**DOCUMENT OF CURRICULUM**

**CIVIL ENGINEERING STUDY PROGRAM**

**2016**

****

**FACULTY OF ENGINEERING**

**UNIVERSITAS SEBELAS MARET (UNS)**

**INSTITUTIONAL SUMMARY**

Study Programme (SP) : Civil Engineering (Bachelor Programme)

Faculty : Engineering

University : Universitas Sebelas Maret (UNS), Surakarta

Address : Jl. Ir. Sutami 36A, Kentingan, Surakarta 57126

 Tel: +6281112633314

 Fax: +62271634524

 Web: <http://sipil.ft.uns.ac.id>

Management

Name : Wibowo, ST., DEA.

Position : Head of Civil Engineering Study Programme, Faculty of Engineering, Universitas Sebelas Maret

Email : wibowotsipil87@ft.uns.ac.id

**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 Sebebelas 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 Acreditation 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 estabilshment 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, Kemenristekdikti, 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. **References of Curriculum Development**

The documents refered 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 Acreditation 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. **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 accomodated 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. **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 | 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 | 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 | 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 socioeconomics 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. **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 responsiblility 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 | **LO1.** 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 | **LO10.** Being able to build broad insights and need to understand the impact of engineering solutions in a global, economic, environmental and social context. |
| **LO11.** Be able to identify current issues and discuss the role of the civil engineering profession in addressing these issues.  |
| mastering the knowledge of communication techniques and latest and latest technological developments | **LO9.** 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. |
| 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 | **LO6.** 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 | **LO7.** 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 | **LO8.** Able to take professional commitment and ethical work responsibilities. |
| managing learning independently | **LO12.** 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 outcomess Expected by ABET and JABEE

|  |  |  |
| --- | --- | --- |
| ***ABET General Criteria for Learning Outcomes*** | ***JABEE Criteria Guide for Learning Outcomes*** | **Learning Outcomes of CESP** |
| 1. *an ability to apply knowledge of mathematics, science, and engineering*
 | *(c) Knowledge of and ability to apply mathematics and natural sciences* | **LO1.** Able to apply the knowledge of engineering mathematics, basic science, and engineering science principles to solve complex issues of discipline in society. |
| 1. *an ability to design and conduct experiments, as well as to analyze and interpret data*
 |  | **LO2.** Able to design, execute, analyze and interpret experimental data and testing based on correct scientific principles. |
| 1. *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*
 | *(e) Design ability to respond to requirements of the society by utilizing various sciences, technologies and information* | **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. |
| 1. *an ability to function on multidisciplinary teams*
 | *(i) An ability to work in a team* | **LO7.** Able to perform roles and functions effectively in multidisciplinary / multi-cultural teams and maintain networking for the right purpose. |
| 1. *an ability to identify, formulate, and solve engineering problems*
 | *(d) Knowledge of the related professional fields, and ability to apply* | **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) An ability to manage and accomplish tasks systematically under given constraints* | **LO6.** Able to use the basic concepts of project management and leadership in construction work, supervision, and operational work. |
| 1. *an understanding of professional and ethical responsibility*
 |  | **LO8.** Able to take professional commitment and ethical work responsibilities. |
| 1. *an ability to communicate effectively*
 | *(f) Communication skills including logical writing, presentation and debating* | **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. |
| 1. *the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context*
 | *(b) An ability of understanding of effects and impact of professional activities on society and nature, and of professionals social responsibility* | **LO10.** Able to build broad insights and need to understand the impact of engineering solutions in a global, economic, environmental and social context. |
| *(a) An ability of multidimensional thinking with knowledge from global perspective* |
| 1. *a recognition of the need for, and an ability to engage in life-long learning*
 | *(g) An ability of independent and life-long learning* | **LO12.** Able to recognize and appreciate lifelong learning. |
| 1. *a knowledge of contemporary issues*
 |  | **LO11.** Able to identify current issues and discuss the role of the civil engineering profession and respond these issues. |
| 1. *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*
 |  | **LO5.** Able to select and utilize techniques, skills, and tools - such as the latest information technology and computing-based tools necessary for engineering practice. |

**STAGE 2. BODY OF KNOWLEDGE**

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

The Body of Knowledge (BOK) of Civil Enginering 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’ coginitive 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 | L2 | L3 | L4 | L5 | L6 |
| ***Know-******Ledge******(Remem-ber)*** | ***Compre-hension******(Under-stand)*** | ***Application******(Apply)*** | ***Analysis******(Analyse)*** | ***Evaluation******(Evaluate)*** | ***Creation******(Create)*** |
|  **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 |
| 1. Basic Sciences
 | **S1(B)** | **S1(B)** | **S1(B)** |  |  |  | Basic Physics, Basic Chemistry, Environmental Engineering and Sanitary |
| 1. 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** |  |  |  |  |  |  |
| 1. Construction Materials Sciences
 | **S1(B)** | **S1(B)** | **S1(B)** |  |  |  | Construction Materials and their Properties, Mechanics of materials |
| 1. 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. |
| 1. Basic Engineering Sciences; *Problem recogn. & solving*
 | **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, |
| 1. Experiment
 | **S1(B)** | **S1(B)** | **S1(B)** | **S1(B)** | **S2(M)** |  | Basic Physics, Building Materials and Property Materials, Hydraulics, Pavement Pavement, Soil Mechanics, |
| 1. 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. |
| 1. Project Management
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Systems and Construction Management, Construction Methods, Engineering Economics |
| 1. Risk and Uncertanties
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Statistics and Probability, Hydrology, Introduction to Structural Dynamics and Earthquake Engineering. |
| 1. Sustainability
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Introduction to Civil Engineering, Environmental and Sanitary Engineering  |
| 1. Contemporary Issues and Perspective
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Internship, Basic Social and Cultural Sciences, Civics Education, Entrepreneurship |
| 1. Breadth in CE
 | **S1(B)** | **S1(B)** | **S1(B)** | **S1(B)** |  |  | *Elective courses* |
| 1. Specialization in CE
 | **S1(B)** | **S2(M)** | **S2(M)** | **S2(M)** | **S2(M)/S3** | **S3** | *Elective Courses, Graduate equivalent lectures* |
| **Professional Knowledge**  |  |  |  |  |  |  |  |
| 1. Communication
 | **S1(B)** | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  | Indonesian, English, Technical Drawing, CAD, Internship, Curriculum-wise |
| 1. Public Policies
 | **S1(B)** | **S1(B)** | **SPro** |  |  |  | Systems and Construction Management, Construction Methods, Engineering Economics, Basic Social and Cultural Sciences, Civics Education, Entrepreneurship |
| 1. Business and Public Administration
 | **S1(B)** | **S1(B)** | **SPro** |  |  |  | Systems and Construction Management, Engineering Economics, Entrepreneurship. |
| 1. Globalization
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Basic Social and Cultural Sciences, Civics Education, Entrepreneurship |
| 1. Leadership
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Internship, Entrepreneurship, Curriculum-wise |
| 1. *Teamwork*
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Internship, Introduction to Civil Engineering, Curriculum-wise |
| 1. *Attitudes*
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** |  |  | Religious Education, Pancasila Education, Internship, Introduction to Civil Engineering and Design, Curriculum-wise |
| 1. Lifelong Learning
 | **S1(B)** | **S1(B)** | **S1(B)** | **SPro** | **SPro** |  | English, Final Project / Thesis, Curriculum-wise |
| 1. 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 mat 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 graphiccommunication. | Carrying out or using a procedure in a givensituation. | Breaking material into its constituent partsand detecting how the parts relate to one another andto an overall structure or purpose. | Making judgments based on criteria andstandards. | Putting elements together to form a novel, coherent whole or make an original product. |
|  | 1.1 Recognizing1.2 Recalling | 2.1 Interpreting2.2 Exemplifying2.3 Classifying2.4 Summarizing2.5 Inferring2.6 Comparing2.7 Explaining | 3.1 Executing3.2 Implementing | 4.1 Differentiating4.2 Organizing4.3 Attributing | 5.1 Checking5.2 Critiquing | 6.1 Generating6.2 Planning6.3 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 |  |  2 |   |
| 6 | TKS22224 | Numerical Method and Computation | 2 |   |   |
| 7 | TKS21104 | Basic Physics | LO2. | Able to design and execute experiments and analyze and interpreting data based on correct scientific principles | 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 estabilished 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** | **LO1** | **LO2** | **LO3** | **LO4** | **LO5** | **LO6** | **LO7** | **LO8** | **LO9** | **LO10** | **LO11** | **LO12** |
| **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** | **LO1** | **LO2** | **LO3** | **LO4** | **LO5** | **LO6** | **LO7** | **LO8** | **LO9** | **LO10** | **LO11** | **LO12** |
| **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** | **LO1** | **LO2** | **LO3** | **LO4** | **LO5** | **LO6** | **LO7** | **LO8** | **LO9** | **LO10** | **LO11** | **LO12** |
| **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** | **LO1** | **LO2** | **LO3** | **LO4** | **LO5** | **LO6** | **LO7** | **LO8** | **LO9** | **LO10** | **LO11** | **LO12** |
| **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** | **LO1** | **LO2** | **LO3** | **LO4** | **LO5** | **LO6** | **LO7** | **LO8** | **LO9** | **LO10** | **LO11** | **LO12** |
| **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** |
| **Geotechical 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 outcomess, 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 | Advanched 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 |  | TKS22230xConstruction 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 |  |  |  |  |  |  |  |  |  |