

**DOCUMENT OF CURRICULUM
CIVIL ENGINEERING STUDY PROGRAM
2016**



**FACULTY OF ENGINEERING
UNIVERSITAS SEBELAS MARET (UNS)**

INSTITUTIONAL SUMMARY

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FOREWORD

The Civil Engineering Study Program is one of the pioneering programs and was established in 1976 in conjunction with the establishment of the Faculty of Engineering and Universitas Sebelas Maret. With such long experience we are confident to give the best education to the students as well as contribute to construction industries in Indonesia and the world.

The current state of the world is characterized by rapid change, increasingly complex and interconnected problems, pressing ecological and sustainability issues. The profession of civil engineers is also required to be more adaptive in responding to the condition and formulating its position in facing the new world.

Therefore, the Civil Engineering Study Program of FT UNS strengthens itself by integrating the outcomes-based education paradigm, in line with the Indonesian National Qualification Framework, and the criteria of the world's engineering accreditation bodies (e.g. Accreditation Board for Engineering and Technology [ABET], Japan Accreditation Board for Engineering Education [JABEE], *Akkreditierungsagentur für Studiengänge der Ingenieurwissenschaften, der Informatik, der Naturwissenschaften und der Mathematik* [ASIIN]). The 2016 curriculum is designed and implemented on PSTS as an effort to equip students with knowledge, skills and strong character to be high-qualified graduates.

The 2016 curriculum book contains 3 sections, in accordance with the stages of curriculum design. The first section contains references, analysis of stakeholders' inputs, analysis of labor market share conditions and the steps taken by the Civil Engineering program to formulate the objectives of the study program and the learning outcomes. The second section contains the analysis of the body of knowledge and teaching materials that support learning achievement. The third section contains the structure of the new curriculum.

This handbook is designed and structured to describe the objectives and the end products of our civil engineering education. Thus, it is expected that students and lecturers and all stakeholders of Civil Engineering Department are able to follow this education program well

Wibowo, ST., DEA
Head of Study Program

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GENERAL DESCRIPTIONS, PROCESSES AND STEPS OF CURRICULUM 2016 DEVELOPMENT

The Civil Engineering Study Program (CESP), was founded along with the establishment of Faculty of Engineering (FE) of Universitas Sebelas Maret (UNS) on March 11, 1976. Since then CESP has produced civil engineering graduates with civil infrastructure and technological competence. Since its inception to date, CESP has developed expertise in 5 majors civil engineering fields; Water Resources and Environment Engineering, Construction Materials and Structural Engineering, Geotechnical Engineering, Transportation Engineering, and Construction Management and ICT. Recent rapid developments in the civil engineering science and technology have forced CESP to review the educational process by integrating the outcome-based education paradigm to produce highly qualified civil engineering graduates.

A comprehensive implementation of outcome-based education in Civil Engineering Study Program involves three integral components:

1. **Outcome-based curriculum.** In this aspect, one of the key questions is, "What is the student expected to be able to do after graduating from Civil Engineering Study Program?". To answer this question Civil Engineering Study Program develops an **explicit formulation of learning outcomes** of the curriculum 2016.
2. **Outcome-based learning and teaching.** Furthermore, this aspect asks, "How to make students achieve the learning outcomes?" Civil Engineering Study Program implements the curriculum with **student-centered learning**.
3. **Outcome-based assessment.** "How to measure what the student has achieved?" is the next key question. To answer this, Civil Engineering Study Program will conduct a learning assessment using an **assessment rubric** to measure the extent to which the learning outcomes are achieved.

By integrating the **outcome-based education** paradigm, in line with **the Indonesian National Qualification Framework**, and the criteria of the world's **engineering education accrediting bodies** (eg ABET, JABEE, ASIIN) the curriculum 2016 was designed and is currently implemented in Civil Engineering Study Program by:

1. Using **explicit** statement of **learning outcomes** to measure what students can do after graduating from the Civil Engineering Study Program education.
2. Providing activities (experiences) of learning in Civil Engineering Study Program that help students achieve the learning outcomes.
3. Measuring the extent to which Civil Engineering Study Program students and graduates meet the learning outcomes by using explicit assessment criteria (eg: **assessment rubric**).

In the development of the curriculum 2016 of the CESP Faculty of Engineering (FT) of Universitas Sebelas Maret (UNS), the task force uses a framework that refers to the process chart and the curriculum development phase developed by DIKTI in 2013. The chart is shown in the Figure 1.

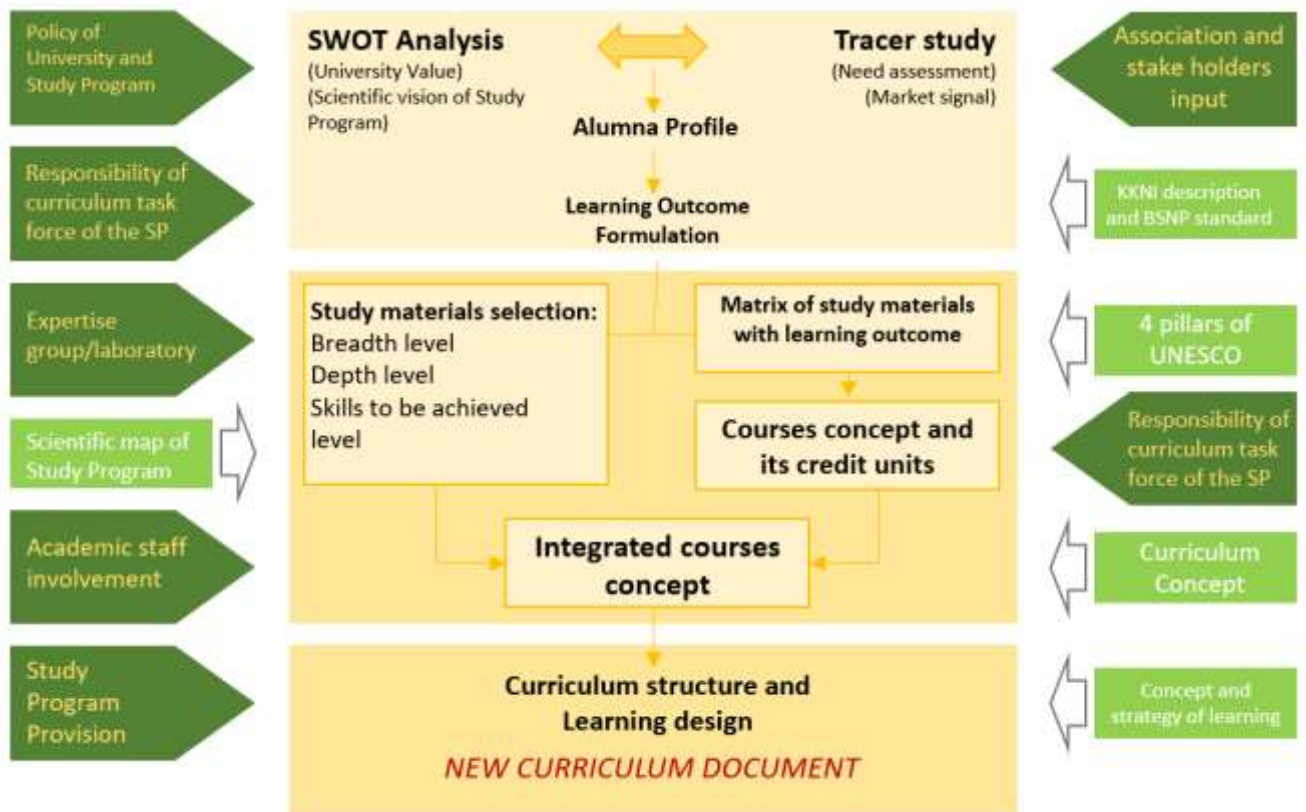


Figure 1. Chart of the process and stages of curriculum development
 Source: *Panduan Penyusunan Kurikulum Pendidikan Tinggi, Kemendikbud, 2016 (in bahasa)*

Referring to the chart, there are three stages of curriculum development, namely:

Stage 1. Formulation of learning outcomes

This stage begins with an analysis of the market needs (job markets) and the study of how institutions (UNS, FT, CESP) are able to comply with internal institutional policy. Using this analysis, Civil Engineering Study Program formulates graduate profiles and learning outcomes.

Stage 2. Subject of Study: Body of Knowledge (BOK) of Civil Engineering

After the learning outcomes are formulated, the second step ensures that the subject (course) are selected and structured to achieve the learning outcomes. This phase begins with a study of Body of Knowledge (BOK) of Civil Engineering proposed by American Society of Civil Engineering (ASCE), 2008, that includes the depth, breadth and competence to be achieved by the graduates. This step ends with the preparation of the matrix of subject and learning outcomes.

Stage 3. Curriculum and Syllabus Structure

The curriculum structure is then structured at the final step to ensure that each subject (course) contributes harmoniously to achieve the learning outcomes. The syllabus of each subject should state the objectives that reflect students' **outcomes** after learning.

STAGE 1. FORMULATION OF LEARNING OUTCOMES

1.1. References of Curriculum Development

The documents referred in the development of the Curriculum 2016 are as follows:

1. Regulation of the Minister of Research, Technology and Higher Education No. 44 of 2015 on National Standards of Higher Education
2. -, **Indonesia National Qualification Framework (KKNI), Presidential Regulation no. 8 Year 2012**, Directorate General of Higher Education, Ministry of Education and Culture, Republic of Indonesia, 2012
3. -, **Criteria for Accrediting Engineering Programs 2015-2016**, ABET, 2014
4. -, **Common Criteria for Accreditation of Professional Education Programs applicable in the year 2015**, JABEE, 2014
5. Technical Committee of Civil Engineering, Surveying and Architecture, Subject Specific Criteria, ASIIN e.V., 2012.
6. ASCE Steering Committee, **The Vision for Civil Engineering in 2025**, American Society of Civil Engineers (ASCE), 2007
7. ASCE Task Committee, **The Vision for Civil Engineering in 2025; A Roadmap for the Profession**, American Society of Civil Engineers (ASCE), 2007
8. Body of Knowledge Committee, **Body of Knowledge for the 21st Century**, 2nd ed, American Society of Civil Engineers (ASCE), 2008.
9. Krathwohl, David R., **A Revision of Bloom's Taxonomy: An Overview**. Theory into Practice, Volume 41, Number 4, College of Education, The Ohio State University, Autumn 2002.

The curriculum of the Civil Engineering Study Program refers to the criteria: [1] Indonesia National Qualification Framework (KKNI), [2] Criteria for Accrediting Engineering Programs 2015-2016, issued by ABET Accreditation Board for Engineering and Technology Inc., USA, and [3] Common Criteria for Accreditation of Professional Education Programs applicable in the year 2015 issued by Japan Accreditation Board for Engineering Education (JABEE).

The selection of the subjects (courses) in curriculum 2016 refers to the Civil Engineering Body of Knowledge (BOK) for 21st Century, 2nd edition (2008), issued by the American Society of Civil Engineers (ASCE).

1.2. Needs Analysis and Future Challenges of Civil Engineer Profession

As a field of study, civil engineering science has been quite old and mature. As a profession, civil engineering engineers have made extensive and profound advances in the quality of life for human civilization. It is very difficult to imagine the progress of human civilization to this modern era without the support of civil engineering.

However, recent conditions characterized by rapid globalization, ecological pressures and sustainability issues are demanding our attention, making the civil engineering profession to redefine its position in facing the future. The vision of the future (2025) of the profession of civil engineering engineers is formulated carefully by some of professional leaders of civil engineering accommodated by ASCE as follows:

“Entrusted by society to create a sustainable world and enhance the global quality of life, civil engineers serve competently, collaboratively, and ethically as master:

- **planners, designers, constructors, and operators** of society's economic and social engine—the built environment;
- **stewards of the natural environment** and its resources;
- **innovators and integrators of ideas and technology** across the public, private, and academic sectors;
- **managers of risk and uncertainty** caused by natural events, accidents, and other threats; and
- **leaders in discussions and decisions** shaping public environmental and infrastructure policy.”

1.3. Stakeholders' Input Analysis

To adequately design the curriculum 2016, CESP analyzed input from its stakeholders. The mechanism of input collection from stakeholders is done by survey, tracer study, questionnaire and hearing in the discussion forum. Table 1 summarizes the stakeholder input of Civil Engineering Study Program, Civil Engineering, UNS.

Table 1. Stakeholders Input

Stakeholders	Content/Input
Students	<ol style="list-style-type: none"> 1. Students do not really understand the relevance between courses; that is how the basic course can be applied to advanced courses 2. Students assume that the classroom materials are different and there is no correspondence between class syllabi. 3. Students assume that software that supports the analysis and design of civil buildings is not adequately provided, poorly taught or well applied.
Graduates	Most of the fresh graduates feel confident enough to enter the workforce. Some of them feel quite confident to pursue their post-graduate program in domestic universities, whilst their mastery in English language still hinder them pursue their studies in overseas universities.
Alumnus	The ability to communicate work result in English is still insufficient, including report writing skills, calculation and design results, and presentation.
Lecturer	<ol style="list-style-type: none"> 1. Lecture roadmap needs to be improved 2. Courses that encourage the competence in civil-building design need to be developed and reinforced. 3. The syllabi need to be improved and reviewed in the Expertise Group and all of the lecturers are expected to implement the syllabi with discipline.
Graduate and Industrial Users	<ol style="list-style-type: none"> 1. Graduates of Civil Engineering CESP FT UNS are skillful, have good intellect to develop, and are loyal enough, but lack in teamwork, leadership and communication. 2. Courses that help improve the design skills need to be strengthened; including rule control, standards and software for design 3. Multidisciplinary field practice needs to be multiplied 4. The competence of current engineering practice is not honed because of the involvement of practitioners in less learning process. 5. Knowledge of socioeconomic issues of globalization and sustainable development needs to be sharpened. 6. Softskills; among others, the ability to discuss, give presentation, and write in English, leadership, and creativity need to be sharpened. 7. The final project form as the project design exercise needs to be more reproduced.

1.4. Vision and Mission Universitas Sebelas Maret (UNS) and Faculty of Engineering (FT) UNS

In the process of designing the curriculum 2016, Civil Engineering Study Program also paid close attention to the internal policies of UNS and FE. Curriculum 2016 is designed to align and contribute to the realization of the vision and mission of UNS and Engineering Faculty formulated as follows:

Vision of UNS

Becoming the center of the development of science, technology, and arts that excel at the international level with the basis of the noble values of national culture.

Mission of UNS

1. Organizing education and teaching that demands self-development of lecturers and encouraging students independence in acquiring knowledge, skills and attitudes.
2. Conducting research leading to new discoveries in science, technology, and arts.
3. Conducting community service activities oriented to community empowerment efforts.

Vision of Engineering Faculty of UNS

The Faculty of Engineering of Sebelas Maret University will be developed as a leading faculty in higher technical education, capable of producing graduates who have good morality, professional, innovative and independent, to support the nation's development.

Mission of Engineering Faculty of UNS

1. Providing academic and professional level education, which supports the development of the nation, by promoting a healthy academic atmosphere, and utilizing the latest technology and information.
2. Conducting research-oriented development of education and development of science and technology to answer the problems of local, national, regional, and international level.
3. Conducting community service programs with orientation to empowerment of all layers of society.

1.5. Vision and Mission of Civil Engineering Study Program of Engineering Faculty UNS

Referring to the analysis of the future needs and challenges of the civil engineering profession, stakeholder expectations, the Civil Engineering Study Program parent institution policy, and studying the direction of the development trends of civil science and the profession of the civil service, the vision and missions of Civil Engineering Study Program of Engineering Faculty of UNS are formulated as follows:

Vision:

Civil Engineering Study Program, Faculty of Engineering, Universitas Sebelas Maret, is **one of strong contributors in developing engineering solutions for our current and future pressing problem in the society, based on science, engineering knowledge, and local wisdom.**

Missions:

- M1.** Conducting a rigorous civil engineering education, but rich in learning experiences to produce graduates who are ready to become leaders in the civil engineering profession and in the broader social context.
- M2.** Producing, disseminating, and applying science and technology in collaboration with all parties to solve complex engineering problems in society.
- M3.** Building the ability and community spirit to work more effectively, creatively, and wisely for the nation's progress.

1.6. The Objectives of Education and Graduates' Profile of Civil Engineering Study Program (S1) Engineering Faculty UNS

By studying the future needs of the civil engineering profession and carrying out its mission, CESP FE UNS formulates its educational program objectives. The following Program Educational Objectives [PEO] are formulated consistently with the vision and mission of the University, Faculty and CE Dept. Formulation of PEO states that graduates of CESP are expected to be able to:

- PEO-1.** *Apply knowledge of basic science, math, engineering science and construction management to undertake work as a civil engineering infrastructure designer, constructor, operator or policy maker.*
- PEO-2.** *Assess technical solution alternatives and contributing to problem solving in professional work and in general public by taking into account public safety, socio-economic aspects, ethical values, sustainability and environmental protection*
- PEO-3.** *Demonstrate professional integrity, polite behavior, and enthusiasm for success in work that is in his/her responsibility at the national and international level.*
- PEO-4.** *Demonstrate passion for self-development and lifelong learning, being able to earn professional certificate, and being able to continue post-graduate studies especially in civil engineering discipline.*

With this aim, Civil Engineering Department of Engineering Faculty of UNS expects its graduates to have professional profile [PP] as:

- PP-1. Infrastructure Planners** who carry out conceptual and technical thinking processes to organize, manage and evaluate the activities required to achieve civil infrastructure development objectives.
- PP-2. The Civil Designer** who is capable of performing the design process of civil buildings in a particular environment with CAD (Computer Aided Design) and CAE (Computer Aided Engineering) to: [a] produce creative and tested designs, [b] solve problems encountered and [c] formulate clear specifications for the design.
- PP-3. Implementers and supervisors of construction and infrastructure projects** who are able to use the concepts and principles of management and construction methods and technology to realize civil designs that meet the determined criteria and standards
- PP-4. Operators** who are capable of performing operations and maintenance by ensuring the functionality and sustainability of the infrastructure facilities under their responsibility.
- PP-5. Policy makers** who conduct precise and accurate assessments in accordance with scientific principles to assist in the formulation of policies and good decision-making in infrastructure development in the community.

1.7. Formulation of Learning Outcomes; comparative analysis with ABET, JABEE and KKNi criteria

The Civil Engineering Study Program of Engineering Faculty UNS formulates learning outcomes (LO) in line with the description of KKNi level 6 (undergraduate equivalent) and general criteria formulated by ABET 2015 and JABEE 2014. The learning outcomes states that a **graduate of the civil engineering course Engineering Faculty UNS is able to:**

- LO-1.** Apply knowledge of mathematics, science, and engineering to solve complex civil engineering problems.
- LO-2.** Design and conduct experiments as well as analyze and interpret data based on correct scientific principles.
- LO-3.** Design systems, components and construction processes for more than one context of civil engineering; buildings, water structures, foundation and ground buildings, roads, bridges and other civil infrastructure, which meet design criteria, technical standards, performance aspects, reliability, and applicability.
- LO-4.** Identify, formulate and solve engineering problems within the limits of public safety, economics, social, ethics, and realistic environmental impacts.
- LO-5.** Selecting and utilizing techniques, skills, and tools - such as the latest information technology and computing-based tools necessary for engineering practices.

- LO-6.** Using the basic concepts of project management and leadership in construction work, supervision and operational work.
- LO-7.** Perform roles and functions effectively on multidisciplinary teams and maintain networking for the right purpose.
- LO-8.** Taking on professional commitment and ethical work responsibilities.
- LO-9.** Communicate in spoken or written expressions effectively by using technical drawing and other appropriate audio-visual tools with regard to function, scale and target of communication.
- LO10.** Develop broad insights and needs to understand the impact of engineering solutions in a global, economic, environmental and social context.
- LO-11.** Identify current issues and discuss the role of the civil engineering profession in addressing these issues.
- LO-12.** Recognize and appreciate lifelong learning.

The following matrix shows the relationship between **learning outcomes (LO)** of graduate with **the Program Educational Objectives (PEO)** of CESP.

Table 2. Matrix of Learning Outcomes (LO) linked to Program Educational Objectives (PEO)

(Learning outcomes [LO])	(Program Educational Objectives[EO])			
	PEO-1.	PEO-2.	PEO-3.	PEO-4.
LO-1.	✓	✓		
LO-2.	✓	✓		✓
LO-3.	✓	✓	✓	
LO-4.		✓		
LO-5.		✓	✓	✓
LO-6.		✓	✓	
LO-7.	✓		✓	✓
LO-8.	✓		✓	
LO-9.	✓	✓	✓	✓
LO-10.	✓	✓	✓	✓
LO-11.		✓	✓	
LO-12.				✓

The formulation of learning outcomes of CESP based on the Indonesian National Qualification Framework (KKNI) level 6 equivalent undergraduate (S1) can be seen in table 3. While the comparison of learning outcomes analysis (Learning Outcomes) Civil Engineering, Engineering Faculty UNS with general criteria of expected learning outcomes by ABET and JABEE can be seen in table 4. In comparison matrix, it can be seen that the formulation of CESP learning outcomes has been quite comprehensive and consistent with KKNI, ABET and JABEE criteria

Table 3. Comparison of Indonesia National Qualification Framework (KKNI) and Learning Outcomes of CESP

Descriptors		Learning Outcomes of CESP		
		Generic Description Level 6 KKNI	Deskripsi Generik Level 6 KKNI	Learning outcomes of CESP FE UNS
A	a) Able to do ... b) With the method ... c) Showing results ... d) Under the conditions ...	Able to utilize science and technology in the field of expertise and able to adapt to the situation encountered in solving the problem.	Able to apply math, science, and engineering principles to solve complex engineering problems.	LO1. Able to apply the knowledge of engineering mathematics, basic science, and engineering science principles to solve complex issues of discipline in society.
			Able to find the source of engineering problems through the process of investigation, analysis, interpretation of data and information based on engineering principles.	LO4. Be able to identify the source of engineering problems, formulate, and assess alternative technical solutions to engineering problems within the economic, environmental, social, political, ethical, health and safety, and realistic sustainability constraints.
			Able to formulate alternative solutions to solve complex engineering problems by taking into account economic, health and safety factors of public, cultural, social and environmental (environmental consideration)	
			Able to conduct research that includes identification, formulation and analysis of engineering problems	LO2. Able to design, execute, analyze and interpret experimental data and testing based on correct scientific principles.
			Able to design systems, processes, and components with an analytical approach and take into account technical standards, performance aspects, reliability, ease of implementation, sustainability, and attention to economic, health and safety factors of public, cultural, social and environmental factors	LO3. Able to design civil construction systems, components and construction processes for more than one context of civil engineering; buildings, water structures, foundations and land structures, roads, bridges and other civil infrastructure, which fulfill design criteria established taking into account technical standards, performance aspects, reliability, ease of application.
			Capable of selecting resources and utilizing design tools and engineering analysis based on appropriate information and computing technologies to perform engineering activities	LO5. Be able to select and utilize techniques, skills, and tools - such as the latest information technology and computing-based tools necessary for engineering practice.

B	a) Mastering knowledge ... b) To be able to do ...	Mastering theoretical concepts of certain field of knowledge in general and theoretical concept of the specific knowledge in depth and capable of formulating procedural problem solving.	Mastering the theoretical concepts of natural science, application of engineering mathematics; engineering principles, engineering science and engineering design required for the analysis and design of systems, processes, products or components	L01. Able to apply the knowledge of engineering mathematics, basic science, and engineering science principles to solve complex issues of discipline in society.
			mastering the principles and techniques of designing systems, processes, or components	
			mastering the latest principles and issues in economics, social, ecology in general	L010. Being able to build broad insights and need to understand the impact of engineering solutions in a global, economic, environmental and social context.
			mastering the knowledge of communication techniques and latest and latest technological developments	L011. Be able to identify current issues and discuss the role of the civil engineering profession in addressing these issues.
C	a) Able to manage ... b) Having an attitude ...	Being able to make strategic decisions based on information and data analysis, and provide guidance on choosing different alternative solutions independently and in groups.	making decisions appropriately in the context of problem solving in the area of expertise, based on the analysis of information and data	L06. Able to use the basic concepts of project management and leadership in construction work, supervision and operational work.
			developing and maintaining networks with counselors, colleagues, colleagues both within and outside of their institutions	L07. Be able to perform roles and functions effectively in multidisciplinary / multi-cultural teams and maintain networking for the right purpose.
		Responsible for the work itself and can be given responsibility for the achievement of the work of the organization.	showing a responsible attitude towards the work in the field of expertise independently	L08. Able to take professional commitment and ethical work responsibilities.
			managing learning independently	L012. Being able to recognize and appreciate lifelong learning.

Table 4. Comparison of Learning Outcomes of Civil Engineering Study Programs FE UNS and General Criteria of Learning outcomes Expected by ABET and JABEE

ABET General Criteria for Learning Outcomes	JABEE Criteria Guide for Learning Outcomes	Learning Outcomes of CESP
a) <i>an ability to apply knowledge of mathematics, science, and engineering</i>	(c) <i>Knowledge of and ability to apply mathematics and natural sciences</i>	LO1. Able to apply the knowledge of engineering mathematics, basic science, and engineering science principles to solve complex issues of discipline in society.
b) <i>an ability to design and conduct experiments, as well as to analyze and interpret data</i>		LO2. Able to design, execute, analyze and interpret experimental data and testing based on correct scientific principles.
c) <i>an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</i>	(e) <i>Design ability to respond to requirements of the society by utilizing various sciences, technologies and information</i>	LO3. Able to design civil construction systems, components and construction processes for more than one context of keteniksipilan; buildings, water structures, foundations and land structures, roads, bridges, and other civil infrastructure, which meet design criteria established taking into account technical standards, performance aspects, reliability, ease of application.
d) <i>an ability to function on multidisciplinary teams</i>	(i) <i>An ability to work in a team</i>	LO7. Able to perform roles and functions effectively in multidisciplinary / multi-cultural teams and maintain networking for the right purpose.
e) <i>an ability to identify, formulate, and solve engineering problems</i>	(d) <i>Knowledge of the related professional fields, and ability to apply</i>	LO4. Able to identify the source of engineering problems, formulate, and assess alternative technical solutions to engineering problems within the economic, environmental, social, political, ethical, health and safety, and realistic sustainability constraints.
	(h) <i>An ability to manage and accomplish tasks systematically under given constraints</i>	LO6. Able to use the basic concepts of project management and leadership in construction work, supervision, and operational work.
f) <i>an understanding of professional and ethical responsibility</i>		LO8. Able to take professional commitment and ethical work responsibilities.
g) <i>an ability to communicate effectively</i>	(f) <i>Communication skills including logical writing, presentation and debating</i>	LO9. Able to communicate in spoken or written expressions effectively by using technical drawing and other appropriate audio-visual tools with regard to function, scale and target of communication.

<p><i>h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context</i></p>	<p><i>(b) An ability of understanding of effects and impact of professional activities on society and nature, and of professionals social responsibility</i></p> <p><i>(a) An ability of multidimensional thinking with knowledge from global perspective</i></p>	<p>LO10. Able to build broad insights and need to understand the impact of engineering solutions in a global, economic, environmental and social context.</p>
<p><i>i) a recognition of the need for, and an ability to engage in life-long learning</i></p>	<p><i>(g) An ability of independent and life-long learning</i></p>	<p>LO12. Able to recognize and appreciate lifelong learning.</p>
<p><i>j) a knowledge of contemporary issues</i></p>		<p>LO11. Able to identify current issues and discuss the role of the civil engineering profession and respond these issues.</p>
<p><i>k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</i></p>		<p>LO5. Able to select and utilize techniques, skills, and tools - such as the latest information technology and computing-based tools necessary for engineering practice.</p>

STAGE 2. BODY OF KNOWLEDGE

2.1. Selection of Subjects (Courses); Body of Knowledge (BOK) Civil Engineering

The Body of Knowledge (BOK) of Civil Engineering can be defined as **the depth and breadth of knowledge, skills and attitudes required by an individual candidate of civil engineers to enter civil engineering practice at a professional level**. The Body of Knowledge is filled with a combination of formal higher education at the university level (undergraduate and graduate / postgraduate) and experience (e.g. professional education by professional associations).

Compared to the approaches and practices currently used, future candidates of civil engineer - before entering civil engineering practice - are expected:

1. Mastering more in mathematics, the natural sciences, and the foundations of engineering science;
2. Maintaining the breadth of technical knowledge;
3. Gaining wider exposure to the humanities and the social sciences;
4. Obtaining additional results of a wide variety of professional practices; and
5. Achieving the level of depth of mastery of technical knowledge --ie, specialist education.

ASCE in 2008 proposed the second edition BOK that accommodates the future challenges of the profession of civil engineering engineers. In the proposal, BOK is stated in: **Foundational knowledge, Knowledge of Civil Engineering** (technical), and **Professional Knowledge** (Professional). Adopting the proposal, CESP designed the study material that was divided into several categories as shown in Figure 2.

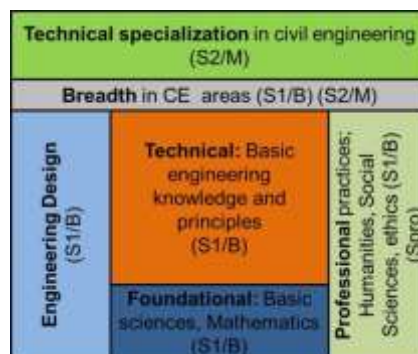


Figure 2. Categories and design of body of knowledge in curriculum 2016

Furthermore, **Table 5** shows the BOK and the minimum level of achievement that must be mastered by students and graduates of FT UNS civil engineering program, as well as study materials (courses) that support the BOK. Table 5 contains 23 learning outcomes materials (outcomes) for which each subject is determined at its cognitive achievement level. This level of achievement was adopted from **Revised Bloom's Taxonomy** (Anderson and Krathwohl, 2001) as a tool for **describing the minimum cognitive achievement level** of each outcome. Each individual student and graduate is expected to demonstrate this level of competency before entering the practice of the civil engineering profession. Furthermore, this table is supplemented with the proposed study materials (courses) that support the performance materials specified by the BOK. Table 6 illustrates how students' cognitive processes can be encouraged by setting learning objectives that reflect the achievement of learning outcomes at each level specified in the BOK.

Table 5. Body of Knowledge, level of achievement and subjects (courses) in the curriculum 2016

Title of Subject	Level of Achievement						Subjects
	L1 <i>Know- Ledge (Remem- ber)</i>	L2 <i>Compre- hension (Under- stand)</i>	L3 <i>Application (Apply)</i>	L4 <i>Analysis (Analyse)</i>	L5 <i>Evaluation (Evaluate)</i>	L6 <i>Creation (Create)</i>	
Foundational Knowledge							
1. Mathematics	S1(B)	S1(B)	S1(B)				Calculus, Advanced Calculus and Linear Algebra, Differential Equations, Statistics and Probability, Methods and Numerical Computation
2. Basic Sciences	S1(B)	S1(B)	S1(B)				Basic Physics, Basic Chemistry, Environmental Engineering and Sanitary
3. Humanities and Social Sciences	S1(B)	S1(B)	S1(B)				Religious Education, Pancasila Education, Civics Education, Basic Social and Cultural Sciences, Entrepreneurship, Indonesian, English
Civil Engineering Technical Knowledge							
4. Construction Materials Sciences	S1(B)	S1(B)	S1(B)				Construction Materials and their Properties, Mechanics of materials
5. Engineering Mechanics	S1(B)	S1(B)	S1(B)	S1(B)			Statics, Mechanics of Materials, Fluid Mechanics, Hydraulics, Soil Mechanics, Structural Analysis, Structural Analysis with Matrix Method.
6. Basic Engineering Sciences; <i>Problem recogn. & solving</i>	S1(B)	S1(B)	S1(B)	S2(M)			Computer Programming, Soil Science and Geomatics, Transportation Systems, Mass Transportation Systems, Traffic Engineering & Engineering Water Resources and Coastal Engineering, Introduction to Structural Dynamics and

							Earthquake Engineering, Concrete Structures. Steel Structure,
7. Experiment	S1(B)	S1(B)	S1(B)	S1(B)	S2(M)		Basic Physics, Building Materials and Property Materials, Hydraulics, Pavement Pavement, Soil Mechanics,
8. Design	S1(B)	S1(B)	S1(B)	S1(B)	S1(B)	S1(B)/SPro	Introduction to Civil Engineering, Engineering Drawing, CAD, Material Mechanics, Irrigation and Water Building, Drainage, Traffic Engineering & Management, Road Geometry, Pavement Piling, Foundation Engineering, Concrete Structure Design, Steel Structure Design, Bridge Recreation.
9. Project Management	S1(B)	S1(B)	S1(B)	SPro			Systems and Construction Management, Construction Methods, Engineering Economics
10. Risk and Uncertainties	S1(B)	S1(B)	S1(B)	SPro			Statistics and Probability, Hydrology, Introduction to Structural Dynamics and Earthquake Engineering.
11. Sustainability	S1(B)	S1(B)	S1(B)	SPro			Introduction to Civil Engineering, Environmental and Sanitary Engineering
12. Contemporary Issues and Perspective	S1(B)	S1(B)	S1(B)	SPro			Internship, Basic Social and Cultural Sciences, Civics Education, Entrepreneurship
13. Breadth in CE	S1(B)	S1(B)	S1(B)	S1(B)			<i>Elective courses</i>
14. Specialization in CE	S1(B)	S2(M)	S2(M)	S2(M)	S2(M)/S3	S3	<i>Elective Courses, Graduate equivalent lectures</i>

Professional Knowledge

15. Communication	S1(B)	S1(B)	S1(B)	S1(B)	SPro	Indonesian, English, Technical Drawing, CAD, Internship, Curriculum-wise	
16. Public Policies	S1(B)	S1(B)	SPro			Systems and Construction Management, Construction Methods, Engineering Economics, Basic Social and Cultural Sciences, Civics Education, Entrepreneurship	
17. Business and Public Administration	S1(B)	S1(B)	SPro			Systems and Construction Management, Engineering Economics, Entrepreneurship.	
18. Globalization	S1(B)	S1(B)	S1(B)	SPro		Basic Social and Cultural Sciences, Civics Education, Entrepreneurship	
19. Leadership	S1(B)	S1(B)	S1(B)	SPro		Internship, Entrepreneurship, Curriculum-wise	
20. Teamwork	S1(B)	S1(B)	S1(B)	SPro		Internship, Introduction to Civil Engineering, Curriculum-wise	
21. Attitudes	S1(B)	S1(B)	S1(B)	SPro		Religious Education, Pancasila Education, Internship, Introduction to Civil Engineering and Design, Curriculum-wise	
22. Lifelong Learning	S1(B)	S1(B)	S1(B)	SPro	SPro	English, Final Project / Thesis, Curriculum-wise	
23. Ethics and Professional Responsibility	S1(B)	S1(B)	S1(B)	S1(B)	SPro	SPro	Internship, Final Project / Thesis, Curriculum-wise

Note: S1 (B): portion of BOK fulfilled through Bachelor's education; **S2 (M):** portion of BOK is fulfilled through postgraduate education (S2); **SPRO:** a portion met with professional education (certification of association).

The level of achievement of knowledge is then further elaborated by preparing the learning objectives that refer to the cognitive skills framework in table 6. Lecturers are expected to develop learning objectives so that students are able to perform cognitive skills in harmony with the level of achievement in table 5.

Table 6. Cognitive skills framework and preparation of learning objectives (Anderson and Krathwohl, 2001) in the curriculum 2016

The Cognitive Processes dimension — categories & cognitive processes from lower order thinking skills to higher order thinking skills						
	1.0 Remember	2.0 Understand	3.0 Apply	4.0 Analyze	5.0 Evaluate	6.0 Create
	Retrieving relevant knowledge from long-term memory.	Determining the meaning of instructional messages, including oral, written, and graphic communication.	Carrying out or using a procedure in a given situation.	Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.	Making judgments based on criteria and standards.	Putting elements together to form a novel, coherent whole or make an original product.
	1.1 Recognizing 1.2 Recalling	2.1 Interpreting 2.2 Exemplifying 2.3 Classifying 2.4 Summarizing 2.5 Inferring 2.6 Comparing 2.7 Explaining	3.1 Executing 3.2 Implementing	4.1 Differentiating 4.2 Organizing 4.3 Attributing	5.1 Checking 5.2 Critiquing	6.1 Generating 6.2 Planning 6.3 Producing

2.2. Competency Matrix and Subjects

To link each subjects in the BOK with learning outcomes [LO1 - LO12], CESP developed matrix as follows:

Table 7. Course linked with learning outcomes of the curriculum 2016

CURRICULUM CIVIL ENGINEERING STUDY PROGRAM FT UNS 2016				Subjects in the category		
No	Code	Subject of Study	The combination of major learning achievements in the study materials group	Mathematics and basic sciences	Engineering science	humanities and Social Sciences
1	TKS21103	Calculus	LO1. Able to apply the knowledge of engineering mathematics, basic science, and engineering science principles to solve complex issues of discipline in society.	4		
2	TKS21209	Advanced Calculus and Linear Algebra		4		
3	TKS22116	Differential Equation		4		
4	TKS22117	Statistic and Probability		2		
5	TKS22115	Computer Programming	LO2. Able to design and execute experiments and analyze and interpreting data based on correct scientific principles		2	
6	TKS22224	Numerical Method and Computation		2		
7	TKS21104	Basic Physics		4		
8	TKS21105	Basic Chemistry		2		
9	TKS21213	Environmental and Sanitary Engineering			2	
10	TKS21211	Statics		4		
11	TKS22118	Fluid Mechanics		2		
12	TKS22120	Mechanics of Materials		4		
13	TKS21207	Engineering Drawing	LO9. Able to communicate in spoken or written expressions effectively by using technical drawing and other appropriate audio-visual tools with regard to function, scale and target of communication.		2	
14	TKS21210	Computer Aided Design (CAD)			2	
15	TKS21101	English				2
16	TKS21208	Indonesian				2
17	TKS21106	Introduction to Civil Engineering	LO4. Be able to identify the sources of engineering problems, formulate, and assess alternative technical solutions to engineering problems within the economic, environmental, social, political, ethical, health and safety, and realistic sustainability constraints.		2	
18	TKS21214	Surveying and Geomatics			4	
19	TKS22122	Building Materials and Their Properties			2	
20	TKS22228	Structural Analysis			2	
21	TKS23135	Matrix Structural Analysis			2	
22	TKS21212	Soil Mechanics I	LO5. Be able to select and utilize techniques, skills, and tools - such as the latest information technology and computing-based tools necessary for engineering practice.		2	
23	TKS22121	Soil Mechanics II			2	
24	TKS22225	Hydrology			2	
25	TKS22226	Hydraulics			2	

Table 7. Course linked with learning outcomes of the curriculum 2016 (continued)

CURRICULUM CIVIL ENGINEERING STUDY PROGRAM FT UNS 2016				Subjects in the category		
No	Code	Subject of Study	The combination of major learning achievements in the study materials group	Mathematics and basic sciences	Engineering science	humanities and Social Sciences
26	TKS22119	Transportation System	LO10. Being able to build broad insights and need to understand the impact of engineering solutions in a global, economic, environmental and social context.		2	
27	TKS23133	Mass Transport System			2	
28	TKS23134	Traffic Engineering				2
29	TKS23243	Earthquake Engineering	LO7. Be able to perform roles and functions effectively in multidisciplinary / multi-cultural teams and maintain networking for the right purpose.		2	
30	TKS23241	Water Resources Engineering			2	
31	TKS23138	Concrete Structure			2	
32	TKS23139	Steel Structure			2	
33	TKS22230	Construction Management	LO6. Able to use the basic concepts of project management and leadership in construction work, supervision and operational work.		4	
34	TKS23137	Construction Method			2	
35	TKS24150	Engineering Economics			2	
36	TKS22227	Highway Geometry Design	LO3. Able to design civil construction systems, components and construction processes for more than one context of civil engineering; buildings, water structures, foundations and land structures, roads, bridges and other civil infrastructure, which established design criteria and taking into account technical standards, performance aspects, reliability, ease of application.		4	
37	TKS23242	Pavement Engineering			4	
38	TKS22229	Foundation Engineering I			2	
39	TKS23136	Foundation Engineering II			2	
40	TKS22231	Irrigation and Hydraulic Structure			4	
41	TKS23132	Drainage			2	
42	TKS23244	Concrete Structure Design			4	
43	TKS23245	Steel Structure Design			4	
44	TKS23246	Bridge Engineering		2		
45	TKS240xx	Elective courses			12	
46	TKS24149	On the job training/ Internship	LO12. Being able to recognize and appreciate lifelong learning.		2	
47	TKS24000	BSc Thesis			5	
48	TKS21100	Religion	LO8. Able to take professional commitment and ethical work responsibilities.			2
49	TKS21102	Pancasila				2
50	TKS23240	Civics Education				2
51	TKS22223	Basic Social and Cultural Science	LO11. Be able to identify current issues and discuss the role of civil engineering profession in addressing these issues.			2
52	TKS24147	Community Development Service				2
53	TKS24148	Entrepreneurship				2
Number of credits				32	93	16
Total credits				145		
Percentage				22,1%	66,9%	11,0%

Tables 8 to 10 show the link between the first year courses to the fourth year respectively with the LO. While table 12 shows the links between the elective courses with a statement of learning outcomes.

Table 8. Linkage of first year courses with learning outcomes of curriculum 2016

CURRICULLUM 2016 CIVIL ENGINEERING STUDY PROGRAM FACULTY OF ENGINEERING UNS				Credit unit/ CU	Relation between course and learning outcomes [LO]												
Nr		Code	Course		L01	L02	L03	L04	L05	L06	L07	L08	L09	L010	L011	L012	
First year																	
1	Semester 1	TKS21100	Religion	2							H					H	
2		TKS21101	English	2							H		H				H
3		TKS21102	Pancasila	2								H					
4		TKS21103	Calculus	4	H												
5		TKS21104	Basic Physics	4	H	H											
6		TKS21105	Basic Chemistry	2	H												
7		TKS21106	Introduction to Civil Engineering	2	H							H	H		M		H
8		TKS21207	Engineering Drawing	2					H				H				
9	Semester 2	TKS21208	Indonesian	2								H					
10		TKS21209	Advanced Calculus & Linear Algebra	4	H												
11		TKS21210	Computer Aided Design (CAD)	2					H				H				
12		TKS21211	Statics	4	H			H									
13		TKS21212	Soil Mechanics I	2	H	H					H						
14		TKS21213	Environmental & Sanitary Engineering	2	H			H						H	H		H
15		TKS21214	Surveying & Geomatics	4	H				H								

Table 9. Linkage of second year courses with learning outcomes of curriculum 2016

CURRICULLUM 2016 CIVIL ENGINEERING STUDY PROGRAM FACULTY OF ENGINEERING UNS				Credit Unit/ CU	Relation between course and learning outcomes [LO]												
Nr		Code	Course		L01	L02	L03	L04	L05	L06	L07	L08	L09	L010	L011	L012	
Second year																	
16	Semester 3	TKS22115	Computer Programming	2	H				H								
17		TKS22116	Differential Equation	4	H												
18		TKS22117	Statistic and Probability	2	H				H								
19		TKS22118	Fluid Mechanics	2	H		M	H									
20		TKS22119	Transportation System	2				M								H	
21		TKS22120	Mechanics of Materials	4	H												
22		TKS22121	Soil Mechanics II	2	H	H											
23	TKS22122	Building Materials & Their Properties	2	H	H												
24	Semester 4	TKS22223	Basic Social & Culture Science	2												H	
25		TKS22224	Numerical Method & Computation	2	H				H								
26		TKS22225	Hydrology	2				H	H								
27		TKS22226	Hydraulics	2	H	H	M										
28		TKS22227	Highway Geometry Design	4			M		H			H	M				
29		TKS22228	Structural Analysis	2	H				H								
30		TKS22229	Foundation Engineering I	2	H	H	H										
31		TKS24150x	Engineering Economics	2		H	H			H							
32		TKS23240x	Civics Education	2								H		H	H		

Table 10. Linkage of third year courses with learning outcomes of curriculum 2016

CURRICULLUM 2016 CIVIL ENGINEERING STUDY PROGRAM FACULTY OF ENGINEERING UNS				CU	Relation between course and learning outcomes [LO]												
Nr		Code	Course		L01	L02	L03	L04	L05	L06	L07	L08	L09	L010	L011	L012	
Third year																	
33	Semester 5	TKS23131	Irrigation & Hydraulic Structure	4		H	H					M	H				
34		TKS23132	Drainage	2	H	H	H		H	H							
35		TKS23133	Mass Transport System	2				M								M	
36		TKS23134	Traffic Engineering	2			H	H						H			
37		TKS23135	Matrix Structural Analysis	2	H				H								
38		TKS23136	Foundation Engineering II	2	H	H	H										
39		TKS23137	Construction Method	2				H	H	H		H					
40		TKS23138	Concrete Structure	2				M		M							
41		TKS23139	Steel Structure	2	H		H										
42	Semester 6																
43		TKS23241	Water Resources Engineering	2				H				M		M	H		
44		TKS23242	Pavement Engineering	4		H	H					M	H				
45		TKS23243	Earthquake Engineering	2	H				H					M			
46		TKS23244	Concrete Structure Design	4			H		H								
47		TKS23245	Steel Structure Design	4	H		H		H				H				
48		TKS22230x	Construction Management	4				H	H	H		H					

Table 11. Linkage of fourth year courses with learning outcomes of curriculum 2016

CURRICULLUM 2016 CIVIL ENGINEERING STUDY PROGRAM FACULTY OF ENGINEERING UNS				CU	Relation between course and learning outcomes [LO]												
Nr		Code	Course		L01	L02	L03	L04	L05	L06	L07	L08	L09	L010	L011	L012	
Fourth year																	
49	Semester 7	TKS24147	Community Development Service	2						H	H				H	H	
50		TKS24148	Entrepreneurship	2						H	H	H					H
51		TKS24149	On the job training/ Internship	2					H	H	H	H	H				H
52		TKS23246x	Bridge Engineering	2			H		H		H	M	H				
		TKS240xx	Elective courses														
				12													
53	8	TKS24000	BSc Thesis	5	H	H	H	H	H		M	M	H	M	M	H	

Table 12. Linkage of fourth year elective courses with learning outcomes of curriculum 2016

CURRICULLUM 2016 CIVIL ENGINEERING STUDY PROGRAM FACULTY OF ENGINEERING UNS				CU	Relation between course and learning outcomes [LO]											
Nr	Code	Course			L01	L02	L03	L04	L05	L06	L07	L08	L09	L010	L011	L012
Structural engineering electives																
54	TKS24001	Finite Element Method	3	H				H								
55	TKS24002	Structural Dynamics	3	H			H	H								
56	TKS24003	Advanced Concrete Technology	3			H	H					H				
57	TKS24004	Timber Structure	3			H	H					H				
58	TKS24005	Pre-stressed Concrete Structure Design	3			H	H					H				
59	TKS24006	Composite Structure Design	3			H	H					H				
60	TKS24007	High-Rise Building Structural System	3			H	H					H				
61	TKS24008	Special Topics in Structural Engineering	3											H		
Transportation engineering electives																
62	TKS25021	Transportation Planning	3	H		H	H									
63	TKS24022	Airport Design	3			H	H			H		H				
64	TKS24023	Railway Engineering	3				M								M	
65	TKS25024	Advanced Traffic Engineering	3	H		H	H					H				
66	TKS24025	Traffic Management					H						H			
67	TKS24026	Transportation & Environment Safety	3				M				M		H			
68	TKS24027	Transportation Economics	3	H			H						H	H		
69	TKS24028	GIS in Transportation Planning	3			H	H	H								
70	TKS24029	Transportation Facilities Planning	3			H	H	H								
71	TKS24030	Pavement Performance*	3				H					H		H		
72	TKS24030	Transportation Impact Control*	3				M								M	
		*Special Topics in Transportation														
Water resources and environmental engineering electives																
73	TKS24041	River Engineering & Sediment Transport	3	H		H	H	H								
74	TKS24042	App of GIS on Water Resources Management	3			H	H	H								
75	TKS24043	Design of Hydraulic Infrastructures	3		H	H	H	H				H				
76	TKS24044	Waste Management	3			H	H									
77	TKS24045	Coastal & Port Engineering	3			H		H		H		H				
78	TKS24046	Water Resources Modelling	3	H		H	H	H								
79	TKS24047	Special Topics on Water Resources Engineering	3												H	
Construction management electives																
80	TKS24061	Construction Scheduling & Planning	3						H	H						
81	TKS24062	Projects	3			H			H	H						
82	TKS24063	Risk Management	3	H					H						H	
83	TKS24064	Infrastructure Management	3			H			H		H				H	
84	TKS24065	Legal Aspect in Construction Services	3						H		H					
85	TKS24066	Estimation & Control of Construction Cost	3						H		H		H	H		
86	TKS24067	Special Topics in Construction Management							H						H	

Table 12. Linkage of fourth year elective course with learning outcomes of curriculum 2016 (Continued)

CURRICULLUM 2016 CIVIL ENGINEERING STUDY PROGRAM FACULTY OF ENGINEERING UNS				CU	Relation between course and learning outcomes [LO]											
Nr	Code	Course			LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10	LO11	LO12
Geotechnical engineering electives																
87	TKS24081	Soil Improvement	3			H	H	H								
88	TKS24082	Engineering Geology	3			H	H	H								
89	TKS24083	Geotechnical Investigation	3	M	H							M				
90	TKS24084	Soil Dynamics & Earthquake Engineering	3	H			H									
91	TKS24085	Computational Geotechnics	3	H	H			H								
92	TKS24086	Unsaturated Soil Mechanics	3	H	H										H	
93	TKS24087	Geosynthetics for Soil Reinforcement	3	H	H											
94	TKS24088	Pavement & CAM	3	H	H		H									
Electives																
95	TKS24091	Advanced Programming	3	H				H								H
96	TKS24092	Techno-preneurship	2				H			H						H

STAGE 3. CURRICULUM AND SYLLABUS STRUCTURE

To realize the goals of educational programs and learning outcomes, Civil Engineering Study Program developed its curriculum structures and syllabus. The structures of the curriculum 2016 may be seen in the Table 13.

Table 13. The Course Structure of First Year Curriculum of Civil Engineering Program 2016

First Year									
Semester 1				Semester 2					
No	Code	Courses	c.u.*	No	Code	Courses	c.u.		
1	TKS21100	Religion	2	1	TKS21208	Indonesian	2		
2	TKS21101	English	2	2	TKS21209	Advanced Calculus & Linear Algebra	4		
3	TKS21102	Pancasila	2	3	TKS21210	Computer Aided Design (CAD) (T)	2		
4	TKS21103	Calculus	4	4	TKS21211	Statics (T)	4		
5	TKS21104	Basic Physics (P)	4	5	TKS21212	Soil Mechanics 1	2		
6	TKS21105	Basic Chemistry	2	6	TKS21213	Environmental and Sanitary Engineering (P)	2		
7	TKS21106	Introduction to Civil Engineering	2	7	TKS21214	Surveying and Geomatics (P)	4		
8	TKS21207	Engineering Drawing (T)	2						
Total Credits			20	Total Credits			20		

*c.u. = credit unit

Table 14. The Course Structure of Second Year Curriculum of Civil Engineering Program 2016

Second Year									
Semester 3				Semester 4					
No	Code	Courses	c.u.	No	Code	Courses	c.u.		
1	TKS22115	Computer Programming (T)	2	1	TKS22223	Basic Social and Cultural Science	2		

2	TKS22116	Differential Equation	4	2	TKS22224	Numerical Method and Computation (T)	2
3	TKS22117	Statistics and Probability	2	3	TKS22225	Hydrology	2
4	TKS22118	Fluid Mechanics (P)	2	4	TKS22226	Hydraulics (P)	2
5	TKS22119	Transportation System	2	5	TKS22227	Highway Geometry Design (T)	4
6	TKS22120	Mechanics of Material (T)	4	6	TKS22228	Structural Analysis (T)	2
7	TKS22121	Soil Mechanics 2 (P)	2	7	TKS22229	Foundation Engineering 1	2
8	TKS22122	Building Materials and Their Properties (P)	2	8	TKS24150x	Engineering Economics	2
				9	TKS23240x	Civics Education	2
Total Credits			20	Total Credits			20

Table 15. The Course Structure of Third Year Curriculum of Civil Engineering Program 2016

Third Year							
Semester 5				Semester 6			
No	Code	Courses	c.u.	No	Code	Courses	c.u.
1	TKS23131	Irrigation and Hydraulic Structure (T)	4	1	TKS23241	Water Resources Engineering	2
2	TKS23132	Drainage	2	2	TKS23242	Pavement Engineering (P)	4
3	TKS23133	Mass Transportaion System	2	3	TKS23243	Earthquake Engineering	2
4	TKS23134	Traffic Engineering	2	4	TKS23244	Concrete Structure Design (T)	4
5	TKS23135	Matrix Structural Analysis (T)	2	5	TKS23245	Steel Structure Design (T)	4
6	TKS23136	Foundation Engineering 2 (T)	2	6	TKS22230x	Construction Management (T)	4
7	TKS23137	Construction Method	2				
8	TKS23138	Concrete Structure	2				
9	TKS23139	Steel Structure	2				
Total Credits			20	Total Credits			20

Table 16. The Course Structure of Fourth Year and Elective Course of Fourth Year Curriculum of Civil Engineering Program 2016

Forth Year							
Semester 7				Semester 8			
No	Code	Courses	c.u.	No	Code	Courses	c.u.
1	TKS24147	Community Development Service	2	1	TKS24000	BSc Thesis	5
2	TKS24148	Enterpreneurship	2				
3	TKS24149	Internship	2				
4	TKS23246x	Bridge Engineering (T)	2				
5	TKS240xx	Elective Courses	12				
Total Credits			20	Total Credits			5

Table 17. List of Elective Courses Based on Curriculum Curriculum Program of Civil Engineering 2016

Forth Year							
Structural Engineering Electives				Tranportation Engineering Electives			
No	Code	Courses	c.u.	No	Code	Courses	c.u.
1	TKS24001	Finite Element Method	3	1	TKS24021	Transportation Planning	3
2	TKS24002	Structural Dynamics	3	2	TKS24022	Airport Design	3
3	TKS24003	Advanced Concrete Technology	3	3	TKS24023	Railway Engineering	3
4	TKS24004	Timber Structure	3	4	TKS24024	Advanced Traffic Engineering	3
5	TKS24005	Pre – Stressed Concrete Structure Design	3	5	TKS24025	Traffic Management	3
6	TKS24006	Composite Structure Design	3	6	TKS24026	Transportation and Environment Safety	3
7	TKS24007	High – Rise Building Structural System	3	7	TKS24027	Transportation Economics	3
8	TKS24008	Special Topics in Structural Engineering	3	8	TKS24028	Geographic Information System in Transportation Planning	3
				9	TKS24029	Transportation Facilities Planning	
				10	TKS24030	Special Topics in Transportation Engineering	3
Total Credits			24	Total Credits			27
Water Resources and Environmental Engineering Electives				Consctruction Management Electives			
No	Code	Courses	c.u.	No	Code	Courses	c.u.
1	TKS24041	River Engineering and Sediment Transport	3	1	TKS24061	Construction Scheduling and Planning (T)	3
2	TKS24042	Application of GIS on Water Resources Management	3	2	TKS24062	Projects	3
3	TKS24043	Design of Hydraulics Infrastructures	3	3	TKS24063	Risk Management	3
4	TKS24044	Waste Management	3	4	TKS24064	Infrastructure Management	3
5	TKS24045	Coastal and Port Engineering	3	5	TKS24065	Legal aspect in Construction Services	3
6	TKS24046	Water Resouces Modelling	3	6	TKS24066	Estimation and Control of Construction Cost	3
7	TKS24047	Special Topics on Water Resources Engineering	3	7	TKS24067	Special Topics in Construction Management	3
Total Credits			21	Total Credits			21
Geotechnical Engineering Electives				Electives			
No	Code	Courses	c.u.	No	Code	Courses	c.u.
1	TKS24081	Soil Improvement	3	1	TKS24091	Advanced Programming	3
2	TKS24082	Engineering Geology	3	2	TKS24092	Techno - preneurship	2
3	TKS24083	Geotechnical Investigation	3				
4	TKS24084	Soil Dynamics and Earthquake Engineering	3				
5	TKS24085	Computational Geotechnics	3				
6	TKS24086	Unsaturated Soil Mechanics	3				
7	TKS24087	Geosynthetics for Soil Reinforcement	3				
8	TKS24088	Pavement and Cakar Ayam Modified System (CAM)	3				
Total Credits			24	Total Credits			5

Table 18. Roadmap of Courses in Curriculum of Civil Engineering Study Program 2016

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8
TKS21100 Religion 2	TKS21208 Indonesian 2	TKS22115 Computer Programming (T) 2	TKS22223 Basic Social & Culture Science 2	TKS23131 Irrigation & Hydraulics Structure (T) 4	TKS23241 Water Resources Engineering 2	TKS24147 Community Development Service 2	TKS24000 BSc Thesis 5
TKS21101 English 2	TKS21209 Advanced Calculus & Linear Algebra 4	TKS22116 Differential Equation 4	TKS22224 Numerical Method & Computation (T) 2	TKS23132 Drainage 2	TKS23242 Pavement Engineering (P) 4	TKS24148 Entrepreneurship 2	
TKS21102 Pancasila 2	TKS21210 Computer Aided Design (CAD) (T) 2	TKS22117 Statistics & Probability 2	TKS22225 Hydrology 2	TKS23133 Mass Transport System 2	TKS23243 Earthquake Engineering 2	TKS24149 Internship 2	
TKS21103 Calculus 4	TKS21211 Statics (T) 4	TKS22118 Fluid Mechanics (P) 2	TKS22226 Hydraulics (P) 2	TKS23134 Traffic Engineering 2	TKS23244 Concrete Structure Design (T) 4	TKS23246x Bridge Engineering (T) 2	
TKS21104 Basic Physics (T) 4	TKS21212 Soil Mechanics 1 2	TKS22119 Transportation System 2	TKS22227 Highway Geometry Design (T) 4	TKS23135 Matrix Structural Analysis (T) 2	TKS23245 Steel Structure Design (T) 4	TKS240xx Electives 12	
TKS21105 Basic Chemistry 2	TKS21213 Environmental & Sanitary Engineering (P) 2	TKS22120 Mechanics of Material (T) 4	TKS22228 Structural Analysis (T) 2	TKS23136 Foundation Engineering 2 (T) 2	TKS22230x Construction Management (T) 4		
TKS21106 Introduction to Civil Engineering 2	TKS21214 Surveying & Geomatics (P) 4	TKS22121 Soil Mechanics 2 (P) 2	TKS22229 Foundation Engineering 1 2	TKS23137 Construction Method 2			
TKS21207 Engineering Drawing (T) 2		TKS22122 Building Materials & Their Properties (P) 2	TKS24150x Engineering Economics 2	TKS223138 Concrete Structure 2			
			TKS23240x Civics Education 2	TKS23139 Steel Structure 2			