditional education to enable students to develop both practical and social skills. The program design also encourages students to collaborate with industry to build artificial intelligence and computer engineering solutions to support the country's development. The goal is to fully develop the potential of learners in order to effectively meet the needs of the industrial sector.

Our mission is to foster the development of talented engineers and researchers who are ready for the next wave of digital disruption. Throughout the AIEI, students will explore how to apply AI techniques to major aspects of computing, including human-centric design and visualization, scalable and distributed computing systems, privacy, and security. Students will learn through hands-on experience, working alongside engineers and designers to solve the real-world problems of our industrial partners.

AIEI Vision

To be a creative driving force in engineering and innovation of highest quality in the university and worldwide.

AIEI Mission

To inspire, educate, and foster the development of artificial intelligence and computer engineers capable of tackling fundamental engineering problems and important societal challenges, and to do so with the highest commitment to quality, integrity, and respect for others.

We aim to develop students' breadth of knowledge across the subject areas of AI and computer engineering, including their ability to apply engineering theory, abstraction, design, and implementation to solve problems and innovate through an interdisciplinary approach.

AIEI Program Educational Objectives

Our program educational objectives are as follows. The objectives represent our vision for what our graduates will be doing in their careers five years after graduation.

- **Engineering Experts:** Our graduates will be able to solve problems by applying engineering

fundamentals. Their solutions will reflect the depth and understanding of technology, drawing upon multiple disciplines and considerations for the problem.

- **Entrepreneurial Innovators:** Our graduates will demonstrate creativity in their engineering practice. They will be able to consider a system-oriented approach in their design. They will be able to strategically plan and execute successful engineering projects in their own businesses or organizations.
- **Ethical Leaders:** Our graduates will take initiative, demonstrating their resourcefulness and ability to collaborate in diverse and multidisciplinary teams. They will also be leaders in their organizations or professions while being aware of potential economic and societal impacts of their actions.

AIEI DEGREES OFFERED

Some universities in within the Institute will offer competency-based degrees using AIEI curriculum content. These degrees include:

CMKL University

Bachelor of Engineering in Artificial Intelligence and Computer Engineering (International Program)

King Mongkut's Institute of Technology Ladkrabang

Bachelor of Engineering in Computer Innovation Engineering (International Program)

Prince of Songkla University

Bachelor of Engineering in Artificial Intelligence and System Engineering

Master of Engineering in Artificial Intelligence and System Engineering

Khon Kaen University

Bachelor of Engineering in Artificial Intelligence and Computer Engineering

Other universities within the Institute will enhance existing degree programs by allowing students to use competency-based study from AIEI to satisfy existing program requirements. These degrees include:

CMKL University

Master of Science in Artificial Intelligence and Computer Engineering (International Program)

Master of Science in Artificial Intelligence Innovation (International Program)

Doctor of Philosophy in Artificial Intelligence and Computer Engineering (International Program)

Mahidol University

Bachelor of Science in Digital Science and Technology

Chiang Mai University

Bachelor of Science in Data Science

Master of Science in Data Science

Doctor of Philosophy in Data Science

Khon Kaen University

Bachelor of Engineering in Computer Engineering

Master of Engineering in Computer Engineering

Doctor of Philosophy in Computer Engineering

Students will be supervised by faculty advisors from their home universities who will help them to create and define learning journeys to complete in pursuit of their degree. The advisors from home and host universities will also assist with selection of learning activities and other elements of the program based on the student's background and academic goals.

This manual is intended to summarize the main features and requirements of the AIEI educational effort. This includes both features that are general to all university members and features that are specific to particular members. It includes, in its appendices, the current list of competencies and the

degree requirements for each AICE member. This manual is not exhaustive and will be subject to revision from time to time.

In particular, the reader should note that the definition of curriculum competencies is still under development. Thus, the curriculum details later in this manual should be viewed as provisional, not final.

AI ENGINEERING INSTITUTE STATEMENT OF EQUAL ACCESS

AI Engineering Institute (AIEI) does not discriminate in admission, employment, or administration of its programs or activities on the basis of race, color, national origin, sex, handicap or disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Additionally, AIEI and CMKL University adhere to non-discrimination policies set forth in Thai national laws and executive orders.

Inquiries concerning the application of and compliance with this statement should be directed to the AIEI Director, CMKL University, 1 Soi Chalongkrung 1, Ladkrabang, Bangkok 10520, Thailand. Obtain general information about CMKL University by calling +66 65 878 5000.

AI ENGINEERING INSTITUTE FACULTY

Throughout their time in the AIE program, students will encounter a variety of faculty and staff members from home and host universities who will help them on their way to completing their degree.

This list is provisional and will likely change as the Institute develops and becomes more mature.

AIEI Committees

- AIEI Director: Dr. Akkarit Sangpetch
- Committee and Secretary: Assoc. Prof. Wanida Kanarkard
- Committee: Asst. Prof. Dr. Panarat Cherntanomwong
- Committee: Assoc. Prof. Dr. Juggapong Natwichai
- Committee: Asst. Prof. Dr. Wannarat Suntiamorntut
- Committee: Dr. Pattanasak Mongkolwat

Course Instructors

Paulo Garcia
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Ph.D., Department of Electronics & Computer Engineering, University of Minho, Portugal

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School of Engineering, King Mongkut's Institute of Technology Ladkrabang
Adjunct Faculty, Department of Electrical and Computer Engineering, Carnegie Mellon University
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Ph.D., Computer Science and Engineering, The Pennsylvania State University

Pattanasak Mongkolwat
Dean, Faculty of Information And Communication Technology, Mahidol University
Ph.D., Computer Science, Illinois Institute of Technology.

Wanida Kanarkard
Lecturer, Faculty of Engineering Khon Kaen University
Ph.D. , Computer Engineering, University of Hertfordshire UK

Juggapong Natwichai
Deputy Dean, Faculty of Engineering, Chiang Mai University
Ph.D., Computer Science, The University of Queensland, Queensland, Australia

Wannarat Suntiamorntut
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Ph.D., Computer Science, The University of Manchester, United Kingdom

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Assistant Professor, Computer Innovation Engineering, King Mongkut's Institute of Technology Ladkrabang
D.Eng. in International Development Engineering, Tokyo Institute of Technology

Ekapol Chuangsuwanich
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Adjunct Faculty, CMKL University
Ph.D., Electrical Engineering and Computer Science, Massachusetts Institute of Technology

Chaya Hiruncharoenvate
Senior Officer, Securities and Exchange Commission, Thailand

Adjunct Faculty, CMKL University
Ph.D., Computer Science, Georgia Institute of Technology

Suporn Pongnumkul
Senior Researcher, National Electronics and Computer Technology Center
Adjunct Faculty, CMKL University
Ph.D., Computer Science and Engineering, University of Washington

Pongsin Poosankam
Data Innovation, Krungthai Bank
Adjunct Faculty, CMKL University
Ph.D., Computer Science, Carnegie Mellon University

AIE ACADEMIC PROGRAM

Overview

The Artificial Intelligence Engineering (AIE) program uses an innovative, flexible, self-paced curriculum based on **competencies** rather than courses. A competency is defined as a set of specific knowledge topics and skills that students must master in order to proceed toward their degree. Competency is an active learning concept; for most competencies, mastery will be assessed not by traditional examinations but by the completion of tasks or projects.

The amount of work required to master a competency will depend on both the specific competency and the student's pre-existing capabilities. Students can choose to proceed directly to the assessment process if they believe they already have the skills encompassed by the competency. On the other hand, students with no prior background in the areas covered by the competency can study the concepts and complete practice exercises to develop their skills before assessing their level of mastery.

Each competency provides a specified number of credit units, based on the faculty's estimate of the average amount of work required for mastery. Typically, the successful mastery of a competency will earn a student 3 or 4 credit units, though some competencies may have smaller or larger scope. Since traditional courses at CMKL normally provide either 9 or 12 units, this suggests that completing three or four competencies will be the equivalent of a traditional course. However, in the AIE program the mapping between competencies and courses that show up on the student's final transcript is flexible. Indeed, a specific course might be mapped to several alternative sets of competencies.

At the end of any semester, a student can request an academic transcript which will include course grades that indicates the student's mastery level based on associated competencies. However, the AIE program treats courses as derived concepts. The focus of the curriculum is on competencies, and specific mastery requirements are stated in terms of competencies, not courses.

The current set of defined competencies in the AIE curriculum is presented in the section below entitled [AIE DEGREE REQUIREMENTS](#).

Degree Progress and Planning

Student Responsibility

The AIE program requires students to take responsibility for their own learning. This includes defining a learning roadmap for each semester, which specifies a set of competency milestones as well as target dates for achieving them. The program will offer some pre-defined roadmaps, but the student will normally adapt these milestones based on their background, interests and self-evaluation of learning styles. The AIE program goal is to permit self-paced learning, avoiding the problem in traditional courses where material is presented too quickly for some students and too slowly for others.

Because each student will potentially be involved in different, individual learning activities, instructors will not be monitoring the students' daily schedules. For instance, even for required competencies, a student will not necessarily have to attend lectures if he or she feels this is not useful.

This means that students need to be proactive and responsible in selecting learning activities, doing reading, research and practice tasks, and deciding when they are ready to attempt formal assessment activities.

In short, students who are passive learners and who expect to be given detailed directions for every step in their degree process will not be successful in AIE.

At the same time, every student will have an assigned academic advisor who will serve as a mentor and guide. Advisors can help students plan their learning paths as well as suggesting best practices for effective studying and time management.

Ultimately it is the sole responsibility of the student to manage the academic progression of their program. If a student is not progressing as expected or is concerned about completing degree requirements, he or she is expected to seek advice and counsel from the academic advisor.

Registering for Competencies

Students enrolled in the program will use a custom-developed, competency-based software platform to plan their learning paths for each semester. Adding a competency milestone to the semester roadmap is similar to registering for a course in a more traditional program. The main differences are that the activities associated with a competency will usually have a duration shorter than the full semester, and that the students have control of when they will assess their mastery. The midterm and final examination schedule published in the CMKL University calendar is not relevant to the AIE program.

Although the AIE competency-oriented curriculum is flexible and self-paced, adding a competency to the road map is viewed as a commitment to mastering that competency within the semester. Students have the option of adding competencies/milestones to their roadmap up until the add/drop deadline in the university calendar. If a student wishes to add a competency after the add/drop deadline, he or she must obtain the formal approval of both the instructor responsible for the competency and the academic advisor.

Students have the option of removing competencies from their road map, up until the drop deadline. When a competency is dropped before the drop deadline, it does not appear in the student's

transcript. However, the platform will retain information about any skills within the competency for which the student has already demonstrated mastery, so the student will not need to repeat any work if the competency is added in a later semester.

Academic Credits

Each competency in the curriculum is associated with a specific number of credit units. Each degree program will state the minimum number of credits required to achieve the degree, the maximum number of credits that can be earned, and often, minimum credits for different categories of content. Credits earned appear on the student's final transcript and are used to calculate the quality point average (QPA).

Credit units are related to expected work hours for a competency. However, given the self-paced nature of the AIE program, the required working time is just an estimate.

Furthermore, the official definition of credit unit is based on a full semester. Each credit is intended to represent one hour of work per week during the roughly fifteen weeks of a full semester. In contrast, most competencies have a smaller scope than a full course and are expected to be completed in a shorter time. In addition, some students may have prior experience or knowledge which will allow them to spend less time than implied by the credit unit allocation to master a particular competency.

For example, assume that a competency is associated with 4 credits. If the student sets a goal for completing the competency in five weeks, this implies a workload of $(4 \times 15) / 5$ or 12 hours of work per week.

Repeating Competencies

At the end of each semester, information about the students' progress in achieving competencies will be aggregated to the course level and visible in the home university's registration system. The levels of mastery achieved for each competency associated with the course will be combined and transformed into a standard grade. Grades and mastery levels are discussed below in the section entitled [ACADEMIC STANDARDS](#).

Students will have the option of reviewing their course grades before those grades become official. If a student does not achieve mastery of the competencies required for a course (defined as a grade of at least B), they have the option of redoing some of the work and the assessments. This is discussed in the ACADEMIC STANDARDS section. If the student chooses to finalize the grade, that grade will be recorded to the transcript and factored into the cumulative QPA.

Transferring Credits from External Institutions

Under some conditions, students may be able to transfer credits from another university, or to receive credit for advanced courses taken in high school.

In these situations, the external courses must be mapped to competencies within the AIE curriculum. The individual member universities will establish their own policies for administering credit transfer.

Transferring Credits from Other AIEI Members

One of the objectives of the AIEI is to simplify the process by which students at one member institution can study and receive credit for learning at another member institution. In general, if a student completes a competency in one member university, he or she can automatically transfer the credit to his or her home university. The A1CE management application will provide the necessary documentation to certify the student's work.

ACADEMIC STANDARDS

Grades and Mastery

The AIE curriculum measures performance in terms of mastery. A student assessment for a competency will result in one of four levels of mastery (legend, master, apprentice, novice, translated as levels from 4, 3, 2 and 1) which are considered equivalent to grades A,B,C, and D respectively. To demonstrate achievement of a skill associated with a competency, a student must get either an A or B. If a student receives C or D, he or she can repeat the learning and the assessment. If the student still gets C or D, the student should consult with her advisor who might provide alternative learning paths or assessments.

Individual universities within the institute can decide to offer additional intermediate grading levels (e.g. "B+" or "B-") according to the policies of their institution.

Incomplete Grade

Since the AIE program is based on competencies rather than courses, the question of an "Incomplete" grade does not arise. Students will receive course credit only when they have successfully completed and demonstrated mastery of the set of competencies defined by the course. If they have not completed all the necessary competencies, the course will not appear on the students' transcript at all for the relevant semester. However, a student may complete missing competencies in a following semester. In this case, the course will appear on the transcript for the semester in which the competencies were completed.

Withdrawal Grade

Since students do not register directly for courses, the issue of a Withdrawal Grade does not arise. Students can remove a competency from their road map at any time before the add/drop deadline. If, after that deadline, they do not complete a committed competency within the semester, their situation will be as described in the previous section regarding incomplete grades.

Academic Performance

Credit Units and Quality Points

AIE has adopted the method of assigning a number of "units" for each competency, and by extension, each course, to represent the quantity of work required of students. For the average student, **one credit unit represents one work-hour of time per week throughout the semester**. The number of units in each competency and course is established by the faculty members in consultation with the AIE program committee.

For example, a 9-unit semester-long course should require 9 hours of student engagement, on average, including class time; if the instructor requires 3 hours of lecture and 1 hour of recitation, they can expect students to spend 5 hours outside of class engaging in class work. (Note, however, that the AIE self-directed, competency-based curriculum generally does not “require” class attendance and would rarely if ever involve as much as 3 hours of lecture per week.)

Individual competencies typically have a smaller scope and involve less work than an entire course, and correspondingly, provide fewer units. Estimating the workload for a competency depends on the student’s goal for completing the competency. For example, assume that a competency provides 4 credits. If the student sets a goal for completing the competency in five weeks, this implies a work load of $(4 * 15) / 5$ or 12 hours of work per week.

Quality Point Average

According to AIE policies, students must have a cumulative QPA of at least 2.0 in order to graduate. The cumulative QPA consists of all eligible courses completed as a student at an AIEI member university (either home university or host university), up to 400 units.

Since AIE aims for students to demonstrate mastery, the program goal is that every student should get A or B in every course. If a student receives a C or a D, he or she will have the option of repeating the competency learning and assessment, as described earlier. The detailed process will be as follows:

- Student will be informed that his or her grade is lower than B and asked if they want to accept/confirm the grade or to try again.
- If student confirms the grade, this will become the grade on his or her transcript.
- If student says they do not want to confirm, they have the chance to redo the work for the competencies associated with the course and assess again, hopefully receiving a higher grade. In this case, the new grade will appear on the transcript, for the semester in which the work was actually done. The original grade will not be visible to the outside world, though of course AIEI will maintain the history information in its database.
- If the second attempt also results in a grade lower than B, this is the grade that will appear on the transcript, assuming that the course/competency set is required for graduation.
- If the course/competency set is optional or elective, the student can choose to omit it completely from his or her transcript. However, in this case, the student may need to undertake additional learning activities in order to reach the minimum credits for graduation.

Academic Probation and Suspension

A student is usually be considered to be on academic probation when performance either for the semester or cumulatively fails to meet the minimum standard. Students who remain in academic probation status for several terms will usually be suspended.

The detailed policies for academic probation and suspension will be set by individual universities. AIEI does not control these policies.

Academic Integrity

AIEI students are engaged in preparation for professional activity of the highest standards. Each profession constrains its members with both ethical responsibilities and disciplinary limits. To assure the validity of the learning experience a university establishes clear standards for student work.

AIEI adheres to CMKL's policies on academic integrity and all students are expected to review these policies prior to their arrival at university.

In any presentation, creative, artistic, or research, it is the ethical responsibility of each student to identify the conceptual sources of the work submitted. Failure to do so is dishonest and is the basis for a charge of cheating or plagiarism, which is subject to disciplinary action.

The individualized, self-paced nature of the AIE program places even more stringent demands on students' integrity. Since much of the student's learning will be self-directed and mastery will be demonstrated largely via creation of designs, programs, and systems, the student will need to rely on external sources and information. It is critical that students identify what work is their own and what work is derived from other sources. Furthermore, students must adhere to instructors' guidelines regarding what types of external sources are permitted

Finally, some work at the program will be done in teams, while other work will be individual. Students should note that an individual assignment must be solely their own work. Copying of any sort on an individual assignment is a violation of ethical standards and will be subject to severe penalties.

Penalties for Violating Academic Integrity

Instructors are responsible for defining academic integrity for students in their courses/competencies, including student performance expectations and attendance requirements. Students are responsible for understanding and abiding by the instructor's academic integrity policies. Policies may vary from instructor to instructor and students should seek further guidance from a faculty member if they have specific questions about a course's academic integrity policy.

Should an instructor believe that an academic integrity violation has occurred, he or she may consult with the Office of the Dean of Student Affairs at his or her home university, who will assist the faculty member in handling a possible academic integrity violation and, if a student is found responsible for violating academic integrity policies, determining possible sanctions. Sanctions may include being required to redo work, losing credit and/or public admissions of guilt.

If a student is found to have violated the academic integrity policy for a second time, the student will be dropped from the AIE program at the end of the semester in which the infraction has occurred.

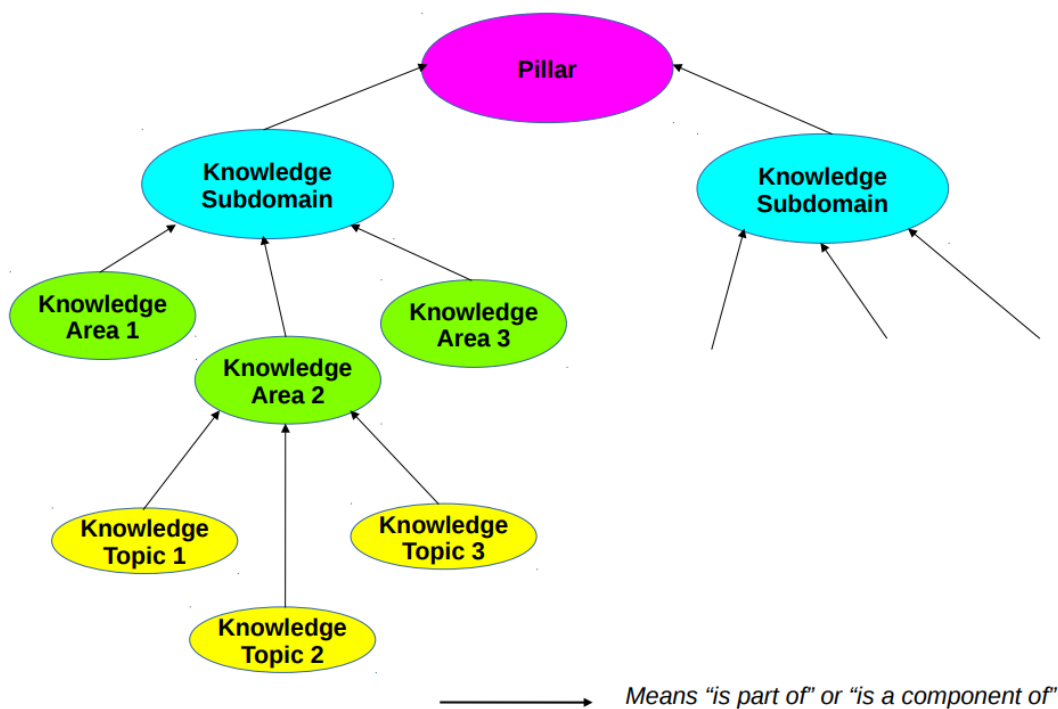
Students have the right to appeal an academic integrity decision.

AIEI Unified Curriculum Model

The AIEI competencies are organized according to knowledge pillars. Each pillar represents a broad set of topics and concerns. There are six central pillars in the program: Artificial Intelligence Core, Human-Centered Design, Cybersecurity, Scalable Systems, Modern Computer System and Entrepreneurship and Innovation. In many cases these major categories are divided into subcategories called subdomains.

In addition to these central pillars, we also incorporate science, mathematics, humanities, and other competencies, which would normally be viewed as external electives or general education, into our scheme. Additional competencies may be available through AIEI university network and student can request for competency credit transfer through AIEI system.

Knowledge Hierarchy



Pillar: Artificial Intelligence Core

Foundational content including essential theory and practical skills related to computer engineering and AI

Subdomain	Code	Competency
Programming, Data Structures, and Algorithms (PDA)	AIC-099	Programming Essentials
	AIC-101	Algorithmic Thinking & Problem Solving
	AIC-102	Intro to Programming
	AIC-103	Programming Multi-module Applications

	AIC-104	Object Oriented Programming
	AIC-105	Functional Programming
	AIC-106	Dataflow Programming
	AIC-107	Fundamental Data Structures
	AIC-108	Advanced Data Structures and Algorithms
Mathematics for AI*	AIC-201	Matrices and Linear Transformation (Linear algebra)
	AIC-202	Data Domains Time/Frequency Domain
	AIC-203	Descriptive Statistics
	AIC-204	Producing Data
	AIC-205	Probability distribution
	AIC-206	Inference Statistics
	AIC-207	Discrete Mathematics
Artificial Intelligence	AIC-301	Symbolic AI
	AIC-302	Probability-based Models
	AIC-303	Planning and Search Strategies
	AIC-304	Neural Network and Deep Learning
Data Mining	AIC-401	Information Retrieval and Extraction Search and Indexing
	AIC-402	Proximity Measurement and Cluster Analysis
	AIC-403	Classification and Regression
Machine Learning	AIC-501	Supervised Learning and Unsupervised Learning
	AIC-502	Reinforcement Learning
	AIC-503	Transformer Network
AI Applications **	AIC-601	Recommender System
	AIC-602	Natural Language Processing (NLP)
	AIC-603	Autonomous Agents
	AIC-604	Computer Vision

Pillar: Human-Centered Design

Knowledge and skills related to building highly usable systems that complement human capabilities and that support accessibility, diversity and equality among users.

Subdomain	Code	Competency
Analysis and Presentation	HCD-101	Visualization
	HCD-102	User experience and Interface design
	HCD-103	User Interface Development & Evaluation
	HCD-104	Immersive Environments (AR/VR/MR/XR)
Understanding Context of Use	HCD-201	Accessibility & Universal Design
	HCD-202	User Research Methodologies, Data and Design Thinking
Design for Human-Machine Teaming	HCD-301	Ethics in computer engineering
	HCD-302	Creating Explainable AI
	HCD-303	***Human Psychology for User Interface Design
	HCD-304	Interaction Design and Experience Design
Engaging in Critical Oversight	HCD-401	*** Ethical Principles for AI (Fairness, Accountability, Transparency, Ethics)

Pillar: Cybersecurity

Knowledge and skills related to designing, building and managing systems that are secure, robust against attackers, and trustworthy in protecting private data.

Subdomain	Code	Competency
Data Acquisition, Management and Governance	SEC-101	Data Acquisition, Preparation, Transformation and Cleaning

	SEC-102	Data Reduction and Compression
	SEC-103	Data Governance
Data Privacy, Security and Integrity	SEC-201	Data Privacy, Security & Integrity
	SEC-202	Creating Secure Software
	SEC-203	Securing System Infrastructure
	SEC-204	Security Policy and Processes
	SEC-205	Distributed ledger and Blockchain
	SEC-401	Privacy Attacks
	SEC-402	Differential Privacy (DP)
AI System Security	SEC-301	Security Challenges in Modern AI Systems
	SEC-302	Robustness of AI Components and Systems

Pillar: Scalable Systems

Knowledge and skills related to building systems that evolve gracefully and that exhibit excellent performance even with heavy user or data loads.

Subdomain	Code	Competency
Computing and Computer Fundamentals	SYS-101	Operating Systems (Unix Basics)
	SYS-102	Real Time and Unix Operating Systems*
	SYS-103	Basic Computer Architecture
	SYS-104	Web Architectures
	SYS-105	Storage and File Systems Fundamentals
	SYS-106	Computer Design: Processor Architectures and Digital Design using HDLs*
	SYS-107	Networks
Software Development and Maintenance (SDM)	SYS-201	Software Engineering Processes
	SYS-202	Software Testing
	SYS-203	Software System Design
	SYS-204	Designing and implementing data bases
Computer System Fundamentals	SYS-301	Cyber Physical System
	SYS-302	Cloud Computing
	SYS-303	Scalable Management of Data and Models
	SYS-304	Scalable Algorithms and Infrastructure
Big Data Systems	SYS-401	Parallel Computing
	SYS-402	Distributed Data Storage
	SYS-403	Big Data Computing

Pillar: Modern Computer System

Knowledge and skills related to an integrated system including machine hardware, an instruction set, system software, application programs, and user interfaces.

Subdomain	Code	Competency
Modern Computing	MCS-101	Modern Computing
High Performance Computing	MCS-201	Hardware acceleration
Internet of Things (IoT)	MCS-301	Data gathering

Pillar: Entrepreneurship and Innovation

Knowledge and skills related to working with real world stakeholders, considering the business, organizational and social contexts of solution development

Subdomain	Code	Competency
Entrepreneurship and Innovation	ENI-101	Create Innovation-driven Enterprise (Path Selection)****
	ENI-102	Product Design and Development (Including Design Thinking)
	ENI-103	Intellectual Property
	ENI-104	Startup from Idea to Impact
	ENI-105	Building Effective Teams to drive Innovation
	ENI-106	Entrepreneurial finance*****
Strategy and Innovation	ENI-201	Strategic Innovation Development
	ENI-202	Business Strategy****
	ENI-203	Platform Strategy
Leadership and Communication	ENI-301	Inclusive Leadership***
	ENI-302	Persuasive and Leadership Communication***
	ENI-303	Negotiation***
Business Application Domains **	ENI-401	Retail and Services Applications
	ENI-402	Logistics
	ENI-403	***** Biomedical, Bioinformatics and Health
	ENI-404	Gaming and Creative Industries
	ENI-405	***** Fintech
	ENI-406	Educational Technology

Pillar: Science

Fundamentals of physical and biological sciences relevant to computer engineering

Subdomain	Code	Competency
Science	SCI-101	Fundamentals of Biology
	SCI-102	Fundamentals of Chemistry
	SCI-103	Physics II
	SCI-104	Quantum Physics
	SCI-105	Kinematics: describe motion (Physics I)
	SCI-106	Dynamics: explain motion (Physics I)
	SCI-107	Energy and Momentum (Physics I)
	SCI-108	Thermodynamics (Physics I)

Pillar: Mathematics

Mathematics fundamentals relevant to AI and computer engineering

Subdomain	Code	Competency
Mathematics	MAT-101	Calculus - Differentiation
	MAT-102	Calculus - Basic derivatives
	MAT-103	Calculus - Integration
	MAT-104	Calculus - Optimization
	MAT-105	Vector Calculus
	MAT-106	Analytical Geometry
	MAT-107	Differential Equations and Approximation

Pillar: Communication and Presentation

Sharing information and influencing opinion through different communication methods

Subdomain	Code	Competency
Communication and Presentation	COM-101	Research and Technical Writing
	COM-102	Creative Writing
	COM-103	Graphics and visual storytelling
	COM-104	Analytical Thinking and Problem Solving
	COM-105	Presentation and Storytelling
	COM-106	Project Management

Pillar: Humanities, Arts and Social Sciences

Social sciences and human behavior

Subdomain	Code	Competency
People, Places, Cultures	HAS-101	Sociology and Cultural Anthropology
	HAS-102	Social Psychology
	HAS-103	Political Studies
	HAS-104	Human Geography
	HAS-105	Global Histories
	HAS-109	Ethics and Policy Issues
	HAS-110	Character Development I
	HAS-111	Character Development II
Arts and Music	HAS-106	History of visual arts
	HAS-107	History of music
Economics	HAS-108	Economics

Pillar: Soft Skills

Attitudes and behaviors related to working with people in a professional environment including ethical considerations

Subdomain	Code	Competency
Adaptability	SOF-101	Creative flexibility
	SOF-102	Working flexibility
Empathy	SOF-201	Human-centered focus
	SOF-202	Respect for diversity
Ethics	SOF-301	Social consciousness
	SOF-302	Honesty
	SOF-303	Fairness
	SOF-304	Respect for privacy and confidentiality
Proactiveness	SOF-401	Service orientation
	SOF-402	Continuous improvement focus
Professionalism	SOF-501	Responsibility
	SOF-502	Compliance with organizational norms
	SOF-503	Time management

	SOF-504	Quality focus
	SOF-505	Professional awareness
	SOF-506	Interpersonal relations
Self-Learning	SOF-601	Motivation to learn
	SOF-602	Active learning
Teamwork	SOF-701	Attention
	SOF-702	Respect and courtesy
	SOF-703	Openness
	SOF-704	Team spirit

Assessing Competencies

A *competency* is a set of skills related to some content within the curriculum. When a student has mastered all the associated skills, we can say that he or she has demonstrated the associated competency. Competencies usually have a smaller granularity than a full, semester-long course. There is no hard and fast rule, but in general studying the material and practicing the skills in a competency might be expected to take four to eight weeks for an average student.

Skill is an active learning concept. Skills are defined by stating what a student should be able to do with some curriculum content. The implication is that knowledge alone is not sufficient; students must be able to use their knowledge in specific ways. Example skills might be: create a computer program that uses multiple functions to break up its processing; apply linear regression to a data set in order to predict some dependent variable given independent variables; analyze the usability of a website and write a critique suggesting how it could be improved.

In order to determine whether a student has mastered a specific skill, the AIE curriculum requires an assessment for every skill. Assessments are defined in terms of a task or tasks the student must do to demonstrate mastery. The level of detail for an assessment can vary, but it should be sufficiently concrete that an instructor could convert it to a specific assignment.

As an example, here are the skills and assessments that have been defined for the Supervised and Unsupervised Machine Learning (ML) competency, which is the introductory competency in the ML area.

Skill Title	Assessment
Understanding fundamental ML concepts	Take a quiz that evaluates key distinctions and concepts including model, training versus testing, prediction versus classification, etc.
Applying unsupervised learning methods	Given an unlabeled set of data, use a third party framework like sklearn or Weka to do K-Means clustering. Vary the number of clusters and repeat. Write one to two pages describing and interpreting the results.
Applying supervised learning methods	Given a labeled data set, use a framework like sklearn or Weka to train a decision tree, then test its accuracy. Vary several of the parameters and repeat. Write one to two pages describing and interpreting the results.

It is up to the individual instructor how to perform evaluate and grade the mastery of a particular skill, but AIE has developed a set of recommendations.

- Assessment should take place one skill at a time. The instructor should have previously posted the details of the assessment tasks for each skill so students can work on these tasks on their own.
- Assessment will involve the instructor reviewing the task output, possibly asking questions or having the student explain further, and ultimately assigning a grade from 0 to 100. This will be mapped to a mastery level by the A1CE platform.
- Assessment will take place during the instructor's regular office hours. A student who wishes to be assessed for some skill will need to make a reservation one week before, indicating what competency and skill he or she wants to demonstrate. We will provide a form for this.
- As part of this reservation form, the student must submit or provide links to the work completed for the assessment task. The student must also state what learning activities he or she undertook in order to acquire this skill. This can be attending lectures or labs at CMKL, or can be experience in other contexts (e.g. work experience, internship or courses taken at other institutions). The purpose is to insure that students have some evidence that they've done work other than just completing the assessment task.
- AIE assessment includes the possibility of group and/or peer assessment. This can be handled in the same basic framework even though the group must reserve together.

Curriculum Quality Assurance

AIEI is committed to continuous quality improvement. As the first AI Engineering Institute, we have a responsibility to deliver curricula of exceptional quality. Thus, we will undertake systematic quality assurance processes.

The curriculum quality assurance policy frames the purpose, scope, and rationale for curriculum, in accordance with the criteria established by Ministry of Higher Education, Science, Research and Innovation (MHESRI). This policy applies to all competencies and curriculum material leading to a credential at AIEI, including new and existing curricula offered full-time, part-time, or conjointly with other post-secondary institution.

Quality assurance will involve two complementary efforts:

Curriculum presentation, review and critique

Proposals for new or modified competencies (or higher level curriculum entities such as pillars or subdomains) will be reviewed twice yearly by the AIEI committee or delegated individuals. The curriculum review group will provide feedback and recommendations to insure the quality of the material and its consistency with existing curriculum and the overall program goals. This committee will approve changes and manage their integration into the curriculum.

Data-driven quality assurance

The A1CE platform which all AIE students will use to manage their studies and review their accomplishments will gather a wealth of data which can be used to evaluate the effectiveness of the curriculum in terms of achieving its objectives. Many different metrics will be available for analysis, including but not limited to:

- Time to complete a competency (on average, or for specific competencies);
- Mastery levels achieved in first or subsequent assessments;
- Competencies that cause the most problems for students;
- Competencies that are rarely selected (which may be candidates for deletion);
- How often students modify their roadmaps within a semester (a possible indication of “thrashing”)
- How often students decide to drop competencies;
- Et cetera.

In all cases these data can be analyzed in aggregate or on a per student basis. The AIE committee as well as the MHESRI can use these data to define KPIs, to discover problems and to propose modifications that will improve the program.

Note that any individual student data extracted from AIE will be anonymized to protect the privacy of the students involved.

In addition to these methods, we will also gather feedback from students every term, to discover what aspects of the program they perceive as more or less successful.

AI ENGINEERING DEGREE REQUIREMENTS

AI Engineering Institute University Network

Students participating in the study through AI Engineering Institute's (AIEI) university network can request for the competency transfer directly using AIEI system in lieu of submitting the transcript. Students can also request for a dual, or multiple-degree program evaluation to be considered for additional degree recipients from other host universities through AIEI. Note that the students must complete AIE program requirement from Home University in order to receive degree.

Each university in the network may have different detailed requirements regarding credits, competencies, distribution and so on. These requirements may also vary for different degrees within a single university.

This section provides an overview of the degree requirements for each university. For details, see Appendices A through E.

CMKL UNIVERSITY

Degree offered: B.Eng in Artificial Intelligence and Computer Engineering (AiCE)

Minimum credits required for graduation: 360

Maximum allowed credits: 400

Credit distribution requirements: 66 units of arts, humanities, social science and communication electives, 90 units of math/science, 132 units of core technical fundamentals, and 54 units of undergraduate research and development.

Competency Summary by Pillar

Pillar	Available Credits	Required Credits
Artificial Intelligence Core	132	72
Human-Centered Design	52	20
Cybersecurity	50	20
Scalable Systems	76	28
Entrepreneurship & Innovation	74	34
Science	60	Sufficient for distribution requirements
Mathematics	36	Sufficient for distribution requirements
Communication & Presentation	50	Sufficient for distribution requirements
Humanities, Arts & Social Sciences	77	Sufficient for distribution requirements

Competencies offered are presented in the section above entitled **AIEI Unified Curriculum Model**, with the following exceptions:

- Competencies under Modern Computer Systems pillar are not offered.

KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG - CIE

The CIE degree requirement adheres to AiCE degree requirement from CMKL University.

Degree offered: B.Eng in Computer Innovation Engineering (International Program) (CIE)

Minimum credits required for graduation: 360

Maximum allowed credits: 400

Credit distribution requirements: 66 units of arts, humanities, social science and communication electives, 90 units of math/science, 132 units of core technical fundamentals, and 54 units of Undergraduate Entrepreneurship and Innovation (18 units of Entrepreneurship and Innovation Projects and 18 units of Entrepreneurship and Innovation Competencies and 18 units of Capstone Project), 0 units of Innovation Internship* is required.

*Students are required to participate in an Innovation Internship, which carries no credit value. During this internship, students have the option to join internships for 8 weeks in industries, research labs, or startups.

In addition, there is a co-operative option available for students. This option allows them to spend the first semester of their fourth year working with a company. If students choose this path, they are required to complete co-op reports and a presentation by the end of the semester. They must also declare and transfer the competency credits they have gained back to the program. These credits can be counted towards any AI Engineering Pillars within the program.

Competency Summary by Pillar

Pillar	Available Credits	Required Credits
Artificial Intelligence Core	132	90
Human-Centered Design	52	18
Cybersecurity	50	24
Scalable Systems	76	32
Entrepreneurship & Innovation	74	18
Science	60	Sufficient for distribution requirements
Mathematics	36	Sufficient for distribution requirements
Communication & Presentation	50	Sufficient for distribution requirements
Humanities, Arts & Social Sciences	77	Sufficient for distribution requirements

Competencies offered are presented in the section above entitled **AIEI Unified Curriculum Model**, with the following exceptions:

- Competencies under Modern Computer Systems pillar are not offered.

PRINCE OF SONGKLA UNIVERSITY

Degree offered: B.Eng in Artificial Intelligence and System Engineering

Minimum credits required for graduation: 360

Maximum allowed credits: 400

Credit distribution requirements: 66 units of arts, humanities, social science and communication electives, 150 units of core technical fundamentals (6 units of competencies from modern computer system pillar are required), 90 units of math/science, and 54 units of undergraduate research and development.

Competency Summary by Pillar

Pillar	Available Credits	Required Credits
Artificial Intelligence Core	118	100
Human-Centered Design	42	18
Modern Computer System	18	18
Scalable Systems	72	42
Entrepreneurship & Innovation	57	21
Science	24	Sufficient for distribution requirements
Mathematics	36	Sufficient for distribution requirements
Communication & Presentation	28	Sufficient for distribution requirements
Humanities, Arts & Social Sciences	72	Sufficient for distribution requirements

Competencies offered are presented in the section above entitled **AIEI Unified Curriculum Model**, with the following exceptions:

- Competencies under Cybersecurity pillar are not offered

CHIANG MAI UNIVERSITY

The B.S. in Data Science degree requirements mainly adhere to competencies designated in AI Engineering core pillars from CMKL University.

Degree offered: B.S. in Data Science

Minimum credits required for graduation: 131

Maximum allowed credits: 368

Credit distribution requirements: A minimum of 30 credits composed of 30 credits of general education courses (GE), 95 credits of core-courses, and 6 credits of free elective courses. From the 95 credits of the core-courses, 53 credits are for the basic mathematics and science, data science, and AI, are to be required courses. Meanwhile, 27 credits are field specific elective courses which are grouped into Data analytics using mathematical modeling, Statistical data analytics, and Data analytics using computational modeling, in which these three mainly are combined into Artificial Intelligence Subdomain of AiCE. The last part of the core-courses, 15 credits, are opened for minor studies e.g. Economics or Business administration, the students can also opt to study the field specific elective courses instead of minor.

Competency Summary by Pillar

Pillar	Available Credits	Required Credits
Artificial Intelligence Core	130	90
Human-Centered Design	42	18
Science	60	Sufficient for distribution requirements
Mathematics	36	Sufficient for distribution requirements
Communication & Presentation	28	Sufficient for distribution requirements
Humanities, Arts & Social Sciences	72	Sufficient for distribution requirements

Competencies offered are presented in the section above entitled **AIEI Unified Curriculum Model**, with the following exceptions:

- Competencies under Cybersecurity, Scalable Systems, and Entrepreneurship & Innovation pillar are not offered.

MAHIDOL UNIVERSITY

The students must satisfy multiple requirements before the Bachelor of Engineering degree is certified. The undergraduate curriculum requires at least 360 credit units. This includes 66 units of arts, humanities, social science and communication electives, 90 units of math/science, 132 units of core technical fundamentals, and 54 units of undergraduate research and development.

Degree offered: B.S. in Digital Science and Technology

Minimum credits required for graduation: 360

Maximum allowed credits: 400

Credit distribution requirements: 66 units of arts, humanities, social science and communication electives, 90 units of math/science, 132 units of core technical fundamentals, and 54 units of undergraduate research and development.

Competency Summary by Pillar

Pillar	Available Credits	Required Credits
Artificial Intelligence Core	132	72
Human-Centered Design	52	20
Cybersecurity	50	20
Scalable Systems	76	28
Entrepreneurship & Innovation	74	34
Science	60	Sufficient for distribution requirements
Mathematics	36	Sufficient for distribution requirements
Communication & Presentation	50	Sufficient for distribution requirements
Humanities, Arts & Social Sciences	77	Sufficient for distribution requirements

Competencies offered are presented in the section above entitled **AIEI Unified Curriculum Model**, with the following exceptions:

- Competencies under Modern Computer Systems pillar are not offered.

KHONKAEN UNIVERSITY

Current students in the following programs: B.Eng in Computer Engineering, M.Eng in Computer Engineering, Ph.D. in Computer Engineering are applicable to taking courses at other accredited institutions (colleges and universities), as part of exchange programs or other departmentally approved programs, or while on leave from Home University are also called “AIE students”. In order to meet the AiCE competency requirements via the AIEI competency scheme, students must demonstrate this competency in order to gain the AIEI certificates.

Degree offered: B.Eng in Artificial Intelligence and Computer Engineering

AIEI Certificate offered: B.Eng in Computer Engineering
M.Eng in Computer Engineering
Ph.D. in Computer Engineering

Minimum credits required for graduation: 190

Maximum allowed credits: 400

Competency Summary by Pillar

Pillar	Available Credits	Required Credits
Artificial Intelligence Core	130	90
Human-Centered Design	42	18
Cybersecurity	42	24
Scalable Systems	78	32
Entrepreneurship & Innovation	68	26

Competencies offered are presented in the section above entitled **AIEI Unified Curriculum Model**, with the following exceptions:

- Competencies under Science, Mathematics, Communication & Presentation, Humanities, Arts & Social Sciences are not offered.

CONCLUSION

AIEI represents a bold step forward for Thai engineering education. By enabling cooperation among multiple institutions of higher education and building a common curriculum repository, it facilitates knowledge sharing and allows member universities to take advantage of each other's strengths, while retaining the unique focus of their own degree programs. Using jointly developed curriculum structure and content will increase efficiency in delivering learning opportunities and free up resources to improve the learning experience. Quality assurance activities conducted across universities will support continuous improvement of learning outcomes.

Meanwhile, individualized, competency-based learning offers many advantages for students. No longer will they be forced to sit in classes designed for the average student, where students with more ability will be bored and students who need special help will be lost. Instead, students can customize their education according to their personal strengths and weaknesses, interests and experience. This learning model will demand more maturity and independence from students than traditional course-based programs, helping them to acquire the proactiveness, self-learning skills and self-discipline need to succeed in today's fast-paced technical environment.

The AIE competency-based model de-emphasizes grades. Students who do not perform well on a skill assessment can always try again. Hopefully this flexibility will encourage students to be more inner-directed, motivated by curiosity and interest in learning rather than by an obsession with their final transcript. At the same time, the activity-oriented assessment model in the AIE program actually provides a more informative and rigorous measure of a student's learning than does a grade on a final exam.

Finally, the open model of AIE credit transfer will give students new opportunities. It will lower the barrier to studying in another institution by offering virtual (or physical) exchange programs. Students will have the opportunity to meet both peers and professors from other universities, thus starting to build professional networks which will be important in the future.

We are excited about the potential of the AI Engineering Institute. We feel confident that it will help Thailand generate the skilled engineering resources it needs to address the many challenges of the future.