UNS UNIVERSITAS SEBELAS MARET | MATHEMATICS faculty mathematics and natural sciences

ACADEMIC GUIDELINES

MATHEMATICS STUDY PROGRAMME,

FACULTY OF MIPA UNS




1. Introduction

Mathematics Study Programme of Faculty of Mathematics and Natural Sciences (FMIPA) Universitas Sebelas Maret (UNS) is the embryo of the establishment of FMIPA UNS which began in 1982. One of its pioneering activities in 1986-1994 was the development of basic sciences, especially Mathematics through cooperation between UNS and the *International Development Project (IDP)* Australia. Forms of cooperation include *technical assistance* (TA) activities for the teaching and learning process as well as curriculum design and materials for the field of operations research. The collaboration provided encouragement and initiative to be able to establish a Mathematics Study Programme. In addition, that UNS does not yet have a study programme that can cover the development of basic sciences.

Furthermore, the establishment of a Mathematics Study Program under the Department of Civil Engineering was proposed and approved based on the Decree of the Directorate General of Higher Education Number 206/D2/1989 dated 26 January 1989. Six years later, on 12 July 1995, the establishment of FMIPA UNS was proposed through the Directorate of Higher Education (Dirjen Dikti) and in 1996 the Faculty of Mathematics and NaturalSciences (MIPA) was established as the 9th faculty at UNS based on the Decree of the Minister of National Education No. 0297/0/1996 dated 1 October 1996.

Referring to Carl Friedrich Gauss' statement "*Mathematics is the queen of the sciences and number theory is the queen of mathematics*", the development of mathematics *is* very important as the basis of other fields of science. One of the advantages possessed by Mathematics graduates is that they are more able to think critically and sequentially and tend to be easier to learn new things.

2. Vision, Mission and Objectives

As one of the study programmes of FMIPA UNS, the vision, mission, and goals as well as the development direction of the Mathematics Study Programme refer to the strategic plan that has been outlined by FMIPA UNS. As for the learning process, the human resource development system and facilities and infrastructure along with the work mechanism of the Study Programme refer to the vision, mission and objectives of the Mathematics Study Programme FMIPA UNS.

2.1. Vision

To become a centre for learning, studying, developing mathematics and its application that excels at the international level based on the pillars of the philosophy of science.

The vision is described in 3 (three) perspectives as operational definitions. The following is the intended description.

(1) As a centre for the learning, study, development and application of mathematics, the mathematics study programme is a centre for renewal:
   a. Novelty learning and assessment.
   b. Development and application of scientific novelty to solve real problems.

(2) Excelling at the international level
   The mathematics study programme prepares itself as an agent and partner of progress in delivering society to the international arena.

(3) Based on the philosophical pillars of science

The mathematics study programme equips itself with 3 philosophies of science, namely what science is (ontology), how science is (epistimology) and what science is used for (axiology). Here are the 3 pillars.

a. Ontology (nature)

Ontology is one of the most ancient philosophical studies and originated in Greece. The study discusses the existence/nature of something that is concrete/existent. Ontology is concerned with the question of "what".

b. Epistimology (method)

Epistomology is a systematic knowledge that discusses the occurrence of knowledge, sources of knowledge, the origin of knowledge, methods or ways of obtaining knowledge, validity and truth of (scientific) knowledge. Epistemology discusses how a human method of gaining knowledge. Epistemology is related to the question "how/why".

c. Axiology (for what)

Axiology discusses the ethical and aesthetic value of knowledge. The value of something depends on its purpose. The same applies to knowledge. All knowledge has an objective purpose. Axiology is related to the question "for what", for what knowledge in the form of science is used.

2.2. Mission

Based on its vision, the mission of the Mathematics Study Programme is described as follows.

1. Organising student-centred mathematics education and learning and lecturer self-development and encouraging student independence in knowledge, skills and attitudes.
2. Equipping graduates to have mathematical thinking, have high creativity and have various alternative problem solving, communicate scientifically orally and in writing, have the ability to develop themselves and their potential.
3. Developing research in mathematics and its applications that can be utilised by the wider community.
4. Empower *networking* with alumni to enhance the role of the institution.
5. Build cooperation initiatives with other institutions locally, regionally, nationally, and internationally to improve the relevance of graduates and the image of the institution.

2.3. Destination

The Mathematics Study Programme has the following objectives

1. Creating an academic climate that is conducive to increasing productivity, creativity, and enthusiasm for work for the entire academic community.
2. Produce graduates who can internalise academic values, norms and ethics; who are independent with high competitiveness; and have the ability to continue their studies to a higher level.

3. Produce research *outputs in* mathematics and its applications that are beneficial for the development of science and technology (IPTEK).
4. Optimising alumni participation in the implementation of education in the Mathematics Study Program FMIPA UNS as well as self-image, promotion and publication of study programs in the world of work, *stakeholders*, and the wider community.
5. Creating the quantity and quality of co-operation with government agencies, business and industry both nationally and internationally.

2.4. Target

1. Each graduate of the mathematics study programme has a global outlook, is professional, innovative, creative, and able to work in teams, and has competence for problem solving in the field of mathematics.
2. Every academic community is able to produce, develop, disseminate and applyscience and technology that is beneficial to society.

2.5. Achievement Strategy

1. Carry out monitoring and evaluation of the implementation of the teaching and learning process, optimal internal quality assurance system and curriculumevaluation.
2. Build and enhance *networking* with alumni.
3. Increase the publication of research results: increase the number of international journals and increase the number of nationally accredited scientific journals.
   a. Organise national and international symposiums and seminars on a regular basis.
   b. Motivate lecturers to publish their research results in international journals.
4. Increase study programme accreditation from A grade to International accreditation by 2024.
5. Improve the quality and development of academic staff. At present the percentage of lecturers at the doctoral level is 50%, it is expected that by 2023 the teaching staff with doctoral level will reach 60%.
6. Building cooperation initiatives with other institutions locally, regionally, nationally, and internationally as well as expanding cooperation in the form of *student exchange* and *lecturer exchange*.
7. Provide services to the community in the form of consultation, training and counselling in accordance with the competence of lecturers.
8. Create a *website* for the study programme that contains the alumni *database*.

3. Governance and Leadership

3.1. Governance

The governance system runs effectively through a mutually agreed mechanism, and can maintain and accommodate all elements, functions and roles in the study programme. Governance is supported by an organisational culture that is reflected in the existence and enforcement of rules, procedures for selecting leaders, lecturer ethics, student ethics, education staff ethics, reward and sanction systems and service guidelines and procedures.

Based on the organisational structure as shown in Figure 1, the Mathematics Study Program is led by the Head of the Study Program assisted by the Head of Laboratory

and administrative staff as well as several commissions. The commissions are Quality Assurance Commission, Curriculum Commission, Human Resources Commission, Journal Commission, Student Cooperation and Internship Commission, Research and Community Service Commission, Final Project Commission, Student and Alumni Commission, Academic Achievement Development Commission, Information Technology Commission, and each commission consists of a chairperson and members. In line with the policy of the Institute for Research and Community Service (LPPM), research groups (RG) were formed, namely Combinatoral Mathematics, Mathematics Soft Computing and Pure Mathematics and Application.

A concise description of the system and implementation of governance in the study programme to build a credible, transparent, accountable, responsible and fair governance system.

1. The head of the study programme is elected every 4 years through an open election of the lecturer council. The Head of Study Program has the duties and authority to a) plan, implement, and evaluate lecture programmes every semester, b) plan budget plans and annual work programmes, c) evaluate lecturer performance through lecturer workload *reviews* every semester, and d) evaluate student achievements both in academic and non-academic fields by optimising the role of Academic Advisors and student advisors.
2. The study programme's governance is supported by an organisational culture that is reflected in the existence and enforcement of rules, procedures for selecting leaders, lecturer ethics, student ethics, education staff ethics, reward and sanction systems and service guidelines and procedures.
3. In planning the annual work programme and budget, the head of the department seeks the advice of the lecturer council through a meeting. The work programme and budget plan are then presented at the faculty level for approval. After the budget plan and work programme are ratified at the faculty level, the caprodi then socialises the budget plan and work programme again in a lecturer council meeting.
4. Kaprodi together with the curriculum commission in preparing the curriculum involves internal and external *stakeholders* so that the curriculum is in accordance with market demands. Internal stakeholders include students, lecturers, and education staff. The external *stakeholders* consist of alumni, government, industry, and the general public.
5. Kaprodi together with the head of the laboratory and administration compile a lecture schedule by taking into account the suggestions of the lecturer in charge of the course and evaluate lectures and lecturer performance through several techniques and strategies, namely:
   a) monitoring the implementation of lectures through checking attendance and lecture minutes,
   b) review the syllabus/RPS, and
   c) prepare instruments and media to evaluate the performance of the study programme, analyse them, and follow up.

6. The Head of Study Programmes together with the student PA lecturers and several student activity supervisors evaluate student achievements through study programme meetings. In addition, the Head of Study Programmes analyses the performance index of students every semester, students who have problems are immediately resolved through PA while students who excel are given awards.
7. In planning the annual work programme and budget, the head of the department seeks the advice of the lecturer council through a meeting. The work programme and budget plan are then presented at the faculty level for approval. After the budget plan and work programme are ratified at the faculty level, the caprodi then socialises the budget plan and work programme again in a lecturer council meeting.

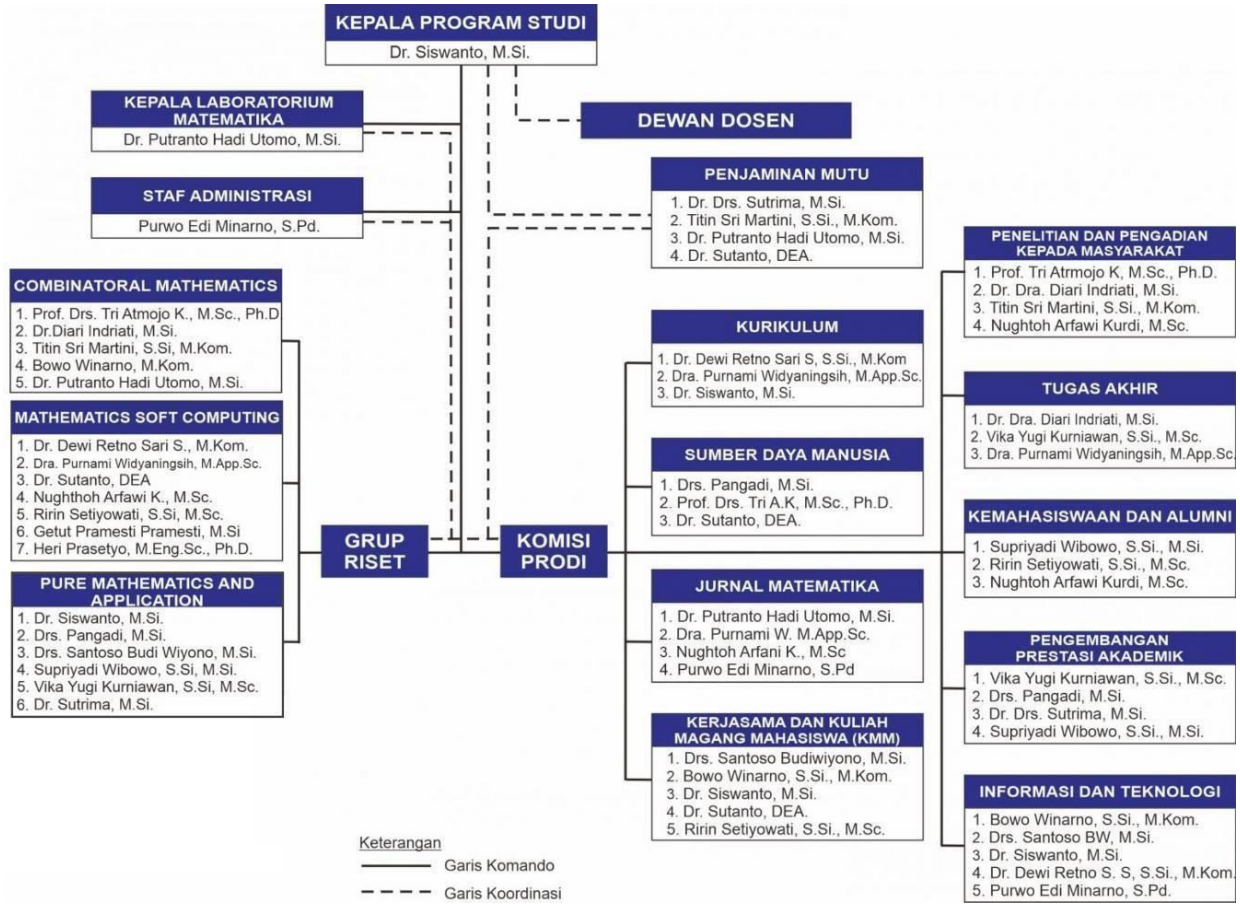

Figure 1: Organisation structure of Mathematics Study Program

4. Long-term Programme Planning and Implementation Monitoring

The vision of the UNS mathematics study programme is designed to provide a strong foundation for policy management, as well as the management of programmes and activities at UNS in the period 2015-2030. It is derived from the programmes outlined by UNS which are divided into eight strategic programmes.

1. Excellence in education and student affairs (Quality teaching programme based on *learning distance* and access expansion).
2. Excellence in research (Excellent research development programme and patent acquisition).
3. The advantages of in transfer anddevelopment science knowledge (Science and Technology empowerment programmes according to community needs and *employability*).
4. Excellence in knowledge management (Continuing education management development programme and study programme accreditation upgrade).
5. Excellence in human resources (Programme to develop professionalism, capacity and competence of staff to strengthen *teaching*)
6. Excellence in quality and service management (Quality and service system improvement programme towards improving accreditation of study programmes and institutions).
7. Internationalisation and public image excellence (Programme for strengthening international reputation base and disciplinary reputation).

Based on the set objectives, the development is focused on the 7 strategic programmes shown in Table 1.

Table 1. Seven Strategic Programmes of the Study Programme

No.	**Year 2020-2025**	**Year 2025-2030**	**Year 2030-2035**
1. Quality teaching programme based on *learning distance* and access expansion			
1	Implementation of global-minded education with expert lecture	Implementation of education with an outlook global with expert lectures	Implementation of education with an outlook global with expert lectures
2	Potential development student interests/talents	Potential development student interests/talents	Potential development student interests/talents
3	Relationship enhancement with alumni	Relationship enhancement with alumni	Relationship enhancement with alumni
4	Index Achievement Cumulative GradePoint Average (GPA) of graduates at least 3.25	Grade Point Average (GPA) of graduates of at least 3.30	Grade Point Average (GPA) graduates minimum 3.35
5	Time wait graduate got first job 4.5 months	Time wait graduates got first job 4.2 months	Time wait graduate got first job 4.0 months
6	Field of interest awards national level	Field of interest awards international level	Field of interest awards international level
2. Flagship research development programme			

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1	Number of nationally accredited publications and international : 6	Number of nationally accredited publications and international : 8	Number of nationally accredited publications and international : 12
2	Multidisciplinary research	Multidisciplinary research	Multidisciplinary research

No.	Year 2020-2025	Year 2025-2030	Year 2030-2035
3. Science and technology empowerment programmes based on community needs and *employability 4.*			
4. Continuous education management development and improvement programme study programme accreditation			
1	Study programme accreditation: A	Study programme accreditation: A	Study programme accreditation: A
5. Professionalism, capacity and competency development programme for staff 5. *teaching* reinforcement			
1	The percentage of lecturers with S3 education level is 50%	Percentage of lecturers with doctoral level education is75%	The percentage of lecturers with S3 education level is 90%
2	Master of Mathematics opening Applied	Increase in number graduate students	Increase in number graduate students
3	*Lecturer Exchanges*	*Lecturer Exchanges*	*Lecturer Exchanges*
6. Quality and service system improvement programme towards accreditation enhancement study programme and institution			
1	Structuring the college *website on line* (SPADA)		
2	Compilation of lecturer performance supportsystem: educator performance index	Compilation of lecturer performance supportsystem: educatorperformance index *online* based	
7. Programme to strengthen international reputation base and discipline reputation (Internationalisation and Public Imaging)			
1	Profile and website development study programme *website*	*Fully bilingual* (Indonesian-English) profile and *website* setup	Improvement and development of a *fully bilingual* profile and *website* (Indonesia-English)

5. Human Resources

Currently, the human resources of the study programme are 15 people, qualified and have a variety of diverse fields of expertise with 68.75% having a master's degree and 31.25% having a doctoral degree with one professor, and two people are currently pursuing doctoral programmes abroad. One study programme support staff has a bachelor's degree. The quality of these resources continues to be improved through several training activities and further studies. The lecturer:student ratio is 1:18.

Here are some ways of developing human resources.

a. Sending staff for further studies. Currently, 1 staff is enrolled in a doctoral programme.
b. Send staff to participate in local, national and international seminars
c. Invite experts from within the institution (LPP UNS) to provide *Technical Assistance* in the field of *Student Centered Learning* (SCL).
d. Invited experts from outside the institution, namely from ITS, UGM and ITB to provide *Technical Assistance* in the field of mathematical modelling in industry.
e. Invite experts from UGM to provide *Technical Assistance* in the field of *Self Access Terminal* (SAT) management.
f. English language training for preparation of scientific presentations in international forums and improvement of TOEFL scores for preparation of further studies.

In addition to this form of development, study programme staff are given ample opportunity to improve their managerial skills by being given the authority to organise and manage activities autonomously.

One of the excellent products that have been produced by the staff of the Mathematics Study Programme is several patents related to batik patterns and intellectual property rights in the form of textbooks both in the field of mathematics and other fields. In addition, as a supervisor, students are always encouraged to disseminate their research results at scientific meetings, both on a national and international scale, thus increasing student achievement in scientific publications.

6. Learning and Teaching

6.1 Learning.

Curriculum and syllabi review *workshops*, *active learning* training and learning model development have been organised. Based on the results of these activities, several *student-centred learning* (SCL) and *cooperative learning* innovations have been implemented for several courses. With these activities, the efficiency of the student study period was achieved, the completion of the final project was shorter, the GPA increased and the numberof dropout students decreased. In addition, the process of socialisation and application of student skills to the real world through KMM courses has an impact on the waiting periodfor getting a job which is getting shorter. In addition, the study programme also prepares a *website* to communicate each course, the *website* is kuliah *on line* (KULON). Library or reference needs can be obtained by students through the FMIPA library as well as *downloading* books and journals whose internet networks have been facilitated by the study programme.

6.2 Learning Models and Methods

The selection of learning forms and methods is based on the necessity that the expected abilities have been determined in a learning stage in accordance with the ELOs. Forms of learning in the form of: lectures, receptions, tutorials, seminars or equivalent, practicum, field practice, research, community service and / or other equivalent forms of learning. While learning methods in the form of: discussion group, simulation, case study, collaborative learning, cooperative learning, *project-based learning*, *problem-based learning*, or other learning methods, which can effectively facilitate the fulfilment of graduate learning outcomes. The combination of learning models and methods can be carried out depending on the characteristics of the course, the interrelationship of learning forms. The recommended learning methods at UNS with the change of UNS to PTN-BH, are

1. *Case method*
   a. The student plays the role of the "protagonist" who tries to solve the case;
   b. students analyse cases to provide solutions, recommend solutions with group discussions to test and develop draft solutions; and
   c. Students actively discuss, while the lecturer acts as a facilitator who observes, asks questions, and directs the discussion, asks questions, and makes observations.
2. *Team-based project* learning:
   a. The class is divided into groups of more than 1 (one) student to work on the task together for a specified period of time;
   b. groups are given a real-life community problem or complex question, then given space to create a work plan and collaboration model;
   c. each group prepares a final presentation/work that is displayed in front of thelecturer, class, or other audience that can provide constructive feedback;
   d. lecturers mentor each group during the project work period and encourage students to think critically and creatively in collaboration; and
   e. Group-based project learning requires the output to be a portfolio.

6.3 Teaching

As a result of the opening of a new study programme, Statistics, the courses in the Mathematics study programme adjusted to the new vision and mission with the development of a new curriculum. All courses with the new curriculum have been arranged syllabus, which is intended to *achieve the* suitability of strategies and methods with the objectives of each course. In order to increase the efficiency and productivity of teaching, several innovations are given: SCL learning, methods, teaching materials and teaching media. Prodi provides laptop and LCD teaching media as well as teaching observation for each course. Learning innovations are always carried out in coordination with the Learning Development Institute (LPP) UNS and the parent professional organisation (INDOMS). Teaching activities each semester for 2 credits at least 16 meetings and 3 credits at least 32 meetings.

6.4 Final Project

For students who are working on their final project, they are provided with a clinic room. TA.

6.4 Softskills

The study programme provides the widest possible opportunity for students to develop knowledge and understanding of material in accordance with their fields, transferable general skills, understanding and utilisation of abilities, independent learning abilities, motivational values, attitudes and teamwork through several activities. These activities include public lectures, basic leadership training by the Mathematics Student Association (HIMATIKA), writing training with LATEX, training with several *Mathematica software* and R *software*. In addition, participating in various committees, internships in the computing lab as assistants, and course assistants.

6.5 Assessment of learning progress and success

The assessment system in K-DIKTI uses learning assessment standards, which in Permendikbud Number 49 of 2014 article 18 paragraph 1 is defined as minimum criteria regarding the assessment of student learning processes and outcomes in order to fulfil graduate learning outcomes. Assessment of student learning processes and outcomes includes: assessment principles; assessment techniques and instruments; assessmentmechanisms and procedures; implementation of assessment; assessment reporting; and student graduation.

1. Assessment principles

   Assessment principles include educational, authentic, objective, accountable, and transparent principles that are carried out in an integrated manner. The principles of assessment are as follows:

   a) Educational = motivating in improving learning plans and methods, and achieving learning outcomes.
   b) Authentic = assessment that is orientated towards the continuous learning process and learning outcomes that reflect student abilities.
   c) Objective = assessment whose standards are agreed between lecturers and students (lecture contract), and free from the influence of the subjectivity of lecturers and students.
   d) Accountable = assessment carried out in accordance with clear procedures andcriteria, agreed upon at the beginning of the lecture (lecture contract), and understood by the students.
   e) Transparent = the assessment is procedurally conducted and the results are accessible to all stakeholders.

2. Assessment Techniques and Instruments

   Assessment techniques and instruments refer to the SLOs, which include attitudes, knowledge, general skills and special skills, and the final assessment results are an integration of all assessed components. Explanations of assessment techniques and instruments and examples for rubrics and portfolios can be shown in Tables 17, 18, and 19. The rubrics can be developed according to the characteristics of the course.

Table 2. Assessment Techniques and Instruments

Assessment	Engineering	Instrument
Attitude	Observation	• Rubric for process assessment
General Skills	Observation Participation/Activity Performance Written Test	- Holistic rubric - Descriptive/analytical rubric • Portfolio or project or design work for assessment of results
Knowledge	Oral Test Questionn aire	- Portfolio of progress - Comprehensive portfolio
Specialised Skills		-
- The final assessment result is the integration of various assessment techniques and instruments.		

Table 3. Holistic Rubric

Grade	Score	Indicator s
Very good Once	>=85	The design presented is systematic, problem-solving, implementable and innovative
Very good	80 - 84	The design presented is systematic, problem-solving, implementable, but less innovative
Good	75 - 79	Design which presented systematised, complete problem, but less implementable
Simply	70 -74	Design which presented systemised but less solve the problem
Less	65 - 69	Design which presented systemised but not solve the problem
Very less	60 - 64	The design presented is less systematic
Very Very less	< 60	Design which presented not organised and not solve the problem

3. Assessment Mechanism and Procedure

The assessment mechanism related to the stages of assessment, assessment techniques, assessment instruments, assessment criteria, assessment indicators and assessment weights is carried out with the following flow

a) Develop Assessment; deliver assessment (course contract); agree (course contract); implement; provide feedback; and document.
b) Planning: activities of giving questions, assignments or projects; observation; taking observation results; giving final grades.

4. Assessment Mechanism and Procedure

The implementation of the assessment is carried out in accordance with the lesson plan and can be done by:

a) Lecturer or team of lecturers
b) Lecturers or a team of lecturers involving the theory course assistants
c) Lecturer or team of lecturers by involving practicum course assistants
d) Supervisor and field supervisor for KMM

e) Supervisor and examiner for Thesis/Final Project

5. Assessment Reporting

The assessment report contains the learning experiences assessed, with scores on a scale of 100, and then the total score is calculated using an agreed formula. The final score on a scale of 100 is then converted using a reference.

Table 4. Grade Conversion

Scale (S)	Figures	Lettering
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. Judicium

Judgement is given through KHS by the Academic Advisor (PA) at the end of each semester. The continuity of students to follow the learning process is determinedby evaluations every two years and four years. It has been explained above that the judicium for each course taken per semester for each student is given by the PA at the end of each semester. For judicium before student graduation, it is held at least once pergraduation period depending on needs.

7. Student Graduation

Students are declared to have graduated from S1 Mathematics if they have taken the entire learning load set and have the graduate learning outcomes targeted by the study programme with a cumulative grade point average (GPA) greater than or equal to 2.00 (two point zero zero) and no subjects that are not passed. Graduation in the undergraduate programme is given a predicate:

a) students are declared to have graduated with a satisfactory predicate if they achieve a GPA of 2.76 (two point seven six) to 3.0 (three point zero); or
b) students are declared to have graduated with a very satisfying predicate if they achieve a GPA of 3.01 (three point zero one) up to 3.50 (three point five zero.)
c) students are declared to have graduated with a very satisfactory predicate if they achieve a GPA greater than 3.50 (three point five zero) with a study period of more than 4 (four) years or 8 (eight) semesters.
d) Undergraduate students are declared to have graduated with honours (cum laude) if they achieve a GPA of greater than 3.50 (three point five zero) and with a study period not exceeding the limit of 4 (four) years or 8 (eight) semesters.
e) students with a GPA of less than 2.76 are declared to have graduated without honours.

7. Quality Assurance System

Referring to Law No. 20 of 2003 concerning the National Education System, *Higher Education Long Term Strategy* (HELTS) 2003-1010, and Government Regulation No. 19 of

2005 concerning National Education Standards, the implementation of quality assurance in higher education is a mandatory activity.

The quality assurance system of higher education institutions (HEIs) is carried out on the basis of Internal Quality Assurance (PMI), External Quality Assurance (PME), and Study-Based Programme Evaluation.

Self Evaluation (EPSBED). The Study Programme has made quality assurance efforts, thisis indicated by the preparation of several Standard Operating Procedures (POS). Quality management by implementing this POS has been carried out periodically not only on the curriculum and teaching and learning process, but also on TA.

Curriculum evaluation in the form of curriculum review in the past five years has changed once, namely in mid-2011 by implementing the Competency-Based Curriculum (KBK). The implementation of the KBK is a follow-up to the user's desire for mathematics graduates to be able to apply their knowledge and be competent in their fields.

Furthermore, by considering: (1) referring to the UNS Rector Regulation Number 528/UN27/HK/2016 concerning the Implementation and Management of Undergraduate Education at Sebelas Maret University that study programmes should immediately reconstruct their curriculum in accordance with the Indonesian National Qualifications Framework (KKNI) and the National Higher Education Standards (SN-DIKTI) and the characteristics of the study programme concerned (Article 2, Paragraphs 2 and 3), (2) the opening of a new study programme, Statistics, which was originally a field of concentration in the mathematics study programme, the mathematics study programme adjusted itself by reconstructing a new curriculum, the 2015 curriculum.

Evaluation of the teaching and learning process through learning questionnaires has also been carried out routinely at the end of each semester. This monitoring system was initially manual by distributing questionnaires to students at the end of the lecture or at the end of the semester exam. Starting in 2007 the monitoring system has been *on line* through SIAKAD and filling out the questionnaire is a prerequisite for the final grade of the course.

Evaluation of the thesis preparation system by students has also been carried out with the formation of the Final Project Preparation POS. Furthermore, at the end of the semester, the study programme quality assurance team evaluates the learning index score for lecturers as a result of the questionnaire, the semester index score of lecturers obtained from the average value of the results of all courses taught by each lecturer and the presentation of lecturer attendance in lectures during one semester. The evaluation results are reported to thestudy programme and the study programme follows up by disseminating the learning results to lecturers and students. In addition, the results of quality assurance are also submitted during internal evaluation monitoring from the university.

9. Graduate Profile and Learning Outcomes

Graduates of the Mathematics Study Programme are expected to have a career as researchers, experts, educators, public servants, leaders or entrepreneurs based on science/mathematics. The profile and description of the graduate profile are presented in the following table.

Table 5. Graduate Profile

Graduate Profile	**Graduate Profile Description**
Researcher	Mathematics graduates who have the ability to implement scientific principles in research and communicate the results. in accordance with academic ethics and norms.
Expert	Bachelor of mathematics who has the ability to implement the scientific principles of mathematics in a particular technical field.
Educator	Mathematics graduates who have the ability to *transfer knowledge* in formal, informal and non-formal education.
Public Servant	Bachelor of mathematics who has job independence in other fields of mathematics and science.
Leaders or Employers	Bachelor of mathematics who has managerial and human resource development skills, especially in the field of science.

10. MBKM

The implementation of the independent learning programme means that students are free to take courses outside the study programme on campus or take courses outside the campus, either in the same or different study programmes, or also in industry. Merdeka Learning Independent Campus (MBKM) activities referring to the UNS Rector Regulation No. 31 of 2020 are: Student Exchange, Student Internship / Practical Work, Teaching Assistants in Education units, Research / Research, Humanitarian Social Activities, Entrepreneurial Activities, Independent Studies / Projects, Building villages / thematic real work campuses, Military training, and other forms stipulated by the Rector's Regulation.

11. Mathematics Study Programme Curriculum

In order to prepare graduates who can work well in the industrial world, the determination of courses refers to the 2020 Merdeka Learning Campus and (MBKM) curriculum guidelines. For students outside the Mathematics Study Program of FMIPA UNSwho are interested in taking courses in the Mathematics Study Program of FMIPA UNS as one of their MBKM programmes, they can refer to the page https://math.mipa.uns.ac.id/kampus-merdeka-merdeka-learn/.

To accommodate students' interest in conducting final project research, Mathematics Study Programme offers students to choose the field of interest in accordance with the research groups in Mathematics Study Programme, namely *Combinatorial Mathematics, Mathematical Soft Computing, Pure Mathematics and Application, and Applied and Mathematical Analysis*. The introduction of this field of interest is socialised to early-level students so that students can choose courses that are in accordance with the interests / research topics that will be carried out for the final project.

The following is a list of courses offered in the Mathematics Study Programme, Faculty of Mathematics and Natural Sciences:

Table 6. Required Courses

No.	Course Code	Course Name	Course Name *(English)*	SKS	Course Code Prerequisite Courses	Prerequisite Courses
First Semester						
1.	MAT310201	English	*English*	2		
2.	MAT310202	General Biology	*General Biology*	2		
3.	MAT310203	Basic Physics	*Basic Physic*	2		
4.	MAT310204	Basic Chemistry	*Basic Chemistry*	2		
5.	MAT310205	Matrices and Spaces Vector	*Matrix and Vector Space*	2		

No.	Course Code	Course Name	Course Name *(English)*	SKS	Course Code Prerequisite Courses	Prerequisite Courses
6.	MAT310306	Differential Calculus	*Differential Calculus*	3		
7.	MAT310307	Maths Logic and Sets	*Mathematical Logic and Sets*	3		
8.	MAT310308	Exploratory Data Analysis	*Explorative Data Analysis*	3		
		Subtotal credits		**19**		
Second Semester						
1.	MAT320201	Religious Education	*Religion*	2		
2.	MAT320202	Educ. Citizenship	*Civic Education*	2		
3.	MAT320203	Bahasa Indonesia	*Indonesian Language*	2		
4.	MAT320304	Integral Calculus	*Integral Calculus*	3		
5.	MAT320305	Analytical Geometry	*Analytical Geometry*	3		
6.	MAT320306	Linear Algebra	*Linear Algebra*	3		
7.	MAT320307	Statistical Analysis	*Statistical Analysis*	3		
8.	MAT320308	Basic Algorithms and Programming with Python	*Basic Programming and Algorithms with Python*	3		
9	MAT330201	Pancasila	*Pancasila*	2		
		Subtotal credits		**23**		
Third Semester						
1.	MAT330202	Introduction to Graph Theory	*Introduction to Graph Theory*	2		
2.	MAT330303	Introduction to Numerical Mathematics	*Introduction to Numerical Mathematics*	3		
3.	MAT330304	Multivariable Calculus	*Multivariate Calculus*	3		
4.	MAT330205	Introduction to Special Functions	*Introduction to Special Functions*	2		
5.	MAT330306	Theory and Calculation of Chance	*The Theory and Calculation of Probability*	3		
6	MAT330307	Ordinary Differential Equations	*Ordinary Differential Equation*	3		
7.	MAT330308	Advanced Programming with Python	*Advance Programming with Python*	3		
		Subtotal credits		**19**		
IV Semester						
1.	MAT341201	Research Methodology and Scientific Writing in Mathematics	*Research Method and Mathematical Scientific Writing*	2	MAT320203	Bahasa Indonesia
2.	MAT340302	Numerical Maths	*Numerical Mathematics*	3	MAT330303	Introduction Numerical Maths
3.	MAT340303	Maths Statistics	*Mathematical Statistics*	3	MAT330306	Theory and Calculate Odds,

No.	Course Code	Course Name	Course Name *(English)*	SKS	Course Code Prerequisite Courses	Prerequisite Courses
					MAT330304	Variable Calculus Many
4.	MAT340204	Group Theory	*Group Theory*	2	MAT310307	Mathematical Logic and The set
5.	MAT340305	Complex Functions	*Complex Functions*	3	MAT330304	Multivariable Calculus
6.	MAT340306	Deterministic Operations Research	*Deterministic Operation Research*	3	MAT310306 MAT320306	Differential Calculus, Linear Algebra
7.	MAT340307	Boundary Condition Problem	*Boundary Condition Problems*	3	MAT330307	Ordinary Differential Equations
Subtotal credits				**19**		
V Semester						
1.	MAT351202	Entrepreneurship	*Entrepreneurship*	2		
2.	MAT351203	Introduction to Discrete Mathematics	*Introduction to Discrete Mathematics*	2	MAT330202	Introduction to Graph Theory
3.	MAT351204	Introduction to Stochastic Processes	*Introduction to Stochastic Processes*	2	MAT340303	Maths Statistics
4.	MAT351305	Simulation Technique	*Simulation Techniques*	3	MAT330308	Programming Continue with Python
5.	MAT351306	Ring Theory	*Ring Theory*	3	MAT340204	Group Theory
6.	MAT351307	Real Analysis I	*Real Analysis I*	3	MAT310306 MAT320304	Differential Calculus, Calculus Integral
Subtotal credits				**15**		
VI Semester						
1.	MAT361201	Student Internship Activities *)	*Student Internship Activity*	2	MAT351203	Research Methodology and Scientific Writing Maths
Subtotal credits				**2**		
VII Semester						
1.	MAT370201	Community Service Course*)	*Community Service Programme*	2		*already 110 credits
Number of credits				**2**		
Semester VIII						
1.	MAT380601	Final Project *)	Thesis	6		
Subtotal credits				**6**		
Total number of credits				**107**		

Description:

***)** Student Internship, Community Service and Final Project courses are offered in both semesters (odd/even), provided that the minimum number of credits is met.

Directed Elective Courses

Table 7. List of Directed Elective Courses

No.	Course Code	Elective Courses	Elective Courses *(language English)*	SKS	Prerequisite Course Code	Prerequisite Courses
VI Semester						
1.	MAT361202	Discrete Maths	*Discrete Mathematics*	2	MAT340201	Introduction to Maths Discrete
2.	MAT361303	Real Analysis II	*Real Analysis II*	3	MAT351307	Real Analysis I
3.	MAT361204	Epidemiological Modelling	*Epidemiology Modelling*	2	MAT330307	Differential Equation Regular
4.	MAT361205	Mathematical Modelling	*Mathematical Modelling*	2	MAT330307	Differential Equation Regular
5.	MAT361206	Game Theory	*Game Theory*	2	MAT340306	Deterministic Operations Research
Total number of credits				**11**		

Elective Courses

Table 8. List of Elective Courses

No.	Course Code	Elective Courses	Elective Courses *(English)*	SKS	Course Code Prerequisite Courses	Prerequisite Courses
Third Semester						
1.	MAT332201	Set Theory	*Sets Theory*	2	MAT310307	Mathematical Logic and Set
2.	MAT332202	Fuzzy Sets and Logic	*Fuzzy Sets and Fuzzy Logic*	2	MAT310306	Differential Calculus
3.	MAT332203	Artificial Neural Network	*Artificial Neural Network*	2	MAT310306	Calculus Differential
4.	MAT332304	Database Management	*Database Management*	3	MAT310308	Exploratory Data Analysis
5.	MAT332205	Mathematical Communication	*Mathematical Communication*	2		
Subtotal credits				**11**		
IV Semester						
1.	MAT342301	Forecasting Maths	*Forecasting Mathematics*	3	MAT310306	Calculus Differential
2.	MAT342202	Introduction to Control Theory	*Introduction to Control Theory*	2	MAT330307	Differential Equation Regular
3.	MAT342203	Graph Theory	*Graph Theory*	2	MAT330202	Introduction to Graph Theory
4.	MAT342304	Insurance Maths	*Mathematical Insurance*	3	MAT330306	Theory and Calculate Odds
5.	MAT342205	Risk Model	*Risk Model*	2	MAT330306	Theory and Calculation of Chance

6.	MAT342206	Artificial Intelligence	*Artificial Intelligence*	2	MAT330202	The set and Fuzzy Logic
Subtotal credits				**14**		

No.	Course Code	Elective Courses	Elective Courses *(English)*	SKS	Course Code Prerequisite Courses	Prerequisite Courses
V Semester						
1.	MAT352201	Numerical Differential and Integral Equations	*Numerical Differentiation and Integration*	2	MAT330303	Introduction to Maths Numerical
2.	MAT352302	Probabilistic Operations Research	*Probabilistic Operation Research*	2	MAT330306	Theory and Calculation of Chance
3.	MAT352203	Non-linear Programming	*Nonlinear Programming*	2	MAT330303	Introduction to Maths Numerical
4.	MAT352304	Theory of Differential Equations	*Theory of Differential Equations*	3	MAT330307	Differential Equation Regular
5.	MAT352305	Science Data	*Data Science*	3	MAT332304 MAT330308	Database Management, Advanced Programming with Python
Subtotal credits				**12**		
VI Semester						
1.	MAT362201	Numerical Partial Differential Equations	*Numerical Partial Differential Equations*	2	MAT351307	Boundary Condition Problem
2.	MAT362202	Module Theory	*Module Theory*	2	MAT351206	Ring Theory
3.	MAT362303	Introduction to Cryptography and Coding Theory	*Introduction to Cryptography and Coding Theory*	3	MAT320306 MAT351206	Linear Algebra Ring Theory
4.	MAT362204	Linear Algebra Numerical	*Numerical Linear Algebra*	2	MAT320306	Linear Algebra
5.	MAT362205	Technopreneurship	*Technopreneurship*	2	MAT351202	Entrepreneurship
6.	MAT362206	Biometrics	*Biometrics*	2	MAT330307	Programming Continue with Python
Subtotal credits				**13**		
VII Semester						
1.	MAT372301	Fractional Calculus	*Fractional Calculus*	3	MAT330304	Multivariable Calculus
2.	MAT372202	Functional Analysis	*Functional Analysis*	3	MAT361303	Real Analysis II
3.	MAT372203	Linear System	*Linear Systems*	2	MAT342202	Introduction to Control Theory
4.	MAT372204	Integral Theory	*Theory of Integral*	2	MAT361303	Real Analysis II
5.	MAT372205	System Dynamics	*Dynamical System*	2	MAT340204 MAT361303	Group Theory Real Analysis II
6.	MAT372206	Capita Selekta	*Capita Selecta*	2	MAT351203	Research Methodology and Scientific Writing Maths
7.	MAT372207	Bilinear and Multilinear Algebra	*Bilinear and Multilinear Algebra*	2	MAT362202	Module Theory
Subtotal credits				**16**		

Total number of credits		**66**	

COURSE DESCRIPTION

A GENERAL COURSES

1	**Course Content**	:	**English**
	Weight	:	2 CREDITS
	Semester	:	I
	Competency Standard	:	Understand basic mathematical terminology and be able to speak, write, and simple reading in English
	Prerequisites	:	-
	Material	:	Properties and shapes, location, structure, revision, measurement 1, process 1, function and ability, process 2, actions in sequence, revision, measurement 2, quantity, process 3, cause and effect, mea-surement 3, ratio and proportion, revision, measurement 4, frequency, probability, tendency, process 4, method, consolidation.
	Bibliography	:	Hall, D. and T. Bowyer, *Nucleus: English for Science and Technology (Mathe-matics)*, Longman Group Limited, England, 1980.
2	**Course Content**	:	**General Biology**
	Weight	:	2 CREDITS
	Semester	:	I
	Competency Standard	:	Apply biological concepts in problem solving In everyday life.
	Prerequisites	:	-
	Material	:	Principles of Biology, Scientific Method, Glycolysis, Krebs Cycle, Chain Respiration, Mendelian & Molecular Genetics, Basics of Classification, Evolution, Basic Zoology (Diversity, Structure, Embryology, Physiology), Basic Botany (Diversity, Structure, Embryology, Photosynthesis), Basic Microbiology (Diversity, Structure, Physiology), Basic Ecology, Applications of Biology (Fermented Foods, Biotechnology, Genetic Engineering)
	Bibliography	:	[1] Kimbal, J.W., *Biology, i*(translation from *Biology*), Erlangga Publishers, Jakarta, 1998. [2] Purwoko, T, *Microbial Physiology*, Bumi Aksara, Jakarta, 2007 [3] Radiopoetro, *Zoology*, Erlangga Publisher, Jakarta, 1990 [4] Prentis, S., *Biotechnology* (translation of *Biotechnology*), Erlangga Publishers, Jakarta, 1990.
3	**Course Content**	:	**Basic Physics**
	Weight	:	2 CREDITS
	Semester	:	I
	Competency Standard	:	Apply principles about physics and measurement, vibration, waves, fluid mechanics, thermodynamics and geometric optics.
	Prerequisites	:	-
	Material	:	Physics and measurement, vibration or oscillatory motion laws of gravity, waves, fluid mechanics, thermodynamics, optics geometry and interference light waves.
	Bibliography	:	[1] Nolan, Peter J. 1993. *Fundamentals of College Physics*. Melbourne: Wm. C. Brown Publishers. [2] Serway Reymond A. 1986. *Physics for Scientists and engineers with Modern Pysics*, Saunders. [3] Giancoli, Douglas C. 1988. *Physics for Scientists and Engineers*, Prentice. Hall. [4] Ohanian, Hans C. 1989. *Physics*, Norton.
4	**Course Content**	:	**Religious Education**
	Weight	:	2 CREDITS
	Semester	:	II
	Competency Standard	:	To become scientists and professionals who have faith and devotion to God The Almighty, has noble character, work ethic, and upholds the values of humanity and life.
	Prerequisites	:	-
	Material	:	Discusses the definition of religion in various forms, the problem of being and

creator, faith, morals, understanding about religion for disciplines in terms of psychology, science and technology, as well as some legal and social issues.

Bibliography : Religious books

5 Course Content : Civic education

Weight 2 CREDITS
Semester : II
Competency Standards: Able to master knowledge about citizenship and apply it in daily life, have a stable personality; think critically; be rational; have a broad view; and have a democratic attitude that is civilised.
Prerequisites : -
Material : Introduction includes introduction, nation, state, rights and obligations of citizens, human rights, democracy, state defence, insight into the archipelago, national resilience, National Politics and Strategy (Polstranas).
Bibliography : [1] Mudiyo, *Civic Education in Higher Education*, UPT MKU, UNS Press, 2005.
[2] *Collection of Papers at the Training of Civic Education Lecturers in Higher Education*, UPT MKU-UNS on 21 July 2005.
[3] *Collection of State Defence Pentaloka Didodik Courses*, Rindana I Diponegoro Magelang.
[4] Collection of Papers at the MPK Lecturer Seminar at MKU UNS on 20 July 2006.

6 Course Content : Entrepreneurship

Weight 2 CREDITS
Semester : V
Competency Standards: Have an understanding of the nature of entrepreneurship and be able to become an entrepreneur.
Prerequisites : -
Materials : Some terms in entrepreneurship, characteristics of successful entrepreneurs and failed entrepreneurs, urgency of entrepreneurship development and Kwu education and culture, self-recognition analysis, meaning of self-potential, creativity, motivation and communication.
Bibliography : Exploration is tailored to the basic competencies.

7 Subject : Student Internship

Weight 2 CREDITS
Semester : VI
Competency Standard : Introducing the world of work and providing skills and work experience
Prerequisite. Research Methodology and Scientific Writing
Materials Debriefing and working materials from partnerinstitutions or companies
Bibliography: -

8 Course Content FinalProject

Weight 6 CREDITS
Semester : VIII
Competency Standard : Have the ability to think scientifically and write scientific papers.
Prerequisite 110 CREDITS
Material According to the interests of students with the approval of the supervisor. Bibliography : According to the final project material.

B. COURSE PROGRAMME

1Course :Mathematical Logic and Sets

Weight 3 CREDITS
Semester : I
Competency Standards: Think logically and systematically according to mathematical rules. Prerequisites : -
Materials : Mathematical language, universal quantifiers, existential quantifiers, mathematical proof, finite sets, cartesian sets, power sets, relations, functions.
Bibliography : [1]Devlin, K., Sets, Functions and Logic: An Introduction to Abstract

Mathematics, second edition, Chapman and Hill, London, 1992.
[Soehakso, Abstract Algebra, FMIPA UGM, Yogyakarta, 1978.
[Soehakso, Sets, Relations and Functions, FMIPA UGM, Yogyakarta, 1984

2	**Course Content**	**:**	**Linear Algebra**
	Weight	:	2 CREDITS
	Semester	:	I
	Competency Standard	:	Use the concept of linear transformation and the concept of eigenvalue and eigenvector in solving problems.
	Prerequisites	:	-
	Material	:	Orthogoral basis, linear transformation, eigenvalues and eigenvectors.
	Bibliography	:	[1] Anton H., Elementary Linear Algebra, John Wiley and Sons, New York, 1994. [2] Leon, S. J., Linear Algebra and its Applications, (Translation by Alit Bondan), Fifth Edition, PublisherErlangga, Surabaya, 1998. [3] Mathews, J. H., Numerical Methods: For Mathematics, Science, and Engineering, Second Edition, Prentice-Hall International, Inc, London, 1992. [4] Anton H., Elementary Linear Algebra, John Wiley and Sons, New York, 1994. [5] Leon, S. J., Linear Algebra and its Applications, (Translation by Alit Bondan), Fifth Edition, PublisherErlangga, Surabaya, 1998. [6] Mathews, J. H., Numerical Methods: For Mathematics, Science, and Engineering, Second Edition, Prentice-Hall International, Inc, London, 1992. [7] Sigmon K., MATLAB Primer, Third Edition, Department of Mathematics, University of Florida, Gainesville, 1993. [8]_____The Student Edition of MATLABTM, For MS-DOS Personal Computers, Prentice-Hall, Inc, Englewood Cliffs, New Jersey, 1992.
3	**Course Content**	**:**	**Matrices and Vector Spaces**
	Weight	:	2 CREDITS
	Semester	:	I
	Competency Standard	:	Using matrices and determinants, vector space concepts.
	Prerequisites	:	-
	Material	:	Matrices, determinants and systems of linear equations, vector spaces.
	Bibliography	:	[1] Anton H., Elementary Linear Algebra, John Wiley and Sons, New York, 1994. [2] Leon, S. J., Linear Algebra and its Applications, (Translation by Alit Bondan), Fifth Edition, PublisherErlangga, Surabaya, 1998. [3] Mathews, J. H., Numerical Methods: For Mathematics, Science, and Engineering, Second Edition, Prentice-Hall International, Inc, London, 1992. [4] Anton H., Elementary Linear Algebra, John Wiley and Sons, New York, 1994. [5] Leon, S. J., Linear Algebra and its Applications, (Translation by Alit Bondan), Fifth Edition, PublisherErlangga, Surabaya, 1998. [6] Mathews, J. H., Numerical Methods: For Mathematics, Science, and Engineering, Second Edition, Prentice-Hall International, Inc, London, 1992. [7] Sigmon K., MATLAB Primer, Third Edition, Department of Mathematics, University of Florida, Gainesville, 1993. [8]_____The Student Edition of MATLABTM, For MS-DOS Personal Computers, Prentice-Hall, Inc, Englewood Cliffs, New Jersey, 1992.
4	**Course Content**	**:**	**Differential Calculus**
	Weight	:	3 CREDITS
	Semester	:	I
	Competency Standard	:	Explain concepts, definitions, theorems, and use them to solve problems about number systems, limits, derivatives, and theorems. draw graphs of functions.
	Prerequisites	:	-
	Material	:	Number system, absolute values, inequalities, functions and their graphs, limits of functions, derivatives, applications of derivatives to curvature, l'hospital's rule, indeterminate forms, extremes of a function and series, application of extremes, maxima and ninima.

	Bibliography	:	[1] Purcell, E.J. and D. Valberg, Calculus and Analytical Geometry, (Translated by I Nyoman Susila, Bana Karta Sasmita and Rawuh), Edition. Fourth, Erlangga Publishers, Jakarta, 1989. [2] Martono, K., Calculus, Third Edition, Bandung Institute of Technology, Bandung, 1992. [3] Muslich, Mathematics I, First Edition, UNS Press, Surakarta, 1989.
5	**Course Content**	**:**	**Exploratory Data Analysis**
	Weight	:	3 CREDITS
	Semester	:	I
	Competency Standard	:	Summarise a cohort in the form of tally and bar and leaf charts, calculate the numerical summary of a cohort and use it to draw box and dot charts and calculate standardisation, determine the appropriate transformation of a generation, calculate regression estimates in an exploratory manner.
	Prerequisites	:	-
	Material	:	Compiling numbers, generation, bar and leaf diagrams, numerical summaries, centre of generation, median, data distribution, use of numerical summaries, box and dot diagrams, standardisation, generation transformation, transformations logarithms, selecting superior transformations, exploratory regression analysis, straightening. Bibliography:
	Bibliography	:	[Sri Haryatmi, Statistical Data Analysis, UT, 1986. [Erickson and Nosanchuk, (Translation: Sembiring and Manase Malo), LP3ES, 1987.
6	**Course Content**	**:**	**Statistical Analysis**
	Weight	:	3 CREDITS
	Semester	:	II
	Competency Standard	:	Describe, analyse data with SPSS, make interpretations, apply in fieldwork descriptive statistics, probability and inference statistics and write fieldwork reports. Group.
	Prerequisites	:	-
	Material	:	Introduction, descriptive statistics, introduction to probability, random variables, probability distribution, normal distribution, inference statistics: estimation and testing hypothesis for one and two populations.
	Bibliography	:	[1] Bhattachryya, G. K., R.A. Johnson, Statistical Concepts and Methods, John Wiley and Sons, Inc, New York, 1977. [2] Freund, J., Modern Elementary Statistics, Prentice-Hall, 1979. [3] Practicum Module, SPSS Program Package.
7	**Course Content**	**:**	**Integral Calculus**
	Weight	:	3 CREDITS
	Semester	:	II
	Competency Standard	:	Explain concepts, definitions, theorems, and use them to solve problems solve problems on indefinite integrals, definite integrals, and their applications.
	Prerequisites	:	-
	Material	:	Indefinite integrals, definite integrals, application of definite integrals.
	Bibliography	:	[1] Purcell, E.J. and D. Valberg, Calculus and Analytic Geometry, Fourth Edition, (Translation by I Nyoman Susila, Bana Karta Sasmita, and others). Rawuh), Erlangga Publisher, Jakarta, 1989. [2] Martono, K., Calculus, Third Edition, Bandung Institute of Technology, Bandung, 1992. [3] Muslich, Mathematics I, First Edition, UNS Press, Surakarta, 1989.
8	**Course Content**	**:**	**Analytical Geometry**
	Weight	:	3 CREDITS
	Semester	:	II
	Competency Standard	:	Use coordinate systems on the plane and in space in solving problems. problems, constructing and using line equations and plane equations in space, equations of circles and spheres, and intersection equations

			cones in problem solving, simplify and use the general equation of second degree in problem solving, construct and use the equation of the area of a circle and the area of second degree in problem solving. problem solving.
	Prerequisites	:	-
	Material	:	Coordinate system, vectors, line and plane, circle and sphere, intersection cones, generalised second-degree equations, e l l i p s o i d s , hyperboloids and paraboloids.
	Bibliography	:	[1] Purcell E. J., D. Varberg, E. R. Steven, Calculus and Analytical GeometryVolume 2, Edition Eighth Edition, (Translation byJulian Gressando), 2003. [Sharma G.S., IJS Sarna, Engineering Mathematics, Second Edition, 1982. [3] Douglas, F. R., Analytic Geometry, 1992.
9	**Course Content**	**:**	**Basic Algorithms and Programming with Python**
	Weight	:	3 CREDITS
	Semester	:	II
	Competency Standard	:	Analyse, determine or create algorithms and flowcharts to solve a problem and be able to implement them. algorithm and flowchart in the Python programming language.
	Prerequisites	:	-
	Material	:	Algorithms and flowcharts, Pascal programme structure, input and output statements, condition statements, looping statements, procedures and functions, types data, pascal environment.
	Bibliography	:	[1] Abdul Kadir, *Turbo Pascal Programming*, Elex Media Komputindo, Jakarta, 1992. [2] Alwin Sanjaya, *Quickly Mastering Pascal Language*, IlmuKomputer.com, 2004. [Behforooz. A. and O. H. Martin, *Problem Solving And Structured Programming With Pasca*, Brooks Cole Publishing Company, 1986. [4] Insap Santoso, *Basics of Pascal Programming, Theory and Applied Programmes*, Publisher Andi Offset, Yogyakarta, 1987.
10	**Course Content**	**:**	**Fuzzy Sets and Logic**
	Weight	:	2 CREDITS
	Semester	:	III
	Competency Standard	:	able to apply fuzzy sets and logic in everyday life namely for clustering, inference, forecasting and industrial fields
	Prerequisites	:	Maths logic and Sets
	Material	:	Fundamentals of fuzzy sets, fuzzy set relations, fuzzy operators and applications of fuzzy logic using methods in fuzziness inference, fuzzy C mean clustering and fuzzy control
	Bibliography	:	[1] H.-J. Zimmermann, 2001, "Fuzzy Set Theory- and Its Applications", Kluwer Academic Publisher, LLC, New York, Fourt Edition.
11	**Course Content**		**Artificial Neural Network**
	Weight		2 CREDITS
	Semester		III
	Competency Standard		Understand the theory of artificial neural networks, more specifically: Principles and basic structure of JST, Adaptive Linear Neuron (Adaline), Many Adaline (Madaline), Back Propagation learning procedure, as well as simulation for the JST. some specific case studies.
	Prerequisites		
	Material		History of artificial neural networks (ANN), Principles and basic structure of ANN, Perceptron, Back Propagation
	Bibliography		[1] Daniel Graupe. Principle of Artificial Neural Networks. World Scientific. 2007. [2] Sebastian Raschka and Vahid Mirjalili. Python Machine Learning. Packt Publishing. 2017.
12	**Course Content**	**:**	**Theory and Calculation of Chance**
	Weight	:	3 CREDITS
	Semester	:	III

Competency Standard	:	Formulate and use probability models derived from

a phenomenon.

Prerequisites : -

Material : Introduction, notation and matters related to probability, definition of probability, some properties of probability, conditional probability, counting techniques, discrete random variables, continuous random variables, properties of expectation prices, moment generating functions, distributionsof discrete random variables, distributions of continuous random variables, location parameters and scale parameters, joint distribution of discrete random variables and variables
continuous random, independent random variables, conditional distribution.

Bibliography : [1] Bain, L, J Engelhard. M, Introduction to Probability and Mathematical Statistics 2nd, Duxbury press, 1991.
[2] Ross, S., A First Course in Probability, 2nd ed. Mac Millan, New York, 1984.
[3] Hogg and Craig, Introduction to Mathematical Statistics, Mac Millan, 1978.

13 Course Content : Ordinary Differential Equations

Weight : 3 CREDITS

Semester : III

Competency Standard : Solve mathematical problems related to ordinary differential equations Ordinary and apply transformation Laplace transformation in solving ordinary differential equations

Prerequisites :

Material : First order differential equations of degree one, exact differential equations, second order linear differential equations with constant coefficients, equations first-order differential equations of degree -, simultaneous differential equations, Laplace transform.

Bibliography : [1] De Barra G., Measure Theory and Integrations, Ellis Harwood Ltd., London, 1981.
[2] Rudin W., Principles of Mathematical Analysis, Third Edition, Mc Graw-Hill International Book Company, Singapore, 1976.
[3] Royden H.L., Real Analysis, Second Edition, Mac Millan Publishing Co. Inc, New York, 1968.

14 Course Content : Introduction to Numerical Mathematics

Weight : 3 CREDITS

Semester : III

Competency Standard : Determine the solution of nonlinear equations, ordinary differential equations, systems of li-near equations, and determine function approximation using numerical techniques and understand the importance of error analysis.

Prerequisites : -

Material : Errors in numerical calculations, solving nonlinear equations,
solving ordinary differential equations, solving systems of linear equations, and function approximation.

Bibliography : [1] B. F. Plybon, An Introduction to Applied Numerical Analysis, PWS Kent, Boston, 1992.
[2] K. Atkinson, An Elementary Numerical Analysis, John Wiley & Sons, New York, 1985.
[3] R. L. May, Numerical Methods For Engineers and Scientists, Royal Melbourne Institute of Technology Ltd., Melbourne, 1997.
[4] W. F. Blyth, Analysis of Numerical Methods, Royal Melbourne Institute of Technology Ltd., Melbourne, 1993.
[5] P. Widyaningsih, Practical Numerical Methods, Department of Mathematics, FMIPA UNS, Surakarta, 2006.

15 Course Content : Set Theory

Weight : 2 CREDITS

Semester : III

Competency Standard : Can explain the definition of an infinite set and its properties, and calculate its cardinality.

Prerequisites : Maths Logic and Sets

Material : Definition of relation and its types: reflexive, non-reflexive, irreflexive,

			symmetric, non symmetric, symmetric, transitive, non transitive, intransitive, equivalence, relation as a set: complement, relation between sets, properties of relation, notion of function and its types, inverse of function, specialfunctions, set function and inverse of set function, properties of set function and its inverse, properties of composition (multiplication) of function, notion of infinite set: infinite set, non inductive set, equivalence of two sets, denumerable, non denumerable, countable sets and their properties, cardinality: Aleph Null, Aleph, relation between cardinal numbers, theorem Schroder-Bernstein, Cantor's theorem
	Bibliography	:	[1] Devlin, K., Sets, Functions and Logic: An Introduction to Abstract Mathematics, 2nd. ed., Chapman & Hall, London, 1992. [Kamke, E., Theory of Sets, Dover Publications Inc, New York, 1950. [3] Soehakso, R.J.T., Abstract Algebra, Section of Pasti Science FMIPA UGM, Jogjakarta, 1978.
16	**Course Content**	**:**	**Mathematical Statistics**
	Weight	:	3 CREDITS
	Semester	:	IV
	Competency Standard	:	Constructing and apply limits distribution, statistics and deriving sampling distribution, point estimation, sufficient and complete statistics, interval estimation and the concept of hypothesis testing.
	Prerequisites	:	Theory and Calculation of Chance, Multivariable Calculus
	Material	:	Limit distribution, statistics and sampling distribution, point estimation, sufficient statistics and complete, interval estimation, interval estimation, hypothesis testing.
	Bibliography	:	[1] Bain, L. J and Engelhardt, M., Introduction to Probability and Mathematical Statistics, 1992.
17	**Course Content**	**:**	**Multivariable Calculus**
	Weight	:	3 CREDITS
	Semester	:	IV
	Competency Standard	:	Apply the derivative of functions of several variables, the fold integral and vector calculus.
	Prerequisites	:	-
	Material	:	Multivariable functions, limits and continuity, partial derivatives, tangent planes, chain rule, directional derivatives and gradient vectors, maximum and minimum values, Lagrange multipliers, twofold integrals on rectangles, recurrent integrals, twofold integrals in general regions, recurrent integrals in polar coordinates, application of twofold integrals, surface area, threefold integrals, threefold integrals in cylindrical and spherical coordinates, substitution of variables in a fold integral, vector fields, line integrals, fundamental theorems for the twofold integral. line integral, Green's theorem, Curl and divergence, surface integral, Stokes Theorem, Divergence Theorem
	Bibliography	:	[1] James Stewart. (2003). Calculus. Fourth Edition. (translation: I Nyoman Susila and Hendra Gunawan), Erlangga, Jakarta. [Leitold, L. (1991). Calculus and Analytical Measurement Science. Fifth Edition, Volume 3. (translation: S.M. Nababan), Erlangga, Jakarta. [3] Purcell, E.J Varberg, D. (2003). Calculus and Analytical Geometry. Eighth Edition. (translation: I Nyoman Susila, Bana Kartasasmita and Rawuh), Erlangga, Jakarta.
18	**Course Content**	**:**	**Group Theory**
	Weight	:	2 CREDITS
	Semester	:	IV
	Competency Standard	:	Know the definitions of groups, subgroups with their properties, prove related theorems, construct the development of groups with two operations, define arenas, integral regions and fields, recognises its properties, identifies homomorphisms in algebras.
	Prerequisites	:	Maths Logic and Sets
	Material	:	Groups and subgroups, cyclical groups, cosets, normal subgroups and quotient groups, group homomorphisms, algebras, integral regions, fields, quotient theorems and ideals, quotient algebras, algebra homomorphisms and fundamental theory

			homomorphisms of the arena.
	Bibliography	:	[1] Fraileigh, J. B., A First Course In Abstract Algebra, fifth edition, Addison... Wesley Publishing Company, Inc, New York, 1994. [2] Gallian A, J., Contemporary Abstract Álgebra, second edition, D.C. Heath and Company, Toronto, 1990. [3] Herstain, I.N, Topics in Álgebra, John Wiley & Sons, New York, 1975. [4] Nurul Muchlisah, Algebra I, Department of Mathematics FMIPA UNS Surakarta, 2005. [5] Nurul Muchlisah, Algebra II, Department of Mathematics FMIPA UNS Surakarta, 2005.
19	**Course Content**	**:**	**Introduction to Graph Theory**
	Weight	:	2 CREDITS
	Semester	:	IV
	Competency Standard	:	Apply basic concepts of graph theory to represent world problems for real.
	Prerequisites	:	-
	Material	:	Non mathematical models, mathematical models, graphs, graphs as mathematical models, the degree of a vertex, isomorphic graphs, connected graphs, cut vertices, degree sequence, The Konigsberg Bridge problem : an introduction to Eulerian graphs, the salesman's problem : an introduction to Hamiltonian graphs, party problems.
	Bibliography	:	[1] Chartrand, G., Introductory Graph Theory, Dover Publications, Inc, New York. York, 1977. [2] Chartran, G. and Lesniak, L., Graphs and Digraphs, Wadsworth & Associates, Inc. Brooks, Pacific Grove, California, 1986. [3] Gross, J. and Yellen, J., Graph Theory and Its Application, CRC Press, New York, 1999.
20	**Course Content**	**:**	**Numerical Maths**
	Weight	:	3 CREDITS
	Semester	:	IV
	Competency Standard	:	Solve nonlinear equations, systems of nonlinear equations and numerical approximation of functions and data.
	Prerequisites	:	Introduction to Numerical Mathematics
	Material	:	Newton's algorithm, sequential algorithm, synthetic division algorithm with linear divisor, synthetic division algorithm with quadratic divisor, quadratic factorisation by simple iteration, Bairstow's method, Hermite interpolation, Hermite polynomials & Newton's divided difference, least squares approximation, continuous case, orthogonal polynomials, minimax approximation, near approximation Minimax, Chebyshev economisation.
	Bibliography	:	[1] B. F. Plybon, An Introduction to Applied Numerical Analysis, PWS Kent, Boston, 1992. [2] W. F. Blyth, Analysis of Numerical Methods, RMIT Ltd, Melbourne, 1993. [3] K. Atkinson, An Introduction to Numerical Analysis, John Wiley, New York. York, 1978. [4] L. May, Approximation and Quadrature, RMIT Ltd, Melbourne, 1991. [5] P. Widyaningsih, Practical Numerical Analysis I, Department of Mathematics FMIPA UNS, Surakarta, 2005.
21	**Course Content**	**:**	**Complex Functions**
	Weight	:	3 CREDITS
	Semester	:	IV
	Competency Standard	:	Know and use complex numbers, analytic functions, simple functions, complex integrals, and construct power series, residues, and poles to solve the problem.
	Prerequisites	:	Multivariable Calculus
	Material	:	Complex numbers, analytic functions, simple functions, complex integrals, power series, residues and poles.

Bibliography	:	[1] Marsden, J.E. and Hoffman, M.J., Basic Complex Analysis, W. H. Freeman Company, New York, 1987.

[2] Spiegel, M.R., Theory and Problems of Complex Variables, Mc Graw-Hill, Inc. 1964.
[3] Sumantri, R., Complex Variable Functions.
[4] Wunsch, A.D., Complex Variables with Applications, Addison-Wesley Publishing Company, Inc, New York, 1994.

22	**Course Content**	**:**	**Introduction to Control Theory**
	Weight	:	2 CREDITS
	Semester	:	IV
	Competency Standard	:	Students can understand the effect of control on the system and analyse its stability.
	Prerequisites	:	Ordinary Differential Equations
	Material	:	Introduction to control, Laplace transform, transfer function, block diagram, control first and second order, basic control principles, stability analysis.
	Bibliography	:	[1] Gopal, M., Control System Principles and Design Second Edition, Mc Graw Hill Co, Singapore, 2002. [2] Ogata, K., Automatic Control Techniques, Erlangga, Surabaya, 1997
23	**Course Content**	**:**	**Non-linear Programming**
	Weight	:	2 CREDITS
	Semester	:	V
	Competency Standard	:	Solve optimisation problems for objective function or constraint function is non-linear
	Prerequisites	:	Introduction to Numerical Mathematics
	Material	:	Definition of non-linear programming (PTL) problems and its place in operations research (OR) problems, Modelling of PTL problems: examples for function optimisation problems without constraints, examples for function optimisation problems with constraints, Supporting theory: unimodal functions, convex/convex functions and their properties, relative/absolute minimum/maximum, Methods of investigation: Fibonacci method, Golden Mean (Golden Section/Ratio) method, Approximation methods: DSC method, quadratic approximation method via 3 equidistant/unequidistant points, Newtonian method.., supporting theory: gradient vector, Hess matrix, positive/negative definite/semi-definite matrix, convex/convex functions, properties of convex functions, relative/absolute minimum, direct investigation method: univariate method (one at a time), gradient methods: steepest descent method, Newton method, Fletcher-Reeves method, supporting theory: optimality criteria, farcas lemma, Kuhn-Tucker condition, Lagrange function, problems with linear inequality constraints: Kuhn-Tucker conditions, fisible direction method, problems with linear equality constraints: Lagrange multiplier method.
	Bibliography	:	[1] Adby, P.R. and Dempster, M.A.H. 1974. Introduction to Optimisation Methods. Chapman and Hall Ltd., London. [2] Gray, J.W. 1994. Mastering Mathematica: Programming Methods and Applications. 2nd. Ed. Academic Press, San Diego. [3] Rao, S.S. 1984. Optimisation: Theory & Applications. John Wiley & Sons, New York. [4] Salzborn, F.J.M. 1995. Optimisation Lecture Notes. The University of Adelaide, Adelaide.
24	**Course Content**	**:**	**Real Analysis I**
	Weight	:	3 CREDITS
	Semester	:	V
	Competency Standard	:	Apply the real number system, convergence of real number series, continuity and derivative of functions.
	Prerequisites	:	Differential Calculus, Integral Calculus
	Material	:	Algebraic properties of R, order properties of R, absolute value properties, supremum and infimum, convergence of a line, limit theorem of a line, convergence of a monotone line, Bolzano-Weierstrass theorem, Cauchy line, true divergent line, limit of a function, line criterion for limit of a function, limit theorem of a function, Continuous function, line criterion for a function function continuity, combination of continuous functions, continuous functions on intervals, uniformly continuous, monotone functions, function derivatives, Rolle's theorem, theorem of

			mean value, L'Hospital's rule, Taylor's theorem.
	Bibliography	:	[1] Bartle, R.G and Sherbert, D.R., Introduction to Real Analysis, John Wiley & Sons, Inc. Singapore, 1992. [2] Bartle, R.G., The Elements of Real Analysis. John Wiley & Sons, Inc, Singapore, 1976. [3] Parzynski, W.R and Zipse, P.W., Introduction to Mathematical Analysis,. Mc Graw-Hill International Editions, Singapore, 1987. [4] Apostol, T.M., Mathematical Analysis. Second Edition. Addison-Wesley Publishing Company, California, 1974.
25	**Course Content**	**:**	**Introduction to Discrete Mathematics**
	Weight	:	2 CREDITS
	Semester	:	V
	Competency Standard	:	Apply calculation methods and recurrence relations in elementary graph theory.
	Prerequisites	:	Introduction to Graph Theory
	Material	:	Multiplication and addition principle, permutations and combinations, binomial coefficients and combinatorial identities, pigeonhole principle, path and cycle, shortest-path algorithm (Dijkstra's algorithm), graph isomorphism, planar graph (Kuratowski's theorem, Euler's formula, dual graph), instant insanity puzzle, tree.
	Bibliography	:	[1] Richard Johnsonbaugh, Discrete Mathematics, Second Edition, Mac Millan Publishing Company, New York, 1990. [Susanna S. Epp, Discrete Mathematics with Applications, Second Edition, PWS Publishing Company, Boston, 1995.
26	**Course Content**	**:**	**Boundary Condition Problem**
	Weight	:	3 CREDITS
	Semester	:	V
	Competency Standard	:	Applying orthogonal function systems in problem solving and solving boundary conditions in ordinary differential equations.
	Prerequisites	:	Ordinary Differential Equations
	Material	:	Systems of orthogonal functions, boundary condition problems in ordinary differential equations, introduction to partial differential equations, linear and quasi-linear first order partial differential equations, linear and quasi-linear second order partial differential equations, linear higher order partial differential equations by separation of variables method, heat equation, wave equation, Sturm Liouville boundary condition problem.
	Bibliography	:	[1] Bambang Sudiyono, Mathematical Physics, FMIPA UGM, 1970. [2] Boyce Di Prima, Elementary Differential Equations and Boundary Value Problems, John Wiley, New York, 1986. [3] Finizio, Ladas, Ordinary Differential Equations, (Widiarti Translation). Santoso), Erlangga, Jakarta, 1982. [4] Ross, S.L., Dfferential Equations, John Wiley, New York, 1984.
27	**Course Content**	**:**	**Ring Theory**
	Weight	:	3 CREDITS
	Semester	:	V
	Competency Standard	:	Analyse problems about algebras and their properties by proving related theorems and applying them to real problems, analyse problems about ideals, coefficient algebras and prove related theorems, analyse problems about ideals in DIU and DFT and prove theorems. Related.
	Prerequisites	:	Group Theory
	Material	:	Algebras and types of algebras, subalgebras, integral regions, fields,mappings Homo-morphisms of algebras, quotient fields, ideals and quotient algebras, basic theory of algebraic homomorphisms, prime ideals and maximal ideals, polynomial algebras, roots of an upper polynomial field, evaluation homomorphisms, division algorithms for polynomials, ideals in DIU and DFT, relationship of DIU and DFT.
	Bibliography	:	[1] Enrlich G., Foundamental Concept of abstact Algebra, PWS-KENT

			Publishing Company, Boston, 1991. [2] Fraileigh J.B., A First Course In Abstract Algebra, fifth edition, Addison. Wesley Publishing Company, Inc, New York, 1994. [3] Gallian A.J., Contenporary Abstract Algebra, Second Edition, D.C. Heath and Company, Toronto, 1990.
28	**Course Content**	**:**	**Graph Theory**
	Weight	:	2 CREDITS
	Semester	:	V
	Competency Standard	:	Able to explain the concepts: digraph, metric dimension and magic graph, and understand the application of graph theory in real life problems.
	Prerequisites	:	Introduction to Graph Theory
	Material	:	Digraph, eccentric digraph, metric dimension, planar graph, colouring, Magic Graph.
	Bibliography	:	[1] Chartrand, G., Introductory Graph Theory, Dover Publications, Inc. York, 1977. [2] Chartran, G. and Lesniak, L., Graphs and Digraphs, Wadsworth & Associates, Inc. Brooks, Pacific Grove, California, 1986. [3] Bondy, J.A. and Murty, U.S.R., Graph Theory with Applications, The Mac Milliam Press, Ltd., New York, 1976.
29	**Course Content**	**:**	**Theory of Differential Equations**
	Weight	:	2 CREDITS
	Semester	:	V
	Competency Standard	:	Students can apply theorem existence theorem and existence theorem and singularity of solution, and the theory of differential equations both linear and equations non-linear differential in problem solving.
	Prerequisites	:	Ordinary Differential Equations
	Material	:	Existence and singularity of solutions, theory of linear differential equations, non-linear differential equations.
	Bibliography	:	[1] Ross, S.L., Dfferential Equations, John Wiley, New York, 1984. [Ricard E. Williamson, Introduction to Differential Equations and Dynamics Systems, The Mcgraw-Hill Companies, Inc, 1996. [Robert L Borrelli and Courtney S. Coleman, Differential Equations A Modelling Perspective, John Wiley, New York, 1996.
30	**Course Content**	**:**	**Introduction to Stochastic Processes**
	Weight	:	3 CREDITS
	Semester	:	V
	Competency Standard	:	Applying a stochastic process approach, specifically Markov chains, the process of Poisson, continuous-time stochastic processes, and birth and death processes, to solve problems.
	Prerequisites	:	Mathematical Statistics
	Material	:	Definition of stochastic process, Markov chain, Poisson process, stochastic process continuous time, the birth process.
	Bibliography	:	[1] Howard M. Taylor & Samuel Karlin, An Introduction to Stochastic Modelling, Academic Press Inc, California, 1994. [2] Roe Goodman, Introduction to Stochastic Models, The Benjamin/Cummings Pub. Company, Inc, California, 1988.
31	**Course Content**	**:**	**Forecasting Maths**
	Weight	:	3 CREDITS
	Semester	:	V
	Competency Standard	:	Recognise and apply statistical concepts for forecasting.
	Prerequisites	:	Differential Calculus
	Material	:	Meaning and benefits of forecasting, regression method in forecasting, moving average method, exponential smoothing method, smoothing method direct, some models for seasonal data, interval prediction.
	Bibliography	:	[1] Makridakis & Whellwright, Forecasting Time Series in Management Science Vol. 12, Amsterdam North, Holland, 1979. [2] Untung S.A., Forecasting Methods and Applications, 1992.

[3] Djauhari, M., Subject Matter of Forecasting Methods, UT, Depdikbud, 1986.

32 Course Content : Numerical Linear Algebra

	Weight	:	2 CREDITS
	Semester	:	VI
	Competency Standard	:	Solve systems of linear equations numerically.
	Prerequisites	:	Linear Algebra
	Material	:	Direct methods, pivoting and scaling strategies, vector and matrix norms, ill-conditioning, residual correction methods, solving techniques iterative, convergence rate, and comparison of the methods.
	Bibliography	:	[1] Atkinson, K. E., An Introduction to Numerical Analysis, Wiley & Sons, New York, 1978. [2] May, R. L., Numerical Linear Algebra, RMIT Ltd., Melbourne, 1992. [3] Plybon, B. F., An Introduction to Applied Numerical Analysis, PWS Kent, Boston, 1992.
33	**Course Content**	**:**	**Insurance Maths**
	Weight	:	3 CREDITS
	Semester	:	VI
	Competency Standard	:	Know and construct mathematical models for insurance.
	Prerequisites	:	Theory and Calculation of Chance
	Material	:	The role of maths in the field of insurance, value calculations and Mathematical formulations for utility functions, individual risk models, survival distributions for life insurance, annuities and premiums.
	Bibliography	:	[1] Bowers, Jr. N.L., Gerber, H.U., Hickman, J.C., Jones, D.A., and Nesbitt, C. J., Actuarial Mathematics, The Society of Actuaries, Schaumburg, Illionis, 1997.
34	**Course Content**	**:**	**Introduction to Cryptography and Coding Theory**
	Weight	:	3 CREDITS
	Semester	:	VI
	Competency Standard	:	Able to explain the principles of communication systems, coding theory, and cryptography, able to reconstruct several types of coding systems and cryptography. simple cryptographic system
	Prerequisites	:	Linear Algebra, Ring Theory
	Material	:	Communication systems, linear codes, types and properties of codes, types of crypto systems, simulation of coding systems and cryptography.
	Bibliography	:	[1] Richard A. Mollin, An Introduction to Cryptography, Chapman & Hall/CRC, 2007 [2] W.Cary Huffman & Vera Pless, Fundamentals of Error Correcting Codes, Campbridge, 2003
35	**Course Content**	**:**	**Real Analysis II**
	Weight	:	3 CREDITS
	Semester	:	VI
	Competency Standard	:	Apply Riemann integrals, function series and metric spaces.
	Prerequisites	:	Real Analysis I
	Material	:	Riemann integrals, Riemann criterion for integrality, properties of Riemann integrals, fundamental theorems, integral calculus as limits, convergence of function series, uniform convergence, exchange of limits with calculus properties, definition and examples of neighbourhood metric spaces, interior points, limit points, isolated points, boundary points, sets: open, closed, perfect, closure, compact, Heine-Borel theorem, rows of points in spaces metric, Cauchy line and completeness, global continuity theorem.
	Bibliography	:	[1] Apostol, T.M., Mathematical Analysis, Second Edition, Addison-Wesley Publishing Company, California, 1974. [2] Bartle, R.G. and Sherbert, D.R., Introduction to Real Analysis, John Wiley & Sons, Inc. Singapore, 1992. [Bartle, R.G., The Elements of Real Analysis, John Wiley & Sons, Inc, Singapore, 1976. [4] Bruckner et al., Real Analysis, Prentice-Hall Inc, New Jersey, 1997. [5] Parzynski, W.R. and Zipse, P.W., Introduction to Mathematical Analysis, Mc Graw-Hill International Editions, Singapore, 1987.
36	**Course Content**	**:**	**Discrete Maths**

	Weight	:	2 CREDITS
	Semester	:	VI
	Competency Standard	:	Apply graph theory concepts to MST and Matching, construct a circuit design with boolean expression, apply mathematical induction to prove mathematical theories and number systems. round, apply the inclusion, exclusion and calculation principles, and apply the generating function.
	Prerequisites	:	Introduction to Discrete Mathematics
	Material	:	MST, prim algorithm, Dijkstra's algorithm, bipartite graph, matching, matching in bipartite graph, Hungarian algorithm to find matching, black boxes and gates, the boolean expression corres-ponding to a circuit, the circuit corresponding to a boolean expression, finding a circuit that corresponds to a given input/output table, simplifying combina-torial circuits, the system of integers, the principle of inclusion and exclusion, generating functions.
	Bibliography	:	[1] Bondy, J.A. and Murty, U.S.R., Graph Theory with Applications, The Macmilliam Press Ltd., New York, 1976. [2] Richard Johnsonbaugh, Discrete Mathematics, Second Edition, MacMillan Publishing Company, New York, 1990. [3] Susanna S. Epp., Discrete Mathematics with Applications, Second Edition, PWS Publishing Company, Boston, 1995. [4] Grimaldi, R.P. Discrete and Combinatorial Mathematics, An Applied Introduction, Addison Wesley Publishing Company, Indiana, 1987.
37	**Course Content**	**:**	**Mathematical Modelling**
	Weight	:	2 CREDITS
	Semester	:	VI
	Competency Standard	:	Compile model mathematical model from a problem, then solve and interpret them in real problems.
	Prerequisites	:	Ordinary Differential Equations
	Material	:	Introduction to mathematical modelling, mathematical models in physics, mathematical models in biology, and modelling real-world problems.
	Bibliography	:	[1] Clements, D., Mathematical Modelling, A Case Study Approach, Cambridge University Press, Cambridge, 1989. [Haberman, R., Mathematical Models: Mechanical Vibrations, Population Dynamics, and Traffic Flow, Pretice Hall, Inc, New Jersey, 1977. [3] Heck, A., Introduction to Maple, Springer-Verlag, Inc, New York, 1993.
38	**Course Content**	**:**	**Numerical Partial Differential Equations**
	Weight	:	2 CREDITS
	Semester	:	VI
	Competency Standard	:	Solve partial differential equations numerically.
	Prerequisites	:	Boundary Condition Problem
	Material	:	Direct methods, pivoting and scaling strategies, vector and matrix norms, ill-conditioning, residual correction methods, solving techniques iterative, convergence rate, and comparison of the methods.
	Bibliography	:	[1] Asmar, N. H., Partial Differential Equations and Boundary Value Problems, Prentice Hall Inc, New Jersey, 2000. [2] Smith, G. D., Numerical Solution of Partial Differential Equations: Finite Difference Methods, Claredon Press, New York, 1978. [3] Yu, Ernest, Numerical Solution of Partial Differential Equations, RMIT Ltd., Melbourne, 1989.
39	**Course Content**	**:**	**Module Theory**
	Weight	:	2 CREDITS
	Semester	:	VI
	Competency Standard	:	Students can build module structure and prove the properties of nature.
	Prerequisites	:	Ring Theory
	Material	:	Modules and submodules, Factor Modules and Module isomorphism theorem, Torsion modules, Direct Sums, Exact rows, Free modules, Projective modules
	Bibliography	:	[1] Adkins, W. A., and S. H. Weintraub, 1992, Algebra an Approach via Module Theory, Springer-Verlag, New York.

[2] Hartley, B., T.O., Hawkes, 1994, Rings, Modules and Linear Algebra, Chapman and Hall, London.

40	**Course Content**	**:**	**Probabilistic Operations Research**
	Weight	:	2 CREDITS
	Semester	:	VII
	Competency Standard	:	Searching for the optimal solution of a zero sum game model, some queuing models, markov analysis and probabilistic dynamic programming models.
	Prerequisites	:	Introduction to Stochastic Processes
	Material	:	Zero sum game theory concepts for two parties or n parties, queuing theory concepts, Markov analysis, probabilistic dynamic programming.
	Bibliography	:	[1] Bronson, R., Theory and Problems of Operations Research, (Edj. Hans J. Wospakrik), Erlangga Publishers, Jakarta, 1988. [2] Hillier and Lieberman, Introduction to Operations Research, Mc Graw-Hill Pub. Co., New York, 1990. [3] N. Soemartojo, Operational Research I, Karunika UT Publisher, Jakarta, 1989. [4] Taha, H.A., Operation Research, MacMillan Publishing Co., New York, 1987.
41	**Course Content**	**:**	**Functional Analysis**
	Weight	:	3 CREDITS
	Semester	:	VII
	Competency Standard	:	Apply the concepts of normed spaces, inner product spaces and linear functionals to practical problems.
	Prerequisites	:	Real Analysis II
	Material	:	Vector spaces, normed spaces/Banach spaces, properties of normed spaces, continuous and finite linear operators, Linear functionals, linear operators and functionals on finite-dimensional spaces, dual spaces, inner product spaces/Hilbert spaces, properties of inner product spaces, orthogonal complements and direct sums, orthonormal sets and rows, functional representations on Hilbert spaces, adjoin and self-adjoit operators, spectral theory in finite-dimensional spaces, basic concepts of spectral theory on Hilbert spaces. norm, spectral properties of finite linear operators, spectrum and resolvent properties.
	Bibliography	:	[1] Kreyszig, E., Introductory Functional Analysis with Applications, John Wiley & Sons, Inc. Singapore, 1978. [2] Conway, J.B., A Course in Functional Analysis, Springer-Verlag, New York, 1990. [3] Hutson, V and Pym, J.S., Applications of Functional Analysis and Operator Theory, Academic Press, London, 1980. [4] Berberian, S.K., Introduction to HilbertSpace, Oxford University Press, New York, 1961.
42	**Course Content**	**:**	**Integral Theory**
	Weight	:	2 CREDITS
	Semester	:	VII
	Competency Standard	:	Develop the concepts of descriptive integral, constructive integral, prove the properties of Henstok integral and prove the convergence theorem.
	Prerequisites	:	Real Analysis II
	Material	:	Definition of Newton integral, properties of Newton integral, definition of J integral, properties of J integral, strong derivative, definition of Z Integral, properties of Z integral, definition of Riemann integral, properties of Riemann Integral, fundamental theorem of δ-partitioning fine, definition of Henstock integral, properties of Henstock integral, convergence theorem.
	Bibliography	:	[1] Gordon R,A., The Integrals of Lebesgue, Denjoy, Perron and Henstock, Graduate Studies in Mathematics, American Mathematical Society, USA, 1994. [2] Lee Peng Yee, Lanzhou Lectures on Henstock Integration, World Scientific Publishing, Singapore, 1989. [3] Ralp Henstok, Lectures on The Theory of Integration, World Scientific Publishing, Singapore, 1988.

43	**Course Content**	**:**	**Linear System**
	Weight	:	2 CREDITS
	Semester	:	VII
	Competency Standard	:	Identify some properties of linear systems through their properties.
	Prerequisites	:	Introduction to Control Theory
	Material	:	Linear system models, linearisation, solution of systems of linear differential equations, impulse and step responses, properties of linear systems: controllability, observability. vability, and stability
	Bibliography	:	[1] Kailath, T., Linear Systems, Prentice Hall Inc, London, 1980 [2] Olsder, G. J., Mathematical System Theory, Delftse Uitgevers, Maatschappij b.v., Delft, 1994.
44	**Course Content**	**:**	**System Dynamics**
	Weight	:	2 CREDITS
	Semester	:	VII
	Competency Standard	:	Analyse the behaviour of discrete dynamical systems and chaos phenomena for simple functions.
	Prerequisites	:	Group Theory, Real Analysis II
	Material	:	Definition of dynamical systems, discrete dynamical systems, Examples of dynamical systems: finance, ecology, determining the root number, Orbits: definition, types, Graphical analysis: graphical analysis, orbit analysis, phase portrait, Bifurcation, Family of quadratic functions, Itinerary, The Sequence Space, The Shift Map, Conjugation, Itinerary, The Sequence Space, The Shift Map, Conjugation, Properties of chaotic systems, Examples of chaotic systems, Properties of chaotic systems, Examples of chaotic systems.
	Bibliography	:	[1] Devaney, Robert, L. 1992. A First Course in Chaotic Dynamical Systems. Addison-Wesley Publishing Company, Inc, Massachusetts.
45	**Course Content**	**:**	**Capita Selekta**
	Weight	:	2 CREDITS
	Semester	:	VII
	Competency Standard	:	-
	Prerequisites	:	Research Methodology and Scientific Writing
	Material	:	Specific topics in mathematics that are relatively new or a deepening of a special topic of a course that has been given previously
	Bibliography	:	It depends on the topic chosen.

STAFF BIODATA
Permanent Lecturers, Professional Lecturers, Practitioner Lecturers, Overseas Lecturers and Educational Staff - Academic
Department of Mathematics, Faculty of Mathematics and Natural Sciences, Sebelas Maret University Surakarta

No.	Name	Address	Education History
A	**PERMANENT FACULTY**		
1	Dra. PURNAMI WIDYANINGSIH, M.App.Sc. NIP. 196208151987032003	Ngabean RT 03/06 Margorejo Village, Tempel Sub-district, Sleman Regency,Yogyakarta Province Kampung Petoran RT 03/IX No 39 Jebres, Surakarta57126	S1 UGM; S2 RMIT Melbourne Australia
2	Dr DIARI INDRIATI, M.Si. NIP. 196101121988112001	Jl. Kutilang 129 Perum Dosen UNS Triyagan Mojolaban, Sukoharjo. Tel.0271-827870/ 081548507220	S1 UGM; S2 UGM
3	Prof. TRI ATMOJO KUSMAYADI, M.Sc., Ph.D. NIP. 196308261988031002	Jl. Wijayakusuma 25 B Kelurahan Kauman, Laweyan Sub-district, Surakarta City. Tel.0271-661534/ 08156747800	S1 UGM; S2 & S3 Curtin University Of Technology Australia
4	Drs. PANGADI, M.Si.	District Colomadu, Karanganyar Regency	S1 UGM, S2 ITB
5	Drs. SANTOSO BUDI WIYONO, M.Si. NIP. 196202031991031001	Gendingan Urban Village RT 02/16 Jebres Sub-district City Surakarta	S1 UNRI PEKANBARU; S2 UGM
6	Dr SISWANTO, M.Si. NIP. 196708131992031002	Jongkang RT 4/5 Buran Village, Tasikmadu Subdistrict, Karanganyar Regency. Tel. 081548507199	S1 FMIPA UGM, S2 PPS UGM, S3 UGM
7	Dr SUTRIMA, M.Si. NIP. 196610071993021001	Jongkang RT 4/5 Buran Village, Tasikmadu Subdistrict, Karanganyar Regency. Tel. 081329342384	S1 UNS; S2 UGM
8	SUPRIYADI WIBOWO, M.Si NIP. 196811101995121001	Plososkerep No.133 RT.03/XI Keecamatan Jaten Karanganyar Regency. Tel. 081329278295	S1 UNS; S2 UGM
9	Dr SUTANTO, DEA. NIP. 197103021996031001	Jl. Angsana 14 Jaten Permai Karanganyar Regency Telp. 08562819147	S1 UNS; Master's and doctoral degrees in France

10	Dr DEWI RETNO SARI S., M.Kom. NIP. 197007201997022001	Jl. Mawar I/63 Perumnas Palur, Jaten District, Karanganyar Regency.	S1 UNS, S2 UGM, S3 IPB

No.	Name	Address	Education History
		Tel.0271-825587/08122624401	
11	TITIN SRI MARTINI, M.Kom. NIP. 197501202008122001	Perum Gebang Permai G-1 Wedomartani Yogyakarta Tel. 085643705060	S1 UNS, S2 UGM
12	BOWO WINARNO, M.Kom. NIP. 198104302008121001	Tegalterik RT.04/01 Trangsan Village, Gatak Subdistrict, SukoharjoRegency. Tel. 0856 4232 4474	S1 UNS, S2 UGM
13	NUGHTHOH ARFAWI KURDHI, M.Sc. Ph.D. NIP. 198507172010121003	Jl. Sawi No. 8 Pulisen Boyolali Kabupatem	S1 UNS, S2 UGM, S3 TUE (NL),
14	Dr PUTRANTO HADI UTOMO, M.Si. NIP. 198609072012121002	Jongkang, Buran, Tasikmadu, Karanganyar Tel. 08561184844	BACH ELOR IPB, S2 IPB, S3 TUE (NL)
15	VIKA YUGI KURNIAWAN, M.Sc. NIP. 198707012015041001	Pajang, Kec.Laweyan Surakarta Tel. 08562528707	S1 UNS, S2 UGM
16	RIRIN SETIYOWATI, M.Sc. NIP. 198909242020122003	District Jogonalan,Klaten Regency. Tel. 085228391724	S1 UNS, S2 UGM
B.	**Professional Lecturer**		
1	Drs. MUSLICH, M.Si	Karanganyar Regency	S1 UGM, S2 ITB
2	ADE SUSANTI, M.Si.	Special Region of Yogyakarta	S1 UNS, S2 ITB
C.	**Practitioner Lecturer / Overseas Lecturer**		
1	Prof. ZAILAN BIN SIRI, Ph.D.	Universiti Malaya (UM)	S1 Universiti Malaya S2 Universiti Putra Malaysia S3 Universiti Kebangsaan Malaysia
2	Dr ASLINA BAHARUN, M.Sc., Ph.D.	Universiti Malaysia Sabah (UMS)	S1 Universiti Malaysia Sabah S3 Universiti Teknologi MARA S3 Universiti Kebangsaan Malaysia
3	PAIMAN, S.Si	Director of PT Dobel Network International	S1 UNS
D.	**Academic Administration Staff**		

1	PURWO EDI MINARNO, S.Pd	Kalangsari village, Rengasdengklok sub-district, Kab. Karawang Tel. 082134536766	S1 UNS