CURRICULUM DOCUMENT
MATHEMATICS STUDY PROGRAM

FACULTY OF MATHEMATICS AND NATURAL SCIENCES

UNIVERSITAS SEBELAS MARET

SURAKARTA

CURRICULUM DOCUMENT

MATHEMATICS STUDY PROGRAM

FACULTY OF MATHEMATICS AND NATURAL SCIENCES

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UNIVERSITAS SEBELAS MARET

SURAKARTA

2020

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
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KEPUTUSAN REKTOR UNIVERSITAS SEBELAS MARET
NOMOR 204.11 /UN27/HK/2021

TENTANG

KURIKULUM PROGRAM SARJANA PENDIDIKAN MATEMATIKA
UNIVERSITAS SEBELAS MARET

REKTOR UNIVERSITAS SEBELAS MARET,

Menimbang :

a. bahwa Universitas Sebelas Maret sebagai lembaga pendidikan tinggi yang menyelenggarakan Program Sarjana Pendidikan Matematika mengemban tugas untuk menghasilkan lulusan yang memiliki sikap, keterampilan umum, keterampilan khusus, dan pengetahuan yang mampu bersaing secara global;
b. bahwa untuk menyelenggarakan Program Sarjana Pendidikan Matematika diperlukan kurikulum;
c. bahwa untuk keperluan sebagaimana tersebut pada huruf a, dan huruf b, perlu menetapkan Keputusan Rektor tentang Kurikulum Program Sarjana Pendidikan Matematika Universitas Sebelas Maret.

Mengingat

1. Undang-Undang Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional (Lembaran Negara Republik Indonesia Tahun 2003 Nomor 78, tambahan Lembaran Negara Nomor 4301);
2. Undang-Undang Nomor 12 Tahun 2012 tentang Pendidikan Tinggi (Lembaran Negara Republik Indonesia Tahun 2012 Nomor 158, Tambahan Lembaran Negara Republik Indonesia Nomor 5336);
3. Peraturan Pemerintah Nomor 19 Tahun 2005 tentang Standar Nasional Pendidikan (Lembaran Negara Republik Indonesia Tahun 2005 Nomor 41, Tambahan Lembaran Negara Republik Indonesia No 4496) sebagaimana diubah beberapa kali terakhir dengan Peraturan Pemerintah Nomor 13 Tahun 2015 tentang Perubahan Kedua Atas Peraturan Pemerintah Nomor 19 Tahun 2005 tentang Standar Nasional Pendidikan (Lembaran Negara Republik Indonesia Tahun 2015 Nomor 45, Tambahan Lembaran Negara Republik Indonesia No 5670);
4. Peraturan Pemerintah Nomor 4 Tahun 2014 tentang Penyelenggaraan Pendidikan Tinggi dan Pengelolaan Perguruan Tinggi (Lembaran Negara Republik Indonesia Tahun 2014 Nomor 6, Tambahan Lembaran Negara Republik Indonesia Nomor 5500);
5. Peraturan Pemerintah Nomor 56 Tahun 2020 tentang Perguruan Tinggi Negeri Badan Hukum Universitas Sebelas Maret (Lembaran Negara Republik Indonesia Tahun 2020 Nomor 228);
6. Keputusan Presiden Nomor 10 Tahun 1976 tentang Pendirian Universitas Negeri Surakarta Sebelas Maret;

7. Peraturan Menteri Pendidikan dan Kebudayaan Nomor 73 Tahun 2013 tentang Penerapan Kerangka Kualifikasi Nasional Indonesia Bidang Pendidikan Tinggi (Berita Negara Republik Indonesia Tahun 2013 Nomor 831);
8. Peraturan Menteri Riset, Teknologi, dan Pendidikan Tinggi Nomor 62 Tahun 2016 tentang Sistem Penjaminan Mutu Pendidikan Tinggi (Berita Negara Republik Indonesia Tahun 2016 Nomor 1462);
9. Peraturan Menteri Pendidikan dan Kebudayaan Nomor 3 Tahun 2020 tentang Standar Nasional Pendidikan Tinggi (Berita Negara Republik Indonesia Tahun 2020 Nomor 47);
10. Peraturan Menteri Pendidikan dan Kebudayaan Nomor 22 Tahun 2020 tentang Rencana Strategis Kementerian Pendidikan dan Kebudayaan Tahun 2020-2024;
11. Keputusan Menteri Riset, Teknologi dan Pendidikan Tinggi Nomor 12449/M/KP/2019 tentang Pengangkatan Rektor Universitas Sebelas Maret Periode Tahun 2019-2023;
12. Keputusan Menteri Pendidikan dan Kebudayaan Nomor 155/O/1998 tentang Pedoman Umum Organisaasi Kemahasiswaan di Perguruan Tinggi;
13. Peraturan Rektor Universitas Sebelas Maret Nomor 31 Tahun 2020 tentang Penyelenggaraan dan Pengelolaan Program Sarjana;
14. Peraturan Rektor Nomor 64 Tahun 2020 tentang Organisasi dan Tata Kerja Unsur di Bawah Rektor Universitas Sebelas Maret.

MEMUTUSKAN:

Menetapkan : KEPUTUSAN REKTOR TENTANG KURIKULUM PROGRAM SARJANA PENDIDIKAN MATEMATIKA UNIVERSITAS SEBELAS MARET.

KESATU : Menetapkan Kurikulum Program Studi Pendidikan Matematika dengan naskah Kurikulum sesuai pada Lampiran yang merupakan bagian yang tidak terpisahkan dari Keputusan Rektor ini;

KEDUA : Beban SKS yang harus diambil mahasiswa Program Sarjana Pendidikan Matematika minimal 144 (seratus empat puluh empat) satuan kredit semester dan masa studi dirancang untuk 8 (delapan) semester;

KETIGA : Keputusan ini berlaku terhitung pada tanggal ditetapkan.;

Ditetapkan di Surakarta
pada tanggal 18 FEB 2021
REKTOR,

JAMAL WIWOHO
NIP 196111081987021001

PREFACE

Praise and gratitude to God Almighty who has given the blessing of health and opportunity so that this curriculum document can be completed. The curriculum is the overall plan and arrangement regarding graduate learning outcomes, study materials, learning processes, and learning assessments used for guidelines of the implementation of the study program. Therefore, the curriculum can be considered as a process to conduct the learning process and a guide for the implementation of the study program.

The Mathematics Study Program has done a quality assurance process through the curriculum development based on learning outcomes. The 2020 curriculum of the Mathematics Study Program, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret is an improvement to the previous curriculum, the 2015 Curriculum. The 2020 curriculum was developed based on the National Higher Education Standards (SNPT), Indonesian National Qualifications Framework (KKNI), Outcome Based Education, and Freedom of Learning-Independent Campus (MBKM) policy and was also taking into account the conditions of the study program, the characteristics of the world of work in the field of Information Technology and entrepreneurship, and the development of the industrial revolution 4.0. Based on the SNPT standards, the standards of graduate competency, content, learning process, and assessment are the main considerations in arranging the distribution of courses in a semester, designing compulsory and elective courses, and determining the amount of study load for each course.

Hopefully, this curriculum document can be a guideline for the implementation of the study program. In addition, it can also be a motivation for educators, education staff, and students to do their best so that the goals of the 2020 Curriculum can be achieved to the greatest extent.

Surakarta, January 8, 2021

Editorial Team

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CHAPTER 1.
STUDY PROGRAM IDENTITY

Study Program	:	Mathematics
Type of Degree	:	Bachelor's Degree
Management Unit of the Study Program	:	Mathematics and Natural Science
University	:	Universitas Sebelas Maret
Number of Decree on the University Creation	:	238/Kep/T3/1976
Date of Decree on the University Creation	:	October 18, 1976
Official Approving Decree on the University Creation	:	Mayor of Surakarta
University Address	:	Jl. Ir. Sutami No. 36A, Kentingan, Surakarta
Number of Decree on the Study Program Establishment	:	0297/O/1996
Date of Decree on the Study Program Establishment	:	October 1, 1996
Official Approving Decree on the Study Program Establishment	:	Bambang Soehendro
First Year of Entry	:	1989 (under Faculty of Engineering)
Call / Fax	:	Call (0271) 669376 – Fax. (0271) 663375
E-Mail and *Website*	:	math@mipa.uns.ac.id and http://math.mipa.uns.ac.id/
Title for Graduate	:	S. Mat. (Bachelor's Degree of Mathematics)
Newest Accreditation Predicate	:	A
Number of SK BAN-PT	:	1932/SK/BAN-PT/Akred/S/VI/2019
Validity Period of Accreditation	:	June 12, 2019, to June 12, 2024

CHAPTER 2.
VISION, MISSIONS, AND OBJECTIVES

Vision:

"To become a superior center for learning, studying, developing mathematics and its application at the international level based on the pillars of science."

Mission:

1) Organizing mathematics education and learning centered on Students and the self-development of lecturers as well as encouraging students' independence in knowledge, skills, and attitudes.
2) Equipping graduates to have mathematical thinking, high creativity, and innovation, various alternatives to solve a problem, science communication in oral and written, and the capability to develop themselves and their potential.
3) Developing research in the field of mathematics and its application for the benefit of the wider community.
4) Empowering networking with alumni in increasing the role of the institution. Building collaborative initiatives with other institutions at local, regional, national, and international to increase the relevance of graduates and the image of the institution.

Objectives:

1) Creating a conducive academic climate for increasing productivity, creativity, and enthusiasm to perform for the entire academic community.
2) Producing graduates who are able to internalize academic values, norms, and ethics; who are independent and highly competitive, and who have the ability to continue to further study.
3) Producing mathematical research outputs and their applications that benefit the development of science and technology (IPTEK).
4) Optimizing the participation of alumni in the implementation of education in the Mathematics Study Program FMIPA UNS, as well as in building self-image, promotion, and publication of study programs in the world of work, stakeholders, and the wider community.
5) Creating cooperation considering its quantity and quality with government institutions, businesses, and industry both nationally and internationally.

CHAPTER 3.
CURRICULUM EVALUATION OF THE STUDY PROGRAM

3.1. Current Curriculum

The Mathematics Study Program stands together with three other study programs; Physics, Chemistry, and Biology; at the Faculty of Mathematics and Natural Sciences (FMIPA) based on the Decree of the Minister of Education and Culture No. 0297/O/1996 dated October 1, 1996. The preparation process of the curriculum for the Mathematics study program is based on the SWOT (Strength, Weakness, Opportunity, and Threat) analysis of the ability of the study program (Scientific Vision) and Need Assessment from Tracer Study (Market Signal), by considering the changes in government policy. The development of the curriculum and the underlying legal basis is illustrated in Figure 1 and Table 1.

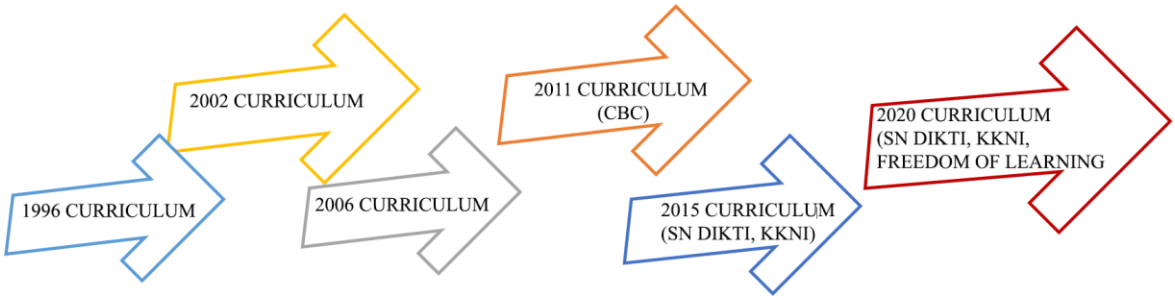

Figure 1. Development of Mathematics Study Program Curriculum

Table 1. Development of Mathematics Study Program Curriculum

Curriculum	Curriculum Foundation	Legal Basis
1996 Curriculum	National Curriculum, Local Curriculum	Decree of The Minister of National Education No. 063/U/1994
2002 Curriculum	Study Program Courses (MKPS), General Courses (MKU)	Decree of The Minister of National Education No. 232/U/2000
2006 Curriculum		Decree of The Minister of National Education No. 045/U/2002
2011	Competency-Based	Law of Higher Education No. 12 of 2012

Curriculum	Curriculum Foundation	Legal Basis
Curriculum	Curriculum (CBC)	Decree of The Rector of Universitas Sebelas Maret No. 491/UN27/PP/2011
2015 Curriculum	Indonesian National Qualification Framework (KKNI), National Standard of Higher Education (SN-DIKTI)	Presidential Regulation No. 8 of 2012 Regulation of The Minister of Research, Technology and Higher Education No. 49 of 2014 Regulation of The Rector of Universitas Sebelas Maret No. 644/UN27/PP/2015
2020 Curriculum	SN DIKTI, KKNI, Freedom of Learning-Independent Campus (MBKM)	Regulation of The Minister of Education and Culture No. 3 of 2020 Regulation of The Rector of Universitas Sebelas Maret No. 31 of 2020 Regulation of The Rector of Universitas Sebelas Maret No. 32 of 2020

The implementation of education in study programs within FMIPA UNS is conducted based on the higher education curriculum as stated in the UNS Statute in accordance with the provisions of the applicable legislation. The curriculum is prepared and developed by the teaching staff in each study program following the vision and mission of the study program as a general guideline for the implementation of teaching and learning activities in the university (Decree of the Minister of National Education No. 232/U/2000 Article 1 point 6). Meanwhile, the UNS Institute for Development of Education (LPP) which established in 2003 serves as a curriculum learning unit for all educational staff and has a role to determine criteria, strategies, and mechanisms for curriculum preparation and development at UNS.

The implementation of the curriculum is the teaching and learning process in the semester credit system (SCS) which is divided into face-to-face, structured, and independent activities listed in the Decree of the Minister of Education and Culture of the Republic of Indonesia No. 0211/V/1982 and No. 212/V/1982 and the Decree of the Director General of Higher Education No. 048/DJ/Kep/1982. The study load and period for each program as well as the assessment of student learning outcomes are also under the guidelines for the preparation of the higher education curriculum which require each study

program to be able to explore and exploit all of its potential in order to be the best and surpass a minimum standard.

The commitment of the leadership of Universitas Sebelas Maret to be able to organize a quality learning process that is in line with the demands of the community is observable through the establishment of the Institute for Development and Quality Assurance of Education of Universitas Sebelas Maret (LPPMP UNS) which the main duties and functions are to improve and develop instructional activities as well as plan assessment, monitoring and evaluation of education implementation. . LPPMP in fulfilling its main functions is led by a chairperson assisted by a secretary, head of the study center and administrative staff. Regular activities to improve the quality of education and quality through curriculum design include training and workshops for competency-based curriculum, Instructional Technical Training Program (PEKERTI), textbook writing workshops, and other activities for lecturers. in the UNS.

Another form of commitment from the leadership of FMIPA UNS for the implementation of curriculum development in study programs and learning methods development is stated in the routine budget allocation. Based on the curriculum training attended by educators in the FMIPA UNS and the available resources at the university, generally, the study programs at FMIPA UNS have put effort to improve and review the curriculum, as well as create documents of a new curriculum for each study program that includes elements of its competence. To find out the relevance of the curriculum, several indicators can be used, including feedback from the business world, studies and workshops by lecturers and graduate users, as well as feedback from alumni (graduates) and students. With the development of a new competency-based curriculum, it is hoped that students who finish their studies at FMIPA UNS can possess higher competitiveness.

3.2. Curriculum Evaluation

In its journey, study programs within FMIPA UNS have generally made curriculum adjustments several times to be in line with the development of the national education system and to meet the needs and developments of the labor market, such as the National Curriculum model from the Decree of the Minister of Education and Culture No.111/Dikti/Kep/1989 and the National Curriculum (Kurnas) and Local Curriculum (Kurlok) under Decree No. 0311/U/1994, the core curriculum and institutional curriculum which are separated into groups of personality development courses (MPK), scientific and

skill courses (MKK), work skills courses (MKB) and work attitude courses (MPB) in accordance with the decision of the Minister of National Education of the Republic of Indonesia No. 232/U/2000. The Decree of the Minister of National Education No. 045/U/2002 reaffirmed that the grouping of courses above was intended to be elements of competence reffering to Competency-Based Curriculum (KBK).

Although in general the university guidelines regarding planning, compiling, and evaluating the curriculum with the development of soft skills has existed, it is still necessary to make more detailed specific guidelines or handbook for the university curriculum so that there is the same understanding starting from the paradigm shift of the lecturers regarding the teaching and learning process in the university.

The curriculum is designed by the study program to achieve the learning process in the form of competence or ability to conduct tasks or work in certain areas of expertise. Competence is a set of intelligent and responsible actions possessed by someone as a condition to be considered capable by the community in performing tasks in certain fields of work (SK Mendiknas 045/U/2002). Graduate competence is a graduate qualification that includes attitudes, knowledge, and skills (Article 1 Paragraph 4, PP No. 19 of 2005). The depth of curriculum in each educational unit is stated in the competence at each level and/or semester in accordance with the National Education Standards. The competencies as referred to above consist of competency standards and basic competencies.

By paying attention to SWOT (Strength, Weakness, Opportunity, and Threat), curriculum evaluation is periodically conducted to improve RAISE (Relevance, Academic atmosphere, Internal management and organization, Sustainability, Efficiency, and productivity), strategic issues, future needs, and foresight of scientific development 2021. In addition, the Universitas Sebelas Maret Policy that aims to be World Class University encourages the Mathematics Study Program to conduct periodic curriculum evaluations, namely:

1. Every 6 months through the association of mathematicians who are members of the Indonesian Mathematical Society, abbreviated as indoms;
2. Every 4 months, through discussions with colleagues in the same field and research groups;
3. Once a year through training and workshops involving alumni, users, stakeholders, and resource persons.

The main result of the identification is the equality of Graduate Learning Outcomes (GLO) of the Mathematics Study Program to the Program Learning Outcomes (PLO). The GLO of Mathematics Study Program is in the form of a description of Attitude, Knowledge, General Skills, and Special Skills.

The Freedom of Learning-Independent Campus (MBKM) policy provides the widest opportunity for students to be able to study for three semesters outside the study program. As a response to this policy, the Mathematics Study Program has re-arranged (re-distributed) courses so that the study program can flexibly facilitate learning activities outside the study program and can be recognized into credits units in the MBKM program.

As a step to strengthen the implementation of MBKM which was launched by the Minister of Education and Culture of the Republic of Indonesia, in December 2020, the Mathematics Study Program has cooperated with other universities by signing an agreement regarding the online student exchange program. The agreemenst includes the Faculty of Science and Mathematics of 5 (five) universities, namely from Universitas Diponegoro, Universitas Gadjah Mada, Universitas Jenderal Soedirman, Universitas Sebelas Maret and Universitas Negeri Yogyakarta.

The Memorandum of Understanding is authentically signed by the Dean of each university. Those 5 deans of each university are Prof. Dr. Widowati, S.Si., M.Si. (Dean of Faculty of Science and Mathematics Universitas Diponegoro); Prof. Dr. Triyono, S.U (Dean of Faculty of Mathematics and Natural Sciences Universitas Gadjah Mada); Drs. Sunardi, M.Si. (Dean of Fakultas Faculty of Mathematics and Natural Sciences Universitas Jenderal Soedirman); Drs. Harjana, M.Si., M.Sc., Ph.D. (Dean of Faculty of Mathematics and Natural Sciences Universitas Sebelas Maret); dan Prof. Dr. Ariswan, M.Si. DEA. (Dean of Faculty of Mathematics and Natural Sciences Universitas Negeri Yogyakarta).

The Cooperation Agreement aims to conduct Freedom of Learning-Independent Campus program (MBKM) by utilizing the five universities' resources for mutual progress. The scope of the Cooperation Agreement encompasses student exchange between the parties as an implementation of MBKM Program by the Ministry of Education and Culture of the Republic of Indonesia.

The obligations and rights of each university to jointly prepare a plan, implementation, and evaluation of the cooperation implementation on MBKM

1) The obligations are as follows:

a) Accepting students from other parties to take courses that have been mutually agreed based on the Standard Operational Guidelines (POB) of each Party
b) Assuring that the student complies with all applicable regulations if the student takes courses in other parties' faculties.
c) Providing grades to students from other parties who take courses at each university.

2) The rights of each university are as follows:
a) Assessing students to other parties to take courses that have been mutually agreed upon based on the POB of each Party.
b) Obtaining grades for their students who take courses on the other parties.
c) Obtaining academic facilities for their students who take courses at other parties.

3.3. Follow-up Plan

The curriculum of the Mathematics Study Program in 2020 will begin to be implemented in the First Semester of the 2020/2021 Academic Year (August 2020 – January 2021). The Mathematics Study Program provides curriculum transition time in the first two semesters of implementation by paying attention to the courses changes (airing semesters and credit loads), resources (lecturer workload), and implementation (schedules distribution)

Micro reviews will be conducted periodically along with the evaluation of each semester's learning implementation. Macro evaluation will be conducted within 5 years after the curriculum is implemented or if there are changes in internal policies of UNS and/or external policies of the Director General of Higher Education of the Ministry of Education and Culture of the Republic of Indonesia.

CHAPTER 4
CURRICULUM PLANNING FOUNDATIONS

Today's new paradigm seemingly leads to a notion that the world of education is a service industry where all activities must be directed to satisfy stakeholders. Therefore, in ensuring the achievement of good quality outputs and outcomes from the educational process that satisfies stakeholders, success rate evaluation, academic audits, and benchmarking will be determined by the academic standards at the study program level

The curriculum is an entire plan and arrangement regarding graduate learning outcomes, study materials, and learning and assessments process that are used as guidelines for the implementation of study programs in the education system, especially higher education. The Mathematics Study Program of FMIPA UNS always follows the development of the current curriculum and develops the curriculum as a response to the demands of stakeholders, and this document will describe the latest curriculum, namely the KKNI-based curriculum, outcome-based education (OBE), and the industrial revolution 4.0.

4.1. Philosophical Foundations

Curriculum development of the Mathematics Study Program employs a philosophical foundation. Curriculum development based on a philosophical foundation is needed in education, especially in determining the visions and goals of education. Philosophy will determine the visions in which the student will follow. For this reason, there must be clarity in terms of the view of human life and its existence. The philosophy embraced by a certain nation or group of people or even by individuals will greatly affect the educational goals to be achieved.

Curriculum development of the Mathematics Study Program, using the notion of pragmatism, namely curriculum development that emphasizes problem-solving, is constructed from previous knowledge. In order to harmonize the lessons given, it also pays more attention to the ability of teaching thinking skills rather than worrying about what knowledge that will be conveyed, because basically the more important thing in pragmatic

notion is the ability of problem-solving skills, while science is constantly changing all the time. Mathematical Sciences is also majorly called as ***"The Mother of all Sciences".***

4.2. Sociological Foundations

The Mathematics Study Program produces graduates who are ready to enter society, therefore, the Mathematics Study Program Curriculum is arranged in such a way in attempt to be able to shape students who are able to live harmoniously in society or the workplace. Referring to this, the formation of student soft skills is vital and must be included in the curriculum. Soft skills must be integrated into courses that are accordant with the soft skills targets that have been described in graduate learning outcomes (GLO).

Some of the sociological foundations of mathematical sciences that underlie the preparation of the 2020 Curriculum are as follows:

1) The scope of mathematics study program graduates in the work industry encompasses quite a lot of potential fields, namely: the field of research and development, the field of experts, as educators in the world of education, as teamwork leaders.
2) A complex occupation in the field of mathematics always involves teamwork between fields, therefore, it needs supporting competencies, for example, leadership skills, communication, presentation, and decent social attitudes.

4.3. Psychological Foundations

Mathematics becomes the mother of various sciences, which gave birth to various sciences and their derivatives, and gave birth to various technological creations that made human life easier. The success of applying science is influential toward the development of technology today.

Students are individuals who are in the process of development, both physical, intellectual, social, emotional, moral, and so on. The main task of a lecturer as an educator is to help to optimize the development of his students based on their developmental tasks. By applying the foundation of psychology in the curriculum development process, the relevant education can hopefully be pursued in accordance with the nature of students, both applicable material adjustments, and the delivery and learning processes as well as the other elements adjustments as educational efforts.

4.4. Historical Foundations

The Mathematics Study Program of FMIPA UNS is the embryo of the establishment of FMIPA UNS which began to be initiated since 1982. Mathematics Study Program in Civil Engineering Study Program, Faculty of Engineering, UNS based on the Decree of the Directorate General of Higher Education Number 206/D/1989 January 26, 1989. Subsequently, on July 12, 1995 it was proposed to the Director General of Higher Education regarding the establishment of FMIPA UNS. The Minister of Education and Culture issued a decree for the establishment of FMIPA UNS which became the 9th faculty with several study programs, namely the Mathematics, Physics, Chemistry and Biology through the Decree of the Minister of Education and Culture of the Republic of Indonesia Number 0297/0/1996 October 1, 1996.

The factor that encourages the establishment of the Mathematics Study Program FMIPA UNS is that in order to improve the implementation of national development, it is necessary to develop science, especially basic sciences, which support the development of technology and potential human resources.

4.5. Juridical Foundations

Juridical foundations of curriculum arrangement by paying attention to:

1) Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System.
2) Law of the Republic of Indonesia Number 12 of 2012 concerning the Higher Education.
3) Decree of the Minister of National Education Number 232/U of 2000 concerning Guidelines for The Preparation of Higher Education Curriculum and Assessment of Learning Outcomes.
4) Government Regulation Number 19 of 2005 concerning the Core Curriculum of Higher Education.
5) Government Regulation of the Republic of Indonesia Number 66 of 2010 concerning Amendments to Government Regulation of the Republic of Indonesia Number 17 of 2010 concerning The Management and Implementation of Education.
6) Presidential Regulation of the Republic of Indonesia Number 8 of 2012 concerning the Indonesian National Qualifications Framework..

7) Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 73 of 2013 concerning the Implementation of the Indonesian National Qualifications Framework (KKNI).
8) Regulation of the Minister of Research, Technology and Higher Education of the Republic of Indonesia Number 44 of 2015 concerning National Standards for Higher Education.
9) Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 3 of 2020 concerning National Standards for Higher Education.
10) Directorate General of Higher Education, Ministry of Education and Culture 2020 concerning Guidelines for The Preparation of Higher Education Curriculum in the Industrial Era 4.0 to Support Freedom of Learning -Independent Campus (MBKM).
11) Regulation of the Rector of Universitas Sebelas Maret Number 31 of 2020 concerning the Management and Implementation of Undergraduate Program Education changes of Regulation of the Rector Number 582/UN27/HK/2016 concerning the Implementation and Management of Undergraduate Program Education.
12) The results of the FMIPA Leaders Meeting are joint courses at the faculty level, namely the Basic Mathematics and Natural Sciences Course which includes Basic Mathematics, Basic Chemistry, Basic Physics and Biology.
13) Suggestions from Alumni, Users, and Students in compulsory and elective courses along with the learning process.

CHAPTER 5
GRADUATES PROFILE AND GRADUATES LEARNING OUTCOME

Graduates of the UNS Mathematics Study Program are expected to have a career as researchers, experts, educators, public servants, leaders or entrepreneurs based on science/mathematics. Graduate profiles and descriptions are presented in the following table.

Table 2. Profile and Graduates Profile Description

Graduates Profile	Graduates Profile Description
Researcher	Bachelor of mathematics who has the ability to implement scientific principles in research and communicate the results according to ethics and academic norms.
Expert	Bachelor of mathematics who has the ability to implement mathematical scientific principles in certain technical fields.
Educator	Bachelor of mathematics who has the ability to transfer knowledge both in the field of formal, informal and non-formal education.
Public Servant	Bachelor of mathematics who has the work independence in the field of mathematics and other sciences.
Leader or Entrepreneur	Bachelor of mathematics who has managerial abilities and human resource development mainly in the field of science.

To obtain a Bachelor of S-1 Mathematics that has a mentioned profile, graduates must have the following attitudes, general skills, knowledge, and specific skills.

Table 3. Description of Graduates Learning Outcomes in Attitudes Aspect

CPL Code	Graduates Learning Outcomes Description
S1	Being devoted to God Almighty and being able to show a religious attitude
S2	Upholding human values in conducting duties based on religion, morals, and ethics

CPL Code	Graduates Learning Outcomes Description
S3	Contributing to advancing the quality of life in society, nation, state, and the progress of civilization based on Pancasila
S4	Being proud citizens who love the homeland, have nationalism and a sense of responsibility to the state and nation
S5	Respecting the diversity of cultures, views, religions, and beliefs, as well as the opinions or original findings of others
S6	Working together and having social sensitivity as well as being aware of community and the environment
S7	Obeying the law and being discipline in social and state life
S8	Internalizing values, norms, and academic ethics
S9	Demonstrating a responsible attitude of their expertise independently
S10	Internalizing the spirit of independence, resilience, and entrepreneurship

Table 4. Description of Graduates Learning Outcomes in General Skills Aspect

CPL Code	Graduates Learning Outcomes Description
KU1	Able to apply logical, critical, systematic, and innovative thinking in the context of the development or implementation of science and technology that concerns and applies humanities values in accordance with their field of expertise
KU2	Able to show independent, quality, and measurable performance
KU3	Able to examine the implications of the development or implementation of science and technology that concern and apply humanities values in accordance with their expertise based on scientific rules, procedures and ethics in order to produce solutions, ideas, designs or art criticism
KU4	Compile a scientific description of the study results mentioned above in the form of a thesis or final project report, and upload it on the university page
KU5	Able to make appropriate decisions in the context of problem solving in their field of expertise, based on the results of information and data analysis
KU6	Able to maintain and develop networks with mentors and colleagues both inside and outside the institution
KU7	Able to be responsible for the achievement of the group work results and supervise and evaluate the completion of work assigned to employee under their responsibility
KU8	Able to conduct the process of self-evaluation of the group work under their responsibility, and able to manage learning activity independently
KU9	Able to document, store, secure, and recover data to ensure validity and prevent plagiarism

Table 5. Description of Graduates Learning Outcomes in Knowledge Aspect

CPL Code	Graduates Learning Outcomes Description
P1	Mastering the basic concepts of mathematics which include the concept of logical/analytical construction of proof, modeling and solving simple problems, and the basics of computation
P2	Mastering theoretical concepts about one of the fields of mathematics, namely analysis, algebra, modeling, system optimization and computer science and applying them in analyzing, designing, and evaluating problem solving

Table 6. Description of Graduates Learning Outcomes in Specific Skills Aspect

CPL Code	Graduates Learning Outcomes Description
KK1	Able to develop mathematical thinking, which begins from procedural/computational to a broad understanding including exploration, logical reasoning, generalization, abstraction, and formal evidence
KK2	Able to observe, recognize, formulate and solve problems through a mathematical approach with or without the help of software
KK3	Able to reconstruct, modify, analyze/think in a structured way about the mathematical problems of a system/problem, assess the accuracy and interpret it
KK4	Able to take advantage of various alternatives for mathematical problems completion
KK5	Able to adapt or develop themselves, both in the field of mathematics and other relevant fields (including fields in the work industry)

Furthermore, the details of the Program Learning Outcome (PLO) contain identification of the suitability of graduate learning outcomes with PLO and identification of graduate profiles with PLO that are presented in the following tables.

Table 7. Program Learning Outcome Details

CPL Code	*Program Learning Outcome*
PLO1	Mastering theoretical concepts and basic principles in mathematics including exploration, logical reasoning, generalization, abstraction, and formal evidence
PLO2	Mastering the principles and applications of mathematics, computing, and its technology (such as software)
PLO3	Mastering the principles of data processing, methods/techniques, and experimentation
PLO4	Mastering knowledge of technology computation and software in solving mathematical problems
PLO5	Able to identify real problems, formulate, and design them mathematically and analyze the results
PLO6	Able to observe, recognize, collect and utilize data, as well as calculate, estimate, interpret, and other standard technical skills related to each course with and without the help of software
PLO7	Able to analyze various alternative solutions existing in real problems with mathematics and conclude them for the right decision making
PLO8	Able to solve nonroutine problem solving and conduct a job/task and develop something relatively new, either independently or in a team/group of mathematicians or across expertise
PLO9	Able to disseminate the results of studies orally and in the form of reports or paperworks based on international scientific standard by utilizing Information and Communication Technology
PLO10	Able to adapt to technological changes, develop themselves independently and sustainably. Communicate and be a good team worker and be responsive to contemporary issues
PLO11	Able to behave as a mathematician with good learning behavior, work ethic, attitude and personality, including curiosity, perseverance, tenacity, accuracy, creativity, honesty and self-confidence as well as understanding professional ethics
PL012	Able to learn endlessly and equip themselves with the most up-to-date knowledge and information

Table 8. Identification of the Suitability of Graduates Learning Outcomes with PLO

CPL Code	Attitude										General Skills									knowledge		Specific Skills				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5
PLO1																				√		√				
PLO2																					√	√				
PLO3																				√		√				
PLO4															√						√			√		
PLO5															√						√	√				
PLO6																					√					√
PLO7											√	√											√			
PLO8													√											√		
PLO9														√	√			√								√
PLO10																			√				√	√	√	
PLO11	√	√	√	√	√	√	√	√	√	√					√	√	√	√	√							√
PLO12	√	√	√	√	√	√	√	√	√	√									√							√

Table 9. Identification of Graduates Profile with PLO

PLO Code	Researcher	Expert	Educator	Public Servant	Leader/Ent-repreneur
PLO1	√	√	√		
PLO2	√	√	√		
PLO3	√	√		√	
PLO4	√	√	√	√	
PLO5	√	√	√		
PLO6	√		√		
PLO7		√			√
PLO8	√	√			
PLO9	√	√	√		√
PLO10	√	√	√	√	√
PLO11	√	√	√	√	
PLO12	√	√	√		√

CHAPTER 6.
SCIENTIFIC LEARNING MATERIAL

6.1. Framework Arrangement of Learning Material

A set of suitable learning materials is needed in order to achieve the proposed Graduate Learning Outcome. The learning materials are specified into sub-learning materials in which the structure and the amount are suitable with each material's necessity and breadth. A type of learning materials or sub learning materials is arranged into a course and each Graduate Learning Outcome is supported by at least one learning material.

The 4.0 Industrial Revolution, which started in the beginning of 21st century, are full of artificial intelligence, e-commerce, nano technology, automatic vehicle, genetic engineering, and innovation. The changes in this era have been happening exponentially which affects the economic growth, industry, and government's policy. In facing the 4.0 Industrial Revolution, human resources need to adapt towards the development of technology. In this case, Educational Institutions, including university, play an important role in preparing human resources by improving graduates' competencies having learning and innovation skill within mastering knowledge and technology based on their fields. Therefore, there are some skills needed in order to support the graduates in achieving their success. Some of these skills are Communication, Collaboration, Critical Thinking and Problem Solving, then Creative Thinking and Innovation.

1. Communication

Communication Skill is a skill used for presenting idea, thought, knowledge, and new information to other people through writing, speaking, picture, figure, and number. This skill includes listening, gaining information, and presenting idea. Sociological basis aims to support the students in helping the society well, so the communication skill is very needed. Human are social creatures who always interact to each other. Therefore, communication is one of the important aspects for humanity. Communication aims to transfer a message through the chosen media, so the message can be easily understood by the receiver. Effective communication happens when a message delivered by a communicator can be received well by the receiver without any misperception. Dimensions and Indicators of the 21st century's communication skills are: (1) articulating thoughts and ideas logically and effectively through verbal or non-verbal media, (2)

listening effectively to comprehend the core of knowledge, value, behavior, and culture from the receiver, (3) utilizing communication tools or relevant technology media, as well as its impact and effectivity, (4) communicating effectively on divergent environment. The role of communication can be taught through learning process. Educators' roles are very important in leading the students in practicing every communication dimensions.

2. Collaboration

Collaboration skill is the ability of cooperating, synergizing, adapting in various roles and responsibilities, working productively, putting empathy in right situation, and respecting differences. Collaboration also refers to the ability of conducting personal responsibilities and flexibilities on working environment, determining and achieving high standards and purposes for individuals and others, and understanding ambiguity. Collaboration skill also fills the flaws and strengths of each individual, so it can solve the upcoming problems under the togetherness feeling.

3. Critical Thinking and Problem Solving

Pragmatism philosophy always becomes the basis in curriculum development, which also takes part in learning material determination. Critical thinking and problem solving skill is the ability in understanding a complicated problem and connecting an information with other information, which creates various perspective and solve the problem. Critical thinking skill also refers to the ability of reasoning, comprehending, making complicated decision, comprehending interconnection between system, arranging problem, revealing problem, analyzing problem, and solving problem. There are some dimensions in critical thinking, namely (1) formulating questions, (2) stating arguments, (3) conducting deduction, (4) conducting induction, (5) evaluating, and (6) making decision. In terms of learning approach, critical thinking skill can be practiced through (1) student-centered learning, (2) raising a question, either academic or contextual question which leads them in comprehending the materials. Moreover, the learning strategies for critical thinking skill are problem-based learning, project-based learning, cooperative group investigation, and inquiry learning.

4. Creativity and Innovation

Creativity and Innovation skills are also needed beside critical thinking and problem-solving skills based on pragmatism philosophy. These skills aim to develop, conduct, and present new ideas to others, and be open and responsive towards new and different

perspective. Creativity is the ability of developing new idea and way from the previous ones. Creativity is also defined as the ability in creating new combination. Creativity very much depends om someone's creative thinking, which refers to someone's thinking process in creating new idea. Meanwhile, being innovative is realized through the innovation of new idea collected from gradual development in a new idea or creation. Creativity and innovation can be practiced by giving new challenges on problem or case study which encourage the students in finding new solution in form of idea or creation in solving the problem.

Besides the skills elaborated above, graduates' competency in terms of information literacy is also needed in 21st century learning process. Information literacy is the ability of conducting knowledge management and learning continuously. Information literacy also refers to the ability in realizing information needs, identifying and finding the location of information needed, evaluating information critically, organizing and integrating information to the existing knowledge, utilizing and delivering the information effectively, legally, and ethically. Information literacy is very needed in the implementation of competency-based curriculum which requires students to utilize a lot of information in various formats. In the globalization era, the competition does not only rely on someone's knowledge, but the graduates should also be able to learn and communicate continuously with others. Therefore, the graduates are expected to have information literacy with specific skills to:

1. Formulating information needs and deciding information scope needed.
    a) Accessing information needed efficiently, ethically, and legally.
    b) Evaluating information and its source, including evaluating whether the information will affect negatively towards psychological, social, economic, politic, and others when being used.
    c) Using information effectively to reach goal.
    d) Integrating selected information in the existing information.
    e) Evaluating existing creation.
2. Conducting lifetime learning independently.

6.2. Study Material

Bahan kajian keilmuan mengacu pada IndoMS 2015 serta kondisi dan karakter khusus Program Studi Matematika. Dalam pelaksanaan kurikulum dan proses pembelajaran mata kuliah serta bahan kajian keilmuan, didukung oleh 4 *Research Group* (GR) yakni GR *Combinatorial Mathematics,* GR *Pure Mathematics and Application,* GR *Mathematical Soft Computing* dan GR *Applied and Mathematical Analysis.* Adapun kemampuan dasar dan bahan kajian ditunjukkan pada tabel berikut. The scientific learning material is based on IndoMS 2015 as well as the condition and special character of Mathematics Study Program. The curriculum implementation and learning process of courses and scientific learning material are supported by four Research Group (RG) namely Combinatorial Mathematics GR, Pure Mathematics and Application GR, Mathematical Soft Computing GR, and Applied and Mathematical Analysis GR.

Table 10. Basic Competence and Learning Material

No.	Basic Competence	Learning Material
1	Basics of Mathematics	Set
		Relations and Functions
		Mathematical Logic
		Mathematical Proof
		Natural Number, Integer, Rational umber Systems
2	Differential Calculus and Integral	Real Number System
		Functions
		Limit
		Continuous Functions
		Derivative
		Integral
		Sequence
		Series
		Vector-Valued Functions
		Multi-Valued Funcions
		Partial Derivative
		Double and Triple Integral
3	Ordinary Differential Equation	Ordinary Differential Equation
4	Matrix and Vector	Matrix
		Vector Space
5	Elementary Linear Algebra	System of Linear Equations

No.	Basic Competence	Learning Material
		Linear Transformation
		Orthogonalization
		Eigenvalues and Eigenvectors
		Diagonalization and Decomposition
		Square
6	Mathematical Optimization	Basic Optimization
7	Geometry	Geometry of Planes and Spaces
8	Statistics	Type of Data
		Descriptive Statistics
		Central Tendency and Statistical Dispersion
		Probability
		Probability Distributions
		Sampling Distributions
		Introduction to Hypothesis Testing
		Confidence Interval
		Simple Linear Regression Analysis
9	Discrete Mathematics	Combinations and Permutations
		Three Main Principals
		Basics of Graph Theory
10	Programming	Basics of Programming
11	Basics of Natural Science	Basic Physic
		Basic Chemistry
		General Biology
12	Basics of Attitude and General Knowledge	Religion
		Pancasila
		Civic Education
		Indonesian Language
		Community Service Program
		Entrepreneurship

CHAPTER 7.
COURSES DETERMINATION

Course Determination is done based on the curriculum recommendation and courses from the professional organization, Indonesian Mathematical Society or IndoMS, as well as discussion about learning achievement. The discussion is conducted with alumni, stakeholders, users, and related experts. The detailed courses determination is based on the diagram in Figure 2.

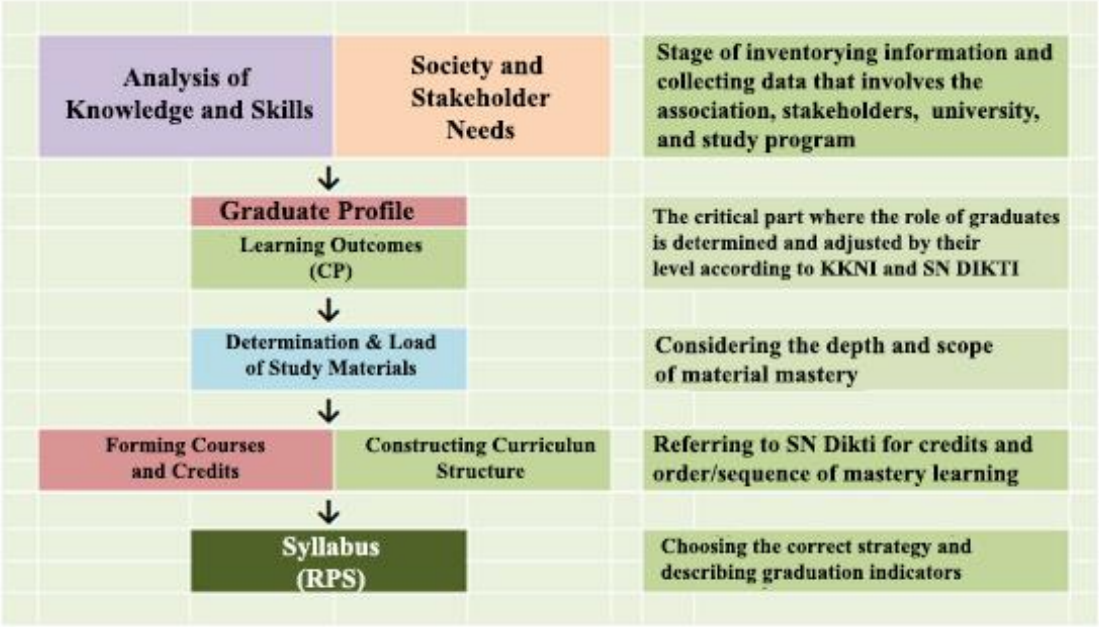

Figure 2. Scheme 1 of Course Forming

Courses forming and determination was started from several indicators of Graduate Learning Outcome, which are suitable as the course forming basis. The courses are optimized to contain knowledge, skill, and attitude aspects. The learning materials in Graduate Learning Outcome are selected simultaneously and elaborated in learning materials through the courses as shown in Figure 3.

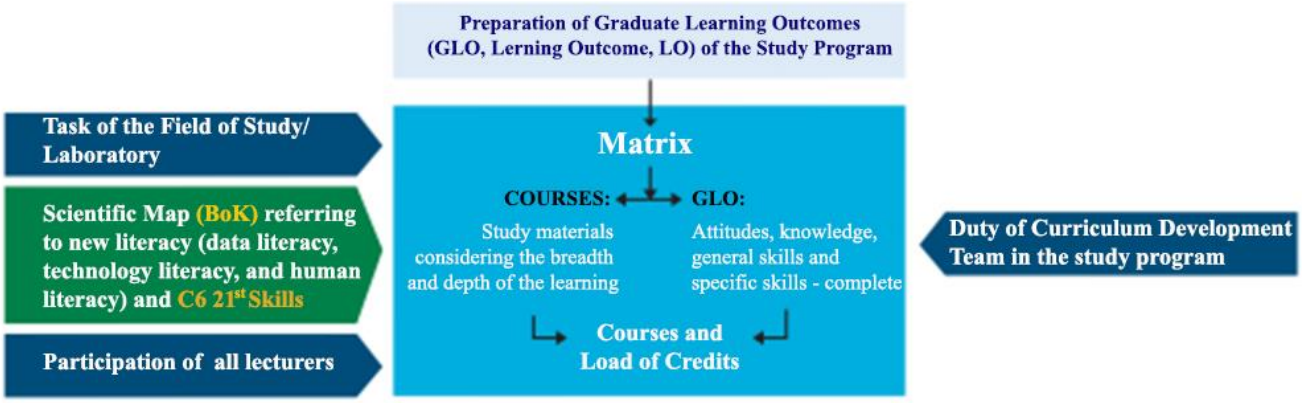

Figure 3. Scheme 2 of Course Forming

The learning materials can be updated or developed based on the technology information and knowledge development of the study program. The determination process of learning materials involves Research Group.

CHAPTER 8.
COURSES ARRANGEMENT

8.1. Courses Arrangement

2020 curriculum arrangement refers to the Regulation of the Minister of Education and Culture Number 3 of 2020 about Freedom of Learning and Independent Campus, which are adapted to the 4.0 Industry Revolution.

Courses distribution is arranged within the semesters during study period. Study period of the Mathematics Study Program is eight semesters, with the 144 minimum credits. The total credits provided consist of 107 credits of compulsory courses (50 courses), 11 credits of directed electives courses (five courses), and 66 credits of electives courses (29 courses). The optional majors in 2020 Curriculum follow the existing Research Group in Study Program, namely:

1) Combinatorial Mathematics Research Group
2) Pure Mathematics and Application Research Group
3) Mathematical Soft Computing Research Group
4) Applied and Mathematical Analysis Research Group

Courses distribution in 2020 Curriculum is elaborated in the table below.

Compulsory Courses

Table 11. List of Compulsory Courses in Mathematics Study Program

No.	Course Code	Course Name (*Indonesian*)	Course Name	Credits	Prerequisite Course Code	Prerequisite Course
Semester I						
1.	MAT310201	*Bahasa Inggris*	English	2		
2.	MAT310202	*Biologi Umum*	General Biology	2		
3.	MAT310203	*Fisika Dasar*	Basic Physic	2		
4.	MAT310204	*Kimia Dasar*	Basic Chemistry	2		
5.	MAT310205	*Matriks dan Ruang Vektor*	Matrix and Vector Space	2		
6.	MAT310306	*Kalkulus Diferensial*	Differential Calculus	3		
7.	MAT310307	*Logika Matematika dan Himpunan*	Mathematical Logic and Sets	3		
8.	MAT310308	*Analisis Data Eksploratif*	Explorative Data Analysis	3		

No.	Course Code	Course Name (*Indonesian*)	Course Name	Credits	Prerequisite Course Code	Prerequisite Course
Credits Subtotal				**19**		
Semester II						
1.	0900012001	*Pendidikan Agama*	Religion	2		
2.	0900012002	*Pend. Kewarganegaraan*	Civic Education	2		
3.	0900012004	*Bahasa Indonesia*	Indonesian Language	2		
4.	MAT320304	*Kalkulus Integral*	Integral Calculus	3		
5.	MAT320305	*Geometri Analitik*	Analytical Geometry	3		
6.	MAT320306	*Aljabar Linear*	Linear Algebra	3		
7.	MAT320307	*An alisis Statistika*	Statistical Analysis	3		
8.	MAT320308	*Algoritme dan Pemrograman Dasar dengan Python*	Basic Programming and Algorithm with Python	3		
9	0900012003	*Pancasila*	Pancasila	2		
Credits Subtotal				**23**		
Semester III						
1.	MAT330202	*Pengantar Teori Graf*	Introduction to Graph Theory	2		
2.	MAT330303	*Pengantar Matematika Numerik*	Introduction to Numerical Mathematics	3		
3.	MAT330304	*Kalkulus Peubah Banyak*	Multivariate Calculus	3		
4.	MAT330205	*Pengantar Fungsi Khusus*	Introduction to Special Functions	2		
5.	MAT330306	*Teori dan Hitung Peluang*	Theory and Calculation of Probability	3		
6	MAT330307	*Persamaan Diferensial Biasa*	Ordinary Differential Equation	3		
7.	MAT330308	*Pemrograman Lanjut dengan Python*	Advance Programming with Python	3	MAT320308	Basic Algorithms and Programming with Python
Credits Subtotal				**19**		
Semester IV						

No.	Course Code	Course Name (*Indonesian*)	Course Name	Credits	Prerequisite Course Code	Prerequisite Course
1.	MAT341201	*Metodologi Penelitian dan Penulisan Ilmiah Matematika*	Research Method and Mathematical Scientific Writing	2	MAT320203	Indonesian Language
2.	MAT340302	*Matematika Numerik*	Numerical Mathematics	3	MAT330303	Introduction to Numerical Mathematics
3.	MAT340303	*Statistik Matematika*	Mathematical Statistics	3	MAT330306 MAT330304	Theory and Calculation of Probability, Multivariate Calculus
4.	MAT340204	*Teori Grup*	Group Theory	2	MAT310307	Mathematical Logic and Sets
5.	MAT340305	*Fungsi Kompleks*	Complex Functions	3	MAT330304	Multivariate Calculus
6.	MAT340306	*Riset Operasi Deterministik*	Deterministic Operation Research	3	MAT310306 MAT320306	Differential Calculus, Linear Algebra
7.	MAT340307	*Masalah Syarat Batas*	Boundary Condition Problems	3	MAT330307	Ordinary Differential Equation
Credits Subtotal				**19**		
Semester V						
1.	0900012005	*Kewirausahaan*	Entrepreneurship	2		
2.	MAT351203	*Pengantar Matematika Diskrit*	Introduction to Discrete Mathematics	2	MAT330202	Introduction to Graph Theory
3.	MAT351204	*Pengantar Proses Stokastik*	Introduction to Stochastic Processes	2	MAT340303	Mathematical Statistics
4.	MAT351305	*Teknik Simulasi*	Simulation Techniques	3	MAT330308	Advance Programming with Python
5.	MAT351306	*Teori Ring*	Ring Theory	3	MAT340204	Group Theory
6.	MAT351307	*Analisis Real I*	Real Analysis I	3	MAT310306 MAT320304	Differential Calculus, Integral Calculus
Credits Subtotal				**15**		

No.	Course Code	Course Name (*Indonesian*)	Course Name	Credits	Prerequisite Course Code	Prerequisite Course
Semester VI						
1.	MAT361201	*Kegiatan Magang Mahasiswa *)*	Student Internship Activity	2	MAT351203	Research Method and Mathematical Scientific Writing
Credits Subtotal				**2**		
Semester VII						
1.	MAT370201	*Kuliah Kerja Nyata *)*	Community Service Program	2		*finished 110 Credits
Credits Total				**2**		
Semester VIII						
1.	MAT380601	*Tugas Akhir *)*	Thesis	6		
Credits Subtotal				**6**		
Credits Total				**107**		

Note:
***)** Student Internship Activity, Community Service Program, and Thesis Courses are available in Both Semesters (odd/even) with fulfilling minimum total credits.

Directed Elective Courses

Table 12. List of Directed Elective Courses

No.	Course Code	Elective Course (*Indonesian*)	Elective Course	Credits	Prerequisite Course Code	Prerequisite Course
Semester VI						
1.	MAT361202	*Matematika Diskrit*	Discrete Mathematics	2	MAT340201	Introduction to Discrete Mathematics
2.	MAT361303	*Analisis Real II*	Real Analysis II	3	MAT351307	Real Analysis I
3.	MAT361204	*Pemodelan Epidemiologi*	Epidemiology Modelling	2	MAT330307	Ordinary Differential Equation
4.	MAT361205	*Pemodelan Matematika*	Mathematical Modelling	2	MAT330307	Ordinary Differential Equation
5.	MAT361206	*Teori Permainan*	Game Theory	2	MAT340306	Deterministic Operation Research
Credits Total				**11**		

Elective Courses

Table 13. List of Elective Courses

No.	Course Code	Elective Course (*Indonesian*)	Elective Course	Credits	Prerequisite Course Code	Prerequisite Course
Semester III						
1.	MAT332201	*Teori Himpunan*	Sets Theory	2	MAT310307	Mathematical Logic and Sets
2.	MAT332202	*Himpunan dan Logika Fuzzy*	Fuzzy Sets and Fuzzy Logic	2	MAT310306	Mathematical Logic and Sets
3.	MAT332203	*Jaringan Syaraf Tiruan*	Artificial Neural Network	2	MAT310306	Differential Calculus
4.	MAT332304	*Managemen Basis Data*	Database Management	3	MAT310308	Explorative Data Analysis
5.	MAT332205	*Komunikasi Matematis*	Mathematical Communication	2		
Credits Subtotal				**11**		
Semester IV						
1.	MAT342301	*Matematika Peramalan*	Forecasting Mathematics	3	MAT310306	Differential Calculus
2.	MAT342202	*Pengantar Teori Kontrol*	Introduction to Control Theory	2	MAT330307	Ordinary Differential Equation
3.	MAT342203	*Teori Graf*	Graph Theory	2	MAT330202	Introduction to Graph Theory
4.	MAT342304	*Matematika Asuransi*	Mathematical Insurance	3	MAT330306	Theory and Calculation of Probability
5.	MAT342205	*Model Resiko*	Risk Model	2	MAT330306	Theory and Calculation of Probability
6.	MAT342206	*Kecerdasan Buatan*	Artificial Intelligence	2	MAT330202	Fuzzy Sets and Fuzzy Logic
Credits Subtotal				**14**		
Semester V						
1.	MAT352201	Persamaan Diferensial dan Integral Numerik	*Numerical Differentiation and Integration*	2	MAT330303	Introduction to Numerical Mathematics
2.	MAT352302	Riset Operasi Probabilistik	*Probabilistic Operation*	2	MAT330306	Theory and Calculation of

No.	Course Code	Elective Course (*Indonesian*)	Elective Course	Credits	Prerequisite Course Code	Prerequisite Course
			Research			Probability
3.	MAT352203	Pemrograman Tak Linear	*Nonlinear Programming*	2	MAT330303	Introduction to Numerical Mathematics
4.	MAT352304	Teori Persamaan Diferensial	*Theory of Differential Equations*	3	MAT330307	Ordinary Differential Equation
5.	MAT352305	Data Sains	*Data Science*	3	MAT332304 MAT330308	Database Management, Advance Programming with Python
Credits Subtotal				**12**		
Semester VI						
1.	MAT362201	*Persamaan Diferensial Parsial Numerik*	Numerical Partial Differential Equations	2	MAT351307	Boundary Condition Problems
2.	MAT362202	*Teori Modul*	Module Theory	2	MAT351206	Ring Theory
3.	MAT362303	*Pengantar Kriptografi dan Teori Koding*	Introduction to Cryptography and Coding Theory	3	MAT320306 MAT351206	Linear Algebra Ring Theory
4.	MAT362204	*Aljabar Linear Numerik*	Numerical Linear Algebra	2	MAT320306	Linear Algebra
5.	MAT362205	*Technopreneurship*	Technopreneurship	2	MAT351202	Entrepreneurship
6.	MAT362206	*Biometrik*	Biometrics	2	MAT330307	Advance Programming with Python
Credits Subtotal				**13**		
Semester VII						
1.	MAT372301	*Kalkulus Fraksional*	Fractional Calculus	3	MAT330304	Multivariate Calculus
2.	MAT372202	*Analisis Fungsional*	Functional Analysis	3	MAT361303	Real Analysis II
3.	MAT372203	*Sistem Linear*	Linear Systems	2	MAT342202	Introduction to Control Theory
4.	MAT372204	*Teori Integral*	Theory of Integral	2	MAT361303	Real Analysis II
5.	MAT372205	*Sistem Dinamik*	Dynamical System	2	MAT340204 MAT361303	Group Theory, Real Analysis II
6.	MAT372206	*Kapita Selekta*	Capita Selecta	2	MAT351203	Research

No.	Course Code	Elective Course (*Indonesian*)	Elective Course	Credits	Prerequisite Course Code	Prerequisite Course
						Method and Mathematical Scientific Writing
7.	MAT372207	*Aljabar Bilinear dan Multilinear*	Bilinear and Multilinear Algebra	2	MAT362202	Module Theory
Credits Subtotal				**16**		
Credits Total				**66**		

Table 14. Matrix of PLO (Program Learning Outcomes) and Courses

Courses	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
English												√
Biology												√
Basic Physics					√							√
Basic Chemistry												√
Matrix and Vector Space	√	√	√									
Differential Calculus	√	√										
Mathematical Logic and Sets	√	√										
Explorative Data Analysis	√	√	√	√		√	√					
Religious Education												√
Civic Education												√
Indonesian												√
Integral Calculus	√	√										
Analytical Geometry	√	√										
Linear Algebra	√	√										
Statistical Analysis	√	√				√						
Basic Algorithms and Programming				√			√			√		

Courses	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
in Python												
Pancasila												√
Introduction to Graph Theory	√	√										
Introduction to Numerical Mathematics	√	√		√								
Multiple variable calculi	√	√										
Introduction to Special Functions	√	√										
Theory and Calculate Opportunities	√	√	√									
Ordinary Differential Equation	√	√										
Advanced Programming with Python				√						√		
Research Methodology and Scientific Writing of Mathematics							√	√	√			
Numerical Math				√	√							
Math Statistics	√	√										
Group Theory	√	√										
Complex Functions	√	√										
Deterministic Operations Research				√	√							
Boundary Condition Problem	√	√										
Basic Socio-Cultural Sciences												√

Courses	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
Entrepreneurship								√				√
Introduction to Discrete Mathematics	√	√										
Introduction to Stochastic Process	√					√	√					
Simulation Technique				√	√	√	√					
Ring Theory	√	√										
Real Analysis I	√	√										
Student Internship Activities *)								√	√	√	√	√
Community Service Program for students *)								√	√	√	√	√
Thesis *)								√	√	√	√	√
Discrete mathematics	√	√										
Real Analysis II	√	√										
Epidemiological Modeling		√			√	√	√					
Mathematical Modeling		√		√	√	√	√					
Game Theory	√	√			√		√					
Set Theory	√	√										
Fuzzy Sets and Logic	√	√										
Artificial Neural Network		√		√	√		√					
Database Management		√	√	√		√						
Mathematical Communicatio									√		√	

Courses	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
n												
Forecasting Math		√	√			√	√					
Introduction to Control Theory	√	√										
Graph Theory	√	√										
Insurance Math		√	√		√	√						
Risk Model		√	√		√		√					
Artificial Intelligence		√		√	√	√	√					
Numerical Integral and Differential Equations	√	√		√								
Probabilistic Operations Research		√			√	√						
Non-Linear Programming	√	√										
Differential Equation Theory	√	√										
Science Data		√	√		√	√	√					
Numerical Partial Differential Equations		√	√									
Module Theory	√	√										
Introduction to Cryptography and Coding Theory		√		√								
Numerical Linear Algebra		√		√								
Technopreneurship								√		√	√	√
Biometrics		√		√	√		√					
Fractional Calculus	√	√										
Functional	√	√										

Courses	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
Analysis												
Linear System	√	√										
Integral Theory	√	√										
Dynamic System	√	√										
Capita Selecta								√	√	√		√
Bilinear and Multilinear Algebra	√	√										

8.2. Curriculum Structure of the study program

Table 15. Curriculum Structure

SEM	SCTRUCTURE OF CURRICULUM														Credits
VIII	MAT380601 Thesis														6
VII	MAT370201 Community Service Program													Elective Courses 5 Credits	2
VI	MAT361201 Student Internship Activity						MAT361202 Discrete Mathematics					MAT361303 Real Analysis II	MAT361205 Mathematical Modelling	MAT361204 Epidemiolog Modelling	Elective Courses 5-7 Credits	11
V	0900012005 Entrepreneurship			MAT351201 Basic Social and Culture Knowledge			MAT351203 Introduction to Discrete Mathematics	MAT361206 Game Theory		MAT351306 Ring Theory	MAT351204 Introduction to Stochastic Processes	MAT351307 Real Analysis I	MAT351305 Simulation Techniques		Elective Courses 5-6 Credits	18
IV	MAT341201 Research Method and Mathematical Scientific Writing					MAT340302 Numerical Mathematics		MAT340306 Deterministic Operation Research	MAT340305 Complex Functions	MAT340204 Group Theory	MAT340303 Mathematical Statistics			MAT340307 Boundary Condition Problems	Elective Courses 3-5 Credits	19
III				0900012003 Pancasila		MAT330303 Introduction to Numerical Mathematics	MAT330202 Introduction to Graph Theory		MAT330304 Multivariative Calculus	MAT332202 Fuzzy Sets and Fuzzy Logic	MAT330306 Theory and Calculation of Probability		MAT330308 Advance Programming with Python	MAT330307 Ordinary Differential Equation	Elective Courses 3 Credits	21
II	0900012004 Indonesian Language	0900012001 Religion		0900012002 Civic Education			MAT320306 Linear Algebra		MAT320304 Integral Calculus		MAT320307 Statistical Analysis	MAT320305 Analytical Geometry	MAT320308 Basic Programming and Algorithm with Python			21
I	MAT310201 English	MAT310202 General Biology	MAT310203 Basic Physic		MAT31020 4 Basic Chemistry		MAT310205 Matrix and Vector Space		MAT310306 Differential Calculus	MAT310308 Mathematical Logic and Sets	MAT310308 Explorative Data Analysis					20
															26	118

8.3. Freedom of Learning -Independent Campus

The implementation of Freedom of Learning -Independent Campus means students are able to take courses outside the study program or on the other campus, either in the same or different study programs or in the industry. The Freedom of Learning -Independent Campus (MBKM) refers to the UNS Chancellor's Regulation No. 31 of 2020:

1) Student exchange,
2) Student internship lectures/practical work,
3) Teaching assistant in the education unit,
4) Research/study,
5) Humanitarian activities,
6) Entrepreneurial activities,
7) Independent Study/Project,
8) Community services
9) Military training, and
10) Other forms as determined by the Rector's Regulation.

The mathematics study program supports the implementation of Freedom of Learning -Independent Campus (MBKM) by doing a cooperation agreement with Mathematics Study Programs at the Faculty of Science and Mathematics, Diponegoro University; Faculty of Mathematics and Natural Sciences, Universitas Gadjah Mada; General Sudirman University Faculty of Mathematics and Natural Sciences; The Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret and the Faculty of Mathematics and Natural Sciences, Yogyakarta State University. The 5 study programs hope that the implementation of Freedom of Learning -Independent Campus (MBKM), specifically student exchange, can be started immediately. In addition, some students have implemented Freedom of Learning through the Bangkit and Permata Sakti programs.

CHAPTER 9.
FULFILLMENT STRATEGY OF GRADUATE LEARNING OUTCOMES

9.1. Learning Models and Methods

The selection of learning models and methods follows the condition that the expected abilities are determined in a learning stage in accordance with CPL. The learning models are lectures, responses, tutorials, seminars or the equivalent, practicum, field practice, research, community service, and/or other equivalent learning models. Whereas, the learning methods include: group discussions, simulations, case studies, collaborative learning, cooperative learning, project-based learning, problem-based learning, or other learning methods, that effectively facilitate the fulfillment of graduate learning achievements. The combination of learning models and methods is achievable depending on the characteristics of the courses, the linkages of the courses, learning models, and learning experiences are displayed in the Figure.

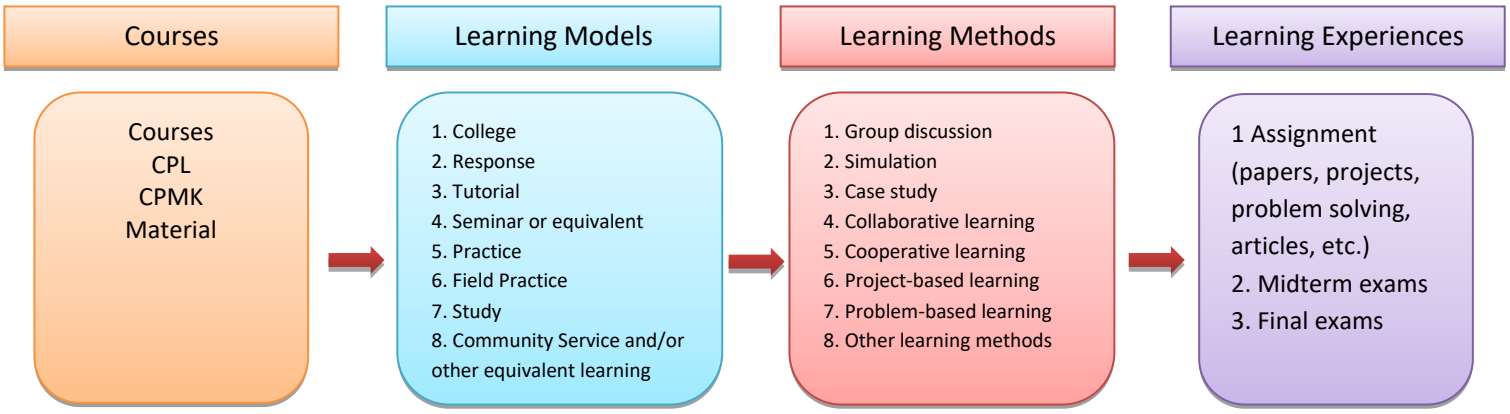

Figure 4. Mathematics Study Program Learning Implementation

The learning methods based on UNS recommendation by changing UNS to PTN-BH (State Higher Education Institutions with Legal Entity) are:

1. Case method

   a. Students act as "protagonists" (main characters) who try to solve cases;

b. Students conduct case analysis to provide solutions, recommend solutions with group discussions to test and develop solution designs; and

c. Students engage in learning discussions actively while the lecturer acts as a facilitator in charge of monitoring, asking questions, directing the discussion, asking questions, and observing.

2. Team-based project learning:

a. The class is divided into groups of more than one student to work on a group task during the specified period;

b. Groups are given actual issues that happen in the society or complex questions and afterward provided space to make work plans and collaboration models;

c. Each group prepares and presents a final work in front of the lecturer, class, or other audience to achieve constructive feedback;

d. The lecturer facilitates each group during the project work period and encourages students to think critically and creatively in collaboration; and

e. Team-based project learning needs the output in the form of a portfolio.

9.2. Learning Assessment

Several programs are maintained to fulfill the learning outcomes of graduates, such as evaluating the curriculum regularly, implementing Focus Group Discussion (FGD) with students, and sharing with alumni and stakeholders.

1. Carrying out observation and evaluation of the implementation of the teaching and learning process, optimal internal quality assurance system, and curriculum evaluation;
2. Building and improving networking with alumni;
3. Increasing the publication of research results: increasing the number of international journals and increasing the number of nationally accredited scientific journals, namely

a. organize symposiums and seminars on a national and international level regularly;

b. motivate lecturers to publish their research results in an international journal;

4. Improving the quality and development of academic staff. Presently, the percentage of lecturers at the doctoral level is 17.64%, and it is expected in 2021 the lecturers at the doctoral level will reach 50%;
5. Building association initiatives with other institutions, both local, regional, national, and international in addition to developing associations in the form of student exchanges and lecturer exchanges; and
6. Providing services to society through consultation, training, and counseling by the competence of lecturers.

The assessment system in K-DIKTI uses learning assessment standards in Permendikbud Number 49 of 2014 article 18 paragraph 1 defined as minimum criteria assessment of student learning processes and outcomes to fulfill graduate learning outcomes. The assessment of student learning processes and outcomes includes principles of assessment, assessment techniques and instruments, assessment mechanisms and procedures, implementation of assessment, assessment reporting, and student graduation.

1. Principles of assessment

The principles of assessment include educative, authentic, objective, accountable, and transparent principles that are maintained in an integrated manner. The five principles explanation is displayed in Table 16.

Table 16. Assessment Principle

Principle	Keterangan
Education	Motivate improvement plans and ways of learning, and achieve learning outcomes
Authentic	Assessment oriented to a continuous learning process and learning outcomes that reflect student ability
Objective	Assessment standards are agreed upon between lecturers and students (course contract) and are free from the influence of subjectivity of lecturers and students
Accountable	The assessment is conducted in accordance with clear procedures

	and criteria, agreed upon at the beginning of the lecture (course contract), and understood by the student.
Transparan	The assessment is conducted procedurally and the value results are accessible to all stakeholders

2. Assessment Techniques and Instruments

Assessment techniques and instruments refer to the CPL, which includes attitudes, knowledge, and general and special skills, and the final result of the assessment is the integration of all the components assessed. The explanations of assessment techniques and instruments and examples for rubrics and portfolios are displayed in Tables 17, 18, and 19. These rubrics can be developed according to the characteristics of the course.

Table 17. Assessment Techniques and Instruments

Evaluation	Technique	**Instrument**
Attitude	Observation	• Rubric for process assessment - Holistic rubric - Descriptive/analytic rubric • Portfolio or project or design work for outcome assessment - Development portfolio - Comprehensive portfolio
General Skills	Observation Participation/Activity Work method	
Knowledge	Written test	
Special Skill	Spoken test Questionnaire	
The final result of the assessment is the integration of various assessment techniques and instruments		

Table 18. Holistic Rubric

Grade	**Score**	**Indiator**
Excellent	>=85	The results presented are systematic, problem-solving, can be implemented, and innovative
Very good	80 - 84	The results presented are systematic, solve problems,

		can be implemented, but are less innovative
Good	75 - 79	The results presented are systematic, and solve problems, but are less implementable
Enough	70 -74	The results presented are systematic but less solve the problem
Not enough	65 - 69	The results presented are systematic but do not solve the problem
Less	60 - 64	The results presented are less systematic
Lesser	< 60	The results presented are irregular and do not solve the problem

Table 19. Presentation Assessment Rubric

Dimension	Load	Value	BxN	Comment (anecdotal notes)
Material mastery	30%			
Problem-solving accuracy	30%			
Communication skills	20%			
Ability to answer questions	10%			
Props/presentations	10%			
Final Score	100%			

3. Assessment Mechanisms and Procedures

The assessment mechanism related to the assessment stages, assessment techniques, assessment instruments, assessment criteria, assessment indicators, and assessment weights is executed by using the following plot:

a) Creating Assessment
   1) Delivering assessment (course contract)
   2) Agreed (course contract)
   3) Implementing
   4) Providing feedback
   5) Documenting.

b) Planning
   1) The activity of giving questions, assignments, or projects

2) Observation
3) Taking observations
4) Final score

4. Implementation of Assessment

The implementation in the assessment is executed by the lesson plan and can be carried out by:

a) Lecturer or teaching lecturer team
b) Lecturer or lecturer team by involving theoretical course assistants
c) Lecturer or lecturer team by involving practical course assistants
d) Supervisor and field supervisor for KMM
e) Supervisor and examiner for Thesis/Final project

5. Assessment Report

The assessment report contains an assessed learning experience, with score values of 100, to later calculate the total values with the agreed formula. The final value in the 100 value is converted using a reference:

Table 20. Score Conversion

Scale (S)	Number	Letter
S >=85	4,0	A
80=< S <85	3,7	A-
75=< S <80	3,3	B+
70=< S <75	3,0	B
65=< S <70	2,7	C+
60=< S <65	2,0	C
55=< S <60	1,0	D
S <55	0	E

6. Student Graduation

Students can officially get a Mathematics Bachelor's degree if they have taken all the study loads and have graduate learning outcomes demanded by the study program with a Grade Point Average (GPA) greater than or equal to 2.00 (two points zero) have passed all courses. Graduation predicate programs are determined by the final GPA as follows:

a) a student is declared graduated with satisfactory predicate the GPA of 2.76 (two point seven six) to 3.0 (three points zero); or

b) a student is declared to have passed with a very satisfactory predicate if the GPA of 3.01 (three point zero one) to 3.50 (three point five zero.)

c) a student is declared to have graduated with a very satisfactory predicate if the GPA is greater than 3.50 (three points five) with a study period of more than 4 (four) years or 8 (eight) semesters.

d) a student is declared graduated with honors (cum laude) if the GPA is greater than 3.50 (three points five) and with a study period not surpassing the limit of 4 (four) years or 8 (eight) semesters.

e) a student with GPA less than 2.76 are declared to have passed without a predicate.

9.3. Facility and Infrastructure

The Mathematics study program to fulfill the learning achievement of graduation provides several facilities that support both academic and non-academic. The academic support facilities include laboratories for course practicums and research laboratories. The study program also provides the facilities and infrastructure that support non-academic activities. The facility is in the form of a particular research laboratory for preparing for student competitions. The laboratory is able to support the competition in the field of IoT and Programming. The prepared competitions such as Gemastik, LIDM, and other competitions.

The faculty also provides other non-academic facilities and infrastructure to support student proficiency and prepare the students to enter the working world. The improvement of student proficiency is in the form of certification of expertise in certain fields. The Mathematics study program has built a collaboration (MoU and MoA) with the Microsoft Technology Associate (MTA) certification agency. The mathematics study program sent several lecturers to join the TOT (Training of Trainers) in two fields: programming python dan Database (Microsoft SQL Server). The ToT program has the advantage that we can provide training to students combined with relevant courses and as a result, students can immediately take the international certification exam. The program can reduce training expenses, considering the training includes

relevant courses, and is learned by lecturers with ToT qualifications, as a result, they only need to pay the certification exam expense. The program can support the Freedom of Learning -Independent Campus (MBKM), and these activities have been conducted since 2018.

The development of UNS into State Higher Education Institutions with Legal Entity (PTN-BH) and along with the availability of Professional Certification Institute (LSP). The availability of this LSP Institution can add to the areas of expertise that can be certified. The Mathematics study program also sends lecturers to take part in the ToT, purposely afterward can provide training to students in the areas of expertise:

1. Programmer Occupational Certification Scheme;
2. Young Network Administrator Occupational Certification Scheme;

The training process is conducted with the included model according to the relevant courses. Therefore, students can get an additional certificate of expertise to add to their provisions in entering the working world.

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