COURSE CONTENT

Master of Soil Science

(Based on the 2020 Curriculum)

DEPARTMENT OF SOIL SCIENCE AND LAND RESOURCE
IPB UNIVERSITY

2024

Contents

Remarks:

SEMESTER 1

TNH1511: Soil Geography

A. Module identity

1	Course Name	Soil Geography
2	Course Code	TNH1511
3	Credit	2(2-0)
4	Semester	1
5	Pre-requisite	-
6	Coordinator	Dr. Ir. Dyah Tjahyandari Suryaningtyas, MApplSc.
7	Lecturers	Prof. Dr. Ir. Budi Mulyanto, MSc.; Dr. Ir. Darmawan, MSc.
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: Master of Soil Science (MSS)
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			
2		2						2

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To describe the relationship between soil distribution and characteristics and their utilization in Indonesia.
2. To utilise soil geography in surveys, land evaluation and land use planning.
3. To establish inventory of soil characteristics according to their geographical location.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to recognize soil types and their characteristics in relation to the general agricultural cultivation patterns in Indonesia.	Direct learning and discussion	Examination

2.	Students are able to understand the role of parent materials on soil characteristics.	Direct learning and discussion	Examination
3.	Students are able to understand the role of climate on soil characteristics.	Direct learning and discussion	Examination
4.	Students are able to understand the relationship between regional shape and land slope.	Direct learning and discussion	Examination
5.	Students are able to distinguish mainlands in Indonesia, recognize its characteristics, and understand their distribution in Indonesia.	Direct learning and discussion	Examination
6.	Students are able to explain geological units, parent materials and soil types	Presentation and discussion	Examination
7.	Students are able to differentiate soils, soil classifications and soil maps.	Direct learning and discussion	Examination
8.	Students are able to identify land spatial data throughout Indonesia.	Direct learning and discussion	Assignment/Project; Examination
9.	Students are able to pinpoint the characteristics and land physiography distribution in lowlands, hills and volcans.	Direct learning and discussion	Assignment/Project; Examination
10.	Students are able to characterize peat and organosols/histosol soils and their distribution, as well as identify the use of peat land in Indonesia.	Direct learning and discussion	Assignment/Project; Examination

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction: land and cultural distribution in Indonesia	2	**4**
Soil Forming Factors: Climate	1	**2**
Soil Forming Factors: Topography	2	**4**
Geology, Climate and Soil	2	**4**
Distribution of Parent Material – Soil Type	2	**4**
Soil Individuals, Classifications, and Maps	2	**4**
Land Spatial Data Throughout Indonesia	1	**2**
Physiography of soils in lowlands, hills and volcans	1	**2**
Peat and Organosol/Histosol: Prospects and Challenges	1	**2**

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

1	Mid-term examination	Week 8	40%
2	Final examination	Week 16	40%
3	Assignments		20%

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Bohn, H.L., B.L. McNeal, and G.A. O'Connor. 2001. Soil chemistry 3rd Edition. John Wiley and Sons
2. Tan, K.H. 2008. Soil in The Humic Tropics and Monsoon Region of Indonesia. CRC Press
3. Tan, K.H. 2011. Principles of Soil Chemistry 4th Edition. CRC Press

Journal articles:

a) Ponnamperuma, F.N. 1972. The chemistry of submerged soils. Adv. Agron., 24: 29–96
b) Selected articles (to be adapted in yearly basis)

Others:

- Brady, M.A. 1997. Dynamics of Coastal Peat Deposits in Sumatra, Indonesia. Dissertation. The University of British Columbia
- Fisher, W.L., Brown Jr., L.F., Scott, A.J., McGowen, J.H. 1969. Delta Systems in The Explanation for Oil and Gas. Bureau of Economic Geology, The University of Texas at Austin. Austin, Texas
- Melling, L. Joo, G.K, Uyo, L.J. Sayok, A. Hatano, R. 2007. Biophysical CharacterisUcs of Tropical Peatland. Malaysian Soil Science Conference. Mukah, Sarawak
- Mohr, E.C.J. 1938. The Soils of Equatorial Regions with Special Reference to The Netherlands East Indies. Ann Arbor, Michigan
- Paramananthan, S., 1998. Malaysian Soil Taxonomy - Second Approximation. Mal. Soc. Soil Science and Param Agriculture Soil Surveys (M) Sdn. Bhd., Serdang, Selangor

TNH1521: Advanced Soil Agro-Eco Chemistry

A. Module identity

1	Course Name	Advanced Soil Agro-Eco Chemistry
2	Course Code	TNH1521
3	Credit	2(2-0)
4	Semester	1
5	Pre-requisite	-
6	Coordinator	Dr. Ir. Untung Sudadi, MSc.
7	Lecturers	Prof. Dr. Ir. Arief Hartono, MScAgr.; Dr. Ir. Syaiful Anwar, MSc.
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			
2		2						2

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain the chemical properties of soil and its correlation with the soils' mineralogical, physical and biological properties and how it affects soil chemical fertility and the environment.
2. To explain the factors that influence the temporal and spatial dynamics of soil chemical properties.
3. To explain amelioration and fertilization processes and how it influences soil chemical properties dynamics.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to demonstrate the importance of developing ideas and instrumentation in soil chemistry, the concepts and definitions of Agro – Eco soil chemistry and basic principles of soil chemistry.	Lecture and discussion	Examination
2.	Students are able to evaluate the composition and electrochemical potential of soil.	Lecture and discussion	Examination; Assignment

3.	Students are able to evaluate solid, gas and liquid phases of soils.	Lecture and discussion	Examination
4.	Students are able to describe soil reaction and mineral stability curves.	Lecture and discussion	Examination
5.	Students are able to explain organic soil colloids.	Lecture and discussion	Examination; Assignment
6.	Students are able to describe inorganic soil colloids.	Lecture and discussion	Examination
7.	Students are able to define soil solution.	Lecture and discussion	Examination
8.	Students are able to explain soil cation and anion exchange reactions.	Lecture and discussion	Examination; Assignment
9.	Students are able to characterize soil ion absorption – release reaction.	Lecture and discussion	Examination
10.	Students are able to evaluate soil sequestration reaction	Lecture and discussion	Examination; Assignment
11.	Students are able to describe the chemical kinetics of soil/sediment - water systems.	Lecture and discussion	Examination
12.	Students are able to explain the chemical reactions occurring during soil formation process.	Lecture and discussion	Examination
13.	Students are able to define chemical interactions between soil, organic matter, and soil contaminants.	Lecture and discussion	Examination

E. Module contents

Topic	Number of Week(s)	Contact Hours
Innovation and Instrument Evolution in Soil Chemistry; Concepts and Definitions of Agro – Eco Soil Chemistry; Basic Principles of Soil Chemistry: Review	1	**2**
Soil Electrochemical Properties, Composition, Potentials, Factors and Dynamics	1	**2**
Solid, Gas, Solution Phases of Soil	1	**2**
Soil Reaction; pH and Soil Mineral Stability to Weathering Curve	1	**2**
Organic Soil Colloids	1	**2**
Inorganic Soil Colloids, Soil – Clay Colloid (Constant charge – isomorphic substitution reactions and pH – dependent charge – protonation – deprotonation reactions), XRD graphs of Amorphous or Para crystalline and Microcrystalline Soil	1	**2**
Soil – Clay Colloid Surface Chemistry (Outer sphere, Inner sphere, precipitation, Co – precipitation, Occlusion) and determining factors	1	**2**
Soil Solution Chemistry (Minerals, Salts)	1	**2**
Soil Cation – Anion Exchange Reaction	1	**2**

Ion Sorption – Desorption Reaction in Soil	1	**2**
Non-Specific Adsorption Reaction (Electrostatic), Specific Adsorption Reactions (Chemisorption, Ligand Exchange)	1	**2**
Soil/Sediment - Water Reaction Kinetics; Chemical Equilibrium, Kinetics and Thermodynamics of Soil Chemical Reactions; Rate Laws	1	**2**
Soil Mineral Weathering, Chemical Reaction Rate during Soil Formation	1	**2**
Complex and Chelation Reactions; Soil – Organic Compound Interactions; Organic – Metal Complex Reactions; Organic – Clay Complex Compounds; Metal Chelate Stability Diagram; Complex Formation, Soil Fertility and Clay Mobility	1	**2**

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1	Mid Term Examination	Week 7	35%
2.	Final Examination	Week 14	35%
3.	Journal Review		30%

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Tan, K.H. 2011. Principles of Soil Chemistry 4th Edition. CRC Press. USA
2. Evangelou V.P. 1998. Environmental Soil and Water Chemistry: Principles and Applications. John Wiley & Sons, Inc
3. Conklin Jr., A.R. 2014. Introduction to Soil Chemistry: Analysis and Instrumentation. 2nd Edition. John Wiley and Sons, Inc
4. Bleam W. 2017. Soil and Environmental Chemistry. 2nd Edition. Elsevier

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1631: Advanced Soil Physics

A. Module identity

1	Course Name	Advanced Soil Physics
2	Course Code	TNH1631
3	Credit	3(3-0)
4	Semester	2
5	Pre-requisite	-
6	Coordinator	Dr. Ir. Dwi Putro Tejo Baskoro, MSc.
7	Lecturers	Dr. Ir. Enni Dwi Wahjunie, MSi, Dr. Ir. Latif Mahir Rahman, MSc
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			
3		3						3

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To understand and master the principles of soil physics and be able to integrate these principles in sustainable soil and water resource management.
2. To analyse and solve land resource management problems using principles of soil physics.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to explain and develop the concept and scope of soil physics to solve agricultural problems.	Lecture and Case Study	Question and Answer
2.	Students are able to define groundwater, water potential, hydraulic conductance, Darcy's equation, and Laplace's equation.	Lecture and Case Study	Question and Answer
3.	Students are able to describe the concept of groundwater movement,	Lecture and Case Study	Question and Answer

	both saturated and unsaturated, and expand its application		
4.	Students are able to recognize and apply groundwater movement modelling.	Lecture and Case Study	Question and Answer
5.	Students are able to demonstrate their understanding in internal redistribution, water movement profile in soil, internal hysteresis and internal redistribution.	Lecture and Case Study	Question and Answer
6.	Students are able to describe water uptake by plant roots and its models, hydraulic properties of plant roots, and water movement in plants.	Lecture and Case Study	Question and Answer
7.	Students are able to explain and improve gas and heat movement concepts in soil.	Lecture and Case Study	Question and Answer
8.	Students are knowledgeable and be able to expand the concepts of ground surface and underground water evaporation as well as salinization.	Lecture and Case Study	Question and Answer
9.	Students are able to explain soil compaction, soil consolidation and soil strength.	Lecture and Case Study	Question and Answer
10.	Students are able to describe and refine the following concepts: drainage, changes in soil physical properties, and wetland soils physical behaviour.	Lecture and Case Study	Question and Answer
11.	Students are able to explain salt balance.	Lecture and Case Study	Quiz
12.	Students are able to define and develop the concepts of water and energy balance around plants	Lecture and Case Study	Question and Answer
13.	Students are able to formulate and resolve issues related to solute transport.	Lecture and Case Study	Project Report
14.	Students are able to explain the concept of spatial variation in soil physical properties.	Lecture and Case Study	Project Report, Project Presentation, Discussion

E. Module contents

Topic	Number of Week(s)	Contact Hours
Scope of Soil Physics and the Relationship between Soil Physics and Agricultural Problems	1	**3**

Groundwater: Water Potential and Groundwater composition; Hydraulic Conductance; Darcy's equation; Laplace's equation	1	**3**
Groundwater movement; Saturated and unsaturated conditions and their applications	1	**3**
Modelling Water Movement in Soil	1	**3**
Internal redistribution and drainage; Water Movement Profile in Soil; Hysteresis in internal redistribution	1	**3**
Water Uptake by Plant Roots; Hydraulic Properties of Plant Roots; Water Movement in Plants; Water Uptake Models	1	**3**
Gas and Heat Movement in Soil	1	**3**
Land Surface and Underground Water Evaporation; Salinization	1	**3**
Soil Compaction, Consolidation Strength	1	**3**
Drainage; Changes in Soil Physical Properties; Wetland Soil Physical Behaviour	1	**3**
Soil Salt Balance	1	**3**
Water and Energy Balance around Plants	1	**3**
Solute Transport: Solute Conservation Equation, Convection-Dispersion Equation, Solute Transport using Transfer Function Model	1	**3**
Spatial Variation Analysis in Soil Physical Properties	1	**3**

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		
2.	Final Examination		
3.	Assignment		
4.	Report		

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Baver, L.D., Gardner, W.H., and Gardner, W. R. 1972. Soil Physics. John Wiley & Sons, Inc
2. Hanks, R. J., and Ashcroft, G.L. 1986. Applied Soil Physics. Springer Verlag
3. Hillel, D. 1971. Soil and Water Physical Principle and Processes. Academic Press
4. Hillel, D. 1980. Fundamental of Soil Physics. Academic Press
5. Jury, W.A., Gardner, W.R., and Gardner, W. H. 2001. Soil Physics. 5th edition. John Wiley & Sons, Inc
6. Koorevaar, P., Menelik, G., and Dirksen, C. 1983. Elements of Soil Physics. Elsevier
7. Hillel, D. 1998. Environmental of Soil Physics. Academic Press

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1641: Advanced Soil Biology

A. Module identity

1	Course Name	Advanced Soil Biology
2	Course Code	TNH1641
3	Credit	3(2-1)
4	Semester	1
5	Pre-requisite	-
6	Coordinator	Dr. Rahayu Widyastuti, MSc
7	Lecturers	Prof. Dr. Ir. Dwi Andreas Santosa, MS; Dr. Ir. Gunawan Djajakirana, MSc
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			
		2*14*50' =1400'						

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain and classify the anatomy and living requirements of soil organism.
2. To describe the carbon cycle through other processes such as mineralization, immobilization, emission, transformation and translocation in the form of BOT.
3. To define N cycle (symbiotic – non-symbiotic fixation, ammonification, nitrification and denitrification) and other nutrients (secondary macro and micro) generated through mineralization, immobilization, loss, transformation, and translocation.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand the taxonomy and special classification of bacteria according to its function	Lecture, class discussion, practicum	Test, Report

	and habitat (aerobic-anaerobic; cellulolytic, lignolytic, proteolytic, autotroph-heterotroph), as well as their role in C and N cycles.		
2.	Students are able to classify fungi and actinomycetes, and describe special classification according to function (cellulolytic, lignolytic, proteolytic), fungal-plant symbiosis (mycorrhiza)	Lecture, class discussion, practicum	Test, Report
3.	Students are able to understand the taxonomy of Protozoa and algae and classify them according to their function (predator, parasite) and symbiotic relationship of algae with certain plants (BGA - Azola), Lichen	Lecture, class discussion, practicum	Test, Report
4.	Students are able to understand the role of microbial biomass, the difference between population and biomass, procedures for determining population and biomass using various method	Lecture, class discussion, practicum	Test, Report
5.	Students are able to recognize diverse soil microbes (cosmopolitan, true climax and marginal species), succession, interactions between microbes, interactions between microbes and meso or macrofauna.	Lecture, class discussion, practicum	Test, Report
6.	Students are able to understand the importance of C cycle, Photosynthesis-respiration, short cycle, long cycle, local cycle, global cycle, the organisms involved, C compounds that sustain life (hexoses: aldose, ketose, glucose, mannose, galactose, fructose, pentose}	Lecture, class discussion, practicum	Test, Report
7.	Students are able to understand the reasons for the N cycle, symbiotic-non-symbiotic fixation, nitrification, denitrification, short cycles, long cycles, local cycles, global cycles, the organisms involved, the composition of N compounds that are important for plants, the cycle P, K, mineralization, immobilization, washing	Lecture, class discussion, practicum	Test, Report

8.	Students are able to understand the life of earthworms, their living conditions, anatomy, reproductive system, taxonomy, benefits.	Lecture, class discussion, practicum, video	Test, Report
9.	Students are able to understand the life of ants and termites, their living conditions, food, caste structure, anatomy, taxonomy and role	Lecture, class discussion, practicum, video	Test, Report
10.	Students are able to understand the macro life of other arthropods (isopods, Diplopods, chilopod and arachnids), their living conditions, food, anatomy, taxonomy and role	Lecture, class discussion, practicum	Test, Report
11.	Students are able to understand the micro life of arthropods (springtail, Acari), the conditions its life, food, anatomy, taxonomy and role	Lecture, class discussion, practicum	Test, Report

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction	1	
Bacteria	1	
Fungi and Actinomycetes	1	
Protozoa and Algae	1	
Microbial Density in Soil	1	
Soil Microbial Community	1	
Carbon Cycle	1	
Nitrogen Cycle and Other Nutrients	1	
Earthworms	1	
Termites and Ants	1	
Soil Macrofauna	1	
Soil Mesofauna	2	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		30%
2.	Final Examination		30%
3.	Practicum		30%
4.	Assignment		10%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Alexander, M. 1977. Introduction to Soil Microbiology. John Wiley and Sons
2. Bardgett, R.D., Usher, M.B., and Hopkins, D.W. 2005. Biological Diversity and Function in Soil. Cambridge University Press
3. Borror, D.J., Triplehorn, C.A., and Johnson, N.F. 1989. An introduction to the Study of Insects. Saunders College Publisher
4. Dindal, D.L. 1990. Soil Biology Guide. John Wiley and Sons
5. Fenchel, T. and Blackburn, T.H. 1979. Bacteria and Mineral Cycling. Academic Press
6. Minnich, J. 1977. The Earthworm Books: How to Raise and Use Earthworms for Your Farm and Gardens. Rodale Press
7. Mukerji, K.G., Manoharachary C., and Singh, J. 2006. Microbial Activity in the Rhizosphere. Springer
8. Paul, E.A. and Clark, F.E. 1989. Soil Microbiology and Biochemistry. Academic Press
9. Rao, N. S. 2007. Mikroorganisme Tanah dan Pertumbuhan Tanaman. UI Press
10. Schinner, F., Öhlinger, R., Kandeler, E., and Margesin, R. 1996. Methods in Soil Biology. Springer-Verlag
11. Suhardjono, Y.R., Deharveng, L, and Bedos, A. 2012. Collembola (Ekor Pegas). Vegamedia
12. Sumawinata, B., Djajakirana, G., Suwardi, and Darmawan. 2014. Carbon Dynamic in Tropical Peatland Planted Forests: One Year Research Finding in Sumatra. IPB Press

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

- Wikipedia: The Carbon Cycle
- Earthworm dissection: hjps://youtu.be/FzAN9ErE6E8
- Darwin's Earthworms: hjps://youtu.be/nKeJj_aXeTw
- Reproductive System of Earthworm 512 1: hjps://youtu.be/J_f55aO_cu0
- Nutrient cycles - AQA A Level Biology + Exam Questions Run Through: hjps://youtu.be/5wx5P9Y1tRI
- Nitrogen Cycle: A level biology AQA. Saprobionts, nitrogen-fixing, ammonification & nitrification: hjps://youtu.be/2ifo_UXJnS8
- Facts About Ants - Secret Nature | Ant Documentary | Natural History Channel: hjps://youtu.be/tBQD0Zghwg8

TNH1602: Land Resource Management

A. Module identity

1	Course Name	Land Resource Management
2	Course Code	TNH1602
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	

8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A	Knowledge	1. Discourse 2. Videos 3. Discussion	1. quiz scores 2. Midterm scores: 10 Multiple choice questions

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

•

SEMESTER 2

TNH1601: Research Methodology

A. Module identity

1	Course Name	Research Methodology
2	Course Code	TNH1601
3	Credit	3(3-0)
4	Semester	2
5	Pre-requisite	
6	Coordinator	Dr. Ir. Darmawan, MSc.
7	Lecturers	Dr. Ir. Iskandar; Dr. Ir. Lilik Tri Indriyati, MSc.
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To comprehend the philosophical foundations of education, scientific philosophy, ethics and morals in research, reasoning and logic.
2. To understand and understand the basis of research related to research topics (field of science), developments and problems (state of the art) that exist on a topic, research ideas based on problems, questions and/or specific phenomena and/or hypotheses that need to be answered proven by research, research objectives and designing valid research methods.
3. To design research and present it in a research proposal
4. To comprehend good research quality evaluation, requirements and procedures for publishing scientific papers, procedures for processing IPR registration

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods

1.	Students are able to explain what knowledge is, science, understand ethics and scientific morals	Lecture and discussion	Test, Report
2.	Students are able to explain the difference between reason and logic, what is meant by a scientist and its characteristics, the meaning of research and types of research, concepts scientific method	Lecture and discussion	Test, Report
3.	Students are able to understand how to choose problems as research material, differentiate between types of problems, how to formulate research titles and how to conduct preliminary studies.	Lecture and discussion	Test, Report
4.	Students are able to explain how to formulate problems in research, understand the importance of formulating basic assumptions, formulate hypotheses, understand Hypothetical causes are not proven	Lecture and discussion	Test, Report
5.	Students are able to understand how to choose and use good libraries, how to find good library sources, understand that not all published libraries are good and can be used, what are the procedures for writing libraries in the world, how to how to cite or quote, understand how to read and take good notes	Lecture and discussion	Test, Report
6.	Students are able to explain what is meant by research methodology, the differences between methods, procedures and techniques, understand the variety and development of research, understand historical research methods, their varieties, nature and characteristics.	Lecture and discussion	Test, Report
7.	Students are able to explain what is meant by research methodology, descriptive, nature and characteristics, varieties, experimental research methods, nature and characteristics, criteria, requirements, other relevant research methods, understanding procedures for preparing budgets, procedures for preparing work plans.	Lecture and discussion	Test, Report
8.	Students are able to explain what is meant by variables in research,	Lecture and discussion	Test, Report

	procedures for identifying and classifying variables, procedures for defining variables in research, recognizing various types of variables.		
9.	Students are able to understand the importance of selecting and developing data collection tools, procedures for preparing research designs, determining samples, sampling procedures, data collection and analysis.	Lecture and discussion	Test, Report
10.	Students are able to understand how to make a research proposal, starting from creating a title, writing background, hypothesis, if necessary, objectives, preparing a budget and research schedule	Lecture and discussion	Test, Report
11.	Students are able to understand how procedures for writing a thesis/dissertation/scientific reports/articles for journals	Lecture and discussion	Test, Report
12.	Students are able to understand how procedures in scientific communication, preparation and creation of materials good presentation	Lecture and discussion	Test, Report
13.	Students are able to explain what is meant by IPR, the purpose of granting IPR, understanding the types of IPR, granting IPR, scope of IPR	Lecture and discussion	Test, Report
14.	Students are able to understand IPR, there are bodies that organize it both domestically and, in the world, be able to explain how to find and utilize patents whose protection period has expired, know trends in world IPR progress, and utilize IPR for research collaboration opportunities.	Lecture and discussion	Test, Report

E. Module contents

Topic	Number of Week(s)	Contact Hours
What is Science? Knowledge, Scientific Ethics and Morals	**1**	
Scientists and Research: Reason, Logic, Characteristics, Categories, Framework	**1**	
Research Problem: Gap, Type, Formulation and Preliminary Study	**1**	
Problem Formulation: Assumptions and Hypothesis	**1**	

Citation: Library Utilization, Sources, Bibliography, Quotation, Reading and Note – taking techniques, Summary	**1**	
Methodology: Procedures, Types, Development, Historical Method (Characteristics, Data Source and Types)	**1**	
Descriptive Method (Characteristics and Types), Experimental Method (Characteristics and Requirements), and Other Research Methods (Qualitative, Budgeting, Workplan)	**1**	
Implementation: Research Variables	**1**	
Implementation: Data collection, Research Design, Sampling, Analysis	**1**	
Making a Research Proposal: Title, Problem, Background, Hypothesis, Literature Review, Objective, Budget and Time	**1**	
Scientific Writing	**2**	
Introduction to Intellectual Property Rights (IPR)	**2**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		40%
2.	Final Examination		40%
3.	Assignment		20%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Arikunto, S. 2002. Prosedur Penelitian: Suatu Pendekatan Praktek. Rineks Cipta
2. Day, R. A. 1988. How to Write and Publish a Scientific Paper. 3rd Edition. Oryx Press
3. Moore, N. 1995. How to Do Research. Translation by E. Suradikusumah. Penerbit ITB
4. Nasoetion, A. H. 2003. Pengantar ke Ilmu-ilmu Pertanian. PT Pustaka Litera AntarNusa
5. Nazir, M. 2003. Metode Penelitian. Ghalia Indonesia

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

- What are intellectual property rights? hjps://www.wto.org/english/tratop_e/trips_e/intel1_e.htm
- Inside WIPO. What is WIPO? hjps://www.wipo.int/about-wipo/en/
- Intellectual property hjps://en.wikipedia.org/wiki/Intellectual_property

TNH1511: Soil Processes

A. Module identity

1	Course Name	Soil Processes
2	Course Code	TNH1511
3	Credit	3(2-1)
4	Semester	2
5	Pre-requisite	
6	Coordinator	Dr. Ir. Suwardi, M.Agr
7	Lecturers	Dr. Ir. R.A. Dyah Tj. Suryaningtyas, MAppl.Sc
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain the physical, chemical and biological weathering processes of minerals and rocks into soil parent material as well as the processes of organic soil formation.
2. To explain the processes of pedogenesis from soil parent material to soil which are grouped into 4 pedogenesis processes, namely: addition, loss, transformation and translocation of material.
3. To understand the basics of soil chemical processes such as chemical equilibrium, solubility, oxidation-reduction, acid-base, chelation, dispersion and others that underlie the processes that occur in the soil.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A.	**Lecture**		
1.	Students are able to understand the processes of soil formation from mineral and organic soil and the inherited properties	Lecture and Class Discussion	Written Test

2.	Students are able to explain the processes of pedogenesis	Lecture and Class Discussion	Written Test
3.	Students are able to explain the factors that form soil	Lecture and Class Discussion	Written Test
4.	Students are able to explain processes in the soil	Lecture and Class Discussion	Written Test
5.	Students are able to explain the three phases of soil and their functions in the soil	Lecture and Class Discussion	Written Test
6.	Students are able to explain the development of land classification in Indonesia	Lecture and Class Discussion	Written Test
7.	Students are able to understand and explain soil colloids, their characteristics and their relationship to the properties and characteristics of soil	Lecture and Class Discussion	Written Test
8.	Students are able to understand and explain the development of soil horizons	Lecture and Class Discussion	Written Test
9.	Students are able to understand and explain the process and results of weathering	Lecture and Class Discussion	Written Test
10.	Students are able to understand and explain the characteristics of Andisol, Spodosol, Micromorphology	Lecture and Class Discussion	Written Test
11.	Students are able to understand and explain the pedogenesis of paddy fields. soil chelates	Lecture and Class Discussion	Written Test
12.	Students are able to understand and explain soil which develops from organic material	Lecture and Class Discussion	Written Test
B.	**Practicum**		
1.	Students are able to understand and explain the processes of mineral and rock weathering that occur in soil as well as the processes of organic soil formation	Practicum and Group Discussion	Report, Progress Report
2.	Students are able to explain the physical weathering of minerals and rocks	Practicum and Group Discussion	Report, Progress Report
3.	Students are able to explain chemical weathering	Practicum and Group Discussion	Report, Progress Report
4.	Students are able to explain biological weathering	Practicum and Group Discussion	Report, Progress Report
5.	Students are able to explain the processes of adding materials to the soil	Practicum and Group Discussion	Report, Progress Report

6.	Students are able to explain the processes of loss of materials from the soil	Practicum and Group Discussion	Report, Progress Report
7.	Students are able to explain translocation processes in the soil	Practicum and Group Discussion	Report, Progress Report
8.	Students are able to understand and explain the factors that form soil, the processes that form soil in an independent profile.	Practicum and Group Discussion	Report, Progress Report
9.	Students are able to understand and explain the solubility of organic compounds	Practicum and Group Discussion	Report, Progress Report
10.	Students are able to describe, understand and explain the characteristics of Andisol	Practicum and Group Discussion	Report, Progress Report
11.	Students are able to understand and explain soil dispersion and flocculation	Practicum and Group Discussion	Report, Progress Report

E. Module contents

Topic	Number of Week(s)	Contact Hours
LECTURES		
Introduction: • Soil Formation from Minerals and Rocks • Diagenesis vs Pedogenesis Process	1	
Pedogenesis Process: • Combining Organic Materials with Minerals • Weathering of Minerals and Rocks • Secondary Mineral Formation • Movement of Materials • Reorganization of Soil Matrix	1	
Soil Formation Factors: • Weathering of Minerals and Rocks • Erosion • Water, Wind and Temperature • Gravity • Chemical Interactions • Living Organism • Pressure Difference • Parent Material, Climate, Topography and Time	1	
Soil Processes: • Eluviation and Illuviation • Leaching • Enrichment, • Surface Erosion • Cumulation • Decalcification • Salinization and Desalinization • Alkalinization	1	

• Lessivage		
Soil Processes: • Podzolization • Desilication (feralitization, ferritization, allitization, laterization, latosolization) • Decomposition-synthesis • Melanization-leucination • Littering- humification • Paludization • Ripening mineralization • Braunification (brown) • Rubification ferugination • Oxidation and gleization • Loosening and hardening.	1	
Three Phases in Soil: • Solid phase (minerals and organic matter, including living organisms) • Liquid phase (water and nutrients dissolved in it) • gas phase (e.g. oxygen which is important for root respiration)	1	

Soil Classification Development:
• What is land?
• Meaning of Classification
  ○ Thorp and Smith, 1949
  ○ Dudal and Soepraptohardjo, 1955
  ○ FAO -UNESCO, 1974
  ○ Soil Taxonomy, 1975
  ○ National soil classification
• Global Soil Map.
	1	

Soil Colloids: • Types • Characteristics • Soil Characteristics	**1**	
Soil Horizon Formation	**1**	
Soil Weathering: • Types • Factors • Product	**1**	

Andisols and Spodosol:
• Characteristics
• Specific characteristics and processes
• Definition of micromorphology
  ○ Characteristics
  ○ Identification methods
	1	

1. Characteristics of paddy soil 2. Oxidation-Reduction reactions: • Definition • Characteristics • Examples of redox reactions.	**1**	

1. Organic soil: • Influencing factors • Characteristics 2. Chelation • Chelation soil science • Chelating compounds and agents • Chelation in organic soil	**1**	
PRACTICUM		
Introduction to mineral and rock weathering in soil	**1**	
Physical weathering of minerals and rocks: rock breaking, exfoliation processes	**1**	
Chemical weathering: oxidation, reduction, acid-base	**1**	
Biological weathering: the ability of plant roots, flora and fauna groups in the soil to decompose organic matter	**1**	
The processes of adding materials to the soil	**1**	
Processes of loss of material from the soil: erosion, leaching of nutrients, evapotranspiration, etc.	**1**	
Translocation processes in the soil: formation of albic, argillic, spodic horizons, etc.	**1**	
Soil Profile Construction: • Processes • Factors and classifications of Horizons • Secondary data collection	**2**	
Solubility of Organic Compounds from Biomass	**1**	
Dispersion-flocculation	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		30%
2.	Final Examination		30%
3.	Practicum		40%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Buol, Stanley W.; Southard, Randal J.; Graham, Robert C.; McDaniel, Paul A. (2011). Soil genesis and classification (Sixth ed.). Hoboken, New Jersey: Wiley- Blackwell. ISBN 978-0-813-80769-0. Retrieved 26 September 2021.
2. David L. Rowell. Soil Science: Methods & Applications. Published in 1994.

3. Jenny, Hans (1994). Factors of soil formation: a system of quantitative pedology. New York, New York: Dover. ISBN 978-0-486-68128-3. Archived (PDF) from the original on 25 February 2013. Retrieved 26 September 2021.
4. Nyle C. Brady and Ray R. Weil. The Nature and Properties of Soils - 15th Edition, Published in 2016
5. Paul, A. Soil Microbiology, Ecology, and Biochemistry. 4th Edition, Published in 2014
6. Stanley W. Buol, Randal J. Southard, Robert C. Graham, and Paul A. McDaniel. Soil Genesis and Classification. 6th Edition, Published in 2011
7. William F. Bleam. Soil and Environmental Chemistry. Published in 2016

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1612: Land Evaluation

A. Module identity

1	Course Name	Land Evaluation
2	Course Code	TNH1612
3	Credit	2(2 – 0)
4	Semester	2
5	Pre-requisite	
6	Coordinator	Dr. Ir. Darmawan, M.Sc
7	Lecturers	Prof. Dr. Ir. Widiatmaka, DAA; Dr. Ir. R.A. Dyah Tj. Suryaningtyas, MAppl.Sc
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain the definition and basic principles of land evaluation and describe its scope and role in optimizing land resource utilization.
2. To identify the types and sources of data for land evaluation and explain the concepts and technical stages of data acquisition and procurement. This includes: 1) the concept of data procurement through survey approaches and thematic mapping specifically for land resources, primarily soil/land surveys and mapping, and 2) the stages of data acquisition from existing data and its analysis/interpretation for land evaluation.
3. To explain internationally developed and used land evaluation concepts, including land capability and land suitability assessment, and describe the implementation stages. Capable of identifying the concept of Land Use Types (LUT) in land suitability, conducting land suitability assessments according to LUT, explaining and applying the principles of parametric/mathematical model land suitability evaluation, and outlining the planning and development stages of criteria for commodity suitability.
4. Proficient in identifying land assessment approaches beyond land capability and suitability concepts, including The Fertility Capability Soil Classification System (FCC), Land Evaluation for Irrigation, and Critical Land and Degraded Land Classification.
5. To explain the extended uses of these various land evaluation concepts for regional and spatial planning, including Agro-ecological Zones (AEZ), Land Use Planning, Spatial Planning, and Land Reclamation concepts.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to explain the basic meaning and principles of land evaluation and describe its scope and role in optimizing land resource use.	Lecture and Class Discussion	Written Test
2.	Students are able to identify the types and sources of data for land evaluation and describe the concepts and technical stages of data procurement and acquisition, including: 1) the concept of data procurement through a thematic survey and mapping approach specifically for land resources, primarily soil/land surveying and mapping, and 2) the data acquisition stage from existing data and its analysis/interpretation for land evaluation.	Lecture and Class Discussion	Written Test
3.	Students are able to understand survey implementation methods, including the role of the implementing organization, from initiation to data completion	Lecture and Class Discussion	Written Test, Assignment

4.	Students are able to explain land evaluation concepts that have been developed and used internationally, including the concepts of land capability assessment and land suitability, and can explain the stages of implementation. They are able to detail the LUT concept in land suitability, explain land characteristics and plant requirement criteria, and carry out land suitability assessments according to LUT.	Lecture and Class Discussion	Written Test
5.	Students are able to understand and explain AEZ, FCC, land for irrigation, critical land, and reclamation.	Lecture and Class Discussion	Written Test
6.	Students are able to explain and implement the principles of parametric land suitability evaluation and mathematical models and can outline the planning and stages of developing criteria for the suitability of a commodity.	Lecture and Class Discussion	Written Test, Assignment
7.	Students are able to explain and understand land use cases	Lecture and Class Discussion	Written Test
8.	Students are able to explain and understand spatial planning or regional planning cases	Lecture and Class Discussion	Written Test, Assignment
9.	Students are able to communicate their independent observations results on previously given materials.	Discussion	Discussion

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction: • **Definition and Scope of Land Evaluation** • Basic Principles of Land Evaluation: Direct and Indirect • Land Evaluation Data Source	**1**	

Land Resource Data:
• **Land Unit Mapping versus Land Mapping, Survey Levels and Map Scale, Map Legend**
• **Collection of**
  ○ **supporting information for the Implementation of Land/Land Surveys and Mapping**
  ○ **existing land/land data that is directly used for land evaluation (role and acquisition method)**
	1	

Methods and Techniques for Carrying Out Land Resource Surveys and Mapping, Land Mapping Case:	**1**	

• **Aims and Objectives** • **Preparation and Design** • **Implementing Organization**		
Land Suitability Evaluation: FAO Concepts and Principles (1). Land Utilization Types (LUT)	**1**	
FAO Land Suitability Evaluation (2). Land Characteristics vs Crop Requirements / Criteria	**1**	
FAO Land Suitability Evaluation (3). Case example of land suitability assessment	**1**	
Non-FAO Land Evaluation (1): • Agro-ecological Zones (AEZ) • The Fertility Capability Soil Classification System (FCC) • Land Evaluation for Irrigation • Critical Land • Reclamation and Other Land Improvements	**1**	
Principles of Parametric Land Evaluation	**1**	
Computerized Land Evaluation (LECS, LESA etc.)	**1**	
Development of Criteria for the Suitability of a Commodity	**1**	
Land Evaluation in Land Use Management: Case Examples	**1**	
Land Evaluation in Spatial Planning/Regional Planning: Case Examples	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		45%
2.	Final Examination		45%
3.	Assignment		10%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

•

TNH1632: Advanced Water and Soil Conservation

A. Module identity

1	Course Name	Advanced Water and Soil Conservation
2	Course Code	TNH1632
3	Credit	3(3-0)
4	Semester	2
5	Pre-requisite	
6	Coordinator	Dr. Ir. Enni Dwi Wahjunie, M.Si
7	Lecturers	Prof. Dr. Ir. Suria Darma Tarigan, M.Sc; Dr. Ir. Yayat Hidayat, M.Si; Dr. Sri Malahayati Yusuf., SP., M.Si.
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			
3		3*50'*14 = 2100'						

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To Understand and master the principles of Soil and Water Conservation and be able to apply them in preventing land degradation to achieve sustainable land use.
2. Be able to identify, analyse, and solve problems related to Soil and Water Conservation, including:
    a. Factors affecting erosion
    b. Tolerable erosion
    c. Erosion hazard levels
    d. Conservation agriculture planning
    e. Application of Soil and Water Conservation techniques for erosion and sedimentation control
    f. Prediction of peak flow rate and volume using the SCS Curve Number and Rational methods
    g. Erosion prediction using USLE, MUSLE, SWAT methods
    h. Performance, monitoring, and evaluation of watershed sustainability
    i. Constraints and challenges in implementing Soil and Water Conservation
    j. Regulations and legislation on Soil and Water Conservation

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand, explain, and develop the concept of Soil and Water Conservation (KTA) in sustainable development.	Lecture and Case Study	Question and Answer, Discussion
2.	Students are able to understand, explain, and develop the processes and forms of erosion, as well as their impacts.	Lecture and Case Study	Question and Answer, Discussion
3.	Students are able to understand, explain, and develop the factors that influence Tolerable Soil Loss (TSL) and Erosion Hazard Level (TBE)	Lecture and Case Study	Question and Answer, Discussion
4.	Students are able to understand, explain, and apply Conservation Agricultural Planning	Lecture and Case Study	Question and Answer, Discussion, Assignment
5.	Students are able to understand, explain, and develop the concept of KTA Technology	Lecture and Case Study	Question and Answer, Discussion
6.	Students are able to understand, explain, and develop the concepts of debit and volume estimation, as well as peak surface flow using the SCS Curve Number Method	Lecture and Case Study	Question and Answer, Discussion
7.	Students are able to understand, explain, and develop the concept of estimating surface flow discharge and peak volume using the Rational Method	Lecture and Case Study	Question and Answer, Discussion
8.	Students are able to understand, explain, and develop the concepts of estimating soil discharge and erosion using the USLE, MUSLE, and SWAT methods	Lecture and Case Study	Question and Answer, Discussion, Assignment
9.	Students are able to understand, explain, and develop the concepts of performance, monitoring, and evaluating watershed sustainability.	Lecture and Case Study	Question and Answer, Discussion
10.	Students are able to understand, explain, and develop the concept of obstacles and challenges to KTA implementation	Lecture and Case Study	Question and Answer, Discussion
11.	Students are able to understand, explain, and develop the concept of KTA regulations and legislation	Lecture and Case Study	Question and Answer, Discussion
12.	Students are able to understand, explain, and develop the concept of	Lecture and Case Study	Question and Answer, Discussion

	KTA success in Indonesia and the world, as well as WOCAT		
13.	Students are able to understand, explain, and develop the concept of conservation agriculture	Lecture and Case Study	Question and Answer, Discussion
14.	Students are able to understand, explain, and develop the concept of using various erosion and peak river flow estimation models	Lecture and Case Study	Question and Answer, Discussion

E. Module contents

Topic	Number of Week(s)	Contact Hours
• Uses and Scope • KTA Perspective in Sustainable Development • Definition and Understanding of Soil and Water Conservation (KTA) • History of KTA Implementation in Indonesia and Around the World	**1**	
• Process and Forms of Erosion • Consequences and Impacts of Soil Erosion and Sedimentation	**1**	
Factors that influence soil erosion	**1**	
• TSL (Tolerable Soil Loss) • TBE (Erosion Hazard Level) • Conservation Agriculture Planning	**1**	
Technologies in Soil and Water Conservation: • Approach • Civil – Mechanical Engineering • Agronomic and Vegetative Techniques • Water Harvesting Management	**1**	
Estimation of Discharge and Peak Volume of Surface Flow Using the SCS Curve Number Method	**1**	
Estimation of Surface Flow Discharge and Peak Volume Using the Rational Method	**1**	
Soil Discharge and Erosion Estimation using USLE, MUSLE, and SWAT	**1**	
The Relationship and Role of Soil and Water Conservation in Watershed Management: • Watershed Sustainability Performance • Monitoring and Evaluating Watershed Sustainability	**1**	
Obstacles and Challenges in Soil and Water Conservation	**1**	
Soil and Water Conservation Regulations: • **History of Soil and Water Conservation Regulations (Indonesia and Worldwide)** • **Soil and Water Conservation Laws and Regulations in Indonesia (Law No. 37/2014) and other related regulations**	**1**	

• **Successful Soil and Water Conservation practices in Indonesia** • **Successful Soil and Water Conservation Practices around the world** • **WOCAT**	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		25%
2.	Final Examination		25%
3.	Assignment and Project Base Learning		50%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Adams, W. M. 2001. Green Development. 2nd edition. Environment and sustainability in the Third World. Routledge, Taylor & Francis Group. London, New York.
2. Arsyad, S. 2010. Konservasi Tanah dan Air. Edisi kedua. IPB Press. Bogor.
3. Arsyad, S., I. Amien, T Sheng, and W. Moldenhauer (Editor). 1992. Conservation Policies for Sustainable Hillslope Farming. Soil and Water Conservation Society, Ankeny. IO.
4. Gittinger, J. P. 1982. Economic Analysis of Agricultural Projects. The John HopkinsUniv. Press, Baltimore and London.
5. Hudson, N. 1971. Soil Conservation. BT Basford limited, London.
6. Sanders, D., P. C. Huszar, S. Sombatpanit, and T. Enters. 1999. Incentives in Soil Conservation: From Theory to Practice. Oxford and IBH Publishing Co. PVT, Ltd. New Dehli

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

- Direktorat Bina Rehabilitasi Hutan dan Lahan. 2011. Manual Konservasi Tanah dan Air. Untuk Kegiatan Rehabilitasi Hutan dan Lahan. Ditjen. Bina Pengelolaan DAS dna Perhutanan Sosial, Kementerian Kehutanan, RI.
- Food and Fertilizer Technology Center for the Asian and Pasific Regon. 1995. Soil Conservation Handbook. Council of Agriculture, ROC – Taiwan Provincial Soil and Water Conservation Bereau – Chinese Soil and Water Conservation Society, ROC.
- Goldman, S. J., K. Jackson, and T. A. Bursztynsky. 1986. Erosion and Sediment Control Handbook. McGraw Hill Book C. New York.
- Gregersen, H. M., K. N. Brooks, J. A. Dixon, and L. S. Hamilton. 1988. Guidelines for economic appraisal of watershed management projects. FAO Conservation Guide 16. FAO of UN, Rome.
- Kartodihardjo, H., K. Murtilaksono, dan U. Sudadi. 2004. Institusi Pengelolaan Daerah Aliran Sungai. Konsep dan Pengantar ke Analisis Kebijakan. Fakultas Kehutanan, IPB.

TNH1642: Advanced Soil Ecology

A. Module identity

1	Course Name	Advanced Soil Ecology
2	Course Code	TNH1642
3	Credit	2(2-0)
4	Semester	2
5	Pre-requisite	
6	Coordinator	Dr. Dra. Rahayu Widyastuti, M.Sc.Agr
7	Lecturers	Prof. Dr. Ir. Dwi Andreas Santosa, M.S
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			
2		2*14*50' = 1400						

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain the relationship between abiotic factors and biotic factors in an ecosystem, and the use of biotechnology to overcome environmental problems.
2. To explain the relationship between producers and consumers (trophic levels), the main nutrient cycles (C, N, P, K, Ca, etc.), and the factors that control them.
3. To explain the role of the main types of soil organisms in Indonesia (earthworms, ants, and termites) and other organisms classified as secondary (macro and meso fauna).

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	**Students are able to:** • Understand the lecture rules, schedule, and exams.	Lecture and Class Discussion	Written Test, Assignment

	• Know the percentage sources of the final mark. • Identify the teaching lecturer and the lecture material provided. • Explain the meaning of soil ecology and the relationship between abiotic and biotic factors. • Understand land as one of the abiotic factors.		
2.	**Students are able to:** • Explain the importance of the functions of soil water and air in influencing life in the soil. • Understand the composition of soil solutions and air, as well as the structure of water molecules.	Lecture and Class Discussion	Written Test, Assignment
3.	Students are able to generally understand the function of vegetation as primary producers, the concept of NPP, photosynthesis as the process of capturing solar energy, respiration as part of utilizing the products of photosynthesis for life, the potential of photosynthesis to reduce global warming, and future research directions.	Lecture, Class Discussion, Video	Written Test, Assignment
4.	Students are able to explain the concept of secondary production, heterotrophic respiration, procedures for determining microbial biomass, and future research in utilizing ecological concepts	Lecture and Class Discussion	Written Test, Assignment
5.	Students are able to explain the meaning of wetlands, understand the importance of wetland functions for the ecosystem, and utilize artificial wetlands	Lecture, Class Discussion, Video	Written Test, Assignment
6.	Students are able to explain the importance of earthworms for soil health (as decomposers, organic matter distributors, and bioturbation agents), the potential uses of	Lecture, Class Discussion, Video	Written Test, Assignment

	earthworms, and the dangers of earthworms as invasive species		
7.	Students are able to explain the importance of termites and ants for soil health (as organic matter decomposers and bioturbation agents), the potential use of ants as biological controllers, the dangers of ants as invasive species, the dangers of termites as invasive species, and the potential of termites as GHG contributors	Lecture, Class Discussion, Video	Written Test, Assignment
8.	Students are able to explain the ecological roles and functions of several important macro arthropods that live in soil (such as predators, nutrient sinks, and organic material decomposers)	Lecture, Class Discussion, Video	Written Test, Assignment
9.	Students are able to explain the roles and ecological functions of several important micro arthropods that live in the soil, specifically Collembola (as predators and decomposers of organic matter)	Lecture and Class Discussion	Written Test, Assignment
10.	Students are able to explain the roles and ecological functions of several important micro arthropods that live in the soil, specifically Acari (as predators and decomposers of organic material)	Lecture and Class Discussion	Written Test, Assignment
11.	Students are able to understand the reasons for the carbon cycle, including photosynthesis and respiration, short and long cycles, local and global cycles, the organisms involved, the composition of carbon compounds important for life, and research on BOT or carbon cycle dynamics.	Lecture and Class Discussion	Written Test, Assignment
12.	Students are able to understand the reasons for the nitrogen cycle, including symbiotic and non-symbiotic fixation, nitrification, denitrification, short and long cycles, local and global cycles, the organisms involved, the composition of nitrogen compounds important for plants, and research on nitrogen or nitrogen cycle dynamics	Lecture, Class Discussion, Video	Written Test, Assignment

13.	Students are able to understand the reasons for other macronutrient cycles outside of C and N, including mineralization, immobilization, leaching, short cycles, long cycles, local cycles, global cycles, the organisms involved, the composition of nutrient compounds important for plants, and research on other nutrients or their cyclical dynamics	Lecture and Class Discussion	Written Test, Assignment
14.	students are able to understand the reasons for the existence of micronutrient cycles, including mineralization, immobilization, leaching, short cycles, long cycles, local cycles, global cycles, the organisms involved, the composition of nutrient compounds important for plants, and research on micronutrients or their cycle dynamics	Lecture and Class Discussion	Written Test, Assignment

E. Module contents

Topic	Number of Week(s)	Contact Hours
• **Understanding Ecology** • **Abiotic Factors: Soil**	**1**	
Abiotic Factors: Groundwater, Soil Air	**1**	
Plants/Vegetation as Primary Producers • **Photosynthesis** • **Respiration**	**1**	
Secondary Production: • **Algae, other photosynthetic microbes** • **Heterotrophic Respiration** • **Determination of Microbial Biomass**	**1**	
Wetland Ecology • **Wetlands** • **Ecological function**	**1**	
Worm Ecology	**1**	
Ecology of Ants and Termites	**1**	
Other Macrofauna • **Isopods** • **Diplopoda** • **Chilopoda** • **Arachnids**	**1**	
Mesofauna 1: Colembola	**1**	
Mesofauna II: Acari and other meso fauna	**1**	
Carbon Cycle	**1**	
Nitrogen Cycle	**1**	

Other Macro Element Cycles (S, P, Ca, Mg, K)	**1**	
Micro Element Cycle (Fe, Mn, Cu, Zn)	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		40%
2.	Final Examination		40%
3.	Assignment		20%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Alexander, M. 1977. Introduction to Soil Microbiology. John Wiley and Son, New York. 467 pp
2. Coleman, DC and DA Crossley Jr. 1996. Fundamentals of Soil Ecology. Academic Press, San Diego. 205 pp
3. Killham, K. 1999. Soil Ecology. Cambridge University Press, Cambridge, 242 pp
4. Allen, MF. 1996. The Ecology of Mycorrhizae. Cambridge University Press, Cambridge, 184 pp
5. Davet, P. 2004. Microbial Ecology of the Soil and Plant Growth. Science Publisher Inc. Enfield, USA. 392 pp
6. Alexander, M. 1977. Introduction to Soil Microbiology. John Wiley and Son, New York. 467 pp
7. Edward, CA. 1998. The Earthworm Ecology. CRC Press, Boca Raton, 389 pp.
8. Satchell; JE. 1983. Earthworm Ecology, from Darwin to Vermiculture. Chapman and Hall.
9. Lee, KE. 1985. Earthworm: Their Ecology and Relationships with Soils and Landuse. CSIRO, Academic Press

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

- Ecosystems Part 1 Energy: https://youtu.be/NVd9Ch44s_Y
- Ecosystems Part 2 - Nutrient Cycling: https://youtu.be/eOfMmPGMqoA
- Ecology - Trophic Levels & Nutrient Cycles: https://youtu.be/JtBFzOGi0wM
- Fundamentals of Nutrient Management 2015: Nutrient Cycles: https://youtu.be/4ndeonTT8tQ
- Nitrogen and phosphorus cycles: Always recycle! | Crash Course ecology | Khan Academy: https://youtu.be/6rwoktPmqpY
- Exploring Earthworm Ecology: https://youtu.be/q7Eznl12V_g
- Termites - The Inner Sanctum - The Secrets of Nature: https://youtu.be/DXbo5ubYS9I
- Facts About Ants - Secret Nature | Ant Documentary | Natural History Channel: https://youtu.be/tBQD0Zghwg8
- The Importance of Wetlands: https://youtu.be/5Z7D9sQAmMw
- Wetland: Sponges of the Earth: https://youtu.be/Ezm7S74WgwA

TNH1522: Advanced Soil Fertility

A. Module identity

1	Course Name	Advanced Soil Fertility
2	Course Code	TNH1522
3	Credit	2(2-0)
4	Semester	2
5	Pre-requisite	
6	Coordinator	Dr. Ir. Budi Nugroho, M.Si
7	Lecturers	Dr. Ir. Heru B Pulunggono, M.Agr.Sc.; Prof. Dr. Ir. Arief Hartono, M.Sc
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To develop logical, critical, systematic, and creative thinking through scientific research, creating designs, and preparing scientific conceptions of study results based on scientific rules, procedures, and ethics in the form of theses and scientific publications in the field of soil fertility and nutrient management.
2. To develop academic validation or studies in the field of soil fertility and nutrient management to solve relevant problems in society and industry.
3. To solve problems in the development of soil fertility science and nutrient management through exploratory or experimental studies of valid and reliable data and/or information.
4. To document, store, secure, and recover research data to ensure validity and prevent plagiarism.
5. To present the results of soil fertility characterization and inventory both textually and spatially in accordance with the latest technological developments.
6. To modify procedures for evaluating potential and soil fertility problems according to scientific principles.
7. To apply soil fertility inventory techniques, including activities in the field, greenhouse, and laboratory, according to scientific principles.
8. To study theories of eco-chemical, physical, and biological processes and characteristics of soil using a quantitative and spatial approach in inventorying the potential and problems of soil fertility and nutrient management.

9. To study theories of soil fertility and nutrient management for the productivity and sustainability of land resources.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to explain the history of soil fertility science, the concept of soil fertility, and the relationship between soil fertility and soil-forming factors.	Lecture and Class Discussion	Mid Term Examination
2.	Students are able to explain the relationship between genetic factors and plant growth, the relationship between environmental factors and plant growth, and models of the relationship between growth factors and growth	Lecture and Class Discussion	Mid Term Examination
3.	Students are able to explain the nutrients needed by plants, including essential elements, macro and micronutrients, primary and secondary nutrients, mobile and immobile nutrients in plants, as well as the functions of nutrients such as N, P, K, Ca, Mg, S, Fe, Mn, Cu, Zn, B, Cl, Ni, and Si in plants	Lecture and Class Discussion	Mid Term Examination
4.	Students are able to explain the components of a dynamic soil system, including ion exchange in the soil, cation exchange, soil load, land CEC, determination of CEC for land and BS, high and low activity clay, anion exchange, buffering capacity, root CEC, movement of ions to the roots, and absorption of ions by plants	Lecture and Class Discussion	Mid Term Examination
5.	Students are able to explain the nitrogen (N) cycle, sources of N in soil, N fixation, soil N forms and transformations, soil's ability to provide N, loss of N from soil, the role of denitrification in agriculture and the environment, as well as the availability of N and how to measure it	Lecture and Class Discussion	Mid Term Examination
6.	Students are able to explain phosphorus (P) issues, P content in soil, forms of P in soil and their transformations, P cycling in soil,	Lecture and Class Discussion	Mid Term Examination

	loss of P, P adsorption reactions, factors influencing P retention, transformation of P fertilizer in the soil, measurement of intensity and capacity factors, P absorption equations, how to solve P-related problems, guano, and the understanding and distribution of deposits in Indonesia		
7.	Students are able to explain the general condition of potassium and its role in plants, soil potassium, the main source of potassium in the soil, the potassium cycle in the land-crop-livestock system, factors that influence potassium availability, as well as methods for determining potassium in blood	Lecture and Class Discussion	Mid Term Examination
8.	Students are able to explain: presence of calcium in soil; the function of calcium in plants; magnesium in soil; the function of magnesium in plants; the calcium and magnesium cycle; factors determining the availability of Ca and Mg; corrective approaches for Ca and Mg deficiencies: a) plant requirements, b) cation ratio, c) amelioration	Lecture and Class Discussion	Final Examination
9.	Students are able to explain: sources of sulfur in the soil; the sulfur cycle; inorganic sulfur in soil; organic sulfur in soil; properties of sulfur in soil; soil acidification; the function and levels of sulfur in plants; deficiency symptoms, toxicity, and nutrient interactions; the role of silicon (Si); forms of Si in soil; the main source of Si in soil; factors that influence Si levels in plants; the role of Si in metabolism; the beneficial influence of Si; Si-deficient soils; sources of Si fertilizer; Si fertilization; and factors influencing the concentration of extracted Si	Lecture and Class Discussion	Final Examination
10.	Students are able to explain: the meaning of land pollution; the determination and assessment of land pollution; nitrogen and	Lecture and Class Discussion	Final Examination

	phosphorus pollution; heavy metal and microelement pollution; pesticide pollution; as well as other additional sources of pollution		
11.	Students are able to explain the meaning of acid soil; sources of soil acidity; classification of soil acidity; causes of acidic soil; problems associated with acid soil; how to address problems in acid soil; liming; liming materials; selection of liming materials; lime reaction; benefits of liming; factors influencing lime requirements; methods for determining lime requirements; overliming; providing organic materials; as well as inundation/rice fields	Lecture and Class Discussion	Final Examination
12.	Students are able to explain the levels of microelements in soil, plants, and rocks; types of minerals that contain microelements; the role of microelements in plants; forms of microelements in soil; as well as factors that influence the availability and movement of microelements.	Lecture and Class Discussion	Final Examination
13.	Students can explain the role of soil fertility evaluation, soil fertility evaluation methods, general keys for identifying symptoms of nutrient deficiency, biological test methods, soil test methods, interpretation of soil test data, plant analysis methods, as well as the interpretation of plant analysis data	Lecture and Class Discussion	Final Examination
14.	Students can explain the factors to consider when fertilizing, fertilized plants, fertilizers and their classification, placement of fertilizers, fertilizer selection, fertilization recommendations, calculation of fertilizer doses in the greenhouse and in the field, prescription methods, fertilization efficiency, efforts to increase fertilizer efficiency, as well as the effectiveness of fertilizers	Lecture and Class Discussion	Final Examination

E. Module contents

Topic	Number of Week(s)	Contact Hours
• A Brief History of Soil Fertility • The Concept of Soil Fertility ○ Factors That Influence Soil Formation and Fertility	**1**	
Plant Growth and Growth Factors • Genetic Factors and Plant Growth • Environmental Factors and Plant Growth • Model of the Relationship Between Growth Factors and Plant Growth	**1**	
Nutrients Required by Plants • Definition of Essential Elements • Macro and Micronutrients • Primary and Secondary Nutrients • Mobile and Immobile Nutrients in Plants • Functions of Nutrients N, P, K, Ca, Mg, S, Fe, Mn, Cu, Zn, B, Cl, Ni, and Si in Plants	**1**	
Soil-Plant Relationship • Components of a Dynamic Soil System • Ion Exchange in Soil • Cation Exchange • Soil Charge • Soil CEC (Cation Exchange Capacity) • Determination of Soil CEC and Base Saturation • High and Low Activity Clays • Anion Exchange • Buffering Capacity • Root CEC • Ion Movement to Roots • Ion Absorption by Plants	**1**	
Nitrogen: • The Nitrogen Cycle • Sources of Nitrogen in Soil • Nitrogen Fixation • Forms and Transformations of Soil Nitrogen • Soil's Ability to Supply Nitrogen • Nitrogen Loss from Soil • The Role of Denitrification in Agriculture and the Environment • Nitrogen Availability and Methods of Measurement	**1**	

Phosphorus: • Phosphorus Issues • Phosphorus Content in Soil • Forms of Phosphorus in Soil and Their Transformations • The Phosphorus Cycle in Soil • Phosphorus Loss • Phosphorus Adsorption Reactions • Factors Affecting Phosphorus Retention • Phosphorus Fertilizer Transformations in Soil • Measurement of Intensity and Capacity Factors • Phosphorus Sorption Equations • Solutions to Phosphorus Problems • **Guano:** Definition and Distribution of Its Deposits in Indonesia	**1**	
Potassium: • General Conditions of Potassium and Its Role in Plants • Soil Potassium • Major Sources of Potassium in Soil • The Potassium Cycle in the Soil-Plant-Animal System • Factors Affecting Potassium Availability • Methods for Determining Potassium in Soil	**1**	
Calcium and Magnesium: • Calcium in the Soil • Function of Calcium (Ca) in Plants • Magnesium in the Soil • Function of Magnesium (Mg) in Plants • Calcium and Magnesium Cycle • Factors Determining the Availability of Ca and Mg • Corrective Approaches to Ca and Mg Deficiencies: a) Plant Needs, b) Cation Ratio, c) Amelioration	**1**	
Sulphur and Silicon: • Sources of Sulphur in the Soil • The Sulphur Cycle • Inorganic Sulphur in the Soil • Organic Sulphur in the Soil • Properties of Sulphur in the Soil • Soil Acidification • Function and Levels of Sulphur in Plants • Symptoms of Deficiency, Toxicity, and Nutrient Interactions • Role of Silicon (Si) • Forms of Silicon in Soil • Main Sources of Silicon in the Soil • Factors Influencing Silicon Levels in Plants • Role of Silicon in Metabolism • Beneficial Effects of Silicon	**1**	

• Silicon-Deficient Soils • Sources of Silicon Fertilizer • Silicon Fertilization • Factors Influencing the Concentration of Extracted Silicon		
Soil Pollution: • Understanding Soil Pollution • Detection and Assessment of Soil Pollution • Nitrogen and Phosphorus Pollution • Heavy Metal Pollution and Microelements • Pesticide Pollution • Other Sources of Pollution	**1**	
Soil Acidity and Solutions: • Definition of Acid Soil • Sources of Soil Acidity • Classification of Soil Acidity • Causes of Acidic Soil • Problems Associated with Acidic Soil • Methods for Addressing Acid Soil Problems • Calcification • Liming Materials • Selection of Liming Materials • Lime Reaction • Benefits of Liming • Factors Influencing Lime Requirements • Methods for Determining Lime Requirements • Overliming • Application of Organic Materials • Flooding/Ponding	**1**	
Microelements: • Microelements Levels in Soil, Plants, and Rocks • Minerals Containing Microelements • The Role of Microelements in Plants • Forms of Microelements in Soil • Factors Influencing the Availability and Movement of Microelements	**1**	
Soil Fertility Evaluation: • The Role of Evaluating Soil Fertility • Methods for Evaluating Soil Fertility • General Guidelines for Identifying Symptoms of Nutrient Deficiency • Biological Testing Methods • Soil Testing Methods • Interpretation of Soil Test Data • Plant Analysis Methods • Interpretation of Plant Analysis Data	**1**	

Fertilization: • Considerations for Fertilizing • Fertilized Plants • Fertilizers and Their Classification • Placement of Fertilizer • Selection of Fertilizers • Fertilization Recommendations • Calculating Fertilizer Doses in Greenhouses and Fields • Prescription Methods • Fertilization Efficiency • Methods to Increase Fertilizer Efficiency • Fertilizer Effectiveness	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		35%
2.	Final Examination		35%
3.	Report		30%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Havlin, J. L., J. D. Beaton, S. L Tisdale, and W. L. Nelson. 1999. Soil Fertility and Fertilizers, An Introduction to Nutrient Management. 6th ed. Prentice-Hall, Inc., New Jersey.
2. Tisdale, S. L, W. L. Nelson, and J. D. Beaton. 1985. Soil Fertility and Fertilizers. 4th ed. MacMillan Publishing Company, New York.
3. Prasad, R and J. F. Power. Soil Fertility Management for Sustainable Agriculture. CRC Press, Boca Raton.
4. Sanchez, P. A. 1976. Properties and Management of Soil in the Tropics. John Wiley and Sons, New York.
5. Brady, N. C. 1990. The Nature and Properties of Soils. 10th ed. MacMillan Publishing Company, New York.
6. Mengel, K. and E. A. Kirkby. 1982. Principles of Plant Nutrition. 2nd ed. International Potash Institute, Bern.
7. Werterman, R. L. 1990. Soil Testing and Plant Analysis. 3rd ed. Soil Sci. Soc. Am., Inc., New York.
8. Andrew, C. S. and E. J. Kamprath. 1978. Mineral Nutrition of Legums in Tropical and Subtropical Soils. CSIRO Publ., Australia.
9. IRRI. 1965. The Mineral Nutrition of the Rice Plant. The Johns Hopkins, Baltimore.
10. Epstein, E and A. J. Bloom. 2003. Mineral Nutrition of Plants: Principles and Perspectives. Second Editions. Sinauer Associates, Inc. Publisher, Sunderland.
11. Ma, J. F. and E. Takahasi. 2002. Soil, Fertilizer, and Plant Silicon Research in Japan. Elsevier, Amsterdam.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

- Leiwakabessy, F. M., U. M. Wahjudin, dan Suwarno. 2003. Kesuburan Tanah. Jurusan Tanah, Fakultas Pertanian, IPB.

SEMESTER 3

TNH1515: Land Use Systems

A. Module identity

1	Course Name	Land Use Systems
2	Course Code	TNH1515
3	Credit	2(2-0)
4	Semester	3
5	Pre-requisite	
6	Coordinator	Dr. Ir. Suwardi, M.Agr
7	Lecturers	Prof. Dr. Ir. Budi Mulyanto, MSc; Prof. Dr. Ir. Widiatmaka, DAA
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			
2								

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain the concept and meaning of land use, including an understanding of land, landscapes, ecosystems, regions, and territories.
2. To explain the dimensions and value of land, various legal aspects related to land use planning, and the social functions of land.
3. To understand land as a basis for activity space and connectivity, consider land capability and suitability in land use, and comprehend the relationship between land use and spatial planning. This includes understanding various theories in land use planning (e.g., value, sector, distribution patterns, and horizontal-vertical considerations).
4. To understand land use in rural areas, urban areas, and special ecosystems (such as watersheds, karst regions, swamps, and ancient sites).

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand the concept and meaning of land use, which includes planning, utilization, and management of land for various needs such as agriculture, housing, industry, and environmental conservation.	Lecture and Class Discussion	Written Test
2.	Students are able to explain soil, land, landscapes, ecosystems, regions, and areas, including interdisciplinary analysis that considers physical, biological, social, economic, and environmental aspects, in the context of resource management and sustainable development planning	Lecture and Class Discussion	Written Test
3.	Students are able to explain physical, economic, ecological, social, cultural, and legal aspects	Lecture and Class Discussion	Written Test
4.	Students are able to explain zoning regulations, agrarian law, property rights, environmental regulations, land use permits, and development policies.	Lecture and Class Discussion	Written Test
5.	Students are able to explain housing, economic activities, public spaces, cultural diversity, food security, and community sustainability.	Lecture and Class Discussion	Written Test
6.	Students are able to explain land allocation for agriculture, settlements, industry, forests, conservation, infrastructure, and green open spaces	Lecture and Class Discussion	Written Test
7.	Students are able to analyse soil quality, topography, climate, water availability, accessibility, environmental impact, and economic potential.	Lecture and Class Discussion	Written Test
8.	Students are able to understand and explain the spatial arrangements of various land uses, such as agriculture, residential areas, industry, and conservation, to achieve planned and sustainable regional development.	Lecture and Class Discussion	Written Test

9.	Students are able to understand and explain land value theory, sector theory, spatial pattern theory, as well as horizontal and vertical theories in organizing land use within the context of regional development and management.	Lecture and Class Discussion	Written Test
10.	Students are able to understand and explain land management for soil and water conservation, erosion control, flood prevention, sustainable agriculture development, settlement planning, industrial development, and the preservation of water ecosystem functions.	Lecture and Class Discussion	Written Test
11.	Students are able to understand and explain rural areas, including agriculture, forests, nature conservation, and rural settlements, as well as urban areas, including dense settlements, commercial zones, industrial areas, transportation networks, and green open spaces, to meet population needs and manage urban growth in a sustainable manner.	Lecture and Class Discussion	Written Test
12.	Students are able to understand and explain karst areas, which involve the protection of biodiversity and underground water resources, as well as mining areas, which require the rehabilitation of former mining land and sustainable management to reduce environmental and social impacts.	Lecture and Class Discussion	Written Test
13.	Students are able to understand and explain peat areas, which involve the protection of stored carbon and biodiversity, as well as swamp areas, including management for wet farming, nature conservation, and flood mitigation.	Lecture and Class Discussion	Written Test
14.	Students will able to understand and explain the importance of land use, including the integration of ecological, economic, social, and cultural aspects in land management, to ensure environmental sustainability and the	Lecture and Class Discussion	Written Test

	preservation of ancient sites as part of human cultural heritage.		

E. Module contents

Topic	Number of Week(s)	Contact Hours

Introduction, Concept, and Understanding of Land Use
• Planning
• Utilization
• Management of land for various needs:
  ○ Agriculture
  ○ Housing
  ○ Industry
  ○ Environmental conservation
	1	

Understanding land, landscapes, ecosystems, and regions
• Interdisciplinary analysis:
  ○ Physical aspects
  ○ Biological aspects
  ○ Social aspects
  ○ Economic aspects
  ○ Environmental aspects
• Resource management context
• Sustainable development planning context
	1	

The Dimensions and Value of Land: Physical, Economic, Ecological, Social, Cultural, and Legal Aspects.	**1**	
Various Legal Aspects in Land Use Planning: • Zoning Regulations • Agrarian Laws • Ownership Rights • Environmental Regulations • Land Use Permits • Development Policies.	**1**	
The Social Functions of Land: • Shelter • Economic Activity • Public Space • Cultural Diversity • Food Security • Community Sustainability.	**1**	
The Land Use Balance: • Land Allocation for Agriculture • Settlement • Industry • Forests • Conservation • Infrastructure • Green Open Spaces.	**1**	
Consideration of land capability and land suitability in land use planning: • Analysis of soil quality	**1**	

• Topography • Climate • Water availability • Accessibility • Environmental impact • Economic potential		

The relationship between land use and spatial planning involves:
• Spatial arrangement of various land uses, such as:
  ○ Agriculture
  ○ Residential areas
  ○ Industry
  ○ Conservation
• Achieving planned and sustainable regional development
	1	

Land Use in Watershed Areas: • Land management for soil and water conservation • Erosion control • Flood prevention • Development of sustainable agriculture • Planning for settlements • Industrial development • Preservation of water ecosystem functions	**1**	

Land Use in Rural and Urban Regions :
• **Rural Areas:**
  ○ Agriculture
  ○ Forests
  ○ Nature conservation
  ○ Rural settlements
• **Urban Areas:**
  ○ Dense settlements
  ○ Commercial areas
  ○ Industrial areas
  ○ Transportation networks
  ○ Green open spaces
	1	

Land Use in Karst Areas: • Protection of biodiversity • Preservation of underground water resources **Land Use in Mining Areas:** • Rehabilitation of former mining land • Sustainable management to reduce environmental and social impacts	**1**	

Land Use in Peat Areas: • Protection of stored carbon • Preservation of biodiversity **Land Use in Swamp Areas:** • Management for wet farming • Nature conservation • Flood mitigation	**1**	

Epilogue:
• The importance of integration:
  ○ Ecological aspects
  ○ Economic aspects
  ○ Social aspects
  ○ Cultural aspects
• Ensuring environmental sustainability
• Preserving ancient sites as part of human cultural heritage
	1	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		50%
2.	Final Examination		50%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Arthur C. Nelson, Joseph F. Schilling. Introduction to Land Use Planning and Zoning. Arthur C. Nelson, Joseph F. Schilling. 2017.
2. Julian Conrad Juergensmeyer, Thomas E. Roberts, Patricia E. Salkin. Land Use Planning and Development Regulation Law. West Academic Publishing. 2016
3. Philip R. Berke, David R. Godschalk, Edward J. Kaiser, Jeffrey R. Anderson. Urban Land Use Planning. University of Illinois Press. 2006.
4. Rangkuti, R. Perencanaan Tata Guna Tanah. PT Pradnya Paramita. 2003.
5. Richard L. Morrill, David L. Namowitz. Land Use Planning: A Casebook on the Use, Misuse, and Reuse of Urban Land. Planners Press. 1987.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

ELECTIVE COURSES

TNH1512: Soil Mineralogy

A. Module identity

1	Course Name	Soil Mineralogy
2	Course Code	TNH1512
3	Credit	2(2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Ir. R.A. Dyah Tjahyandari Suryaningtyas, MAppl.Sc
7	Lecturers	Dr Ir Iskandar
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain and describe the dominant minerals in soil, primary and secondary minerals, the main minerals that make up rocks.
2. To explain and relate the dominant mineral content in the soil to the chemical and physical properties of the soil, in accordance with the knowledge that has been obtained.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to recognize the relationship between the minerals in the soil and the soil's properties or processes	Lecture and Class Discussion	Written Test
2.	Students are able to state the definitions of minerals and crystals	Lecture and Class Discussion	Written Test

	and understand the systematics of minerals.		
3.	Students are able to name and describe feldspar, olivine, and pyroxene.	Lecture and Class Discussion	Written Test
4.	Students are able to name and describe carbonate, halide, sulphate, and sulphide minerals.	Lecture and Class Discussion	Written Test
5.	Students are able to name and describe the minerals allophane and imogolite.	Lecture and Class Discussion	Written Test
6.	Students are able to name and describe phyllosilicate minerals.	Lecture and Class Discussion	Written Test
7.	Students are able to name and describe phyllosilicate minerals, including their types and characteristics.	Lecture and Class Discussion	Written Test
8.	Students are able to name and describe the minerals Fe, Al, and Mn oxides/oxyhydroxides.	Lecture and Class Discussion	Written Test
9.	Students are able to name and describe the minerals Fe, Al, and Mn oxides/oxyhydroxides, including their properties and significance.	Lecture and Class Discussion	Written Test
10.	Students are able to name and describe silica minerals.	Lecture and Class Discussion	Written Test
11.	Students are able to name and describe the weathering processes of minerals and rocks.	Lecture and Class Discussion	Written Test
12.	Students are able to explain the processes of soil formation.	Lecture and Class Discussion	Written Test
13.	Students are able to name and describe mineral analysis methods, including polarizing microscopy, XRD, TG/DTA, and IRS.	Lecture and Class Discussion	Written Test

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction: The relationship between mineralogy and soil science	**1**	
Definitions of minerals, crystals, and systematic mineralogy	**1**	
Feldspar, Olivine, Piroxin	**1**	
Carbonates, Halides, Sulfates, Sulfides	**1**	
Allophane, Imogolite	**1**	
Phyllosilicate	**2**	
Fe, Al, Mn- Oxides/Oxyhydroxides	**2**	
Silica	**1**	
Weathering of Minerals and Rocks	**1**	
Soil Formation Process	**2**	

Mineral analysis methods: polarizing microscope, XRD, TG/DTA, IRS	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		35%
2.	Final Examination		35%
3.	Quiz 1		15%
4.	Quiz 2		15%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Hurchman, G.J.; Lowe, D.J. 2012. Alteration, formation, and occurrence of minerals in soils. *In*: Huang, P.M.; Li, Y; Sumner, M.E. (editors) "Handbook of Soil Sciences. 2nd edition. Vol. 1: Properties and Processes". CRC Press (Taylor & Francis), Boca Raton, FL, pp.20.1-20.72
2. Singh, B. & Schulze, D. G. (2015) Soil Minerals and Plant Nutrition. *Nature Education Knowledge* 6(1):1
3. U. Schwertmann and R.M. Taylor. 1989. Iron Oxides. In Minerals in Soils Environments
4. Hsu, P.H. 1989. Aluminum Hydroxides and Oxyhydroxides. In Minerals in Soils Environments
5. Monger, H.C. and E.F. Kelly. 2002. Silica Minerals. In J.B. Dixon and D.G. Schulze (eds). Soil Mineralogy with Environmental Applications. Soil Sci. Soc. Am., Madison, Wisconsin

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1514: Remediation Technology and Ameliorant Materials

A. Module identity

1	Course Name	Remediation Technology and Ameliorant Materials
2	Course Code	TNH1514
3	Credit	2(2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr Ir Darmawan, M.Sc
7	Lecturers	Dr Ir Iskandar
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain and describe the meaning and terms related to soil remediation, including forms of pollutants/contaminants, damage/pollution assessment, and legislation on the prevention and management of land damage/pollution.
2. To explain the basic principles and techniques of soil remediation, including electrokinetic/electrochemical decontamination techniques and phytoremediation.
3. To explain soil quality and the functions of various materials used in soil remediation, such as coal ash, volcanic ash, sand, rock, charcoal/biochar, clay, phosphate rock, etc.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand and explain the meaning and terminology related to soil remediation.	Lecture and Class Discussion	Written Test
2.	Students are able to explain soil, sediment, and groundwater as entities/objects of remediation.	Lecture and Class Discussion	Written Test
3.	Students are able to identify and explain the sources and forms of pollutants/contaminants, as well as the types of land damage, particularly caused by pollution.	Lecture and Class Discussion	Written Test
4.	Students are able to explain damage/pollution assessments and legislation for preventing and managing land damage/pollution.	Lecture and Class Discussion	Written Test
5.	Students are able to explain the basic principles and techniques of soil remediation.	Lecture and Class Discussion	Written Test
6.	Students are able to explain various electrokinetic and electrochemical decontamination techniques.	Lecture and Class Discussion	Written Test

7.	Students are able to explain various decontamination techniques using phytoremediation.	Lecture and Class Discussion	Written Test
8.	Students are able to explain the concept of soil and its role in plant growth.	Lecture and Class Discussion	Written Test
9.	Students are able to explain soil quality.	Lecture and Class Discussion	Written Test
10.	Students are able to name and explain the types and functions of coal ash in improving soil quality.	Lecture and Class Discussion	Written Test
11.	Students are capable of naming and explaining the functions of volcanic ash, sand, and various types of rocks in improving soil quality.	Lecture and Class Discussion	Written Test
12.	Students are capable of naming and explaining the function of charcoal in improving soil quality.	Lecture and Class Discussion	Written Test
13.	Students are capable of naming and explaining the function of clay in improving soil quality.	Lecture and Class Discussion	Written Test
14.	Students are capable of naming and explaining the types and functions of various soil improvers used in soil quality improvement.	Lecture and Class Discussion	Written Test

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction: Definitions and key words related to soil remediation	**1**	
Soil, sediment, and groundwater as entities/objects of remediation.	**1**	
Sources and forms of pollutants/contaminants, and forms of land damage, especially those caused by pollution.	**1**	
Damage/pollution assessment and legislation for preventing and managing land damage/pollution.	**1**	
Basic principles and techniques of soil remediation.	**1**	
Electrokinetic and electrochemical decontamination techniques.	**1**	
Decontamination using Phytoremediation	**1**	
Soil and Plant Growth	**1**	
Soil Quality	**1**	
Coal Ash	**1**	
Vulcanic Ash, Sand, Rocks	**1**	
Charcoal/Biochar	**1**	
Clay	**1**	
Land repair materials	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		50%
2.	Final Examination		50%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Blume, H.-P., Horn, R., Thiele-Bruhn, S. 2010. Soil Conservation Manual**.** Soil ecology and pollution / preventive and defensive protective measures. Wiley- VCH, Weinheim.
2. Mohr, E.C.J., F.A. van Baren, J. Van Schuylenborgh. 1972. Tropical soils: a comprehensive study of their genesis. Nederlands: Gueze Dordrecht
3. Borchardt, G. 1989. Smectites. In J. B. Dixon and S. B. Weed. **Minerals in Soil Environments.** SSSA Book Series.
4.

Journal articles:

a) Selected articles (to be adapted in yearly basis)
b) Nartey, O.D. and Zhao, B. 2014. Biochar Preparation, Characterization, and Adsorptive Capacity and Its Effect on Bioavailability of Contaminants: An Overview. Advances in Materials Science and Engineering (http://dx.doi.org/10.1155/2014/715398)
c) Spokas, K.A. et al. 2012. Biochar: A Synthesis of Its Agronomic Impact beyond Carbon Sequestration (J. Environ. Qual. doi:10.2134/jeq2011.0069
d) Xiao, X. et al., 2018. Insight into Multiple and Multilevel Structures of Biochars and Their Potential Environmental Applications: A Critical Review (Environ Sci Technol. 2018 May 01; 52(9): 5027–5047. doi:10.1021/acs.est.7b06487)
e) Kalus, Kajetan; Koziel, Jacek A.; Opaliński, Sebastian. 2019. "A Review of Biochar Properties and Their Utilization in Crop Agriculture and Livestock Production" *Appl. Sci.* 9, no. 17: 3494. https://doi.org/10.3390/app9173494
f) Jien, S.H. and C.S. Wang. 2013. Effects of biochar on soil properties and erosion potential in a highly weathered soil. Catena 110:225-233 https://doi.org/10.1016/j.catena. 2013.06.021

Others:

- Darmawan, 2001. Feasibility of Electrokinetic Decontamination Technology for Soils That Differ in Cation Exchanger Composition and Polluted by Heavy Metals. Dissertation. Kyushu University
- Zapata, F., R.N. Roy. 2004. Use of Phosphate Rocks for Sustainable Agriculture. Food and Agriculture Organization of the United Nations, Rome. https://www.fao.org/3/y5053e/y5053e00.htm#Contents
- Phosphorus Future. http://phosphorusfutures.net/

PWL1652: Geographic Information Systems

A. Module identity

1	Course Name	Geographic Information Systems
2	Course Code	PWL1652

3	Credit	2(2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Baba Barus, M.Sc
7	Lecturers	Dr. Khursatul Munibah; Dr. Muhammad Ardiansyah, Dr Boedi Tjahjono, Bambang Hendro Trisasongko, M.Si.,Ph.D
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: Master of Regional Planning (MRP) and MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To identify various advanced concepts in GIS knowledge and techniques, including data entry, analytical functions, and examples of GIS applications, particularly in addressing biophysical, social, and economic environmental issues, and designing final outputs.
2. To utilize geographic information systems to inventory land and regional characteristics.
3. To use geographic information systems for planning sustainable land use and management.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand the lecture content: basic GIS concepts and various examples of advanced GIS applications.	Lecture and Class Discussion	Mid Term Examination
2.	Students are able to explain various map projections and coordinate systems in GIS software.	Video and Class Discussion	Mid Term Examination

3.	Students are able to understand and process vector data in GIS software.	Lecture and Class Discussion	Mid Term Examination
4.	Students are able to recognize the structure and form of raster data and process it in GIS software.	Lecture and Class Discussion	Mid Term Examination
5.	Students are able to understand data entry and GPS integration with other data or attributes in GIS software.	Lecture and Class Discussion	Mid Term Examination
6.	Students are able to to recognize and understand the steps for creating, processing, and managing spatial data.	Lecture and Class Discussion	Mid Term Examination
7.	Students are able to understand the steps for processing and managing spatial data.	Lecture and Class Discussion	Mid Term Examination, Assignment, Presentation
8.	Students are able to use functions for analysis, classification, generalization of area measurements, lines, and points in thematic mapping, and calculation of spatial data indices (statistics and pattern quantification).	Lecture and Class Discussion	Final Examination, Assignment
9.	Students are able to utilise neighbourhood function	Lecture and Class Discussion	Final Examination
10.	Students are able to use and explain linking functions.	Lecture and Class Discussion	Final Examination
11.	Students are able to use and explain the function of overlap	Lecture and Class Discussion	Final Examination
12.	Students are able to understand and create GIS modelling for biophysical and socio-economic data analysis. Capable of understanding modelling and GIS simulation for evaluating physical resources and planning.	Lecture and Class Discussion	Final Examination
13.	Students are able to recognize and understand the design of both academic and general spatial and cartographic products.	Lecture and Class Discussion	Final Examination
14.	Students are able to explain the process of presenting results from GIS products within group dynamics.	Peer Assessment	Final Examination and Assignment

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction	**1**	
Map Projection	**1**	
Vector Data Shapes and Structures	**1**	
Form and structure of raster data	**1**	

Collection, entry, preprocessing, and management of data.	**1**	
Database and Management	**1**	
Database and Queries	**1**	
Analysis 1	**1**	
Spatial Neighbourhood Function	**1**	
Spatial linkage functions	**1**	
Spatial Analysis: Overlay	**1**	
Spatial Modelling	**1**	
Cartography	**1**	
Contemporary cartography and webgis	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination	Week 8	
2.	Final Examination	Week 16	
3.	Assignment		

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Baba Barus dan US Wiradisastra, 2000. Sistem Informasi Geografis (diktat Kuliah). Terbitan Dept ITSL, IPB, Bogor
2. Kang-tsung Chang, 2019. Introduction to Geographic Information System. 9th edition. McGraw Hill. 374p
3. M.N DeMeyers, 2003. Fundamentals of Geographic Information Systems. 2nd Edition. Wiley, 636p
4. Menno J Kraak, F Ormeling, 2003. Cartography: Visualization of Geospatial Data. 2nd edition. Prentice Hall. 205p
5. Peter A Burrough, R.A McDonnell, C.D. Lloyd. 2015. Principles of Geographical Information System. 3rd edition, Oxfod Press. 330p
6. R. Laurini, 2001. Information Systems for Urban Planning. 1st edition. Taylor and Francis, 349p

Journal articles:

a) Selected articles (to be adapted in yearly basis)

PWL1653: Techniques in Geographic Information

A. Module identity

1	Course Name	Techniques in Geographic Information
2	Course Code	PWL1653
3	Credit	1(0-1)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Dra. Khursatul Munibah, M.Sc
7	Lecturers	Bambang Hendro Trisasongko S.P. M.Si. Ph.D; Dr. Ir. Baba Barus M.Sc.; Dr.Drs. Boedi Tjahjono; Dr.Ir. Muhammad Ardiansyah M.Eng.Sc.; Wahyu Iskandar S.Hut. MAgr
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MRP and MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To understand and prepare spatial and attribute data for cartographic analysis using Geographic Information Systems (GIS).
2. To input and process spatial and attribute data using various analytical techniques, and to cartographically layout data from analysis results.
3. To work on mini projects based on spatial and attribute data for specific purposes in line with the intended competencies, and to present and disseminate the analysis results to relevant stakeholders.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to distinguish the functions of RBI maps and thematic maps and recognize GIS software (QGIS and ArcGIS).	Lecture and Class Discussion	Discussion
2.	Students are able to register coordinates, digitize spatial data, and analyse the results.	Lecture and Demo	Student Demo, Report
3.	Students are able to input attribute data, join attribute data, and analyse the results.	Peer Lecture	Student Demo, Report
4.	Students are able to overlay vector data and analyse the results.	Peer Lecture	Student Demo, Report
5.	Students are able to overlay raster data and analyse the results.	Peer Lecture	Student Demo, Report
6.	Students are able to build a Digital Elevation Model (DEM), classify slope classes, and analyse the results	Peer Lecture	Student Demo, Report
7.	Students are able to interpolate spatial data (IDW, kriging) and analyze the results	Peer Lecture	Student Demo, Report
8.	Students are able to carry out road network analysis to find the closest area to the centre of activity and analyse the results	Peer Lecture	Student Demo, Report
9.	Students are able to classify PJ data for land use/land cover and analyse the results	Peer Lecture	Student Demo, Report
10.	Students are able to layout spatial data cartographically and find alternative mini project ideas	Peer Lecture	Student Demo, Report
11.	Students are able to design a small project (mini project) starting from determining the concept, operations, and analysis	Class Discussion	Presentation
12.	Students are able to present and disseminate mini project results	Class Discussion	Presentation

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction to map functions and GIS software (Geographic Information Systems)	**1**	
Spatial data input (digitization, GPS data)	**1**	
Inserting Attributes (Labelling Spatial Data, Joint Attribute)	**1**	
Geoprocessing Vector Data	**1**	

Geoprocessing Raster Data	**1**	
Terrain Analysis using Raster Data	**1**	
Spatial Data Interpolation (IDW, Kriging)	**1**	
Identifying Nearby Areas using Road Network Analysis	**1**	
Remote Sensing Data Extraction	**1**	
Cartography and Introduction to the Mini Project	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Class Activity		25%
2.	Report		25%
3.	Mini Project		50%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

- https://www.youtube.com/watch?v=quuN1IaXNig
- https://peraturan.bpk.go.id/Home/Details/149750/uu-no-11-tahun-2020
- https://peraturanpedia.id/peraturan-kepala-badan-informasi-geospasial-nomor-15-tahun-2014/
- https://tanahair.indonesia.go.id/portal-web/downloadpetacetak

PWL1603: Geospatial Techniques

A. Module identity

1	Course Name	Geospatial Techniques
2	Course Code	PWL1603
3	Credit	1(0-1)
4	Semester	
5	Pre-requisite	
6	Coordinator	Bambang Hendro Trisasongko, M.Si.,Ph.D
7	Lecturers	Dyah Retno Panuju, S.P., M.Si; Dr. Khursatul Munibah, M.Sc
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MRP and MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To understand the basic concepts of geospatial data processing.
2. To make predictions and be proficient in modelling land cover/use changes.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand the lecture content: Basic geospatial concepts and their changes.	Lecture and Class Discussion	
2.	Students are able to explore geospatial analyses and methods.	Lecture	Assignment
3.	Students are able to master advanced concepts in remote sensing and machine learning.	Lecture	Presentation
4.	Students are able to demonstrate image classification results using software.	Lecture	
5.	Students are able to explore change analysis.	Lecture	Assignment
6.	Students are able to master mapping techniques and understand mathematical relationships between variables.	Lecture	
7.	Students are able to organize research projects based on previous lecture material.	Lecture	Mini Project 1 Presentation
8.	Students are able to master the concept of land use prediction models (CA-Markov).	Lecture	
9.	Students are able to master the concept of land use prediction models (CluMondo)	Lecture	

10.	Students are able to master the concept of neural network	Lecture	
11.	Students are able to demonstrate their understanding of neural network using RS Toolbox	Lecture and Class Discussion	Assignment
12.	Students are able to master critical thinking in all aspects of this course.	Lecture and Class Discussion	Assignment
13.	Students are able to communicate their findings and their ideas on the given materials.	Lecture and Class Discussion	Assignment

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction	**1**	
Analytical Approaches and Methods	**1**	
Remote Sensing and Machine Learning	**1**	
Image Classification using QGIS Plugins	**1**	
Change analysis: processing preparation and alternative analysis techniques.	**1**	
Dasymetric Mapping & Logistic Regression Analysis	**1**	
Land Use Prediction Model (CA_Marcov)	**1**	
Land use prediction model (CluMondo)	**1**	
Introduction to Neural Networks	**1**	
Implementation of Neural Networks in rstoolbox	**1**	
SCL Discussion	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Final Examination		30%
2.	Mini Project		50%
3.	Assignments		20%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

-

PWL1651: Remote Sensing and Ground-based Sensors

A. Module identity

1	Course Name	Remote Sensing and Ground-based Sensors
2	Course Code	PWL1651
3	Credit	2(2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	Dr. Ir. Muhammad Ardiansyah; Bambang Hendro Trisasongko, S.P., M.Si.,Ph.D; Dr. Dra. Khursatul Munibah
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MRP and MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To understand the basic concepts and meaning of remote sensing, sensor characteristics, remote sensing data, and knowledge related to processing remote sensing data for natural resource management and regional planning.
2. To understand remote sensing technology for inventorying land characteristics.
3. To comprehend the process of remote sensing data processing for land use mapping and land-use change analysis.
4. To understand and utilize remote sensing data for land use and management planning.
5. To manage tasks responsibly, with honesty, cooperation, openness, loyalty, and high integrity in performing duties within the scope of their activities.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand the basic definitions and concepts of remote sensing, and its general applications.	Lecture and Class Discussion	Discussion
2.	Students are able to understand and explain photographic remote sensing systems, including the concepts of aerial photography, aerial sensors/cameras, and the basic characteristics of aerial photography.	Lecture and Class Discussion	Discussion
3.	Students are able to understand and explain the geometry of aerial photography, including projection, relief displacement, and 3D views, as well as the process of interpreting aerial photos.	Lecture and Class Discussion	Discussion, Assignment
4.	Students are able to understand drone photogrammetry and explain the differences between airborne remote sensing and ground-based sensing concepts, as well as explain the use of drone data for land use planning.	Lecture and Class Discussion	Discussion
5.	Students are able to understand operational natural resource satellites, including the characteristics of the satellites and the sensors they carry, and to apply this knowledge for regional planning.	Lecture and Class Discussion	Discussion, Assignment
6.	Students are able to understand operational natural resource satellites, including the characteristics of the satellites and sensors they carry, and to comprehend their applications for regional planning.	Lecture and Class Discussion	Discussion, Assignment
7.	Students are able to understand and explain variations in spectral response from remote sensing data, the spectral response of ground sensors, and the spectral response patterns of plants and soil.	Lecture and Class Discussion	Discussion
8.	Students are able to understand and explain the characteristics of thermal remote sensing, thermal radiation, and thermal imaging, as well as their applications for heat island mapping and mitigation.	Lecture and Class Discussion	Discussion, Assignment

9.	Students are able to understand and explain the initial processing of digital images for further analysis, including mapping built and non-built areas.	Lecture and Class Discussion	Discussion
10.	Students are able to understand and explain pixel grouping (classification), pixel-based classification approaches and strategies, and to master the process of assessing classification accuracy.	Lecture and Class Discussion	Discussion, Assignment
11.	Students are able to understand and explain object-based pixel grouping and its differences from pixel-based classification, pixel-based classification approaches and strategies, and to master the process of assessing classification accuracy.	Lecture and Class Discussion	Discussion
12.	Students are able to understand and explain machine learning-based pixel grouping, technical approaches and strategies for machine learning, and to master operating procedures for machine learning engineering.		Final Examination
13.	Students are able to understand the application of machine learning techniques for land parameterization and mapping, as well as future developments in methodology and applications.	Lecture and Class Discussion	Discussion, Assignment
14.	Students are able to understand and explain land use changes, including the factors and drivers behind these changes, the methodology for monitoring them, and their application in regional planning.	Lecture and Class Discussion	Discussion

E. Module contents

Topic	Number of Week(s)	Contact Hours
Definition and Foundation of Remote Sensing, Applications of Remote Sensing Data	1	
Photographic Remote Sensing System: • Definition and types of aerial photography • Aerial sensors/cameras	1	

• Basic characteristics of aerial photography: endlap/sidelap, scale, photographic resolution, and the process of aerial photo printing		
Basic Geometry of Aerial Photography and the Process of Visual Interpretation: • Geometric Elements of Aerial Photography • Relief Shift, Parallax, and 3D View • Photo/Orthophoto Maps • Interpretation of Aerial Photos for Planning and Land Use	1	
UAV/Drone Photogrammetry: • Definition of UAV/Drone • Drone Characteristics • Flying Mission Planning and Drone Photo/Image Mosaicking • Drone Applications for Detailed Planning and Land Use Mapping	1	
Remote Sensing Satellites for Natural Resources: Medium - Small Resolution • Types and Characteristics of Medium/Small Resolution Satellites: Landsat, Sentinel-2 • Applications for Land Use Mapping and Plant Monitoring	1	
High-Resolution Remote Sensing Satellites for Natural Resources • Types and Characteristics of High-Resolution Satellites: IKONOS/QB, Pleiades, GeoEye, WorldView • Applications for Land Use and Plant Mapping • Review of Basic Characteristics of Remote Sensing Data for Natural Resources	1	
Spectral Response • Spectral Response Patterns • Spectrometry • Spectral Reflectance of Plants and Soil	1	
Thermal Remote Sensing: • Sensing Concept: Thermal Remote Sensing • Thermal Image Interpretation • Surface Temperature Mapping with Thermal Imagery and Its Application for Regional Planning	1	
Digital Image Preprocessing and Image Sharpening: • Preprocessing: Geometric/Radiometric Correction and Image Enhancement • Remote Sensing Data Index and Its Application for Identifying Built-Up Areas	1	

Digital Image Classification: • Image Classification • Pixel-Based Classification Approaches • Assessment of Classification Accuracy	1	
Object-Based Image Classification: • Object-Based Classification • Image Segmentation and Classification Process • Identification and Mapping of Land Use Based on Digital Classification of Remote Sensing Data	1	
Machine Learning: • Basic Concepts of Machine Learning • Machine Learning Techniques and Approaches • Accuracy Assessment	1	
Machine Learning: • Identify land characteristics and land use mapping using machine learning analysis techniques. • Future technical developments in machine learning.	1	
Land Cover/Use Change Detection: • Changes in land use • Change detection methods (binary change, "from-to" analysis, CVA, probability change) • Use change detection techniques for monitoring land allocation and planning	1	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination	Week 8	35%
2.	Final Examination	Week 16	35%
3.	Report		30%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. T.M. Lillesand, R.W. Kiefer, and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition. John Wiley & Sons, Inc.
2. J.R. Jensen. 2015. Introductory Digital Image Processing: A Remote Sensing Perspektive. Prentice-Hall, Engewood Clifft, NJ.

3. R.S. Dwivedi. 2017. Remote Sensing of Soils. Springer-Verlag GmbH, Germany
4. O. Theobald. 2017. Machine Learning for Absolute Beginners
5. A.E. Maxwell, T. A. Warner, and F. Fang. 2018. Implementation of machine-learning classification in remote sensing: an applied review. International Journal of Remote Sensing, 39:9, 2784-2817, DOI: 10.1080/01431161.2018.1433343

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1633: Ecohydrology and Sustainable Water Resource Management

A. Module identity

1	Course Name	Ecohydrology and Sustainable Water Resource Management
2	Course Code	TNH1633
3	Credit	3(3-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Ir. Yayat Hidayat, M.Si
7	Lecturers	Dr. Ir. Enni Dwi Wahjunie, M.Si; Dr. Ir. Dwi Putro Tejo Baskoro, M.Sc.Agr; Dr. Sri Malahayati Yusuf., SP., M.Si.
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To Understand and master the principles of ecohydrology and be able to apply these principles to sustainable water resources management.
2. To analyze, find solutions for, and apply solutions to resolving water resource management problems related to:
    a. Quantity and quality of water resources

b. Economic value of water resources
c. Strategic issues of water resources
d. Conservation of water resources and the environment
e. Hydrometeorological disaster mitigation
f. Integrated watershed management
g. Land use and regional spatial planning
h. Water resources management strategies and policies
i. Integrated water resources management

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand, explain, and develop the concept of ecohydrology as a new paradigm in sustainable water resource management.	Lecture	Question and Answer
2.	Students are able to understand and explain the characteristics of water resources in Indonesia (quantity, quality, continuity).	Lecture	Question and Answer
3.	Students are able to understand, explain, and develop the economic value of water resources in various aspects of life.	Lecture	Question and Answer
4.	Students are able to understand and explain strategic issues in water resource management and their development within integrated water resource management.	Lecture	Question and Answer
5.	Students are able to understand, explain, and develop ecohydrology from the perspective of water resource and environmental conservation.	Lecture	Question and Answer
6.	Students are able to understand, explain, and develop ecohydrology from the perspective of hydrometeorological disaster mitigation (floods and droughts), with a focus on land-based approaches.	Lecture	Question and Answer
7.	Students are able to understand, explain, and develop ecohydrology from the perspective of hydrometeorological disaster mitigation (floods and droughts), with a focus on water bodies.	Lecture	Quiz

8.	Students are able to understand, explain, and develop a watershed approach to water resource management.	Lecture	Question and Answer
9.	Students are able to understand, explain, and develop strategies for restoring watershed hydrological functions in water resource management.	Lecture	Question and Answer
10.	Students are able to understand, explain, and develop aspects of integration and sustainability in water resources management.	Lecture	Question and Answer
11.	Students are able to understand, explain, and develop land use and spatial planning based on water resources.	Lecture	Quiz
12.	Students are able to understand, explain, and develop best management practices for water resource management.	Lecture	Question and Answer
13.	Students are able to understand, explain, and formulate various problems and solutions for sustainable water resource management.	Collaborative learning and Independent Study	Report
14.	Students are able to understand, explain, and formulate management strategies and policies for water resources.	Collaborative learning and Independent Study	Report, Presentation

E. Module contents

Topic	Number of Week(s)	Contact Hours
Ecohydrology and ecohydrological principles in sustainable water resource management	**1**	
• Surface water and groundwater resources • Quantity, quality, and continuity of water resources in Indonesia	**1**	
Economic value of water resources (agriculture, households, cities, industry, fisheries, hydropower, and the environment)	**1**	
• Strategic issues in water resource management related to water balance (availability vs. need) • Flood and drought management • Environmental carrying capacity and environmental health • Integrated spatial planning and resource management	**1**	
Ecohydrology in water resource and environmental conservation	**1**	
Ecohydrology from the perspective of hydrometeorological disaster mitigation (floods and droughts): land-based	**1**	

Ecohydrology from the perspective of hydrometeorological disaster mitigation (floods and droughts): based on water bodies	**1**	
Watershed Approach to Water Resource Management	**1**	
Restoration of Watershed Hydrological Functions in Water Resource Management	**1**	
Aspects of Integration and Sustainability in Water Resources Management	**1**	
Land Use/Spatial Planning Based on Water Resources	**1**	
Best Management Practices for Water Resources Management	**1**	
Review Paper on Ecohydrology and Sustainable Water Resources Management	**1**	
Water Resources Management Strategies and Policies	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Fulazzaky M A. 2014. Challenges of Integrated Water Resources Management in Indonesia. Water (6): 2000-2020. doi:10.3390/w6072000.
2. Rhagunath, H.M. 2006. Hydrology: Principle, Analysis and Design. New Age International (P) Limited, Publisher 4835/24, Ansari Road, Daryaganj, New Delhi – 110002. 477p.
3. Soeprobowati T R. 2010. Ekohidrologi Konsep Pengelolaan Lingkungan Berkelanjutan. BIOMA, Vol. 12, No. 1, Hal. 13-19. ISSN: 1410-8801.
4. Wood P J, D M. Hannah, and JP. Sadler. 2010. Hydroecology and Ecohydrology: Past, Present and Future. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England. 466p.

Journal articles:

a) Selected articles (to be adapted in yearly basis)
b) Zalewski, M. 2010. Ecohydrology for compensation of Global Change. Brazilian Journal of Biology. Vol. 70 (3): 689-695

Others:

- Zalewski M and I W. Lotkowska. 2004. Integrated Watershed Management: Ecohydrology and Phytotechnology Manual. United Nation Environment Program. Divison of Technology, Industry and Economic, and International Environmental Technology Centre. Osaka 538-0036. Japan

- World Meteorological Organization, 2009. Guide to Hydrological Practices, Volume II: Management of Water Resources and Application of Hydrological Practices WMO-No. 168.
- Light H.M, M.R. Darst, L J, Lewis, and D A. Howel. 2002. Hydrology, Vegetation, and Soils of Riverine and Tidal Floodplain Forests of the Lower Suwannee River, Florida, and Potential Impacts of Flow Reductions. United State Geological Survey Profesional Paper 1656A.
- Global Water Partnership and the International Network of Basin Organization. 2009. A Handbook for Integrated Water Resource Management in Basin. Elanders, Sweden. ISBN: 978-91-85321-72-8.

TNH1501: Land Degradation and Rehabilitation

A. Module identity

1	Course Name	Land Degradation and Rehabilitation
2	Course Code	TNH1501
3	Credit	2(2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr Ir. Dwi Putro Tejo Baskoro, MSc
7	Lecturers	Dr Ir. Budi Nugroho MS; Dr Ir. Gunawan Djajakirana
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To explain the scope, meaning, terms, and phenomena related to land damage and degradation, as well as measure and analyze parameters of land damage and degradation, and apply this knowledge to manage land resources to prevent further degradation.
2. To analyse and apply the principles of land rehabilitation to manage land resources effectively, prevent land degradation, and resolve land resource management issues.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to understand, explain, and develop the concepts and scope of land degradation and rehabilitation.	Lecture	Question and Answer
2.	Students are able to explain various forms of erosive land damage on agricultural land.	Lecture	Question and Answer
3.	Students are able to explain various forms of erosive land degradation and efforts to prevent and address it.	Lecture	Question and Answer
4.	Students are able to explain various forms of non-erosive agricultural land damage, as well as their prevention and management.	Lecture	Question and Answer
5.	Students are able to explain various forms of non-erosive land damage, as well as efforts to prevent and address it.	Lecture	Question and Answer
6.	Students are able to explain various forms of erosion related to pollution.	Lecture	Question and Answer
7.	Students are able to explain various forms of erosion related to pollution	Lecture	Question and Answer
8.	Students are able to explain various efforts to prevent and control land degradation caused by pollution, acidification, salinization, and sodification.	Lecture	Question and Answer
9.	Students are able to explain and understand the characteristics of wetlands and the types of degradation that occur in them.	Lecture	Question and Answer
10.	Students are able to explain and understand biological degradation.	Lecture	Question and Answer
11.	Students are able to explain various forms of land damage related to mining activities, as well as methods to prevent and address them.	Lecture	Question and Answer
12.	Students are able to explain the various forms of land damage that occur in wetlands, as well as methods to prevent and address them.	Lecture	Question and Answer
13.	Students are able to explain and evaluate land degradation	Lecture	Question and Answer
14.	Students are able to explain and understand land use planning to anticipate and prevent land degradation	Lecture	Question and Answer

E. Module contents

Topic	Number of Week(s)	Contact Hours
Land Degradation and Rehabilitation Scope	1	
Land Degradation Due to Agricultural Activities: Erosive Degradation – Processes, Mechanisms, Forms, and Impacts of Erosion and Sedimentation	1	
Prevention, Control, and Mitigation of Land Degradation Due to Erosion and Sedimentation	1	
Non-Erosive Land Degradation on Agricultural Land: Chemical Degradation, Organic Material Degradation, Nutrient Depletion, and Leaching	1	
Prevention, Control, and Mitigation of Non-Erosive Land Degradation	1	
Pollution and Acidification	1	
Salinization and Sodification	1	
Prevention, Control, and Mitigation of Land Degradation Due to Pollution, Acidification, Salinization, and Sodification	1	
Characterizing Wetlands and Land Degradation in Wetlands	1	
Biological Soil Degradation - Biological Deterioration	1	
Characteristics of Ex-Mining Land and Land Degradation Processes on Ex-Mining Land	1	
Rehabilitation: Restoration and Reclamation of Wetlands and Ex-Mining Land	1	
Land Degradation Evaluation	1	
Land Use Planning: Anticipatory Methods for Preventing and Overcoming Land Degradation	1	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Arsyad, S. 2006. Konservasi Tanah dan Air. IPB Press. Bogor
2. Barrow, 1991. Land Degradations.
3. Hudson, N. 1971. Soil Conservation. Cornell University Press. NY

4. Troeh, F. R., J. A. Hobbs, and R.L. Donahue. 1980. Soil and Water Conservation for Productivity and Environmental Protection. Prentice Hall Inc. Englewood Cliffs, NY.
5. Hank and Jurinak, 1981. Modern Irrigated Soils.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1541: Agricultural Waste Composting

A. Module identity

1	Course Name	Agricultural Waste Composting
2	Course Code	TNH1541
3	Credit	3(2-1)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Rahayu Widyastuti, MSc
7	Lecturers	Dr. Ir. Gunawan Djajakirana, MSc
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To understand organic fertilizers, including their raw material sources, potential, manufacturing technology, development, properties, quality, use, and economic value.
2. To understand compost in relation to its raw material sources, potential, development, compost-making technology, properties, quality, use, and economic and ecological value.
3. To understand the evaluation of organic fertilizer/compost quality through laboratory tests, as well as the requirements and procedures for obtaining a distribution permit if they wish to commercialize it.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to explain the importance of organic matter for improving the physical, chemical, and biological properties of soil, plant growth and production, and soil quality.	Lecture and Class Discussion	Written Test, Assignment

2.	Students are able to understand the nature, potential, and general uses of various types of agricultural waste.	Lecture and Class Discussion	Written Test, Assignment
3.	Students are able to explain the potential of plant waste from food and horticulture at the national level, including its distribution, general characteristics, and current uses.	Lecture and Class Discussion	Written Test, Assignment
4.	Students are able to explain the potential of plantation waste in Indonesia, including its distribution, general characteristics, and current uses.	Lecture and Class Discussion	Written Test, Assignment
5.	Students are able to explain the potential of livestock and fisheries waste in Indonesia, including its distribution, general characteristics, and current uses.	Lecture and Class Discussion	Written Test, Assignment
6.	Students are able to explain the potential of forestry waste in Indonesia, including its distribution, general characteristics, and current uses.	Lecture and Class Discussion	Written Test, Assignment
7.	students are able to explain the potential of agricultural processing industrial waste in Indonesia, including its distribution, general properties, and current uses.	Lecture and Class Discussion	Written Test, Assignment
8.	Students are able to explain the factors that influence the composting process.	Lecture and Class Discussion	Written Test, Assignment
9.	Students are able to understand the criteria for compost maturity and evaluate the quality of organic fertilizer physically, chemically, and biologically.	Lecture and Class Discussion	Written Test, Assignment
10.	Students are able to understand how to improve the quality of organic fertilizer and the procedures for registering organic fertilizer.	Lecture and Class Discussion	Written Test, Assignment
11.	Students are able to: • Explain the physical, chemical, and biological quality criteria for organic fertilizer • Understand organic fertilizer registration procedures	Lecture and Class Discussion	Written Test, Assignment

	• Evaluate quality and conduct efficacy testing		
12.	Students are able to explain the Minister of Agriculture's regulations on organic fertilizers.	Lecture and Class Discussion	Written Test, Assignment

E. Module contents

Topic	Number of Week(s)	Contact Hours
• Definition of organic matter • Its general properties • Improvement of the physical, chemical, and biological properties of soil with organic matter	**1**	
• Various kinds of organic waste • General characteristics, potential, and use of different types of agricultural waste	**1**	
• Potential agricultural waste from food crops • Potential horticultural waste	**1**	
Potential plantation waste, including its general characteristics and current uses	**1**	
Livestock and Fishery Waste	**1**	
Forestry Waste	**1**	
Agro – Industrial Waste	**1**	
Nutrient content and size of materials	**1**	
• Water content • Inoculum • Temperature	**1**	
Compost Maturity: Criteria and Quality Evaluation	**1**	
Quality Improvement and Registration of Organic Fertilizers	**2**	
Basic Considerations and Criteria	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Mid Term Examination		40%
2.	Final Examination		40%
3.	Assignment		20%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Alexander, M. 1972. Introduction to Soil Microbiology. John Wiley & Sons, Inc. New York and London: 472 pp
2. Federal Compost Quality Assurance Organization. 1994. Methods Book for the Analysis of Compost. 3rd Supplemented and Revised Edition. Abfall Now e.V Publishing House, Stuttgart, 88pp
3. Soepardi. 1983. Sifat dan Ciri Tanah. Jurusan Tanah, Fakultas Pertanian, Institut Pertanian Bogor. Bogor. 591 hal.
4. Insam, H., N. Riddech, S. Klammer (Eds) 2002. Microbiology of Composting. Springer-Verlag Berlin, Heidelberg New York 632p
5. Schinner, F., R. Ohlinger, E. Kandeler and R. Margesin. Methods in Soil Biology. Springer-Verlag Berlin Heidelberg New York:426 pp

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

- Iswandi, A. 1989. Biologi Tanah dalam Praktek. PAU Bioteknologi Institut Pertanian Bogor:254 pp
- Permentan-No.-28-Permentan-SR.130-5-2009-TAHUN-2009-TENTANG- PUPUK ORGANIK, PUPUK HAYATI DAN PEMBENAH TANAH
- Permentan-No. 70 Tahun 2011

TNH1523: Fertilizer Technology and Fertilization

A. Module identity

1	Course Name	Fertilizer Technology and Fertilization
2	Course Code	TNH1523
3	Credit	2(2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Ir. Budi Nugroho, MSi
7	Lecturers	Dr. Ir. Lilik Tri Indriyati, MSc
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To understand mineral fertilizers in relation to their sources, manufacturing technology, properties, usage, and economic value.
2. To understand biological fertilizers in relation to their sources, isolation and development, propagation technology, properties, uses, and economic and ecological value.
3. To understand nutrient evaluation through soil and biological tests, the interpretation of results, and fertilizer recommendations based on soil test approaches, biological tests, or both.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students are able to explain: • The definition of inorganic, organic, and biological fertilizers.	Lecture and Class Discussion	Written Test, Report

	• The history of fertilizer development and types of fertilizers.		
2.	Students are able to explain: • Nitrogen Fertilizer: N fertilizer production technology, types of N fertilizers, and their properties. • Phosphorus Fertilizer: P fertilizer production technology, types of P fertilizers, and their properties. • Potassium Fertilizer: K fertilizer production technology, types of K fertilizers, and their properties	Lecture and Class Discussion	Written Test, Report
3.	Students are able to explain: • Calcium Fertilizer: Production technology and properties • Magnesium Fertilizer: Production technology and properties • Sulfur Fertilizer: Production technology and properties	Lecture and Class Discussion	Written Test, Report
4.	Students are able to explain: • Micro Fertilizer: Production technology, types of micro fertilizers, and their properties. • Slow/Controlled Release Fertilizer: Production technology, types, and properties of slow/controlled release fertilizers	Lecture and Class Discussion	Written Test, Report
5.	Students are able to explain: • The philosophy of organic and biological fertilizers • Organic fertilizer production technology	Lecture and Class Discussion	Written Test, Report

	• Biological fertilizer production technology		
6.	Students are able to explain: • The important role of microorganisms for soil health • Isolation of functional organisms • Multiplication of functional organisms • The potential of functional organisms to increase nutrient availability	Lecture, Class Discussion, Video	Written Test, Report
7.	Students are able to explain: • Mass multiplication of functional organism isolates and the challenges involved • Various types of bioreactors for microorganism multiplication • Characteristics of carrier isolates and their suitability for mass production of biofertilizers	Lecture and Class Discussion	Written Test, Report
8.	Students are able to explain: • Characteristics of organic and enriched organic fertilizers • Population of organisms in single biofertilizers and consortia • Compatibility between functional organisms • Expiry limits for biological fertilizers	Lecture, Class Discussion, Video	Written Test, Report
9.	Students are able to explain: • Nutrient evaluation philosophy • Soil testing • Biological and chemical testing	Lecture, Class Discussion, Video	Written Test, Report

	• Correlation and calibration • Interpretation of results		
10.	Students are able to explain: • Fertilization recommendation philosophy • General recommendations • Recommendations based on geological and soil maps • Location-specific recommendations • Fertilizer recommendations based on soil tests	Lecture and Class Discussion	Written Test, Report
11.	Students are able to explain: • Philosophy of plant analysis • Relationship between age, nutrients, and yield • Factors that influence plant nutrient levels • Interpretation of plant analysis results	Lecture and Class Discussion	Written Test, Report
12.	Students are able to explain: • Philosophy of fertilization programs • Fertilizer placement • Factors influencing fertilizer placement: soil properties, plant characteristics, movement of fertilizers/nutrients, salt index, timing, carryover, and cropping systems	Lecture and Class Discussion	Written Test, Report
13.	Students are able to explain: • Philosophy of fertilization programs • Fertilizer placement • Factors influencing fertilizer placement: soil properties, plant characteristics,	Lecture and Class Discussion	Written Test, Report

	movement of fertilizers/nutrients, salt index, timing, carryover, and cropping systems • Efficient use of fertilizers		
14.	Students are able to explain: • Integrated nutrient diagnosis • Diagnosis and Recommendation Integrated System (DRIS) • Compositional Nutrient Diagnosis (CND) • Deviation of Optimum Percentage (DOP) • Fertilization recommendations based on cation comparison	Lecture and Class Discussion	Written Test, Report

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction	**1**	
N, P, and K Fertilizer Production Technology	**1**	
Ca, Mg, and S Fertilizer Production Technology and Their Derivatives	**1**	
Microfertilizer Production Technology and Slow-Release/Controlled-Release Fertilizers	**1**	
Technology and Production Systems for Organic and Biological Fertilizers	**1**	
The role of microorganisms in soil health and biological fertilizers: isolation, propagation, and potency	**1**	
Biological Fertilizer Production	**1**	
Fertilizer Characterization (Organic and Biological)	**1**	
Evaluation of Nutrient Status and Fertilizer Recommendations Based on Soil Tests	**1**	
Development of Fertilization Recommendations I	**1**	
Development of Fertilization Recommendations II	**1**	
Engineering Concepts and Fertilizer Applications	**1**	
Economics and Efficiency of Fertilizer and Lime	**1**	
Fertilization Program Development	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Test 1 (from **Dr Ir Budi Nugroho MSi)**		30%
2.	Test 2 (from **Dr Ir Lilik Tri Indriati MSc)**		20%

3.	Assignment		30%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Hignet, TP. (Ed). 1987. Fertilizer Manual. Springer -Science + Busines Media BV
2. UNIDO and IFDC (Eds). 1998. Fertilizer Manual. Kluwer Acad. Publs. Dordrecht, The Netherlands
3. Rai, MK. 2006. Handbook of Microbial Fertilizer. The Harword Press. Inc. Binghamton, NY
4. Anonimouse 2006. Biofertilizer Manual. FNCA Biofertilizer group. Japan Atomic Industial Forum (JAIF)
5. Reddy, M.S. et al., (Eds). 2014. Recend Edvances in Biofertilizer and Biofungicides (PGPR) for Sustainable Agriculture. Cambridge Scholars , Publs. Newcastle, UK.
6. Brown, JR. (Ed) 1987. Soil Testing : Sampling , Correlation, Calibration and Interpretation. Soil Science Society of America, Inc. Madison, Wisconsin
7. Tisdale, SL; Nelson, WL and Beaton, JD. 1985. Soil Fertility and Fertilizers. 4th ed. Macmillan Publishing Company. New York (atau terbitan yang lebih baru)
8. Black, CA. 1993. Soil Fertility Evaluation and Control. CRC Press. Boca Raton
9.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1621: Nutrient Movement in Plant-Soil System

A. Module identity

1	Course Name	Nutrient Movement in Plant-Soil System
2	Course Code	TNH1621
3	Credit	2(2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Ir. Lilik Tri Indriyati, M.Sc
7	Lecturers	Dr. Ir. Budi Nugroho, M.Si; Dr. Ir. Untung Sudadi, M.Sc.
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To understand and comprehend the movement of nutrients in both cation and anion forms in the soil, along with the factors that influence this movement.
2. To understand and comprehend the movement of nutrients from the soil to the root surface, including the factors that affect this process.
3. To understand and comprehend the movement of nutrients from the root or leaf surface into the plant, their internal movement within the plant, and their movement out of the plant, as well as the factors that influence these processes.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students will understand: • Discoveries or opinions of philosophers and experts from Greek and Roman times to the modern era.	Lecture and Class Discussion	Written Test, Report

	• The concept of soil systems and phases as a heterogeneous system. • The relationship between the solid, liquid, and gas phases in soil.		
2.	Students will understand and comprehend: • The theory of origin and types of soil loads. • The distribution of ions in soil. • The electric double layer theory and its applications. • The mechanisms and characteristics of cation exchange reactions. • The selectivity of cation exchange.	Lecture and Class Discussion	Written Test, Report
3.	Students will understand and comprehend: • Anion retention. • Electrostatic attraction and repulsion of anions. • Anion exchange and specific and nonspecific sorption. • Molecular retention.	Lecture and Class Discussion	Written Test, Report
4.	Students will understand and comprehend: • Properties of water. • Movement of water into and through the soil. • Movement of water in the soil in terms of energy (water potential). • Saturated and unsaturated flow.	Lecture and Class Discussion	Written Test, Report
5.	Students will understand: • The concept of nutrient bioavailability. • Mechanisms for the movement of nutrients to the root surface through diffusion and mass flow. • Factors influencing diffusion and mass flow.	Lecture and Class Discussion	Written Test, Report

	• The definition and mechanism of root interception.		
6.	Students will understand: • The movement of nutrient ions from soil to roots. • The mechanisms of macro nutrient ion movement from soil to roots for each nutrient in dry land. • The mechanisms of micronutrient ion movement from soil to roots for each nutrient in dry land. • Methods to increase the rate of diffusion of phosphorus (P) and potassium (K) nutrients.	Lecture and Class Discussion	Written Test, Report
7.	Students will understand and comprehend: • Nutrient reactivity and mobility. • Factors influencing the composition of the soil atmosphere. • Soil aeration characteristics. • The effect of aeration on the reactivity and mobility of several macro and microelements.	Lecture and Class Discussion	Written Test, Report
8.	Students will understand and comprehend: • The relationship between stem and root. • The rhizosphere. • Ion concentration in the rhizosphere. • pH and rhizosphere redox potential. • Redox potential and the reduction process.	Lecture and Class Discussion	Written Test, Report
9.	Students will understand and comprehend: • Rhizodeposition and root exudates. • The effects of root exudates on root	Lecture and Class Discussion	Written Test, Report

	development and nutrient availability. • Root exudates and their impact on plant nutrient status. • Ectoenzymes. • Rhizosphere microorganisms that do not infect roots.		
10.	Students will understand: • The uptake and loss of water and solutes at the cellular level. • Short-distance or extravascular transport of water and solutes from cell to cell at the tissue or organ level (lateral transport). • Long-distance or intravascular transport of water and solutes in xylem vessels and phloem to all parts of the plant (at the whole-plant level).	Lecture and Class Discussion	Written Test, Report
11.	Students will understand and comprehend: • Water movement mechanisms: mass flow and its influencing factors, diffusion and its influencing factors, and osmosis and its influencing factors. • Water transport in plants: levels of transport, water transport in roots, and the transport and movement of water in the xylem.	Lecture and Class Discussion	Written Test, Report
12.	Students will understand and comprehend: • Stomata as absorption sites • The structure and function of the cuticle layer • The role of stomata and ectodemata in nutrient uptake and transpiration	Lecture and Class Discussion	Written Test, Report

	• Factors that influence nutrient uptake through leaves • The role, practical aspects, and limitations of foliar fertilization • Leaching of nutrients from leaves		
13.	Students will understand and comprehend: • The definition of mycorrhiza • Basic classifications, morphology, and structure of mycorrhiza • Root infection, photosynthate requirements, and host growth • The role of mycorrhiza in nutrient availability	Lecture and Class Discussion	Written Test, Report
14.	Students will understand and comprehend: • The physicochemical and biological binding of N_2 • The stages of N_2 fixation in the air by N_2-fixing microbes (nodule formation, N_2-fixing mechanism) • The types of airborne N_2 fixation in soil (symbiosis, association, free-living) and the factors that influence the biological N_2 fixation process	Lecture and Class Discussion	Written Test, Report

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark
1.	Test 1 (From **Dr Ir Budi Nugroho MSi)**		35%
2.	Test 2 (From **Dr Ir Lilik Tri Indriati MSc)**		20%

3.	Test 3 (From **Dr Ir Untung Sudadi)**		15%
4.	Report		30%

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Baligar, VC & RR. Duncan. 1990. Crops as Enhancers of Nutient Use. Acad. Press, Inc. Sydney.
2. Bohn, H, B. McNeal & G.O'Connor.1979. Soil Chemistry. John Wiley &Sons
3. Epstein, E & Bloom, AJ. 2005. Mineral Nutrition of Plants: Principles and Perspectives. 2nd ed. Sinauer Assoc. Inc. Pbl. Sunderland, Massachussetts. 400p.
4. Luttge, U & Pitman M.G. 1976. Transport in Plant II, Part B Tissues and Organs. In Encyclopedia of Plant Physiology Vol.2. Springer-Verlag, New York. 481p
5. Marschner,H. 1995. Mineral Nutrition of Higher Plants. Academic Press.
6. Mengel, K, Kirby, EA, Kosegarten, H. & Appel, T 2001. Principles of Plant Nutrition. Kluwer Acad. Pbl.. Bern, Switzerland.
7. Nye,PH & PB.Tinker.1977. Solute Movement in the soil-root system.
8. Tinker,PB & PH.Nye 2000. Solute Movement in the Rhizosphere

Journal articles:

a) Selected articles (to be adapted in yearly basis)

TNH1605: Precision Farming 4.0

A. Module identity

1	Course Name	Precision Farming 4.0
2	Course Code	TNH1605
3	Credit	2 (2-0)
4	Semester	
5	Pre-requisite	
6	Coordinator	Dr. Ir.Dwi Putro Tejo Baskoro, M.Sc.Agr
7	Lecturers	Dr. Ir.Dwi Putro Tejo Baskoro, M.Sc.Agr. Prof. Dr. Ir.Arief Hartono, M.Sc.Agr. Dr. Ir.Darmawan, M.Sc Bambang Hendro Trisasongko, S.P., M.Si.,Ph.D
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Blended system: Traditional classroom 80-100%, Online 0-20%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods

E. Module contents

Topic	Number of Week(s)	Contact Hours
Introduction: understanding and concept of precision farming	**1**	**2**

Soil Test	**1**	**2**
Techniques for Diagnosing Plant Nutrient Status	**1**	**2**
Fertilizer Recommendations	**1**	**2**
Location-Specific Fertilization Recommendations	**1**	**2**
Inventory of Concepts and Techniques to Support Careful Farming	**1**	**2**
Spatial Distribution of Major Land Parameters.	**1**	**2**
Mapping and Extraction of Stoic Attribute Data Using a Fuzzy Approach	**1**	**2**
Evaluation of Land Suitability Using Fuzzy Logic to Support Sustainable Farming	**1**	**2**
Micro-Spatial Distribution of Land Parameters	**1**	**2**
Principles of Agricultural Positioning Automation	**1**	**2**
Sensing and Information Extraction Technologies	**1**	**2**
Biophysical Modelling	**1**	**2**
Developing Precision Farming through Research	**1**	**2**

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a) Selected articles (to be adapted in yearly basis)

Others:

•

TNH1591: Proposal

A. Module identity

1	Course Name	Proposal
2	Course Code	TNH1591
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	-

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A	Knowledge	1. Discourse 2. Videos 3. Discussion	1. quiz scores 2. Midterm scores: 10 Multiple choice questions

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a)

Others:

•

TNH1592: Colloquium

A. Module identity

1	Course Name	Colloquium
2	Course Code	TNH1592
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	Indonesian
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Traditional classroom: 100%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To retrieve, edit, enter, and process data effectively.
2. To archive all relevant data.
3. To formulate research findings and develop them into scientific papers to be presented at seminars.
4. To conduct data analysis that aligns with research objectives.
5. To review research findings based on literature searches and compile them into structured arguments and discussions.
6. To formulate conclusions and recommendations from their research.
7. To prepare PowerPoint presentations on their research findings for seminars.
8. To present research findings both orally and through posters.
9. To respond promptly and accurately, demonstrating strong reasoning skills and discipline.
10. To take responsibility for their research results based on theoretical foundations and prior studies.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students will be able to review articles related to research.	Discussion/Consultation with supervising lecturers	Case based learning
2.	Students will be able to disseminate their research plan	Discussion/Consultation with supervising lecturers	Colloquium article, Presentation, Question and Answer

E. Module contents

Topic	Number of Week(s)	Contact Hours
Relevant and recent proceedings/journal articles/books.	**13**	
1. Communication 2. Presentation techniques 3. Questions and answers	**1**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1. Revision Team 4th Edition. 2019. Guidelines for writing scientific papers for students' final assignments, 4th edition.4. IPB University, IPB Press.

PPS1691: Thesis Seminar

A. Module identity

1	Course Name	Thesis Seminar
2	Course Code	PPS1691
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	Indonesian
9	Program(s) in which the course is offered	Generic course offered by the Graduate School
10	Type of teaching	Traditional classroom: 100%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To retrieve, edit, enter, and process data effectively.
2. To archive all relevant data.
3. To formulate research findings and develop them into scientific papers for presentation at seminars.
4. To conduct data analysis that aligns with research objectives.
5. To review research findings based on literature searches, compiling them into structured arguments and discussions.
6. To formulate research conclusions and recommendations.
7. To prepare PowerPoint presentations on research findings for seminars.
8. To present research findings both orally and through posters.
9. To respond promptly and accurately, demonstrating strong reasoning skills and discipline.
10. To take responsibility for their research findings based on theoretical foundations and previous studies.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
1.	Students will be able to conduct research both in the laboratory and in the field.	Discussion/Consultation with supervising lecturers	Research activities, data tabulation, data analysis
2.	Students will be able to explain the results of their research and present them in a thesis draft.	Discussion/Consultation with supervising lecturers	Systematics of writing a thesis, thesis draft, presentation, question and answer

E. Module contents

Topic	Number of Week(s)	Contact Hours
1. Communication 2. Data collection techniques to presenting research results	**7**	
1. Communication **2. Research data presentation techniques** **3. Question and answers**	**7**	

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a)

Others:

•

PPS1692: Scientific Publications at National Level

A. Module identity

1	Course Name	Scientific Publications at National Level
2	Course Code	PPS1692
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Generic course offered by the Graduate School
10	Type of teaching	-

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A	Knowledge	1. Discourse 2. Videos 3. Discussion	1. quiz scores 2. Midterm scores: 10 Multiple choice questions

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a)

Others:

•

PPS1698: Proceedings of International Conference

A. Module identity

1	Course Name	Proceedings of International Conference
2	Course Code	PPS1698
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	English
9	Program(s) in which the course is offered	Generic course offered by the Graduate School
10	Type of teaching	-

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A	Knowledge	1. Discourse 2. Videos 3. Discussion	1. quiz scores 2. Midterm scores: 10 Multiple choice questions

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a)

Others:

•

PPS1695: Scientific Publications at International Level

A. Module identity

1	Course Name	Scientific Publications at International Level
2	Course Code	PPS1695
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	English
9	Program(s) in which the course is offered	Generic course offered by the Graduate School
10	Type of teaching	-

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A	Knowledge	1. Discourse 2. Videos 3. Discussion	1. quiz scores 2. Midterm scores: 10 Multiple choice questions

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a)

Others:

•

TNH1691: Thesis Exam

A. Module identity

1	Course Name	Thesis Exam
2	Course Code	TNH1691
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	Traditional classroom: 100%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A	Knowledge	1. Discourse 2. Videos 3. Discussion	1. quiz scores 2. Midterm scores: 10 Multiple choice questions

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, Projector, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a)

Others:

•

TNH1692: Thesis

A. Module identity

1	Course Name	Thesis
2	Course Code	TNH1692
3	Credit	
4	Semester	
5	Pre-requisite	
6	Coordinator	
7	Lecturers	
8	Language	Indonesian Language
9	Program(s) in which the course is offered	Internal department: MSS
10	Type of teaching	a. Traditional classroom: 0% b. Blended system: Traditional classroom 40- 80%, Online 0-40% c. e-Learning system: 20% d. Others: 0%

B. Workloads (total contact hours and credits per semester)

Credit		Contact				Self-study	Other	Total
SKS	ECTS	Lecture	Exercise	Laboratory	Practice			

**) Semester credit unit according to the Indonesian higher educational system*
1 credit unit lecture = 2 hours/week for lecture and 2 hours/ week for self-study within 14 weeks/ semester 1 credit unit class exercise or laboratory or field practice = 3 hours/week within 12-14 weeks/semester

***) 1 hour for lecture= 50 minutes; 1 hour for class exercise or laboratory or field practice = 60 minutes*

C. Module objectives (learning outcomes, LO)

Students are able:

1. To ...
2.

D. Detailed learning outcomes in relation to learning domains, teaching strategies and assessment methods

No	LO in Learning Domains	Teaching Strategies	Assessment Methods
A	Knowledge	1. Discourse 2. Videos 3. Discussion	1. quiz scores 2. Midterm scores: 10 Multiple choice questions

E. Module contents

Topic	Number of Week(s)	Contact Hours

F. Course assessment

No	Assessment Type	Schedule (Week Due)	Proportion to the Final Mark

*) Example: mid-term examination, final examination, quiz, homework, project, etc.

G. Media employed

Laptop, PROJECTOR, Microphone, White Board, Marker, Pointer

H. Learning resources

Textbooks:

1.

Journal articles:

a)

Others:

-