กระทรวงการอุดมศึกษา วิทยาศาสตร์ วิจัยและนวัตกรรม
รับทราบการให้ความเห็นชอบหลักสูตรนี้แล้ว
เมื่อวันที่ 10 พฤศจิกายน 2565
ตามรหัสหลักสูตร 25650204001964

Bachelor of Engineering Program in Intelligent Innovation Engineering (English Program) New Curriculum, Academic Year 2022 (2565 BE)

Department of Electrical and Computer Engineering
Faculty of Engineering
Naresuan University

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Program Specification
Program: Bachelor of Engineering
Major: Intelligent Innovation Engineering
New Program, Academic Year 2565 BE (2022 CE)

Institution	:	Naresuan University
Faculty/Department	:	Faculty of Engineering
		Department of Electrical and Computer Engineering

Section 1 General Information

1. Program Title

Thai : หลักสูตรวิศวกรรมศาสตรบัณฑิต สาขาวิชาวิศวกรรมนวัตกรรมอัจฉริยะ (หลักสูตรภาษาอังกฤษ)

English : Bachelor of Engineering Program in Intelligent Innovation Engineering (English Program)

2. Title of the Degree and Field of Study

Full Title	Thai	:	วิศวกรรมศาสตรบัณฑิต (วิศวกรรมนวัตกรรมอัจฉริยะ)
	English	:	Bachelor of Engineering (Intelligent Innovation Engineering)
Abbreviated Title	Thai	:	วศ.บ. (วิศวกรรมนวัตกรรมอัจฉริยะ)
	English	:	B.Eng. (Intelligent Innovation Engineering)

3. Major Subject (If any)

None

4. Total Credits Required

A minimum of 129 credits

5. Program Characteristics

5.1 Degree Level

Bachelor's degree program (4-year program), level 2, in compliance with the 2009 Thai Qualification Framework for Higher Education (TQF:HEd).

5.2 Program Type

Undergraduate Academic Program

5.3 Language Used in the Program

English

5.4 Admission

Thai and foreign students

5.5 Cooperation with Other Institutions

This program is a Naresuan University program.

5.6 Degree Awarded upon Completion of the Program

Bachelor of Engineering Program in Intelligent Innovation Engineering

6. Record of Program Status and Approval / Endorsement

6.1 Program Start Date

From the first semester of the academic year 2022.

6.2 New or Revised Program

This new program has been implemented from the first semester of the 2022 academic year (2565 BE) onwards.

6.3 Program Approval Dates

Approved by	Meeting no.	Date
Naresuan University Academic Committee	8/2021	August 16, 2021
Naresuan University Academic Council	9/2021	September 6, 2021
Naresuan University Council	10/2021	October 17, 2021

7. Expected Date for the Implementation of Program under the 2009 Thai Qualifications Framework for Higher Education

The program will be published as a program with quality and standard according to the 2009 Thai Qualification Framework for Higher Education (TQF:HEd) in the academic year 2024 (2567 BE).

8. Career Opportunities After Graduation

Graduates of the Bachelor of Engineering Program in Intelligent Innovation Engineering (English Program) have engaged in hands-on practices of the integration of the engineering knowledge, business knowledge, the pragmatic knowledge from the industry with the aim to develop smart innovators who will be the core force for Thailand. They are, therefore, well-equipped for a variety of career paths according to their interests and inclinations.

8.1 Works Requiring Engineering Knowledge and Innovation Skills to Create Innovative Ideas

for example:

- Innovation Engineer
- Product Developer
- Innovator

8.2 Works Related to Artificial Intelligence

for example:

- AI Engineer
- Machine Learning Engineer
- Data Scientist
- AI Data Analyst
- Big Data Engineer
- Business Intelligence Developer
- Data Engineer

8.3 Works Related to Embedded Systems and Robotics

for example:

- Embedded Software Engineer
- Robotics Engineer
- Robotics Scientist

8.4 Works Related to Modern Computing Technology such as Cloud Computing, Blockchain, etc.

for example:

- Cloud Engineer
- Block Chain Engineer
- Block Chain Developer
- Financial services IT
- Security Engineer
- DevSecOps Engineer
- Network Engineer

8.5 Works Related to Modern Technology such as Computer Graphics, AR/VR/MR

for example:

- Robotic Process Automation
- Game Developer
- Graphics Engineer
- AR/VR/MR Engineer
- Game Designer
- AR/VR/MR developer

8.6 Work Requiring Ability to Develop Applications

for example:

- Programmer
- Software Developer
- Software Engineer
- Software Tester
- DevOps Engineer

8.7 Others

- Teacher / Lecturer in both Public and Private Educational Institutions
- Self Employment / Entrepreneur
- Researcher

9. Names, Positions and Degrees of the Lecturers in Charge of the Program

No.	First name and last name	Academic Position	Academic Degree	Major	Institution	Country	Year of Graduation	Teaching Load (Hours / Week)	
								Current	Future
1	Jiraporn Pooksook	Lecturer	Ph.D.	Computer Science	Asian Institute of Technology	Thailand	2020	15	15
			M.Eng.	Computer Science	Asian Institute of Technology	Thailand	2011		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2005		
2	Jirarat Ieamsaard	Lecturer	Ph.D.	Electrical Engineering	Naresuan University	Thailand	2017	15	15
			M.Eng.	Electrical Engineering	Naresuan University	Thailand	2011		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2009		
3	Panupong Sornkhom	Lecturer	M.Eng.	Computer Engineering	King Mongkut's University of Technology Thonburi	Thailand	2008	32	37
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2000		
4	Settha Thangkawanit	Lecturer	Ph.D.	Computer Engineering	Naresuan University	Thailand	2019	30	30
			M.Eng.	Electrical Engineering	Naresuan University	Thailand	2008		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2006		
5	Yoseung Kim	Lecturer	M.Eng.	Computer Engineering	ChungNam National University	South Korea	2009	12	12
			B.Eng.	Computer Engineering	HanBat National University	South Korea	2001		
			B.Eng.	Electronics Engineering	The University of Soul	South Korea	1991		

10. Studying Venue

Faculty of Engineering, Naresuan University, Phitsanulok, Thailand.

11. External Factors or Necessary Development to be Considered in Curriculum Planning

11.1 Economic Circumstances / Development

World economic, technological progress, the pandemic of Covid-2019, and the forming of ASEAN Economic Community (AEC) caused drastically changes in Thailand economy. In order to compete in the new era of highly competitive economic, Thailand must accelerate the development of human resources, research, and innovation to ensure the competitiveness of the whole nation. According to the 20-year national strategy (2018 – 2037 CE or 2561 – 2580 BE) and the Thailand national education plan 2560 – 2579 BE (2017 – 2036 CE), the digital industry is one of the key industries driving the future economy. Therefore, the Ministry of Higher Education, Science, Research and Innovation (MHESRI) defined the 4 aspects of future graduates, namely, the development of 21st Century Thai people, the knowledge development and construction, the innovation development, and the higher education revolution

Based on the guideline mentioned above, the department of Electrical and Computer Engineering (ECPE), Faculty of Engineering (NU-ENG), Naresuan University in cooperation with the digital industry has developed the **Intelligent Innovation Engineering** (**IIE**) program with the emphasis on integrating the engineering knowledge, business knowledge, the pragmatic knowledge from the industry with the aim to develop smart innovators who will be the core force for Thailand.

11.2 Social and Culture Circumstances / Development

The fast development of technological knowledge causes new products to be developed and introduced to the market at the much faster rate. As more tools become more available, people change the tools or devices more often in order to take advantages of new advancements. People become get accustomed to the ever-changing technology; hence, the wide-spread adoption of technology in daily life. These phenomena accelerate the social and culture transformation. Consequently, it is necessary for the program to put forward the plan to produce a graduate who is ethical, professional, self-inspired, and innovative engineering who are capable of designing new technology or utilizing the available

technology that is appropriate to the new highly dynamic society and culture of the present and future.

12. Impacts of Factors in 11 on Program Development and Its Pertinence to the Institutional Missions

12.1 Program Development

The following guidelines were used in the program development:

1. The program-level expected learning outcomes (ELO) were designed specifically to conform to the computing competencies defined in
    a. The Computing Competencies for Undergraduate Data Science Curricula (CCDS2021) published in January 2021 by the Association of Computing Machinery (ACM)
    b. The Computing Curricula 2020 (CC2020) Paradigms for Global Computing Education published on December 31, 2020 by the Association of Computing Machinery (ACM) and IEEE Computer Science Society (IEEE-CS).
2. The ELOs were also designed to match the standard of learning outcomes defined in the 2009 Thai Qualification Framework for Computing disciplines (TQF 1 Computer 2009) published in 2009 by Thailand's Ministry of Education.
3. The focused industries defined by the Office of National Higher Education Science Research and Innovation Policy Council (NXPO) of the Ministry of Higher Education, Science, Research and Innovation (MHESI).

12.2 Its Pertinence to the Institutional Missions

Aim to be a 4.0 university, the Naresuan University has set forth the educational policy that education 3I (Internationalization, Innovative Products, Integrative Team & Networking) with P3BL (Project, Problem, and Professional Based Learning) policy. The curriculum committee has adopted this guideline in designing the program by

1. Use English as the studying language (Internationalization)
2. Emphasize on producing innovations as learning outcomes (Innovation product)
3. Emphasize on teamwork and collaboration with project stakeholders (Integrative Team and Networking)
4. Emphasize on systematically applying project management (Project-Based Learning) in solving real-world problem (Problem-Based Learning).

5. Early and continually expose learners with professional practices with 5 field experience courses staring from the second semester of the first year.
6. Embedded the soft skills required by the industry with the university's identity through the 6 courses on soft skills.

13. Relations to Other Programs Offered by Other Faculties / Departments in the Institution (If any)

13.1 Course(s) Offered by Other Faculties / Department / Programs

13.1.1 Foundation Courses o=Offered by the Faculty of Science

IIE students are required to take the following 5 courses from the Faculty of Science.

252182	Calculus 1	3(3-0-6)
252183	Calculus 2	3(3-0-6)
252284	Calculus 3	3(3-0-6)
261103	Introductory Physics	3(3-0-6)
261113	Laboratory in Introductory Physics	1(0-2-1)

13.1.2 Required courses offered by the Faculty of Engineering

IIE students are required to take the following 2 courses from the Faculty of Engineering.

300301	Technopreneur	3(2-2-5)
302151	Engineering Drawing	3(2-3-5)

13.2 Course(s) Offered to Other Faculties / Department / Programs

None

13.3 Program Management

The committee in charge of the program is composed of five highly motivated faculty members who will supervise the program administration, teaching and learning management, academic performance according to the guidelines set forth by the university, the faculty of engineering, and the department of electrical and computer engineering. The committee also directs the academic operations such as class scheduling, instructor assignment, program

assessment and evaluation in compliance with the 2009 Thai Qualification Framework for Higher Education (TQF:HEd) and the university's rules and regulations.

Section 2 Specific Information of the Program

1. Philosophy, Significance and Objectives of the Program

1.1 Program Philosophy

The intelligent innovation engineering (IIE) program, a new curriculum for 2565 BE (2022 CE) aim to produce graduates who can thrive in the ever-change circumstances while introducing innovations that benefit everyone.

1.2 The Importance of the Program

The program is designed to address the increasing demand in the 12 target industries as defined in the ***trend of personnel demand in target industries of the future (New S-curve) and the direction of the country's manpower development policy 2020 – 2024*** announced in 2019 (2562 BE) and updated in 2020 (2563 BE) by the Ministry of Higher Education, Science, Research and Innovation (MHESI).

1.3 Program Objectives

To produce graduates with the following characteristics:

1. Be capable of implementing innovative devices or applications for solving real-world problems, especially those that relevant to the 12 target industries.
2. Possess contemporary work skills such as growth mindset, systematic, creative, innovative, and entrepreneurial thinking, design thinking, communication skills, leadership skills, and project management skills.
3. Be ethical, disciplined, professional, and socially aware.

1.4 Expected Learning Outcomes

Once graduated from the program the graduate should achieve the following expected learning outcomes:

ELO	Description
1	Develop devices and applications (such as IoT, Embedded Systems, etc.) that can communicate with computers.
2	Develop devices or applications that can communicate via networks.
3	Develop and deploy simple data analytic models for various domains such as e-commerce.

ELO	Description
4	Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.
5	Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.
6	Develop applications capable of handling massive amounts of data (such as big data).
7	Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.
8	Think entrepreneurially. Develop a business plan for starting a business.
9	Transfer knowledge and skills to others.
10	Collaborate with others and be a smart team member or leader, and manage projects.
11	Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.
12	Think systematically, creatively, or innovatively.
13	Act with growth mindset.
14	Behave like a responsible, disciplined, ethical engineer and citizen.

2. Development Plan

Development plan	Strategies	Evidences/Indicators
Develop and improve the curriculum	Follow up and evaluate for using the curriculum	Curriculum evaluation and progress reports
Plan for conducting the curriculum	○ Appoint a curriculum chairman ○ Operate the curriculum in accordance with its regulations and the educational quality assurance ○ Develop ability of lecturers and students	○ Curriculum assessment results ○ Action plan ○ Academic performance of teachers and students
Do the plan and the action plan report	○ Allocate resources.	○ Assessment results for student learning support

Development plan	Strategies	Evidences/Indicators
	○ Arrange activities to supplement the curriculum	○ Summary of performance according to the action plan
Develop / improve teaching and learning management, teaching strategies or learning assessment	○ Evaluate lecturers' teaching ○ Support and encourage lecturers to develop themselves	○ Teaching evaluation results of lecturers for all subjects ○ Self-development action report
Develop the curriculum in accordance with the requirement of the graduate student users	○ Survey the satisfaction of graduate student users ○ Improve and develop the curriculum in accordance with the requirement of the graduate student users	○ Satisfaction survey results of the graduate student users ○ Developed curriculum in accordance with the needs of the labor market

Section 3 Educational Management Systems, Program Implementation and Structure

1. Educational Management System

1.1 Academic System

Semester-System – An academic year is composed of 2 semesters. The length of the study for a typical semester is at least 15 weeks.

- 2 semesters per academic year
- A minimum of 15 weeks per semester
- Optional summer semester with study hours comparable to the regular offerings in normal semester

1.2 Summer Semester

Summer semester consists of at least 8 weeks (April – June). The program offers the following courses for the summer semester

- **316390 Internship (Required non-credit)**
  This course is a requirement for graduation. Students are required to enroll in this six-credit course and must satisfy the specified criteria.
- **316190 Working Integrated Learning 1 (Elective and credited)**
  This course is for students who want to pursue the Cooperative and Work Integrated Education track and meet the specified requirements.
- **316290 Working Integrated Learning 2 (Elective and credited)**
  This course is for students who want to pursue the Cooperative and Work Integrated Education track and meet the specified requirements.

1.3 Credit Transfer

Applicants must submit requests to the program committee for consideration and must observe the Naresuan University undergraduate study regulation.

2. Program Implementation

2.1 Class Session

Weekday based on the Naresuan University academic calendar.

First semester : June – October

Second semester : November – March

Summer session : April – June

2.2 Student Qualification

Students are required to have the characteristics and academic qualification according to the Naresuan University regulation on the student qualification.

2.2.1 Applicants for an Academic Bachelor's Degree

The applicants must meet the following qualification:

1. Completing high school diploma or equivalent in other countries certified by the Equivalent Qualification Announcement of Ministry of Education.
2. Be healthy and do not have any serious communicable diseases that can obstruct the study.
3. Have never been convicted under the court's verdict except for negligent or minor offences.
4. Have never been excluded name or expelled from any education institution due to misconduct.

2.3 Limitations of Newly Enrolled Students

The common challenges for most newly enrolled students include

1. The adjustment to different learning environment which demands a higher degree of self-discipline and personal management.
2. The adjustment to different social context where peers with more diverse than whom he or she may have interacted in the secondary education.
3. The usage of English as a medium for studying, especially communication skills.

2.4 Strategies for Mitigating the Students' Limitations

The following strategies are formed to alleviate the students' challenges.

1. Provide an orientation for new students.
2. Assign academic advisors who will guide students throughout their study at the IIE program.
3. Gradually introduce the life skills relevant to intelligent innovation engineering practices through the following 6 courses.
    a. **316101 Soft Skill 1: Exploration** where students will learn about the field of intelligent innovation engineering, learning how to learn, time management, basic project management, and self-exploration.
    b. **316102 Soft Skill 2: Personal Growth** where students will learn how to expand their capabilities, financial management, growth mindset, and multiple project management, and effective people.
    c. **316201 Soft Skill 3: Engineering Teamwork** where students will learn how to work as a self-directed team who collaboratively work to solve the real-world engineering problems using design thinking, team project management, validated learning, and non-violent communication.
    d. **316202 Soft Skill 4: Community Collaboration** where students will learn how to utilize their ability to solve the real-world community-based problems using multi-culture approach, multi-disciplinary teamwork, multi-culture project management, and constructive criticism.
    e. **316301 Soft Skill 5: Professional Practices** where students will learn how to prepare themselves so that they can be ready to work professionally once they graduate from the program.
    f. **300301 Technopreneur** where students will learn how to think entrepreneurially from the multiple perspectives including the business point-of-view.
4. Require students to enroll in 3 English courses
    a. 001211 English Listening and Speaking for Communication
    b. 001212 English Critical Reading for Effective Communication
    c. 001213 English Writing for Effective Communication

2.5 Five-year Plan for Student Admission and Graduation

Class standing	Academic Year				
	2022	2023	2024	2025	2026
1st year	40	40	40	40	40
2nd year		40	40	40	40
3rd year			40	40	40
4th year				40	40
Total	40	80	120	160	160
Expected number of graduates				40	40

2.6 Budgets as Specified in the Plan

2.6.1 Estimated Income (in Thai Baht)

Income	Budget Year				
	2022	2023	2024	2025	2026
Tuition Fees	3,200,000	6,400,000	9,600,000	12,800,000	12,800,000
Total	**3,200,000**	**6,400,000**	**9,600,000**	**12,800,000**	**12,800,000**

Note: Calculated from the tuition fees (40,000) x number of students in each academic year

2.6.2 Estimated Expenses (in Thai Baht)

Expense	Budget Year				
	2022	2023	2024	2025	2026
University	1,545,600.00	3,091,200.00	4,636,800.00	6,182,400.00	6,182,400.00
Faculty	854,497.60	1,708,995.20	2,563,492.80	3,417,990.40	3,417,990.40
Compensation	277,764.00	555,528.00	823,292.00	1,131,056.00	1,131,056.00
Operation	50,000.00	150,000.00	150,000.00	150,000.00	150,000.00
Supplies	60,000.00	60,000.00	60,000.00	60,000.00	60,000.00
Hardware	-	50,000.00	1,000,000.00	1,000,000.00	1,000,000.00
Subsidy	100,000.00	100,000.00	100,000.00	10,000.00	10,000.00
Total	**2,887,861.60**	**5,715,723.20**	**9,333,584.80**	**11,951,446.40**	**11,951,446.40**

2.6.3 Cost Per Head

The cost per head is approximately THB 73,913.21 per year.

2.7 Studying Venue

☑ Classroom

☐ Distance learning mainly through publication.

☐ Distance learning mainly through audiovisual media.

☐ E-learning.

☐ Distance learning through the Internet.

☐ Other (Specify) .....online.....

2.8 Credit Transfer

As specified in the 2016 Naresuan University Regulations for Undergraduate Studies (2559 BE).

3. Program Details

3.1 Program

3.1.1 Number of Credits

A minimum of 129 credits

3.1.2 Program Structure

No.	Category		MoE 2015 Criteria	New Program 2022
1	**General Education**	**a minimum of**	**30**	**30**
	1.1 Languages	a minimum of		12
	Required			
	- English	a minimum of		3
	- Thai	a minimum of		3
	Elective			
	Select from English, Thai, or Foreign language group			
		a minimum of		6
	1.2 Humanities	a minimum of		6
	1.3 Social Sciences	a minimum of		6
	1.4 Science and Math	a minimum of		6
	1.5 Physical Education (required non-credit)			1
2	**Specialization**	**a minimum of**	**72**	**93**
	2.1 Core Course			31
	2.1.1 Fundamental courses in Science			19
	2.1.2 Fundamental courses in Engineering			12
	2.2 Major Specific Courses	a minimum of		62
	2.2.1 Major Required Courses			28
	2.2.1.1 Application Technologies			3
	2.2.1.2 Software Methods and Technologies			6
	2.2.1.3 Systems Infrastructure			6
	2.2.1.4 Computer Hardware and Architecture			13
	2.2.2 Program Specific			16
	2.2.2.1 Technical Skills			3
	2.2.2.2 Soft Skills and Life Skills			8
	2.2.2.3 Practice-oriented			5
	2.2.3 (*) Internship			(6)
	2.2.4 Major Elective Courses			18
3	**Free Elective**	**a minimum of**	**6**	**6**
	Total number of credits	**a minimum of**	**120**	**129**

Notes (*) Requirements for graduation. Students must enroll for internship and must pass the criteria defined by the program.

3.1.3 Courses

(1) General Education — a minimum of 30 credits

(1.1) Language courses — a minimum of 12 credits

(1.1.1) English language — a minimum of 3 credits

001211	English Listening and Speaking for Communication	3(2-2-5)
001212	English Critical Reading for Effective Communication	3(2-2-5)
001213	English Writing for Effective Communication	3(2-2-5)

(1.1.2) Thai language — a minimum of 3 credits

Select from the following courses

001301	Thai Language for Academic Communication	3(2-2-5)
001302	Thai Language for Communication in the 21st Century	3(2-2-5)
001303	Reading in the Digital Age Century	3(2-2-5)

(1.1.3) Foreign language — a minimum of 6 credits

Select from the non-required English language courses or the non-required Thai language courses or the following courses

001311	Korean for Communication	3(2-2-5)
001312	Japanese for Communication	3(2-2-5)
001313	Chinese for Communication	3(2-2-5)
001314	Myanmar for Communication	3(2-2-5)
001315	French for Communication	3(2-2-5)
001316	Spanish for Communication	3(2-2-5)
001317	Lao for Communication	3(2-2-5)
001318	Indonesian for Communication	3(2-2-5)
001319	Vietnamese for Communication	3(2-2-5)
001320	Hindi for Communication	3(2-2-5)
001321	Khmer for Communication	3(2-2-5)

(1.2) Humanities — a minimum of 6 credits

Select from the following courses

001221	Information Science for Study and Research	3(2-2-5)
001222	Language, Society and Culture	3(2-2-5)

001224	Arts in Daily Life	3(2-2-5)
001226	Ways of Living in the Digital Age	3(2-2-5)
001227	Music Studies in Thai Way of Life	3(2-2-5)
001228	Happiness with Hobbies	3(2-2-5)
001238	Media Literacy	3(2-2-5)
001241	Western Music in Daily Life	3(2-2-5)
001242	Creative Thinking and Innovation	3(2-2-5)
001253	Entrepreneurship for Small Business Start-up	3(2-2-5)
001276	Energy and Technology around Us	3(2-2-5)
001331	Social Innovation	3(2-2-5)
001332	Introduction to Data Management in Digital Era	3(2-2-5)

(1.3) Social Sciences a minimum of 6 credits

Select from the following courses

001231	Philosophy of Life for Sufficient Living	3(2-2-5)
001232	Fundamental Laws for Quality of Life	3(2-2-5)
001233	Thai State and the World Community	3(2-2-5)
001234	Civilization and Local Wisdom	3(2-2-5)
001235	Politics, Economy and Society	3(2-2-5)
001236	Living Management	3(2-2-5)
001237	Life Skills	3(2-2-5)
001239	Leadership and Compassion	3(2-2-5)
001251	Group Dynamics and Teamwork	3(2-2-5)
001252	Naresuan Studies	3(2-2-5)
001254	The King’s Philosophy for Living	3(2-2-5)
001351	From Sufficiency Economy Philosophy (SEP) to Practice	3(2-2-5)
001352	Peace and Religion for Human Kinds	3(2-2-5)
001353	Principles of Accounting for Entrepreneur	3(2-2-5)

(1.4) Science and Math a minimum of 6 credits

Select from the following courses

001271	Man and Environment	3(2-2-5)
001272	Introduction to Computer Information Science	3(2-2-5)

001273	Mathematics and Statistics in Everyday Life	3(2-2-5)
001274	Drugs and Chemicals in Daily Life	3(2-2-5)
001275	Food and Life Style	3(2-2-5)
001277	Human Behavior	3(2-2-5)
001278	Life and Health	3(2-2-5)
001279	Science in Everyday Life	3(2-2-5)
001291	Consumption in Daily Life	3(2-2-5)
001292	Circular Economic Lifestyle for 21st Century	3(2-2-5)
	(1.5) Physical Education	1 credit
001281	Sports and Exercises	1(0-2-1)
	(2) Specialization Courses	A minimum of 93 credits
	(2.1) Core Courses	a minimum of 31 credits
	(2.1.1) Fundamental Courses in Science	19 credits
252182	Calculus 1	3(3-0-6)
252183	Calculus 2	3(3-0-6)
252284	Calculus 3	3(3-0-6)
261103	Introductory Physics	3(3-0-6)
261113	Laboratory in Introductory Physics	1(0-2-1)
316131	Computer Mathematics 1	1(0-2-2)
316132	Computer Mathematics 2	2(2-0-4)
316231	Applied Statistics	3(2-2-5)
	(2.1.2) Fundamental Courses in Engineering	12 credits
302151	Engineering Drawing	3(2-3-5)
316121	Computer Programming	3(2-3-6)
316122	Object-Oriented Programming	3(2-3-6)
316232	Data Structures and Algorithms	3(2-2-5)
	(2.2) Major Specific Courses	a minimum of 62 credits
	(2.2.1) Major Required Courses	28 credits
	(2.2.1.1) Application Technologies	3 credits

316311	Database	3(2-2-5)
	(2.2.1.2) Software Methods and Technologies	6 credits
316221	Artificial Intelligence	3(2-2-5)
316321	Introduction to Machine Learning	3(2-2-5)
	(2.2.1.3) Systems Infrastructure	6 credits
316331	Computer and Information Security	3(2-2-5)
316333	Distributed and Cloud Computing	3(2-2-5)
	(2.2.1.4) Computer Hardware and Architecture	13 credits
316141	Introduction to Internet of Things	3(2-2-5)
316241	Introduction to Digital Logic	3(2-2-5)
316242	Computer Networks	3(2-2-5)
316243	Electronics and Circuits	4(3-3-8)
	(2.2.2) Program Specific Courses	16 credits
	(2.2.2.1) Technical Skills	3 credits
316351	Innovation Design and Development	3(2-2-5)
	(2.2.2.2) Soft Skills and Life Skills	8 credits
300301	Technopreneur	3(2-2-5)
316101	Soft Skill 1: Exploration	1(0-3-2)
316102	Soft Skill 2: Personal Growth	1(0-3-2)
316201	Soft Skill 3: Engineering Teamwork	1(0-3-2)
316202	Soft Skill 4: Community Collaboration	1(0-3-2)
316301	Soft Skill 5: Professional Practices	1(0-3-2)
	(2.2.2.3) Practice-oriented	5 credits
316191	Field Experience 1	1(0-3-2)
316291	Field Experience 2	1(0-3-2)
316292	Field Experience 3	1(0-3-2)

316391 Field Experience 4 1(0-3-2)

316392 Field Experience 5 1(0-3-2)

If students would like to learn through additional practical work, they may enroll in the following two optional practice-oriented courses.

316190 Work Integrated Learning 1 3(0-9-5)

316290 Work Integrated Learning 2 3(0-9-5)

(2.2.3) Internship (*) 6 credits

316390 Internship 6 credits

<u>Notes</u> (*) Requirements for graduation. Students must enroll in 316390 internship and must pass the criteria defined by the program.

(2.2.4) Major Elective Courses a minimum of 18 credits

Select from the following 3 tracks

(2.2.4.1) Coursework Track a minimum of 18 credits

For students who would like to gain knowledge and skills through course work and a senior project, they must

(a) Select a minimum of 12 credits from the list of elective courses.

(b) Enroll in the two engineering project courses.

i. 316491 Engineering Project 1 3(0-6-3)

ii. 316492 Engineering Project 2 3(0-6-3)

(2.2.4.2) Practicum Track a minimum of 18 credits

For students who would like to learn from the practical work experience, they must

(a) Select a minimum of 6 credits from the list of elective courses.

(b) Get an approval from the course instructor for the two practicum courses listed below.

(c) Enroll in the following two practicum courses.

i. 316493 Industrial Practicum 1 6(0-18-9)

ii. 316494 Industrial Practicum 2 6(0-18-9)

(2.2.4.3) Research Track a minimum of 18 credits

For students who would like to learn from conducting in-depth research, they must

(a) Select a minimum of 6 credits from the list of elective courses

(b) Get an approval from the course instructor for the two research courses listed below.

(c) Enroll in the following two research courses

i. 316495 Undergraduate Research 1 6(0-12-6)

ii. 316496 Undergraduate Research 2 6(0-12-6)

(d) To graduate under this tracks, student's academic article must be submitted and accepted for publication or presenting at a conference.

List of elective courses

316322	Introduction to Data Analytics	3(2-2-5)
316332	Cybersecurity	3(2-2-5)
316352	Personal Process for Product Development	3(2-2-5)
316353	Software Engineering for IIE	3(2-2-5)
316411	Computer Graphics	3(2-2-5)
316412	Computer Vision	3(2-2-5)
316413	Digital Image Processing	3(2-2-5)
316414	Game Programming	3(2-2-5)
316421	Big Data Analysis	3(2-2-5)
316422	Blockchain Technology	3(2-2-5)
316423	Data Analysis and Visualization	3(2-2-5)
316424	Knowledge Representation and Reasoning	3(2-2-5)
316425	Natural Language Processing System	3(2-2-5)
316431	Network Integration	3(2-2-5)
316432	Sensor Networks	3(2-2-5)
316433	Parallel Computing	3(2-2-5)
316434	Advanced Statistics	3(2-2-5)
316435	Digital Signal Processing	3(2-2-5)
316436	Signals and Systems	3(2-2-5)
316441	Industrial Robot	3(2-2-5)
316442	Embedded System for IIE	3(2-2-5)
316443	Unmanned System Application for IIE	3(2-2-5)

316481	Special Topic in IIE	3(2-2-5)
316482	Current Interest in IIE	3(2-2-5)
316483	New Development in IIE	3(2-2-5)
316484	New Application in IIE	3(2-2-5)
316485	Selected Topic in IIE	3(2-2-5)
316486	Advancement in IIE	3(2-2-5)
316487	Progress in IIE	3(2-2-5)
316488	Emergence in IIE	3(2-2-5)
316489	Special Topic in IIE related fields	3(2-2-5)

(3) Free Elective a minimum of 6 credits

Students may select any course offered in English language by Naresuan University or other institutes approved by Naresuan University.

3.1.4 Study plan

Year 1

First Semester

001xxx	General Education (English Language)	3(2-2-5)
001xxx	General Education (Thai Language)	3(2-2-5)
252182	Calculus 1	3(3-0-6)
261103	Introductory Physics	3(3-0-6)
261113	Laboratory in Introductory Physics	1(0-2-1)
316101	Soft Skill 1: Exploration	1(0-3-2)
316121	Computer Programming	3(2-3-6)
316131	Computer Mathematics 1	1(0-2-2)
316141	Introduction to Internet of Things	3(2-2-5)
	Total	21 credits

Year 1

Second Semester

001xxx	General Education (Language)	3(2-2-5)
001xxx	General Education (Humanities)	3(2-2-5)
252183	Calculus 2	3(3-0-6)
302151	Engineering Drawing	3(2-3-5)
316102	Soft Skill 2: Personal Growth	1(0-3-2)
316122	Object-Oriented Programming	3(2-3-6)
316132	Computer Mathematics 2	2(2-0-4)
316191	Field Experience 1	1(0-3-2)
	Total	**19 credits**

Year 1

Summer Semester (*)

316190	Work Integrated Learning 1	3(0-9-5)
	Total	**3 credits**

Notes

*** This is an option for students who would like to pursue the Practicum track. Students must**

- **pass all required courses of the first semester of Year 1.**
- **receive an approval from the course instructor.**

This course may be treated as a major elective course or a free elective course.

Year 2

First Semester

001xxx	General Education (Language)	3(2-2-5)
001xxx	General Education (Social Sciences)	3(2-2-5)
252284	Calculus 3	3(3-0-6)
316201	Soft Skill 3: Engineering Teamwork	1(0-3-2)
316231	Applied Statistics	3(2-2-5)
316232	Data Structures and Algorithms	3(2-2-5)
316241	Introduction to Digital Logic	3(2-2-5)
316291	Field Experience 2	1(0-3-2)
	Total	**20 credits**

Year 2

Second Semester

001xxx	General Education (Humanities)	3(2-2-5)
001xxx	General Education (Science and Math)	3(2-2-5)
316202	Soft Skill 4: Community Collaboration	1(0-3-2)
316221	Artificial Intelligence	3(2-2-5)
316242	Computer Networks	3(2-2-5)
316243	Electronics and Circuits	4(3-3-8)
316292	Field Experience 3	1(0-3-2)
	Total	**18 credits**

Year 2

Summer Semester (*)

316290	Work Integrated Learning 2	3(0-9-5)
	Total	**3 credits**

Notes

*** This is an option for students who would like to pursue the Practicum track. Students must**

(1) pass all required courses of Year 1

(2) pass all required courses of the first semester of Year 2

(3) receive an approval from the course instructors.

This course may be treated as a major elective course or a free elective course.

Year 3

First Semester

001xxx	General Education (Social Science)	3(2-2-5)
001281	Sports and Exercises (Required non-credit)	1(0-2-1)
316301	Soft Skill 5: Professional Practices	1(0-3-2)
316311	Database	3(2-2-5)
316321	Introduction to Machine Learning	3(2-2-5)
316331	Computer and Information Security	3(2-2-5)
316333	Distributed and Cloud Computing	3(2-2-5)
316391	Field Experience 4	1(0-3-2)
xxxxxx	Free Elective	3 credits
	Total	**20 credits**

Year 3

Second Semester

001xxx	General Education (Science and Math)	3(2-2-5)
300301	Technopreneur	3(2-2-5)
316351	Innovation Design and Development	3(2-2-5)
316392	Field Experience 5	1(0-3-2)
316xxx	Elective Course	3(x-x-x)
316xxx	Elective Course	3(x-x-x)
xxxxxx	Free Elective	3 credits
	Total	**19 credits**

Year 3

Summer Semester

316390	Internship (Required non-credit)	6 credits
	Total	6 credits

Notes

Requirements for graduation. Students must enroll for internship and must pass the specific criteria.

Year 4

First Semester

Students may select one of the following three tracks.

1. Coursework Track[1]

316xxx	Elective Course	3(x-x-x)
316491	Engineering Project 1	3(0-6-3)
	Total	**6 credits**

2. Practicum Track[2]

316493	Industry Practicum 1	6(0-18-9)
	Total	**6 credits**

3. Research Track[3]

316495	Undergraduate Research 1	6(0-12-6)
	Total	**6 credits**

<u>Notes</u>

1. For students who would like to gain knowledge and skills through coursework and conducting a senior project.
2. For students who would like to learn from practical work experience. Students must get an approval from the course instructor before enrolling in this track.
3. For students who would like to learn from conducting in-depth research. Students must get an approval from the course instructor before enrolling in this track. Student's academic article must be submitted and accepted for publication or presenting at a conference.

Year 4

Second Semester

Students may select one of the following three tracks.

1. Coursework Track[1]

316xxx	Elective Course	3(x-x-x)
316492	Engineering Project 2	3(0-6-3)
	Total	**6 credits**

2. Practicum Track[2]

316494	Industry Practicum 2	6(0-18-9)
	Total	**6 credits**

3. Research Track[3]

316496	Undergraduate Research 2	6(0-12-6)
	Total	**6 credits**

<u>Notes</u>

1. For students who would like to gain knowledge and skills through coursework and conducting a senior project.
2. For students who would like to learn from practical work experience. Students must get an approval from the course instructor before enrolling in this track.
3. For students who would like to learn from conducting in-depth research. Students must get an approval from the course instructor before enrolling in this track. Student's academic article must be submitted and accepted for publication or presenting at a conference.

3.1.5 Course descriptions

001211 English Listening and Speaking for Communication 3(2-2-5)

English listening and speaking skills for communication with emphasis on pronunciation, word and sentence stress, intonation, cross-cultural understanding, listening and speaking practice in everyday and job-related topics.

001212 English Critical Reading for Effective Communication 3(2-2-5)

English language skills for critical reading with emphasis on reading for main ideas and supporting details, guessing meaning from contexts, making inferences, distinguishing facts and opinions, identifying the author's purpose, attitude and tone of voice, evaluating information and ideas.

001213 English Writing for Effective Communication 3(2-2-5)

English language skills for effective written communication with emphasis on practice in writing sentences and paragraphs with proper and correct use of vocabulary, grammar, structure and organization.

001221 Information Science for Study and Research 3(2-2-5)

The meaning and importance of information, types of information sources, access to different sources of information; application of information technology and communication, media and information literacy, knowledge management, selection, synthesis, and presentation of information as well as creating positive attitudes and a sense of inquiry in students, diligence, patience, honesty and gratitude to the country.

001222 Language, Society and Culture 3(2-2-5)

The relationship between language and society as well as language and culture in terms of the ways in which language reflects society and culture. The study includes verbal and symbolic communication, new meanings of social and cultural structure, changes of language and usages in borderless world.

001224 Arts in Daily Life 3(2-2-5)

Art fundamentals and understanding in the basic features, meaning, value, differences and the relationship between the various categories of works of art including fine art, applied art, visual art, audio art, audiovisual art, and new media art. Through the artistic experience and basic practice on various types of art. For developing knowledge, understanding and indoctrinating aesthetic judgment that can be applied in daily life, harmonized with the social context in both the global and local levels.

001226 Ways of Living in the Digital Age 3(2-2-5)

Development of skills in media usage, various computer equipment utilization, inquiries, analysis, measurement, rights and creation, including ethical awareness and individual responsibility to the society in communication behaviors.

001227 Music Studies in Thai Way of Life 3(2-2-5)

Music development and characteristic in Thai way of life. Cultural and Social significance role, values, changes, aesthetic as well as the 21st Century competence.

001228 Happiness with Hobbies 3(2-2-5)

Concept of happiness, basic elements of happiness in life, creative thinking, creation of works from hobbies to promote life and social happiness.

001231 Philosophy of Life for Sufficient Living 3(2-2-5)

Basic philosophical and conceptual knowledge on worldview, attitude, philosophy for life, lifestyle, valuable experiences and factors or conditions which influence success in all aspects of life and profession of respected people.

001232 Fundamental Laws for Quality of Life 3(2-2-5)

The laws concerning the quality of student life such as basic rights, human rights, media ethics in the digital age, intellectual property law, environmental laws, the laws relating to the protection of art and culture as well as the laws pertaining to the developments towards the 21st century.

001233 Thai State and the World Community 3(2-2-5)

Relations between Thailand and the world community under changes over time premodern period to the present day and roles of Thailand in the world forum including future trends, applications of knowledge in self-improvement, ethic of life management and being a good citizen of Thailand and the world.

001234 Civilization and Local Wisdom 3(2-2-5)

Development of local wisdom effecting to gain the body of knowledge in art and culture with concrete and abstract areas which is a foundation of Thai civilization and a path of developing innovation in art and culture creatively on a foundation of local wisdom and Thai civilization for maintaining, promoting value with worthiness and sustainable integration.

001235 Politics, Economy and Society 3(2-2-5)

Meaning and relationship of politics, economy and society, development of international politics, fundamental politics, politics and the adjustment of developed and developing countries, Thai politics, World economy systems, influences of globalization in terms of economy, fundamental economy, the development of economy and society of Thailand, human and society, fundamental sociology, social order, social refinement, social characteristics, uniqueness of Thai society and the application of the body of knowledge to one' s living in a dynamic world of change in politics, economy and society and relationships of world and Thai systems.

001236 Living Management 3(2-2-5)

Living Management: knowledge and skills concerning role, duty and human nature as well as factors relating to sustainable development in improving responsibility, thinking skills and being updated with modern science and technology in daily life. Living ethically along the dynamics of the 21st century which is essential to the members of ASEAN Community as well as the world community.

001237 Life Skills 3(2-2-5)

Knowledge, relating to role, duty, and responsibility of an individual both as a member of a family and a member of a society which include adaptation to changes in a society, life and career skills in the 21st century, flexibility and adaptability skills, creativity and self- direction skills, intra- social and cross culture interaction skills, productivity and accountability skills, leadership and responsibility skills.

001238 Media Literacy 3(2-2-5)

The process of media literacy in the digital age. Understanding of the 21st century media effect theories, such as myth semiology and advertising concept, attributes and influence of contemporary and digital media, including analyzing contents on every current platform.

001239 Leadership and Compassion 3(2-2-5)

The importance of leader, leadership in the 21st century, learning and living with love, good global citizenship, studying good practices of conducting public activities as a guideline for learners' own activities.

001241 Western Music in Daily Life 3(2-2-5)

Aesthetics of music, elements, structure and the history of western music. Style of music in daily life. Criticism and admiration of music. The application and process of western music in daily life.

001242 Creative Thinking and Innovation 3(2-2-5)

Innovation development process; means of accessing customers' mind and discovering the roots of problems; generating and selecting ideas, creating rough prototypes, testing in the field and extracting information, quick and efficient design-build-test cycles, getting things done as a multidisciplinary team: brainstorming, making decisions, giving constructive comments and managing conflicts.

001251 Group Dynamics and Teamwork 3(2-2-5)

Various behaviors regarding grouping behaviors, development of group characterization, group' s environments, interpersonal relations versus group involvement, group persuasion, change in group attitudes, intra-group communication, teamwork model, guideline to create team and network, group unity, factors enhancing and practicing teamwork.

001252 Naresuan Studies 3(2-2-5)

This course aims to study on the biography of King Naresuan the Great. The emphasis is placed on economy, society and foreign affair which reflect to Thai identity such as knowledge acquisition, endeavor and tolerance.

001253 Entrepreneurship for Small Business Start-up 3(2-2-5)

The entrepreneurial practices with an emphasis on learning how to find business ideas, evaluation of new market opportunities and starting a new venture; focuses on identifying and evaluating new venture, and how to recognize the barriers to success. Exposure to the stresses of a start-up business, the uncertainties that exist, and the behavior of entrepreneurs. Theoretical overview, entrepreneurs, entrepreneurship's links with other disciplines, and entrepreneurial networks and alliances. Strategies for sustainable survival.

001254 The King's Philosophy for Living 3(2-2-5)

Biography, ideas, philosophy, royal duties, royal initiative projects of the late His Majesty King Bhumibol Adulyadej with special reference to living.

001271 Man and Environment 3(2-2-5)

Ecosystems and biodiversity, man- nature and ecosystem service, human structure and system change that effects on environment, planetary boundary, climate change, sustainable development goals, environmental ethic and consciousness building, and environmental public participation.

001272 Introduction to Computer Information Science 3(2-2-5)

Evolution of computer technology from past to present and a possible future, computer hardware, software and data, how a computer works, basic computer network, Internet and applications on the Internet, risks of a system usage, data management, information system, office automation software, multimedia technology, web-based media publishing, web design and development and an influence of technology on human and society.

001273 Mathematics and Statistics in Everyday Life 3(2-2-5)

Measurement, surface area and volume of geometric shapes, introduction to mathematics in financial fields, survey and data collection methods, data analysis and presentation for basic research, application of probability to statistical decision making.

001274 Drugs and Chemicals in Daily Life 3(2-2-5)

Basic Knowledge of drug and chemical, nutrition, food supplement including cosmetics and herbal medicinal product commonly used in daily life and related to health as well as their proper selection and management for health and environmental safety.

001275 Food and Life Style 3(2-2-5)

Roles and importance of food in daily life, cultures and consumption behavior around the world including the influence of foreign cultures on Thai consumption behavior, identity and wisdom of food in Thailand, proper food selections according to basic needs, food choices, information for purchasing food, and food and life style in the age of globalization with the awareness of environmental conservation.

001276 Energy and Technology around Us 3(2-2-5)

Fundamental knowledge of energy and technology around us; energy sources and knowledge about electrical energy, fuel energy and alternative energy; relationship between technology and energy consumption; direct and indirect energy consumption; global warming and related energy situation; current issues and relationship to energy and technology; participation in energy conservation; efficient energy use and proactive approach to energy issuers.

001277 Human Behavior 3(2-2-5)

The knowledge of human behaviors such as behavioral concepts; biological basis and mechanisms of human behaviors; mindfulness, meditation, consciousness and its involved substances; sensory perception, learning and memory, language; the intelligent and others quotients; social behaviors; abnormal behaviors; human behavioral analysis and applications in daily life.

001278 Life and Health 3(2-2-5)

Life and health behavior, health care and promotion for each age group including the implementation of the health knowledge and skills for continuous improvement of the quality of life for oneself and others.

001279 Science in Everyday Life 3(2-2-5)

The role of science and technology with concentration on both biological and physicals science and integration of earth science in everyday life, including organisms and environments, chemical, energy and electricity, telecommunications, meteorology, earth, space and the new frontier of science and technology.

001281 Sports and Exercises 1(0-2-1)

The sport playing, exercises for improvement of the physical fitness and physical fitness test.

001291 Consumption in Daily Life 3(2-2-5)

Importance of consumption, good nutritional status and practical guidelines for good food consumption, Choosing medicines and safe health products, food safety, management of consumerism effects, consumer rights, laws and organizations for consumer protection.

001292 Circular Economic Lifestyle for 21st Century 3(2-2-5)

Learning the value of nature to human life in the use of resources and being a source of support and pollution treatment, crisis of resource problems, climate and environmental emergency situations, concepts throughout the life cycle and business design

process under the concept of circular economy, business model innovation to the circular economy, lifestyle under the concept of circular economy, awareness and driving force to the way of life under the concept of circulating economy and circulating economy society.

001301 Thai Language for Academic Communication 3(2-2-5)

Reading for information; writing and speaking for academic presentation.

001302 Thai Language for Communication in the 21st Century 3(2-2-5)

Developing Thai communication skills for appropriate and updated use in the 21st century.

001303 Reading in the Digital Age Century 3(2-2-5)

Developing reading skill in context of digital society for knowledge and improving the quality of life.

001311 Korean for Communication 3(2-2-5)

Basic Korean communication skills used in daily life situations and learning of Korean culture.

001312 Japanese for Communication 3(2-2-5)

Basic Japanese communication skills used in daily life situations and learning of Japanese culture.

001313 Chinese for Communication 3(2-2-5)

Basic Chinese communication skills used in daily life situations and learning of Chinese culture.

001314 Myanmar for Communication 3(2-2-5)

Basic Myanmar communication skills used in daily life situations and learning of Myanmar culture.

001315 French for Communication 3(2-2-5)

Basic French communication skills used in daily life situations and learning of French culture.

001316 Spanish for Communication 3(2-2-5)

Basic Spanish communication skills used in daily life situations and learning of Spanish culture.

001317 Lao for Communication 3(2-2-5)

Basic Lao communication skills used in daily life situations and learning of Lao culture.

001318 Indonesian for Communication 3(2-2-5)

Basic Indonesian communication skills used in daily life situations and learning of Indonesian culture.

001319 Vietnamese for Communication 3(2-2-5)

Basic Vietnamese communication skills used in daily life situations and learning of Vietnamese culture.

001320 Hindi for Communication 3(2-2-5)

Basic Hindi communication skills used in daily life situations and learning of Hindi culture.

001321 Khmer for Communication 3(2-2-5)

Khmer language communication skills used in daily life situations and learning of Cambodian culture.

001331 Social Innovation 3(2-2-5)

Introduction to social innovation, future uncertainties (21st Century challenges, 4th Industrial revolution), global Issues (social and environmental issues), sustainable development goals (SDGs), sustainable community (eco village), public participation, introduction to innovation, social enterprises, 21st entrepreneurship (social technopreneur), case study (development of social innovation entrepreneurship).

001332 Introduction to Data Management in Digital Era 3(2-2-5)

Overview of data management, fundamentals and tools for big data and data science, data analytics and techniques of information presentation for business value by using modern tools.

001351 From Sufficiency Economy Philosophy (SEP) to Practice 3(2-2-5)

Meaning, origin, and application of the Sufficiency Economy Philosophy (SEP), the definition of 3 chains 2 conditions, in details, sufficiency philosophy to achieve principles of strategy for livelihood, reasonableness and scientific method to achieve successful working, and immunity to maintain of physical and mental health in relation to life homeostasis, principles of reading habits practice, information searching principles, introduction to information presentation methods, knowledge for the 21st century, principles of being good citizen, honesty, empathy, and public mind practice.

001352 Peace and Religion for Human Kinds 3(2-2-5)

Learning of the value concept, theory, peace, religion principles and morals based on religion and key mans, moral principles, needs, social problems, conflict, organization, socialization, reasonability, friendship, encroachment, harmonious, reconciliation speech, peaceful method, human kind on 21st century, value experience of key man with useful for creatively apply to be human calming and peace to human kinds.

001353 Principles of Accounting for Entrepreneur 3(2-2-5)

Types of business, business formation, basic accounting and taxation for entrepreneurs, components of financial reports, basic analysis of accounting information and management accounting for business decision making, information technology for accounting and taxation.

252182 Calculus 1 3(3-0-6)

Mathematical induction, algebraic and transcendental functions, limits and continuity, derivatives and their applications, integrals and their applications, techniques of integration, improper integrals.

252183 Calculus 2 3(3-0-6)

Prerequisite: 252182 Calculus 1

Sequences and series, tests of series, power series, Taylor's series, Laurent's series, matrices and determinants, rank of matrices, solutions to systems of linear equations, Cramer's rule, vector spaces, subspaces, bases and dimension, linear transformations, eigenvalues and eigenvectors.

252284 Calculus 3 3(3-0-6)

Prerequisite: 252183 Calculus 2

Linear differential equations of first and higher order, analytical and numerical solutions, Laplace transforms and their applications, vector fields, divergence, curl, differentiation and integration of several variables, line integrals, surface integrals, Green's theorem, Gauss's theorem and Stokes's theorem.

261103 Introductory Physics 3(3-0-6)

Mathematics for physics, law of motion and gravitational force, work and energy, momentum and collisions, rotation and rolling motion, properties of matter, fluid mechanics, wave phenomena, thermodynamics, electricity and magnetism, basic electric circuits, modern physics.

261113 Laboratory in Introductory Physics 1(0-2-1)

Basic laboratory in correspond to the contents of introduction physics: law of motion, gravitational force, work and energy, momentum and collisions, rotation, motion, properties of matter, fluid mechanics, wave phenomena, thermodynamics, electricity and magnetism, basic electrical circuits, modern physics.

300301 Technopreneur 3(2-2-5)

Entrepreneurship, characteristics of entrepreneurs, types of entrepreneurs and entrepreneurial concepts, technology-based entrepreneur, introduction to technology ventures/startups, different elements of technology venture creation including opportunity identification and validation, ideation, teaming, customer discovery, market analysis, minimum viable product development, business models, intellectual property, pitching and capital raises, project management.

302151 Engineering Drawing 3(2-3-5)

Lettering; orthographic projection; orthographic drawing and pictorial drawings; dimensioning and tolerancing; sections, auxiliary views and development; freehand sketches; detail and assembly drawings, computer-aided drawing.

316101 Soft Skill 1: Exploration 1(0-3-2)

Introduction to intelligent innovation engineering profession; how to learn and to work, validated learning; personal management, time management, basic financial planning; fundamental knowledge, skills and attitudes for professional; professional and ethical responsibilities.

316102 Soft Skill 2: Personal Growth 1(0-3-2)

Growth mindset, goal management, work planning; self-management, personal canvas; personal balanced score card; personal process; self-reflection; process improvement.

316121 Computer Programming 3(2-3-6)

Basic syntax and semantics of a higher-level language; variables and primitive data types (e.g., numbers, characters, Booleans); expressions and assignments; simple I/O including file I/O; conditional and iterative control structures; functions and parameter passing; recursion.

316122 Object-Oriented Programming 3(2-3-6)

Programming constructs and paradigms; problem-solving strategies; object-oriented design; event-driven and concurrent programming; using application programming interface.

316131 Computer Mathematics 1 1(0-2-2)

Sets; functions; relations; number systems and codes; two's complement number representation; floating point number representation; propositional and first-order logic.

316132 Computer Mathematics 2 2(2-0-4)

Boolean algebra principles, proof techniques; basics of counting; graphs and trees representations and properties; iteration and recursion; finite state machine.

316141 Introduction to Internet of Things 3(2-2-5)

Introduction to understanding for Internet of Things (IoT) concept and design; IoT components; end-device implementation; sensor node; device connectivity and network; introduction to IoT cloud; mobile application design for IoT; case study of modern IoT solution.

316190 Work Integrated Learning 1 3(0-9-5)

Learning through working in a work-place setting.

316191 Field Experience 1 1(0-3-2)

Applying knowledge and skills learned from the first semester of year 1 in real-world environment.

316201 Soft Skill 3: Engineering Teamwork 1(0-3-2)

Non-violent communication; team development and collaboration, self-directed team, high-performance team, shared accountability; task monitoring; inspect-and-adapt cycle; team-reflection; dealing with uncertainty and ambiguity, iterative work-product releases.

316202 Soft Skill 4: Community Collaboration 1(0-3-2)

Effective communication strategies; collaboration with community; knowledge transfer; design thinking, empowerment and reinforcement; process improvement; dealing with multicultural environments; business-hypothesis-driven experimentation; ethical issues: product, judgment, management, profession, and public; multidisciplinary team approaches; philosophical frameworks and cultural issues; engineering solutions and societal effects.

316221 Artificial Intelligence 3(2-2-5)

Fundamental concept of artificial intelligence; intelligent agents; search algorithms; game playing; uncertainty and probability theory; Markov Decision Process; Reinforcement Learning; Bayesian Networks; introduction to machine learning; introduction to neural networks and deep learning; applications of AI techniques.

316231 Applied Statistics 3(2-2-5)

Discrete probability; continuous probability; expectation and deviation; stochastic processes; sampling distribution; estimation; hypothesis tests; correlation and regression.

316232 Data Structures and Algorithms 3(2-2-5)

Data structures: array, linked lists, stacks, queues, trees; relevant tools, standards and/or engineering constraints; basic algorithmic analysis; algorithmic strategies; classic algorithms for common tasks; analysis and design of application-specific algorithms; parallel algorithms and multi-threading; algorithmic complexity.

316241 Introduction to Digital Logic 3(2-2-5)

Introduction to understanding for digital logic concept and design; Number systems and data encoding; Boolean algebra applications; basic logic circuits; modular design of combinational circuits; basic logic design for modern innovation.

316242 Computer Networks 3(2-2-5)

Basics of data communications, OSI model and techniques, applications and control of modern data communication networks; network models; digital and analog transmission; multiplexing, circuit and packet switching; Internet; network protocols analysis.

316243 Electronics and Circuits 4(3-3-8)

Resistive elements and networks; independent and dependent sources; switches and MOS transistors; digital abstraction; amplifiers; energy storage elements; dynamics of first-order and second-order networks; design in the time and frequency domains; analog / digital circuits and applications.

316290 Work Integrated Learning 2 3(0-9-5)

Improving knowledge and skills through working in a work-place setting.

316291 Field Experience 2 1(0-3-2)

Practicing skills and knowledge from year 1 in real-world environment.

316292 Field Experience 3 1(0-3-2)

Applying knowledge and skills from year 1 and the first semester of year 2 in real-world environment.

316301 Soft Skill 5: Professional Practices 1(0-3-2)

Professional characteristics and competency; 360-degree communication; tradeoffs in professional practice; information technology related laws and ethics; contemporary approaches in working such as agile, management 3.0; scaling practices.

316311 Database 3(2-2-5)

Fundamental concepts of database design and implementation; data models (ER, relational and others); data description languages; and query languages (relational algebra and SQL); data normalization; transactions and their properties; physical data organization and indexing; security issues and object databases; new trends in databases.

316321 Introduction to Machine Learning 3(2-2-5)

Linear regression; logistic regression; optimization; decision tress; kNN; probabilistic classifiers; neural network; support vector machine; reinforcement learning; introduction to deep learning; representations and autoencoders; variational autoencoders; generative adversarial network; Hopfield nets.

316322 Introduction to Data Analytics 3(2-2-5)

Digital transformation; exploratory data analysis with critical thinking; data analytics process; data identification; data acquisition & filtering; data analytics tools; data extraction, data validation & cleansing; data aggregation & representation; data analysis; machine learning for data analysis; data visualization; data storytelling.

316331 Computer and Information Security 3(2-2-5)

Introduction to computer and information security; relevant tools, standards, and engineering constraints; data security and integrity; vulnerabilities: technical and human factors; resource protection models; secret and public key cryptography; message authentication codes; network and web security; authentication; trusted computing; side-channel attacks.

316332 Cybersecurity 3(2-2-5)

Identity management; personal compliance with cybersecurity rules, policy and ethical norms; social and behavioral privacy; Personal data privacy and security; risk management; security governance and policy.

361333 Distributed and Cloud Computing 3(2-2-5)

Definition and basic characteristics of distributed systems; processes and communication: client/server, distributed objects, message-oriented, publish-subscribe, peer to peer; synchronization in distributed environments; distributed transactions; selected distributed algorithms, synchronous and asynchronous network models; consensus and coordination without and with failures; group communication; performance evaluation of distributed systems; peer-to-peer systems; cloud computing.

316351 Innovation Design and Development 3(2-2-5)

Creative and innovative mindset; awareness of the innovative product development process; materialization of ideas to commercialization of products; utilizing creative techniques and prototyping tools for ideas and concepts generation and validation; the divergent-convergent characteristic of the design process; incorporating expected user experience and competitiveness insight to the development of design brief and deliverable product features; considering end-user interaction and achieving latest scientific research.

316352 Personal Process for Product Development 3(2-2-5)

Product development process at the personal level; collecting data relevant to personal working process (effort, size, quality, and schedule); effort planning; task planning; schedule planning; progress tracking; quality planning; quality tracking; process improvement; performance analysis.

316353 Software Engineering for IIE 3(2-2-5)

Project management principles; user experience and human-computer interaction; risk, dependability, safety and fault tolerance; Hardware and software processes; requirements analysis and elicitation; system specifications; system architectural design and evaluation; concurrent hardware and software design; system integration, testing and validation; maintainability, sustainability, manufacturability.

316390 Internship 6 credits

Training in IIE field in either private sectors or governmental institutions at least 270 hours in order to gain both academic knowledge, skills, and experiences in intelligent innovation engineering related fields.

316391 Field Experience 4 1(0-3-2)

Solving a practical problem in real-world environment.

316392 Field Experience 5 1(0-3-2)

Developing an intelligent innovation engineering solution for a real-world problem.

316411 Computer Graphics 3(2-2-5)

Light, color and the human visual system; the modern computer graphics pipeline and toolkits; coordinate systems and transformations; color, lighting, and shading models; texture mapping; shader; animation; scene graphs.

316412 Computer Vision 3(2-2-5)

Basic image processing; image segmentation; feature extraction; conventional techniques on object detection and recognition; deep learning techniques on object detection and recognition; object tracking; applications of computer vision.

316413 Digital Image Processing 3(2-2-5)

Theory of signals and systems for two dimensions; fundamental of digital image processing; basic gray level transformation; histogram processing; filtering; color image processing; morphological image processing; image compression; applications of digital image processing.

316414 Game Programming 3(2-2-5)

Game engine scripting; event driven and data driven programming; game engine data structures; basic game related computer graphics; game physics; game control and input; game artificial intelligence; game sound and music.

316421 Big Data Analysis 3(2-2-5)

Fundamentals of Big Data; using Big Data in business; handling and processing Big Data; data ecosystem; Big Data solution; predictive modeling; Big Data management systems and analytical tools.

316422 Blockchain Technology 3(2-2-5)

Introduction to Blockchain technology; evaluating bitcoin; bootstrapping network effects through Blockchain technology and Crypto economics; using tokens to design new types of digital platforms; the future of Blockchain technology.

316423 Data Analysis and Visualization 3(2-2-5)

Digital transformation; data ecosystem; analyze, visualize and communicate data insights; interpret data to inform business strategy; parametric distributions; generalized linear model; model-based analyses; machine learning for data analysis; predictive algorithms; data visualization tools.

316424 Knowledge Representation and Reasoning 3(2-2-5)

Introduction to knowledge representation and reasoning; propositional logic; first-order logic; formalize reasoning; logic programs; non-monotonic logic; answer set programming; abductive reasoning; the logic of time.

316425 Natural Language Processing System 3(2-2-5)

Introduction to natural language processing; tokenization; language modeling; part of speech tagging and information extraction; parsing; sentiment analysis.

316431 Network Integration 3(2-2-5)

The Internet architecture and protocols; layered network architectures, addressing, naming, forwarding, routing, communication reliability, the client-server model, web and email protocols; programming reduced versions of real Internet protocols.

316432 Sensor Networks 3(2-2-5)

Sensor node architecture; WSN network architecture and deployment strategies; medium access control (MAC) in WSN; routing protocols in WSN; data centric and content-based networking; WSN project.

316433 Parallel Computing 3(2-2-5)

Parallel computing models and architectures; parallel programming language structure, sequential algorithms and parallel algorithms; design and analysis of parallel algorithms, complexity analysis; scalable system.

316434 Advanced Statistics 3(2-2-5)

Statistics and linear models; probability, expectations, conditional probabilities, distributions, confidence intervals, binomial proportions; likelihood concepts to hypothesis testing and case-control sampling; linear models for data science, least squares from a linear algebraic and mathematical perspective, statistical linear models, multivariate regression.

316435 Digital Signal Processing 3(2-2-5)

Introduction to digital signal processing; Nyquist sampling theorem; set transformation; techniques to design analog and digital filters; realization diagram of digital filter, discrete Fourier transform (DFT), and fast Fourier transform (FFT).

316436 Signals and Systems 3(2-2-5)

Basic concepts for both continuous-time and discrete-time signals and systems; Signal and system representations for both time and frequency domains; Fourier transform and its generalizations; filtering and filter design, modulation, and sampling for both analog and digital systems; basic concepts of feedback systems for both analog and digital systems.

316441 Industrial Robot 3(2-2-5)

Introduction to robotics; application of robots; robot configurations including mobile robot; spatial descriptions and transformations of objects in three-dimensional space; forward and inverse manipulator kinematics; task and trajectory planning; simulation and off-line programming.

316442 Embedded System for IIE 3(2-2-5)

Introduction to understanding for embedded system architecture and design for innovation solution; embedded system components; bus system; assembly language and high-level language programming for embedded system development; characteristics of embedded systems; firmware techniques for embedded applications; interfacing circuit design for embedded system; case study of modern smart solution.

316443 Unmanned System Application for IIE 3(2-2-5)

Introduction to understanding for modern unmanned system concept and categories; drone concept; drone component; drone configuration; drone safety and operation; drone flight control; drone programming; introduction to commercial home used robot; home robot structure and component; home robot path planning; home robot decision algorithm; case study of related technology.

316481 Special Topic in IIE 3(2-2-5)

Study and research of special topics in IIE and related fields.

316482 Current Interest in IIE 3(2-2-5)

Current interest in the areas of IIE and related fields.

316483 New Development in IIE 3(2-2-5)

New development in IIE and related fields.

316484 New Application in IIE 3(2-2-5)

New application related to IIE.

316485 Selected Topic in IIE 3(2-2-5)

IIE topics of special interest.

316486 Advancement in IIE 3(2-2-5)

Advancement and trends related to application, knowledge, and skills in IIE and related fields.

316487 Progress in IIE 3(2-2-5)

Interesting research topics in IIE and relevant fields that enhance or expand knowledge and / or skills.

316488 Emergence in IIE 3(2-2-5)

Emerging development or emerging applications in the field of IIE.

316489 Special Topic in IIE related fields 3(2-2-5)

Interesting topics in IIE related fields.

316491 Engineering Project 1 3(0-6-3)

Study for interesting topics in the IIE field; performing literature review; study for related theories; making and presenting the project progress reports to the project advisor and committees; establishing objectives and scope of the project.

316492 Engineering Project 2 3(0-6-3)

Research and development for a project in IIE field; study for related theories; making and presenting the project progress reports to the project advisor and committees; oral presentation of the project; project final report.

316493 Industry Practicum 1 6(0-18-9)

Prerequisite: students must receive an approval from the course instructor in order to enroll in this course.

Enhancing knowledge and skills by developing a solution for a real-world problem in a practical working environment.

316494 Industry Practicum 2 6(0-18-9)

Prerequisite: students must receive an approval from the course instructor in order to enroll in this course.

Operating, maintaining, and enhancing the application and/or devices deployed to the working environment.

316495 Undergraduate Research 1 6(0-12-6)

Practice how to search, read, think critically and give oral presentation of research or article in IIE related fields.

316496 Undergraduate Research 2 6(0-12-6)

Practice how to conduct research or build work product and give presentation of research, work product, or article in IIE related fields.

3.1.6 Course Numbering System

(1) The First Three Digits (digits 1 – 3)

001 General Education

300 Engineering Common Courses

305 Computer Engineering

316 Intelligent Innovation Engineering

(2) The Last Three Digits (digits 4 – 6)

Specific for Intelligent Innovation Engineering Program

(3) The Fourth Digit

The study year for which the course is designed.

(4) The Fifth Digit

The course clusters.

0 Foundation Course

1 Application Technologies

2 Software Methods and Technologies

3 Systems Infrastructure

4 Computer Hardware and Architecture

5 Program Specific

6 Program Specific

7 Program Specific

8 Special Topic

9 Practice-oriented courses

(5) The Last Digit (Digit 6)

The order of the course in its course cluster.

3.2 Names, Positions and Degrees of the Lecturers

3.2.1 Lecturers in charge of the program

No.	First name and last name	Academic Position	Academic Degree	Major	Institution	Country	Year of Graduation	Teaching Load (Hours / Week)	
								Current	Future
1	Jiraporn Pooksook	Lecturer	Ph.D.	Computer Science	Asian Institute of Technology	Thailand	2020	15	15
			M.Eng.	Computer Science	Asian Institute of Technology	Thailand	2011		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2005		
2	Jirarat Ieamsaard	Lecturer	Ph.D.	Electrical Engineering	Naresuan University	Thailand	2017	15	15
			M.Eng.	Electrical Engineering	Naresuan University	Thailand	2011		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2009		
4	Panupong Sornkhom	Lecturer	M.Eng.	Computer Engineering	King Mongkut's University of Technology Thonburi	Thailand	2008	32	37
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2000		
3	Settha Thangkawanit	Lecturer	Ph.D.	Computer Engineering	Naresuan University	Thailand	2019	30	30
			M.Eng.	Electrical Engineering	Naresuan University	Thailand	2008		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2006		
5	Yoseung Kim	Lecturer	M.Eng.	Computer Engineering	ChungNam National University	South Korea	2009	12	12
			B.Eng.	Computer Engineering	HanBat National University	South Korea	2001		
			B.Eng.	Electronics Engineering	The University of Soul	South Korea	1991		

3.2.2 Lecturers in the program

No.	First name and last name	Academic Position	Academic Degree	Major	Institution	Country	Year of Graduation	Teaching Load (Hours / Week)	
								Current	Future
1	Paisarn Muneesawang	Professor	Ph.D.	Computer Engineering	The University of Sydney	Australia	2003	4	4
			M.Eng.Sc.	Electrical Engineering	The University of New South Wales	Australia	2000		
			B.Eng.	Telecommunications Engineering	Mahanakorn University of Technology	Thailand	1996		
2	Phongphun Kijsanayothin	Assoc.Prof.	Ph.D.	Computer Science	Texas Tech University	USA	2010	8	11
			M.Eng.	Computer Engineering	Kasetsart University	Thailand	2002		
			B.Eng.	Computer Engineering	King Mongkut's Institute of Technology Ladkrabang	Thailand	1998		
3	Suchart Yammen	Assoc.Prof.	Ph.D.	Electrical Engineering	Vanderbilt University	USA	2001	28	32
			M.Sc.	Electrical Engineering	Vanderbilt University	USA	1998		
			B.Eng.	Electrical Engineering	Chiangmai University	Thailand	1988		
4	Panomkhawn Riyamongkol	Asst.Prof.	Ph.D.	Electrical and Computer Engineering	University of Miami	USA	2003	19	22
			M.S.E.CE.	Electrical and Computer Engineering	University of Miami	USA	1999		
			B.Eng.	Electrical Engineering	Chiangmai University	Thailand	1996		
5	Siriporn Dachasilaruk	Asst.Prof.	Ph.D.	Sound and Vibration	University of Southampton	UK	2015	9	9
			M.Eng.	Electrical Engineering	King Mongkut's Institute of Technology Ladkrabang	Thailand	2000		
			B.Sc.	Material Science	Chiangmai University	Thailand	1994		

No.	First name and last name	Academic Position	Academic Degree	Major	Institution	Country	Year of Graduation	Teaching Load (Hours / Week)	
								Current	Future
6*	Jiraporn Pooksook	Lecturer	Ph.D.	Computer Science	Asian Institute of Technology	Thailand	2020	16	17
			M.Eng.	Computer Science	Asian Institute of Technology	Thailand	2011		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2005		
7*	Jirarat Ieamsaard	Lecturer	Ph.D.	Electrical Engineering	Naresuan University	Thailand	2017	12	15
			M.Eng.	Electrical Engineering	Naresuan University	Thailand	2011		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2009		
8	Jirawadee Polprasert	Lecturer	Ph.D.	Energy/Electric Power System Management	Asian Institute of Technology	Thailand	2015	18	21
			M.Eng.	Energy/Electric Power System Management	Asian Institute of Technology	Thailand	2007		
			B.Eng.	Electrical Engineering	Suranaree University of Technology	Thailand	2004		
9	Sangchai Mungkornthong	Lecturer	Ph.D.	Electronics and Electrical Engineering	University of Southampton	UK	2018	15	15
			M.Sc.	System on Chip	University of Southampton	UK	2012		
			M.Eng.	Telecommunications	Asian Institute of Technology	Thailand	2001		
			B.Eng.	Electrical Engineering	Mahidol University	Thailand	1997		
10*	Settha Thangkawanit	Lecturer	Ph.D.	Computer Engineering	Naresuan University	Thailand	2019	30	30
			M.Eng.	Electrical Engineering	Naresuan University	Thailand	2008		
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2006		
11	Suradet Jitprapaikulsarn	Lecturer	Ph.D.	Electrical Engineering and Computer Science	Case Western Reserve University	USA	2005	32	32
			B.Sc.	Mathematics	Chulalongkorn University	Thailand	1991		

No.	First name and last name	Academic Position	Academic Degree	Major	Institution	Country	Year of Graduation	Teaching Load (Hours / Week)	
								Current	Future
12	Worralak Kongdenfha	Lecturer	Ph.D.	Computer Science and Engineering	University of New South Wales, Sydney	Australia	2009	9	9
			M.Eng.	Computer Engineering	Asian Institute of Technology	Thailand	2000		
			B.Eng.	Telecommunication Engineering	King Mongkut's Institute of Technology Ladkrabang	Thailand	1998		
13*	Panupong Sornkhom	Lecturer	M.Eng.	Computer Engineering	King Mongkut's University of Technology Thonburi	Thailand	2008	32	37
			B.Eng.	Computer Engineering	Naresuan University	Thailand	2000		
14	Rattapoom Waranusast	Lecturer	M.Eng.	Computer Science	Asian Institute of Technology	Thailand	2005	18	18
			B.Eng.	Computer Engineering	Chulalongkorn University	Thailand	1998		
15*	Yoseung Kim	Lecturer	M.Eng.	Computer Engineering	ChungNam National University	South Korea	2009	12	12
			B.Eng.	Computer Engineering	HanBat National University	South Korea	2001		
			B.Eng.	Electronics Engineering	The University of Soul	South Korea	1991		

* Lecturer in charge of the program

4. Components Related to Field Training Experience

In order for the graduate to have experienced in actual professional setting, the Bachelor of Engineering Program in Intelligent and Innovation Engineering (English Program) requires students to enroll in the required non-credit course 316390 Training in IIE in the summer semester of year 3.

316390	Internship (Required non-credit)	3 credits
	Total	**3 credits**

4.1 Standard of Learning Outcomes for Field Training Experience

The expected learning outcomes of the students' field training experience are as follows:

1. Demonstrate discipline, punctuality, honesty, respect for organizational code of conduct, rules and regulations, and adjust to the workplace.
2. Apply knowledge and understanding of concepts/principles/theories learned the class to the practical operations in the workplace.
3. Collaborate with co-workers to accomplish the assigned tasks.
4. Search, identify, and integrate information and its credibility with the knowledge learned in class to the real-life practices.

4.2 Duration

The summer semester of year 3

4.3 Schedule and Timetable

All through the summer semester of year 3

5. Requirements for Undergraduate Thesis (if applicable)

5.1 The Coursework Track

For students who would like to gain knowledge and skills through elective courses and conducting a senior project, they are required to enroll in

1. A minimum of 6 credits in major elective courses.
2. the **316491 Engineering Project 1** and **316492 Engineering Project 2** courses.

Students must conduct a project to demonstrate ability to apply the knowledge and skills to solve a real-world problem or to enhance the students' research experience in the field of intelligent and innovation engineering or related fields. For each project, students may form a team with no more than 3 members.

5.1.1 The Process

For the engineering project, students may follow the process described below.

1. The project must be proposed, presented, and approved by the committee.
2. The progress must be reported regularly to the project advisor.
3. The final presentation must be presented and approved by the committee.
4. The final report must be approved by the committee and submitted for graduation.

5.1.2 Standard of Learning Outcomes

The expected learning outcomes of the students pursuing the coursework track are as follows:

1. Demonstrate the project management skills through the execution of an engineering project.
2. Apply knowledge and skills to solve a problem.
3. Collaborate with team members to accomplish the desired outcome.

5.1.3 Duration

The semesters 1 and 2 of year 4

5.1.4 Number of Credits

6 credits

316491	Engineering Project 1	3(0-6-3)
316492	Engineering Project 2	3(0-6-3)
	Total	**6 credits**

5.1.5 Preparation

The preparations for the engineering project are as follow:

1. The lecturer announces the timeline for the courses.
2. The students propose the topics.
3. The project advisors are appointed.
4. The progress is tracked.
5. The students make the final presentation.
6. The lecturer collects and evaluates the recommendations suggested by the project committee.

5.1.6 Evaluation Procedure

The following procedure may be used in the courses:

1. The project committee evaluates the proposal presentation
2. The project advisors evaluate the progress according to the timeline.
3. The project committee evaluates the final presentation.
4. The project advisors, the project committee, and the lecturer responsible for the courses evaluate the final report.

5.2 The Practicum Track

For students who wish to pursue the practicum track and has passed all the required courses of year 1, 2, and 3, they may enroll in the **316493 Industry Practicum 1** and **316494 Industry Practicum 2** courses where they are required to practice in a real-world setting for at least 960 hours (480 hours per semester) to gain academic and professional experience through their work.

5.2.1 The process

Students pursuing the practicum track may follow the process described below.

1. Contact an organization about the work
2. Get an agreement from the organization about the work supervision and the length of the work
3. Get an approval from the course instructor
4. Work for the organization
5. Periodically report the progress of the work

6. The final presentation must be presented and approved by the course instructor.

5.2.2 Standard of Learning Outcomes

The expected learning outcomes of the students pursuing the practicum track are as follows:

1. Demonstrate discipline, punctuality, honesty, respect for organizational code of conduct, rules and regulations, and adjust to the problem.
2. Apply knowledge and skills to solve problems for the organization.
3. Collaborate with team members to accomplish the desired outcome.

5.2.3 Duration

The semesters 1 and 2 of year 4

5.2.4 Number of Credits

6 credits

316493	Industry Practicum 1	6(0-18-9)
316494	Industry Practicum 2	6(0-18-9)
	Total	**12 credits**

5.2.5 Preparation

The lecturer in charge of the courses will

1. Collaborate with the organizations for monitoring the knowledge and skills that students will be developing.
2. Assist students in establishing baseline knowledge and skills
3. Assist students in preparation for the work
4. Monitor the progress of the student
5. Assist students in post-work self-evaluation
6. Collects and evaluates the recommendations suggested by the organization

5.2.6 Evaluation Procedure

The following procedure may be used in the courses:

1. Assess the students' advancement of knowledge and skills

2. Assess the students' progress according to the timeline.
3. Evaluate the final presentation and report.

5.3 The Research Track

For students who wish to pursue the research track and has passed all the required courses of year 1, 2, and 3, they may enroll in the **316495 Undergraduate Research 1** and **316496 Undergraduate Research 2** courses where they gain knowledge and skills through conducting an in-depth research.

5.3.1 The process

Students pursuing the research track may follow the process described below.

1. Define the problem they would like to solve.
2. Conduct a literature review about the problem and proposed solution.
3. Identify the solution approach that they would like to pursue.
4. Contact a potential research advisor.
5. Get an approval from the course instructor and the research advisor.
6. Conduct the research.
7. Prepare for the publication of the research finding.
8. Submit the article for publication.

5.3.2 Standard of Learning Outcome

The expected learning outcomes of the students pursuing the research track are as follows:

1. Define the problem to solve.
2. Review relevant literatures.
3. Creatively construct a solution approach.
4. Develop a solution for the problem.
5. Present the solution.
6. Publish an article about the research.

5.3.3 Duration

The semesters 1 and 2 of year 4

5.3.4 Number of Credits

6 credits

316495	Undergraduate Research 1	6(0-12-9)
316496	Undergraduate Research 2	6(0-12-9)
	Total	**12 credits**

5.3.5 Preparation

The preparations for the engineering project are as follow:

1. The course instructor announces the timeline for the courses.
2. The students propose the problem to solve.
3. The research advisors are appointed.
4. The progress is tracked.
5. The students made the final presentation.
6. The lecturer collects and evaluates the recommendations suggested by the project committee.

5.3.6 Evaluation Procedure

The following procedure may be used in the courses:

1. The research committee evaluates the proposal presentation.
2. The research advisors evaluate the progress according to the timeline.
3. The research committee evaluates the final presentation.
4. The students submit an article for publication.

Section 4 Expected Learning Outcomes, Teaching and Evaluation Strategies

1. Development of Students' Special Characteristics

Table 4-1 Student's Special Characteristics and Expected Learning Outcomes (ELO)

Special Characteristics	Strategies/Activities	ELO
Think entrepreneurially	1. Develop a business model for the venture 2. Pitch the venture	8
Transfer knowledge and skills to others	1. Develop training materials 2. Practice training peers	9
Collaborate with others	1. Practice win-win thinking 2. Seek to understand first 3. Find one's passion and encourage others	10
Initiate learning by themselves	1. Set smart goals 2. Inspect and adapt 3. Practice self-reflection	11
Systems mindset	1. Decompose into parts 2. Identify interconnection among parts 3. Construct systems mappings 4. Synergize parts	12
Growth mindset	1. Recognize discomfort 2. Sympathize others 3. Focus more on improvement less on performance 4. Constructive criticism	13
Be a responsible, disciplined, ethical engineer and citizen	1. Identify ethical related issues 2. Establish the bottom line 3. Describe decision rationales in details	14

2. Development of Learning Outcomes

2.1 Naresuan University

2.1.1 Development of Students' Special Characteristics

Table 4-2 Student's Special Characteristics and Expected Learning Outcomes (ELO)

Special Characteristics	Strategies/Activities	ELO
Be courageous, diligent, patient, faithful, sacrificial, and grateful to the land.	Integrate contents and activities to follow the footsteps of King Naresuan the Great	8

2.1.2 Strategies to Achieve the Expected Learning Outcomes in Each Area.

(1) Morality and Ethics

a. Learning outcomes

1. Be responsible, courageous, selfless, patient, diligent, honest, and carry out activities that lead to the success of the work; be punctual and have a public mind.
2. Observe a code of conducts in academic study and express it with morals and ethics.
3. Have morals and ethics in life based on the sufficiency economy philosophy.
4. Realize and aware of being Thai.

b. Teaching Strategies

1. Incorporate moral, ethical, responsibility and self-expression concepts for success during teaching and learning by emphasizing on learning on time delivery and neither cheating in exams nor plagiarism of others.
2. Analyze issues of morality, ethics, or case studies about people who live morally and ethically.
3. Organize teaching and learning activities, academic/professional activities, and projects that use moral and ethical methods.

c. Evaluation Strategies

1. Specify the method of evaluation or scoring on moral and ethical expressions in each teaching and learning activities used in the course, attendance; submitting work on time; not cheating in exams or plagiarizing others' works; dare to comment on case studies in class.
2. Determine the method for evaluating participation in academic, professional activities or the effectiveness of participation in public conscious activities.

(2) Knowledge

a. Learning Outcomes

1. Have extensive and systematic body of knowledge in the field of study with the ability to use information, communication, and computer technology; know the principles and theories of the relevant sciences; recognize that the traditions, rules, and regulations related to academic subjects change according to the situation; appreciate art and music and apply them in daily life.
2. Understand the advancement of specialized knowledge in the field of study; have a comprehensive knowledge in humanities, social sciences, sciences, contemporary researches related to problem solving and knowledge enhancement in order to cause awareness of changes in the world situation, love the world, love nature, love the environment, and be able to survive future changes so that one can adapt to Thai, ASEAN, and global societies.
3. Have knowledge that can be used to develop life skills, take care of oneself, and live happily; have extensive knowledge; have a board perspective; be aware of the dynamics in the global situation both physical, biological, social and cultural; and recognize the value of nature; and live on the basis of the Sufficiency Economy Philosophy.

b. Teaching Strategies

1. Lectures, questions and answers, demonstration, and practice in the laboratory
2. Problem-based Learning
3. Experimental-based Learning
4. Project-based Learning
5. Work-integrated Learning
6. Field trips
7. Team teaching
8. Community-based Learning
9. Research-based Learning
10. Professional Training / Co-operative Education

c. Evaluation Strategies

1. Evaluate knowledge and skills by written exams, practice exams, oral exams and observation of learning behaviors.
2. Evaluate the learning attitude using questionnaires or self-reports.
3. Evaluate student's assignments.
4. Evaluate by the sources of professional experience / establishment.
5. Evaluate by proficiency tests.

(3) Cognitive Skills

a. Learning Outcomes

1. Be able to apply knowledge in real-world situations and survive future changes which leads to an adaptation to Thai, ASEAN, and global societies.
2. Apply skills and understandings in the field of study to find facts from various sources to solve analytical, synthetic problems; apply knowledge in humanities, social sciences and sciences to know the dynamics of the global situation; love the world, nature, and environment.

3. Be able to suggest solutions to complex problems taking into accounts the knowledge of theory, practice and the impact of decision making.
4. Have a holistic judgment by being able to link knowledge between the humanities, social sciences, and sciences; think creatively, eager to learn, seek knowledge throughout life; have a positive attitude and innovation works; have the desirable characteristics of the 21st century; and have the attributes of entrepreneurship.

b. Teaching Strategies

1. Problem-based Learning
2. Experimental-based Learning
3. Project-based Learning
4. Work-integrated Learning
5. Field trips
6. Team-based Learning
7. Activity-based Learning

c. Evaluation Strategies

1. Evaluate knowledge and skills by written, practice and oral exams.
2. Evaluate teamwork processes and observing learning behaviors
3. Evaluate student's assignments.
4. Evaluate critical thinking skills and problem-solving skills.
5. Evaluate by proficiency tests.

(4) Interpersonal and responsibility skills

a. Learning Outcomes

1. Be able to work in a team; have leadership and human relationship skills; understand and appreciate oneself and others.
2. Be responsible; conduct learning continuously; self-develop both in terms of physical, emotional, social, and mental.

3. Have skills for learning in different cultures or multi-culture; understand and appreciate the values of society, art, and culture which must lead to adapting to be a valuable citizen for Thai and global society; be able to adapt to live in a society with different cultures.

b. Teaching Strategies

1. Emphasize co-operative and collaborative learning by promoting responsibility for the learning of oneself and peers.
2. Encourage students to continuously research and learn by themselves. (Investigative and Life Long Learning)
3. Use teaching that emphasizes team-based learning.
4. Using integrated learning approach

c. Evaluation Strategies

1. Evaluate responsibilities and participations of learners in teaching and learning activities.
2. Evaluate students' assignment; conduct peer evaluation by having peers assess the work behaviors.
3. Evaluate living attitudes and behavior changes by using questionnaires or self-assessment.

(5) Numerical Analysis, Communication and Information Technology Skills

a. Learning Outcomes

1. Be able to choose and apply appropriate statistical or mathematical techniques in study and suggest solutions to problems.
2. Be able to use information technology to collect information, process, interpret and present information accurately and knowingly.
3. Be able to communicate, analyze, synthesize, summarize contents and issues in speaking, writing and presentations efficiently.

b. Teaching Strategies

1. Lecture, questions and answers, demonstration and practice in laboratory
2. Problem-based Learning
3. Experimental-based Learning
4. Project-based Learning
5. Work-integrated Learning
6. Team-based Learning
7. Seminar

c. Evaluation Strategies

1. Assess the ability to communicate in both speaking, writing and presenting based on the assignments or from the seminar
2. Assess the ability to perform numerical analysis and use of information technology and presentation of the assignments or from the seminar.

Table 4-3 The Program Expected Learning Outcomes (ELO) and the General Education's Expected Learning Outcomes

Program Expected Learning Outcomes (ELO)		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Description	1	2	3	4	1	2	3	1	2	3	4	1	2	3	1	2	3
1	Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.					✓	✓		✓								✓	
2	Develop devices or applications that can communicate via networks.					✓	✓		✓								✓	
3	Develop and deploy simple data analytic models for various domains such as e-commerce.					✓	✓		✓	✓						✓	✓	
4	Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.					✓	✓		✓	✓	✓	✓				✓	✓	
5	Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.					✓	✓		✓		✓					✓	✓	
6	Develop applications capable of handling massive amounts of data (such as big data).					✓	✓		✓	✓	✓	✓				✓	✓	
7	Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.							✓	✓	✓	✓	✓					✓	
8	Think entrepreneurially. Develop a business plan for starting a business.											✓	✓	✓	✓			✓
9	Transfer knowledge and skills to others.										✓						✓	
10	Collaborate with others and be a smart team member or leader, and manage projects.									✓	✓	✓	✓		✓			
11	Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.						✓	✓		✓		✓		✓				
12	Think systematically, creatively, or innovatively.							✓	✓		✓	✓				✓		✓
13	Act with growth mindset.								✓			✓		✓	✓			
14	Behave like a responsible, disciplined, ethical engineer and citizen.	✓	✓	✓	✓	✓	✓	✓										

Table 4-4 Curriculum Mapping between Courses and Expected Learning Outcomes

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
(1) General Education																		
(1.1) Language courses																		
(1.1.1) English Language																		
001211	English Listening and Speaking for Communication	●				●		●	●	●		●	●		●			●
001212	English Critical Reading for Effective Communication	●				●		●	●	●		●	●		●			●
001213	English Writing for Effective Communication	●				●		●	●	●		●	●		●			●
(1.1.2) Thai language																		
001301	Thai Language for Academic Communication	●				●		●	●	●		●	●		●			●
001302	Thai Language for Communication in the 21st Century	●				●		●	●	●		●	●		●			●
001303	Reading in the Digital Age Century	●				●		●	●	●		●	●		●			●
(1.1.3) Foreign language																		
001311	Korean for Communication	●				●		●	●	●		●	●		●			●
001312	Japanese for Communication	●				●		●	●	●		●	●		●			●
001313	Chinese for Communication	●				●		●	●	●		●	●		●			●
001314	Myanmar for Communication	●				●		●	●	●		●	●		●			●
001315	French for Communication	●				●		●	●	●		●	●		●			●
001316	Spanish for Communication	●				●		●	●	●		●	●		●			●
001317	Lao for Communication	●				●		●	●	●		●			●			●
001318	Indonesian for Communication	●				●		●	●	●		●	●		●			●
001319	Vietnamese for Communication	●				●		●	●	●		●	●		●			●

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
001320	Hindi for Communication	●				●		●	●	●		●	●		●			●
001321	Khmer for Communication	●				●		●	●	●		●	●		●			●
(1.2) Humanities																		
001221	Information Science for Study and Research	●				●		●		●		●	●		●			●
001222	Language, Society and Culture	●				●		●				●	●					●
001224	Arts in Daily Life	●				●				●		●			●			●
001226	Ways of Living in the Digital Age	●				●		●		●		●	●					●
001227	Music Studies in Thai way of life	●				●				●					●			●
001228	Happiness with Hobbies	●						●		●		●	●		●			●
001238	Media Literacy	●				●		●	●	●		●			●			●
001241	Western Music in Daily Life	●				●						●			●			●
001242	Creative Thinking and Innovation	●				●		●				●	●		●			●
001253	Entrepreneurship for Small Business Start-up	●				●		●	●			●			●			●
001276	Energy and Technology around Us	●				●		●	●						●			●
001331	Social Innovation	●				●			●						●			●
001332	Introduction to Data Management in Digital Era	●				●			●						●			●
(1.3) Social Sciences																		
001231	Philosophy of Life for Sufficient Living	●		●		●		●	●			●	●		●		●	●
001232	Fundamental Laws for Quality of Life	●						●	●				●					●
001233	Thai State and the World Community	●				●		●	●			●			●			●
001234	Civilization and Local Wisdom	●							●			●	●		●			●

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
001235	Politics, Economy and Society	●				●		●	●						●			●
001236	Living Management	●				●		●	●			●	●		●			●
001237	Life Skills	●						●	●				●		●			●
001239	Leadership and Compassion	●										●	●		●			●
001251	Group Dynamics and Teamwork	●				●		●				●	●		●			●
001252	Naresuan Studies	●						●	●			●	●		●			●
001254	The King's Philosophy for Living	●		●		●		●	●			●	●		●			●
001351	From Sufficiency Economy Philosophy (SEP) to Practice	●		●				●	●			●	●		●			●
001352	Peace and Religion for Human Kinds	●				●		●	●			●	●		●			●
001353	Principles of Accounting for Entrepreneur	●	●			●	●		●							●	●	
(1.4) Science and Mathematics																		
001271	Man and Environment	●				●		●	●			●	●		●		●	
001272	Introduction to Computer Information Science	●				●		●	●				●				●	
001273	Mathematics and Statistics in Everyday Life	●						●	●			●			●		●	
001274	Drugs and Chemicals in Daily Life	●						●	●			●	●					●
001275	Food and Life Style	●						●	●			●						
001277	Human Behavior	●						●	●			●	●		●			●
001278	Life and Health	●						●				●	●		●			●
001279	Science in Everyday Life	●				●		●	●			●			●		●	●
001291	Consumption in Daily Life	●				●		●	●			●	●		●			●
001292	Circular Economic Lifestyle for 21st Century	●		●				●	●			●	●				●	●

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
(1.5) Physical Education																		
001281	Sports and Exercises	●						●				●	●		●			●
(2) Specialization Courses																		
(2.1) Core Courses																		
(2.1.1) Fundamental Courses in Science																		
252182	Calculus 1	●				●				●			●			●		●
252183	Calculus 2	●				●				●			●			●		●
252284	Calculus 3	●				●				●			●			●		●
261103	Introductory Physics	●				●						●	●			●	●	
261113	Laboratory in Introductory Physics	●				●						●	●			●	●	
316131	Computer Mathematics 1	●				●				●				●		●		
316132	Computer Mathematics 2	●				●				●				●		●		
316231	Applied Statistics	●				●				●				●		●		
(2.1.2) Fundamental Courses in Engineering																		
302151	Engineering Drawing	●				●			●					●			●	
316121	Computer Programming		●			●				●			●	●				●
316122	Object-Oriented Programming		●			●			●					●				●
316232	Data Structures and Algorithms	●				●				●			●			●		
(2.2) Major Specific Courses																		
(2.2.1) Major Required Courses																		
(2.2.1.1) Application Technologies																		

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
316311	Database		●				●		●	●			●				●	
(2.2.1.2) Software Methods and Technologies																		
316221	Artificial Intelligence	●				●				●				●		●	●	
316321	Introduction to Machine Learning	●				●				●				●		●	●	
(2.2.1.3) Systems Infrastructure																		
316331	Computer and Information Security		●			●				●				●		●	●	
316333	Distributed and Cloud Computing		●			●			●	●			●					●
(2.2.1.4) Computer Hardware and Architecture																		
316141	Introduction to Internet of Things		●			●				●				●			●	
316241	Introduction to Digital Logic	●				●				●	●		●			●		
316242	Computer Networks	●				●				●	●		●				●	
316243	Electronics and Circuits			●			●					●			●			●
(2.2.2) Program Specific Courses																		
(2.2.2.1) Technical Skills																		
316351	Innovation Design and Development	●						●	●			●	●	●		●	●	●
(2.2.2.2) Soft Skills and Life Skills																		
300301	Technopreneur		●			●	●		●	●	●	●	●	●		●	●	●
316101	Soft Skill 1: Exploration	●						●				●	●	●			●	●
316102	Soft Skill 2: Personal Growth	●						●				●	●	●			●	●
316201	Soft Skill 3: Engineering Teamwork		●					●				●	●	●			●	●
316202	Soft Skill 4: Community Collaboration		●					●				●	●	●	●		●	●

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
316301	Soft Skill 5: Professional Practices		●					●				●	●	●	●		●	●
(2.2.2.3) Practice-oriented																		
316191	Field Experience 1	●			●			●	●					●				●
316291	Field Experience 2	●			●			●	●					●				●
316292	Field Experience 3	●			●			●	●					●				●
316391	Field Experience 4	●			●			●	●					●				●
316392	Field Experience 5	●			●			●	●					●				●
316190	Work Integrated Learning 1	●						●	●					●				●
316290	Work Integrated Learning 2	●						●	●					●				●
(2.2.3) Internship (*)																		
316390	Internship	●						●	●					●				●
(2.2.4) Major Elective Courses																		
(2.2.4.1) Coursework Track																		
316491	Engineering Project 1	●						●		●				●				●
316492	Engineering Project 2	●						●		●				●				●
(2.2.4.2) Practicum Track																		
316493	Industrial Practicum 1	●						●	●					●				●
316494	Industrial Practicum 2	●						●	●					●				●
(2.2.4.3) Research Track																		
316495	Undergraduate Research 1	●					●	●		●	●			●				●
316496	Undergraduate Research 2	●					●	●		●	●			●				●

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
List of elective courses																		
316322	Introduction to Data Analytics		●			●			●				●			●	●	●
316332	Cybersecurity		●			●				●				●		●	●	
316352	Personal Process for Product Development	●				●					●			●		●		
316353	Software Engineering for IIE	●					●				●			●		●		
316411	Computer Graphics	●				●			●					●		●		
316412	Computer Vision	●				●					●			●		●		
316413	Digital Image Processing	●				●			●	●			●			●		
316414	Game Programming	●				●			●					●		●		
316421	Big Data Analysis	●				●			●				●			●		●
316422	Blockchain Technology		●				●		●				●			●		
316423	Data Analysis and Visualization		●			●			●				●			●	●	●
316424	Knowledge Representation and Reasoning	●				●				●				●		●	●	
316425	Natural Language Processing System	●				●				●				●		●	●	
316431	Network Integration	●				●				●	●		●				●	
316432	Sensor Networks		●			●				●				●			●	
316433	Parallel Computing	●					●					●		●		●		
316434	Advanced Statistics		●			●			●				●			●	●	●
316435	Digital Signal Processing	●				●			●	●			●			●		
316436	Signals and Systems		●			●				●				●			●	
316441	Industrial Robot		●			●				●				●			●	

Course		Morality				Knowledge			Cognitive				Interpersonal			Analytical Skills		
No	Title	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
316442	Embedded System for IIE		●			●				●				●			●	
316443	Unmanned System Application for IIE		●			●				●				●			●	
316481	Special Topic in IIE	●						●		●				●				●
316482	Current Interest in IIE	●						●		●				●				●
316483	New Development in IIE	●						●		●				●				●
316484	New Application in IIE	●						●		●				●				●
316485	Selected Topic in IIE	●						●		●				●				●
316486	Advancement in IIE	●						●		●				●				●
316487	Progress in IIE	●						●		●				●				●
316488	Emergence in IIE	●						●		●				●				●
316489	Special Topic in IIE related fields	●						●		●				●				●

2.2 The 2018 Higher Education Standards for Students' Outcomes

The 2018 Higher Education Standards defined the students' outcomes as follows:

1. (**Learner**) Have knowledge, ability, and various resources for building career, stability, and life quality of oneself, family, community, and society together with lifelong learning skills, virtue, perseverance, determination, diligence, and adherence to professional ethics.
2. (**Co-creator**) Be a co-innovator with 21st century skills, ability to integrate various disciplines to develop or solve social problems, entrepreneurship, realize the changes in society and the world, and ability to create opportunities and values to oneself, community society, and country.
3. (**Active Citizen**) Be a strong citizen with moral courage; adhere to truth, value, preserve Thai; join forces to create, develop, and support sustainable peace at the family, community, society, and global level.

Table 4-5 The Expected Learning Outcomes and the 2018 Higher Education Standard for Student Outcomes

Expected Learning Outcomes (ELO)		Generic Skills	Specific Skills	The 2018 Higher Education Standard for Student Outcomes		
No	Description			Learner	Co-creator	Active Citizen
1	Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.		✓		✓	
2	Develop devices or applications that can communicate via networks.		✓		✓	
3	Develop and deploy simple data analytic models for various domains such as e-commerce.		✓		✓	
4	Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.		✓		✓	
5	Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.		✓		✓	
6	Develop applications capable of handling massive amounts of data (such as big data).		✓		✓	
7	Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.		✓		✓	
8	Think entrepreneurially. Develop a business plan for starting a business	✓			✓	

Expected Learning Outcomes (ELO)		Generic Skills	Specific Skills	The 2018 Higher Education Standard for Student Outcomes		
No	Description			Learner	Co-creator	Active Citizen
9	Transfer knowledge and skills to others.	✓		✓	✓	
10	Collaborate with others and be a smart team member or leader, and manage projects.	✓			✓	
11	Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.	✓		✓		
12	Think systematically, creatively, or innovatively.	✓			✓	
13	Act with growth mindset.	✓		✓	✓	✓
14	Behave like a responsible, disciplined, ethical engineer and citizen.	✓		✓		✓

3. The Results of Teaching and Learning According to the ELO

Table 4-6 Teaching and Learning Activities and ELO for each semester

Year	Semester	Learning Activities	ELO
1	1	Study general education courses, science and engineering core courses, fundamental IIE courses, and a soft skill course.	1, 2, 5, 7, 9, 11, 12, 13, 14
	2	Study general education courses, science and engineering core courses, fundamental IIE courses, a soft skill course, and a field experience course.	2, 5, 7, 9, 11, 12, 13, 14
2	1	Study general education courses, science and engineering core courses, intermediate IIE courses, a soft skill course, and a field experience course.	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14
	2	Study general education courses, science and engineering core courses, intermediate IIE courses, a soft skill course, and a field experience course.	1, 2, 4, 5, 7, 9, 10, 11, 12, 13, 14
3	1	Study general education courses, advanced IIE courses, a soft skill course, a field experience course, and a free elective course.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
	2	Study general education courses, advanced IIE courses, a soft skill course, a field experience course, and a free elective course.	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14
	3	Internship	10, 11, 14
4	1	Study elective courses and conduct engineering project, industrial practicum, or undergraduate research.	10, 11, 14
	2	Study elective courses and conduct engineering project, industrial practicum, or undergraduate research.	10, 11, 14

Notes: the expected learning outcomes is defined in section 2, no. 1.4.

3.1 Plans for Preparing Students to Achieve the Expected Learning Outcomes

No.	Expected Learning Outcomes	Preparation Plan
1	Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.	1. Require students to take a pre-test and a post test on how to develop devices and application and how to connect devices to computers. 2. Encourage students to build devices and applications to solve a real-world problem. 3. Encourage students to experiment with various types of computer connections. 4. Employ problem-based learning and project-based learning.
2	Develop devices or applications that can communicate via networks.	1. Encourage students to experiment with various method of network and data communication. 2. Teach students about different kinds of data communication and network. 3. Employ problem-based learning and project-based learning.
3	Develop and deploy simple data analytic models for various domains such as e-commerce.	1. Require students to collect data from various sources. 2. Encourage students to experiment with different data analytic models. 3. Assign a team project for developing simple data analytic models. 4. Employ problem-based learning and project-based learning.
4	Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.	1. Use real-world problem to motivate the exploration of various approaches of applying artificial intelligence concepts.

No.	Expected Learning Outcomes	Preparation Plan
		2. Employ problem-based learning and project-based learning.
5	Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.	1. Encourage students to explore various emerging technology. 2. Assign students to solve simplified real-world using modern computing technology.
6	Develop applications capable of handling massive amounts of data (such as big data).	1. Assign students to collect data from the Internet for processing. 2. Assign students to develop applications that process the collected data.
7	Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.	1. Encourage students to perform design thinking in solving real-world problems. 2. Assign students to explore in depth about modern applications.
8	Think entrepreneurially. Develop a business plan for starting a business.	1. Assign students to develop a business model canvas for their work 2. Assign students to pitch their business plan for funding. 3. Encourage students to think from multiple point of views.
9	Transfer knowledge and skills to others.	1. Assign students work in pair where each student will assist their partners in developing knowledge and skills. 2. Assign students to develop a sample assessment method to gauge their knowledge and skills.
10	Collaborate with others and be a smart team member or leader, and manage projects.	1. Encourage students to take turns to be a team leader.

No.	Expected Learning Outcomes	Preparation Plan
		2. Assign students to develop project plans. 3. Assign students to weekly report the progress of their projects.
11	Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.	1. Encourage students to regularly reflect on themselves. 2. Encourage students to develop and follow through on a plan for self-improvement.
12	Think systematically, creatively, or innovatively.	1. Encourage students to develop alternative solutions for each problem. 2. Encourage students to paraphrase various statements. 3. Encourage students to identify the area that no one has explored. 4. Encourage students to solve problem in a different way. 5. Encourage students to use non-violent communication.
13	Act with growth mindset.	1. Encourage students to regularly reflect on their mindsets. 2. Encourage students to constructively criticize their peer. 3. Encourage students to expand the boundary instead of limiting themselves within the boundary. 4. Encourage students to view problems from multiple perspectives.
14	Behave like a responsible, disciplined, ethical engineer and citizen.	1. Require students to be punctual and take account of their action.

No.	Expected Learning Outcomes	Preparation Plan
		2. Analyze and develop solutions for case studies on ethical issues.

3.2 The Expected Learning Outcomes and the 2009 TQF Computer Standard Learning Outcomes

3.2.1 Morality and Ethics

(1) Program Expected Learning Outcomes

ELO 8 Think entrepreneurially. Develop a business plan for starting a business.

ELO 9 Transfer knowledge and skills to others.

ELO 10 Collaborate with others and be a smart team member or leader, and manage projects.

ELO 11 Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.

ELO 12 Think systematically, creatively, or innovatively.

ELO 13 Act with growth mindset.

ELO 14 Behave like a responsible, disciplined, ethical engineer and citizen.

(2) 2009 TQF Computer Standard Learning Outcomes

1. Realize value, virtue, morality, ethics, sacrifice, and honesty.
2. Have discipline, punctuality, responsibility to oneself, profession, and society.
3. Have leadership and supporter skills; able to work in a team and able to solve conflicts and priorities.
4. Respect the rights and listen to the opinions of others, as well as respect for human values and dignity.
5. Respect the rules and regulations of the organization and society.
6. Analyze the impact of computer use on individuals, organizations and society.
7. Have academic and professional ethics.

3.2.2 Knowledge

(1) Program Expected Learning Outcomes

ELO 1 Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.

ELO 2 Develop devices or applications that can communicate via networks.

ELO 3 Develop and deploy simple data analytic models for various domains such as e-commerce.

ELO 4 Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.

ELO 5 Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.

ELO 6 Develop applications capable of handling massive amounts of data (such as big data).

ELO 7 Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.

ELO 12 Think systematically, creatively, or innovatively.

(2) 2009 TQF Computer Standard Learning Outcomes

1. Have knowledge and understanding of important principles and theories in the subjects studied.
2. Analyze problems, understand and describe computing needs, as well as apply knowledge, skills, and appropriate tools to solve problems.
3. Analyze, design, install, improve and/or evaluate the various components of the computer system to meet the requirements.
4. Follow the academic progress and computer evolution, including application.
5. Master and continuously developing computer proficiency.
6. Have broad knowledge in the field of study in order to discern changes and understand the impact of new technologies involved.
7. Have experiences in developing and/or utilizing software in actual setting.

8. Integrate knowledge in the field of study with knowledge in other related fields.

3.2.3 Cognitive Skills

(1) Program Expected Learning Outcomes

ELO 1 Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.

ELO 2 Develop devices or applications that can communicate via networks.

ELO 3 Develop and deploy simple data analytic models for various domains such as e-commerce.

ELO 4 Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.

ELO 5 Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.

ELO 6 Develop applications capable of handling massive amounts of data (such as big data).

ELO 7 Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.

ELO 8 Think entrepreneurially. Develop a business plan for starting a business.

ELO 9 Transfer knowledge and skills to others.

ELO 11 Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.

ELO 12 Think systematically, creatively, or innovatively.

ELO 13 Act with growth mindset.

(2) 2009 TQF Computer Standard Learning Outcomes

1. Think critically and systematically.
2. Search, interpret and evaluate information for solving problems creatively.
3. Collect, study, analyze and summarize issues, problems and needs.

4. Apply knowledge and skills to solve computing problems appropriately.

3.2.4 Interpersonal Relation Skills and Responsibility

(1) Program Expected Learning Outcomes

ELO 1 Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.

ELO 2 Develop devices or applications that can communicate via networks.

ELO 3 Develop and deploy simple data analytic models for various domains such as e-commerce.

ELO 4 Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.

ELO 5 Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.

ELO 6 Develop applications capable of handling massive amounts of data (such as big data).

ELO 7 Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.

ELO 8 Think entrepreneurially. Develop a business plan for starting a business.

ELO 9 Transfer knowledge and skills to others.

ELO 10 Collaborate with others and be a smart team member or leader, and manage projects.

ELO 11 Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.

ELO 12 Think systematically, creatively, or innovatively.

ELO 13 Act with growth mindset.

ELO 14 Behave like a responsible, disciplined, ethical engineer and citizen.

(2) 2009 TQF Computer Standard Learning Outcomes

1. Communicate both Thai and foreign languages with a wide range of people groups effectively.
2. Assist and facilitate the resolution of various situations, either in the role of the leader or a team member.
3. Use knowledge in the field of study to guide society on appropriate issues.
4. Be accountable for their own actions and take responsibility as a team member.
5. Take initiative to resolve both personal and public issues and express an appropriate standpoint both of oneself and the group.
6. Take responsibilities to continuously learn both in one's own and professionally.

3.2.5 Numerical Analysis, Communication and Information Technology Skills

(1) Program Expected Learning Outcomes

ELO 1 Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.

ELO 2 Develop devices or applications that can communicate via networks.

ELO 3 Develop and deploy simple data analytic models for various domains such as e-commerce.

ELO 4 Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.

ELO 5 Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.

ELO 6 Develop applications capable of handling massive amounts of data (such as big data).

ELO 7 Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.

ELO 8 Think entrepreneurially. Develop a business plan for starting a business.

ELO 9 Transfer knowledge and skills to others.

ELO 10 Collaborate with others and be a smart team member or leader, and manage projects.

ELO 11 Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.

ELO 12 Think systematically, creatively, or innovatively.

ELO 13 Act with growth mindset.

ELO 14 Behave like a responsible, disciplined, ethical engineer and citizen.

(2) 2009 TQF Computer Standard Learning Outcomes

1. Use necessary tools available today for computer-related work.
2. Suggest problems solving approach using mathematical information or creatively displaying applied statistics to relevant problems.
3. Communicate effectively both oral and writing, including choosing the appropriate form of presentation.
4. Use information technology appropriately.

Table 4-7 The Expected Learning Outcomes and the 2009 TQF1 Computer Standard Learning Outcomes

Expected Learning Outcomes (ELO)		Morality and Ethics							Knowledge								Cognitive				Interpersonal Skills and Responsibilities						Analytical Skills			
No	Description	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	1	2	3	4	1	2	3	4	5	6	1	2	3	4
1	Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.								✓		✓	✓		✓	✓		✓		✓	✓						✓	✓			
2	Develop devices or applications that can communicate via networks.								✓	✓	✓		✓		✓	✓	✓		✓	✓						✓	✓			
3	Develop and deploy simple data analytic models for various domains such as e-commerce.								✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓						✓	✓	✓		
4	Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.								✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓						✓	✓	✓	✓	
5	Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.								✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	✓			✓
6	Develop applications capable of handling massive amounts of data (such as big data).								✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	✓	✓		✓

Expected Learning Outcomes (ELO)		Morality and Ethics							Knowledge								Cognitive				Interpersonal Skills and Responsibilities						Analytical Skills			
No	Description	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	1	2	3	4	1	2	3	4	5	6	1	2	3	4
7	Innovatively develop modern applications for people such as smart energy, smart environment, smart economics, smart transportation, smart city, smart health etc.								✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	✓	✓		✓
8	Think entrepreneurially. Develop a business plan for starting a business.			✓													✓		✓		✓	✓	✓		✓	✓			✓	✓
9	Transfer knowledge and skills to others.				✓															✓	✓	✓			✓	✓			✓	✓
10	Collaborate with others and be a smart team member or leader, and manage projects.			✓	✓	✓															✓	✓				✓			✓	
11	Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.		✓																✓					✓		✓			✓	✓
12	Think systematically, creatively, or innovatively.						✓									✓	✓		✓			✓				✓			✓	✓
13	Act with growth mindset.			✓	✓	✓											✓		✓					✓	✓	✓			✓	✓
14	Behave like a responsible, disciplined, ethical engineer and citizen.	✓	✓	✓	✓	✓	✓	✓															✓	✓	✓	✓			✓	

3.3 Strategies for Achieve Program Expected Learning Outcomes

ELO		Strategy	Assessment
1	Develop devices and applications (such as IoT, embedded systems, etc.) that can communicate with the computers.	1. Maker laboratory 2. Lecture 3. Design Thinking workshop	1. Work product 2. Presentation 3. Examination 4. Project
2	Develop devices or applications that can communicate via networks.	1. Network laboratory 2. Lecture 3. Design Thinking workshop	1. Work product 2. Presentation 3. Examination 4. Project
3	Develop and deploy simple data analytic models for various domains such as e-commerce.	1. Modeling workshop 2. Lecture 3. User Interview	1. Work product 2. Presentation 3. Examination 4. Project
4	Develop and deploy applications that utilize modern artificial intelligence concepts such as machine learning.	1. Deployment workshop 2. AI workshop 3. Experiment	1. Work product 2. Presentation 3. Examination 4. Project
5	Implement applications that utilize modern computing technology such as cloud computing, blockchain, etc.	1. Cloud computing workshop 2. Blockchain workshop 3. Implementation workshop	1. Work product 2. Presentation 3. Examination 4. Project
6	Develop applications capable of handling massive amounts of data (such as big data).	1. Big Data workshop 2. Data Analytic workshop 3. Implementation workshop	1. Work product 2. Presentation 3. Examination 4. Project
7	Innovatively develop modern applications for people such as smart energy, smart environment, smart	1. Design Thinking workshop 2. Lecture 3. User Interview	1. Work product 2. Presentation 3. Examination 4. Project

ELO		Strategy	Assessment
	economics, smart transportation, smart city, smart health etc.		
8	Think entrepreneurially. Develop a business plan for starting a business.	1. Business plan workshop 2. Pitching	1. Pitching 2. Presentation 3. Project
9	Transfer knowledge and skills to others.	1. Quiz composition 2. Presentation workshop 3. Teaching workshop	1. Quiz 2. Presentation
10	Collaborate with others and be a smart team member or leader, and manage projects.	1. Team building workshop 2. Retrospective workshop 3. Group discussion	1. Peer Evaluation 2. Postmortem Analysis
11	Initiate learning by themselves and continue to pursue new knowledge, and self-improvement.	1. Study Plan 2. Learning to learn workshop 3. Improvement workshop	1. Pre / Post self-investigation 2. Goal achievement report 3. Reflection report
12	Think systematically, creatively, or innovatively.	1. Six Thinking Hat workshop 2. Lateral thinking workshop 3. Creative thinking workshop 4. Systematic thinking workshop 5. Green / Brown field workshop 6. Design thinking workshop	1. Work product 2. Presentation 3. Project
13	Act with growth mindset.	1. Grow mindset workshop 2. Micro master workshop 3. Paraphrasing workshop	1. Presentation 2. Report 3. Project
14	Behave like a responsible, disciplined, ethical engineer and citizen.	1. Case Study 2. Empathy workshop 3. Debate	1. Report 2. Observation

Section 5 Student Evaluation Criteria

1. Grading Rules/Guidelines

Students are graded according to Naresuan University regulations for undergraduate studies (Appendix D).

2. Standard Verification Process for Student Achievement

2.1 Standard Verification of Learning Outcomes Before Graduation

1. Appoint an academic committee to verify the course syllabus, lesson plans and tests of all courses in each semester and to ascertain that the evaluation and assessment methods in the courses are practical and applicable and that the lecturers or those in charge of the courses have addressed issues related to the standard of the outcomes of the courses.
2. Arrange to have the learning outcomes evaluated by the workplaces, work supervisors and university supervisors.

2.2 Standard Verification of Learning Outcomes After Graduation

1. Survey the employment status of the graduates and their opinions on the Program and the management of the teaching and learning. Conduct a survey with each batch of graduates in terms of the length of time for job hunting, opinions on their knowledge, ability, and confidence in their career.
2. Survey the employers' satisfaction in terms of the graduates' readiness to work and knowledge in their field of study as well as the fields related to their career and the employer's suggestions for improving the quality of the Program.

3. Graduation Requirements

Student must meet the criteria specified in the 2015 standard criteria for bachelor degree (no. 13) and the 2016 Naresuan University regulations for undergraduate studies (no. 19):

19. Qualification for Graduation

19.1 In the last semester before graduation, students must submit the to-be-graduated application through the academic advisor within one month from

the beginning of the semester. Students must maintain the student status in the semester they submit the application.

19.2 In order to graduate, students must meet the following criteria:

19.2.1 Pass all the courses and criteria specified by the program. No courses receive grade I or P. The studying time must meet the following criteria

19.2.1.1 For the 4-year bachelor degree, no earlier than 6 semesters for full-time students and no earlier than 14 semesters for part-time students.

19.2.2 For transfer students, student must register at Naresuan University for a minimum of 1 academic year.

19.2.3 Achieve a minimum cumulative grade point average (GPA) of 2.0.

19.2.4 Take an English proficiency exam and a computer and information technology proficiency exam

19.3 In order to receive a bachelor's degree with honors, students must meet the following additional criteria:

19.3.1 Achieve a minimum cumulative grade point average (GPA) of 3.5 for the 1st honor degree. Achieve a cumulative grade point average (GPA) between 3.25 and 3.49 for the 2nd honor degree.

19.3.2 Never receive an F or U grade and must not register late for any course.

19.3.3 For transfer students, the transfer credits must be no more than one sixth of the total credits for the program.

Section 6 Lecturers' Professional Development

1. New Lecturer Orientation

(1) Provide an orientation or a guidance session for new lecturers to explain the university and the college policies as well as the details of the courses in the Program.

(2) Encourage the lecturers to keep increasing their knowledge and experience of teaching and doing research, provide support for their pursuit of higher degrees, trainings, academic and professional site visits, national and international academic conferences and sabbaticals.

(3) Assign experienced lecturers and/or those with academic titles as mentors for new lecturers during their trial period.

2. Knowledge and Skill Development for Lecturers

2.1 Development of Teaching, Assessment and Evaluation Skills

(1) Encourage lecturers to keep increasing their knowledge and experience in teaching and doing research, provide support for their pursuit of higher degrees, trainings, academic and professional site visits, national and international academic conferences and sabbaticals.

(2) Encourage lecturers to enhance and update their teaching and assessment skills.

(3) Require all lecturers to participate in student development activities by acting as student club advisors, trainers for student competitions at both national and international levels, and guidance teachers at the college's guidance center.

2.2 Other Academic and Professional Development

(1) Participate in community service activities related to the development of knowledge, morality of arts and culture conservation.

(2) Encourage the lecturers to create academic works in the field of English for business communication.

(3) Promote research studies to create new knowledge, develop the teaching and learning process, and enhance professional skills.

(4) Allocate budget for research.

(5) Assign all lecturers to participate in the college's various research groups.

(6) Assign lecturers to participate in the college's academic service activities.

2.3 Lecturers in Charge of the Program

(1) Lecturers in charge of the program must meet the criteria defined in the 2015 Higher Education Curriculum Criteria (2558 BE).

(2) Lecturers receive an approval from the department of electrical and computer engineering.

(3) Encourage lecturers to attend the seminar / courses relating to the development of teaching, assessment, evaluation, and quality assurance skills.

(4) Encourage lecturers to incorporate their researches / services in teaching and learning activities.

2.4 Lecturers in the Program

(1) Lecturers in the program must meet the criteria defined in the 2015 Higher Education Curriculum Criteria (2558 BE).

(2) Lecturers receive an approval from the department of electrical and computer engineering.

(3) Encourage lecturers to attend the seminar / courses relating to the development of teaching, assessment, evaluation, and quality assurance skills.

(4) Encourage lecturers to incorporate their researches / services in teaching and learning activities.

2.5 Thesis Advisors

(1) Thesis advisors must meet the criteria defined in the 2015 Higher Education Curriculum Criteria (2558 BE).

(2) Thesis advisors regularly publish their researches.

(3) Encourage thesis advisors to present at academic conferences or publish their researches.

2.6 Faculty Member Development Plan

(1) The department of electrical and computer engineering allocates budget for lecturers to present their researches, attend academic conferences, attend courses to develop their capability.

(2) The department of electrical and computer engineering allocates budget for teaching assistants so that lecturers will have more time for conducting researching.

(3) The Faculty of Engineering allocates budgets, resources, and facilities for lecturers to conduct researches.

(4) The Faculty of Engineering encourage lecturers to expand their knowledge and skills by taking sabbatical aboard or in the industrials.

Section 7 Quality Assurance

1. Program Administration

The program conducts the quality assurance according to the 2015 Thai Qualifications Framework for Higher Education (TQF:HEd) and the university's criteria as follows:

1.1 Produce the TQF documents and follow up on the TQF implementation in both semesters under the supervision of the dean of the Faculty of Engineering and according to the following details:

- Produce and submit TQFs 3, 4, 5, 6 and 7, and report their KPIs through the TQF Management System.
- The Faculty of Engineering and division of Academic Affair report the submission of TQFs 3, 4, 5, 6 and 7 to the university's academic committee and the academic council respectively.

1.2 The lecturers and departments in charge of the courses must ensure that teaching and learning, and evaluation of the outcomes follow the details provided for the courses.

1.3 The thesis advisors and thesis committee must ensure that the thesis courses and evaluation follow the quality control procedures set by the university and the college.

1.4 Require all full-time and part-time lecturers to have at least a Master's degree or a comparable qualification or an Assistant Professor position in the field of the course contents or in a related field.

1.5 Require a revision of the program according to a specified timeframe, or every 5 years, by updating the program based on the annual evaluation results and performance reports.

2. Graduates

The program studies the demands of the labor market and society and/or the employers' satisfaction with the graduates, the details of which are as follows:

2.1 The Program committee monitors the production of graduates to ensure that their qualifications meet the demands of the labor market, the society and the workplaces in both public and private sectors.

2.2 The program surveys the employers' satisfaction with the graduates and follows up on the graduates' professional advancement according to the criteria in the Thai Qualifications Framework for Higher Education ((TQF:HEd).

3. Students

3.1 Student Admission and Pre-Sessional Preparation

3.1.1 The program specifies the qualifications of applicants based on the standard criteria for undergraduate studies and Naresuan University regulations for undergraduate studies. The program committee participates in the recruitment based on the applications and attached evidence.

3.1.2 The program provides an orientation for new students prior to the beginning of the academic year in order to enable students to adjust and introduce learning techniques, university rules and regulations, facilities provided by the university and the college and the students' academic advisors. Moreover, the program committee organizes an English language and academic subject preparation project every academic year to assist the first-year students in their adjustment to the study at the higher education level.

3.2 Student Promotion and Development

3.2.1 Collaborate with other organizations in Thailand and abroad in student exchange programs to develop students' life and language skills.

3.2.2 Provide community services to be part of community development and to integrate the activities in the Program's courses as part of the promotion of the 21st-centry learning skills.

3.2.3 Promote professional experience and hands-on problem solving through cooperative education.

3.3 Student Supervision

3.3.1 The program committee provides an advisory system to support and give advice to the students and arranges timetables for students to meet with their advisors who give consultation regarding the study plan, research for learning development and various regulations all through students' study period.

3.3.2 The program committee monitors students' retaining and graduation rates according to the program's study plan.

3.3.3 The program committee surveys students' satisfaction with the program and learning facilities and makes use of the results in administering the operation of the program.

3.3.4 The program committee summarizes students' complaints (if any) and reports them to the college every semester.

4. Lecturers

4.1 Recruitment and Appointment of Lecturers in Charge of the Program

4.1.1 The program aims to appoint 5 lecturers to be in charge of the program. The lecturers' qualifications must meet the university's standard criteria for undergraduate programs, and the program's duties and responsibilities.

4.1.2 New lecturers are recruited according to Ministry of Education's standard criteria for undergraduate programs, their understanding of the Program's objectives and goals, their ability to use English as a medium of instruction and to accomplish the college's missions, their knowledge and skills in classroom management, learning outcome evaluation, their research and professional experience in the field of the program. The candidates are recruited and interviewed by a committee appointed by the university. The newly appointed lecturers are given an orientation by the college during which the college's and the university's rules and regulations and the details of the Program administration are provided.

4.2 Lecturer Management

4.2.1 The program makes plan for the management of manpower. The lecturers in charge of the program are given the details of the workload based on their respective qualifications and skills. They can also comment on the workload and assist in the development of guidelines for teaching and learning.

4.2.2 The lecturers participate in the development of guidelines for teaching and learning in meetings during which they plan for course instruction, evaluation, assessment and verification. The information is further employed in the improvement of the teaching and learning as well as the program.

4.2.3 The lecturers exchange methods for student development as well as for creating activities and projects that can sharpen the desired characteristics of students as specified in the program.

4.2.4 The lecturers review and revise the program based on their experience in the teaching and learning process, the development of the desired characteristics of students and the problems related to the implementation of the program. A program revision is scheduled to be undertaken every 5 years.

4.3 Lecturer Promotion and Development

The program follows the Faculty of Engineering's system and mechanism in the promotion and development of the academic knowledge and ability of the lecturers in charge of the program. Faculty of Engineering allocates a budget for lecturer development. This can be used for attending meetings, seminars and trainings. The college also organizes activities to enhance the lecturers' research and teaching potential.

5. Program, Teaching and Learning, Student Evaluation

5.1 The program is designed according to Naresuan University's program development procedure and revised every 5 years.

5.2 The course lecturers are designated in meetings where the lecturers plan for course instruction and workload based on qualifications, experience and evaluation results by students.

5.3 The program provides a guideline for course instruction that integrates key 21st skills in teaching and learning activities.

5.4 The lecturers in charge of the program cooperate in the production of graduates and in monitoring, following up and uploading TQFs 3-7 to the TQF Management System.

5.5 The verification of the students' learning outcomes is as follows:

5.5.1 Review and verify the quality of the learning outcomes and the assessment process based on the information in TQF 3, evaluation results of the course lecturers by the students, and course evaluation by the lecturers. The results are used to improve the course contents and the program.

5.5.2 Review and verify the learning outcomes after graduation by graduates and their employers.

6. Learning Resources

The Faculty of Engineering allocates an annual budget of 13,000 Thai Baht for the program to procure books, printed materials and surveys the lecturers' satisfaction with learning facilities such as classrooms, audio-visual equipment, computer network system, reading room, and the general conditions of the building and environment. The lecturers in charge of the program are encouraged to provide suggestions regarding learning facilities essential for the program and students.

In addition, the Faculty of Engineering encourages lecturers and students to propose a list of books and printed materials to be procured within the allocated budget. The program committee assesses the suitability of the proposed books before submitting the list to the college. Moreover, lecturers and students can submit a list of books from NU Book Fair according to an allocated quota (in the form of coupons) to be procured by the university's central library.

7. Key Performance Indicators

7.1 Directing the indicator 1.1

The program monitors the indicator 1.1 Curriculum Management according to the 2015 Ministry of Education's Standard Criteria for Undergraduate Programs (B.E. 2558).

No	Criteria	Description	Year 1	Year 2	Year 3	Year 4	Year 5
			2022	2023	2024	2025	2026
1	Number of instructors in charge of the program	- A minimum of 5 persons - Can only be in charge only 1 program and must be with the program for the entire period of the being in charge	✓	✓	✓	✓	✓
2	Qualifications of instructors in charge of the program	**For academic program:** - Master degree or equivalent, or academic position at the minimum of assistant professor in related field. - At least 1 academic publication in the past 5 years. **For professional program:** - Master degree or equivalent, or academic position at the minimum of assistant professor in related field. - At least 1 academic publication in the past 5 years. - At least 2 out of 5 instructors in charge of the program must have professional experiences.	✓	✓	✓	✓	✓
3	Qualifications of instructors for the program	- Master degree or equivalent, or academic position at the minimum of assistant professor in related field. - At least 1 academic publication in the past 5 years.	✓	✓	✓	✓	✓

No	Criteria	Description	Year 1	Year 2	Year 3	Year 4	Year 5
			2022	2023	2024	2025	2026
4	Qualifications of instructors teaching for the program	**Full-time instructor:** - Master degree or equivalent, or academic position at the minimum of assistant professor in related field. **Adjunct instructor:** - Master degree or equivalent, or Bachelor degree or equivalent with a minimum of 6-year work experience relevant to the subject being taught. - Teach more than 50% of the credit together are a full-time instructor is in charge of the course	✓	✓	✓	✓	✓
5	Period for Program Revision	- Program revision must take place every 5 year or more frequent	✓	✓	✓	✓	✓
Summary		the indicator 1.1 Curriculum Management according to the 2015 Ministry of Education's Standard Criteria for Undergraduate Programs (B.E. 2558).	☑ Passed ☐ Failed	☑ Passed ☐ Failed	☑ Passed ☐ Failed	☑ Passed ☐ Failed	☑ Passed ☐ Failed

7.2 Core KPIs

The quality assurance KPIs to ensure the quality of the students' learning outcomes are as follows:

No.	Key Performance Indicators	Year 1	Year 2	Year 3	Year 4	Year 5
		2022	2023	2024	2025	2026
1	At least 80% of program designated lecturers have participated in meetings regarding planning, monitoring and reviewing the program administration.	✓	✓	✓	✓	✓
2	Provide the program details in the TQF 2 format which complies with the Thai Qualifications Framework for Higher Education or professional standard/standard of the program (if any).	✓	✓	✓	✓	✓
3	Provide the details of all courses and field experiences (if any) in the TQF 3 and TQF 4 formats before the semester begins.	✓	✓	✓	✓	✓
4	Produce the course report and field experience report (if any) of every course in the TQF 5 and TQF 6 formats within 30 days after the end of each semester.	✓	✓	✓	✓	✓
5	Produce the program report in the TQF 7 format within 60 days after the end of the academic year.	✓	✓	✓	✓	✓
6	There is a verification process for student achievement according to the standard of learning outcomes as indicated in the TQF 3 and TQF 4 (if any) at least 25 % of the courses being offered in each academic year.	✓	✓	✓	✓	✓

No.	Key Performance Indicators	Year 1	Year 2	Year 3	Year 4	Year 5
		2022	2023	2024	2025	2026
7	There is a development/an improvement in teaching and learning, teaching strategies or evaluation strategies of the learning outcomes due to the evaluation results in the TQF 7 of the previous year.		✓	✓	✓	✓
8	Every new lecturer (if any) has participated in the orientation or received advice on teaching and learning.	✓	✓	✓	✓	✓
9	Every full-time lecturer has been academically/professionally developed at least once a year.	✓	✓	✓	✓	✓
10	The number of the supporting staffs (if any) who have been academically/ professionally developed is no less than 50 % per year.	✓	✓	✓	✓	✓
11	The average level of senior students'/new graduates' satisfaction towards the program quality is no less than 3.5 out of 5.0.				✓	✓
12	The average level of employers' satisfaction towards the new graduates is no less than 3.5 out of 5.0.					✓
	Total number of KPI	9	10	10	11	12

7.3 Assessment Criteria for the Approval and Promotion of the Program's Performance

A curriculum that meets the standard of Thai Qualifications Framework must qualify for the following conditions:

(1) The compulsory KPIs (numbers 1-5) must be achieved.

(2) The total number of the achieved KPIs must be no less than 80 percent in the year of the assessment for a minimum of two consecutive years for the program to be approved of its quality and further promoted. The program is required to maintain the assessment.

Section 8 Evaluation and Improvement of the Program Implementation

1. Assessment of Teaching Effectiveness

1.1 Assessment of Teaching Strategy

1.1.1 The lecturers attend meetings to share their viewpoints and consult experienced lecturers regarding teaching strategies.

1.1.2 The course lecturers/the lecturers in charge of the program ask for opinions and recommendations from other lecturers after teaching strategies are designed.

1.1.3 The course lecturers ask the students about the effectiveness of their learning experience by means of course evaluation, questionnaire, group discussion during or at the end of the semester.

1.1.4 The students' learning outcomes are evaluated based on their expressed conduct, participation in activities and test results.

1.2 Assessment of the Lecturers' Skills in Applying Teaching Strategies

1.2.1 The students evaluate lecturers' instructional approaches, punctuality, clarification of course goals, objectives and assessment, and teaching media in all courses at the end of each semester.

1.2.2 The students' learning outcomes are evaluated based on their expressed conduct, participation in activities and test results.

2. Overall Assessment of the Program

The evaluation and assessment of students are indicated the criteria for educational assessment and graduation. The assessment process is as follows:

2.1 Assessment by Students and Alumni

Appoint the program assessment committee consisting of representatives of current students and alumni to plan for a systematic program assessment and to survey information needed for the program assessment from Year 1-4 students and from alumni.

2.2 Assessment by Experts and/or External Assessors

Analyze and assess the overall program and make use of the feedback from the experts and/or external assessors in the assessment.

2.3 Assessment by Employers of Graduates

Follow up on the alumni with their employers/supervisors using questionnaires and interviews.

3. Assessment of the Program Implementation Based on the Program Specification

The annual quality assurance according to the key performance indicators in Section 7, Number 7, is conducted by a faculty-level internal quality assurance committee.

4. Procedure for the Review of Evaluation Results and Plans for the Revision of the Program and Teaching Strategies

The information from Numbers 1-3 above provides an overall picture of the problems related to the program administration as well as those related to individual courses. The latter can and should be addressed immediately in a minor revision of the program. The revision of the overall program is scheduled to be undertaken every 5 years to ensure that the program is up-to-date and relevant to the needs of graduates and their employers.