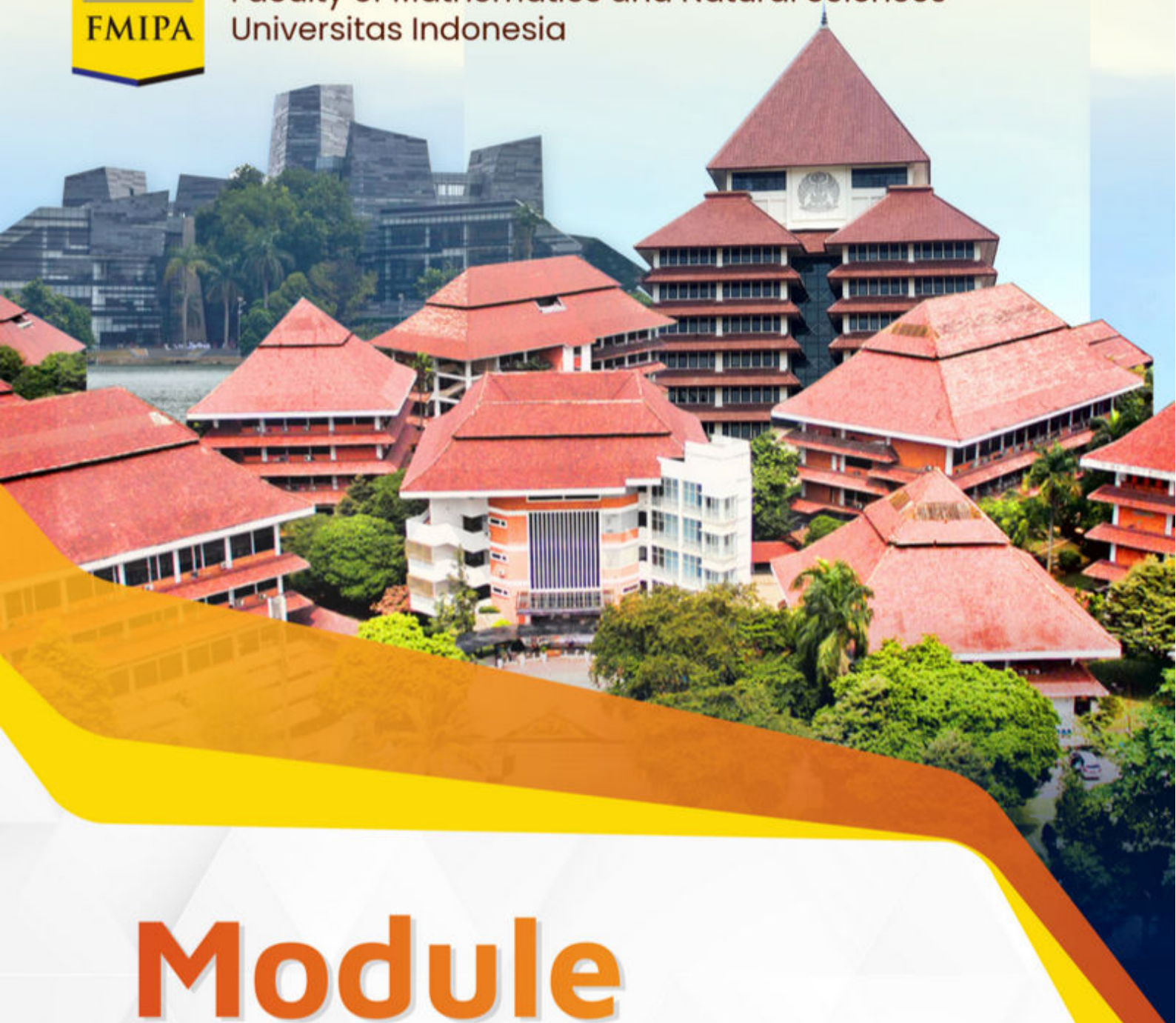
Department of Chemistry
Faculty of Mathematics and Natural Sciences
Universitas Indonesia



Module Handbook

Doctoral Programme in Chemistry

November 2024

Curriculum 2024

UNIVERSITAS INDONESIA
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Contents

Integrated Science and Mathematics

Module designation	*Integrated Science and Mathematics*
Semester(s) in which the module is taught	*1st*
Person responsible for the module	*Team teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Lectures: 4 x 50 minutes per week = 200 minutes per week* *2. Exercises and assignments: 4 x 60 = 240 minutes per week* *3. Independent study: 4 x 60 = 240 minutes per week*
Credit points	*4/7.2 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*- Able to develop logical, critical, systematic and creative thinking in examining sustainable development problems.* *- Able to recommend collaborative solutions to sustainable development problems by involving various fields in the scope of* *mathematics and science.* *- Able to adapt to the latest scientific developments through lifelong learning that is relevant to work or profession.*
Course description	*The Science and Mathematics Integration course is a compulsory course for the postgraduate program in Chemistry. After taking this course, students are able to develop logical, critical, systematic, and creative thinking in studying sustainable development problems, recommending* *collaborative solutions to sustainable development problems involving various fields in mathematics and science, and adapting to the latest scientific developments with lifelong learning that is relevant to work or profession. Learning activities include lectures, podiums, and small group discussions; while assessments include presentations, paper* *review assignments, mid-term and final exams. The language of instruction used is Indonesian.*
Examination forms	*Mid-term exams, final exams, and paper presentations*

Study and examination requirements	1. *Students must have attended at least 75% of the lectures to be able to have a presentation and submit a final report.* 2. *Students must achieve a final grade of B or higher (≥70).*
Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017.* *3. Related scientific journal sources.*

Philosophy of Science

Module designation	*Philosophy of Science*
Semester(s) in which the module is taught	*1st*
Person responsible for the module	*Prof. Dr. Terry Mart, S.Si.*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Independent activities, discussion, lectures and projects*
Workload (incl. contact hours, self-study hours)	*1. Lectures: 2 x 50 minutes per week = 100 minutes per week* *2. Exercises and assignments: 2 x 60 = 120 minutes per week* *3. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Able to develop logical, critical, systematic and creative thinking based on the concept of the philosophy of science (1.1)* *2. Able to recognize the philosophy of science as a basis for understanding science comprehensively and thoroughly (1.2)* *3: Able to link science and culture as an inseparable part of the philosophy of science (1.3)* *4: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession (4.1)*
Course description	*The Philosophy of Science course is a compulsory course for the postgraduate program in Chemistry. After taking this course, students are able to develop logical, critical, systematic, and creative thinking based on the concept of philosophy of science, are able to recognize the philosophy of science as a basis for understanding science comprehensively and thoroughly, are able to relate science and culture as an inseparable part of the philosophy of science, and are able to adapt to the latest developments in science by constantly learning new things that are relevant to any job or profession. Learning activities include lectures, podiums and small group discussions; while assessments include presentations, paper review assignments, mid-term and final exams. The language of instruction used is Indonesian.*

Examination forms	*Assignments, presentations, mid-term exams, and final exams*
Study and examination requirements	1. *Students must have attended at least 75% of the lectures to be able to have a presentation and submit a final report.* 2. *Students must achieve a final grade of B or higher (≧70).*
Reading list	▪ *Kuhn, T.S., Sautoy, D.M., & Hacking, I. (2020). The structure of Scientific Revolutions. Folio Society Ltd.* ▪ *Poincaré, H., Smith, A.E., Stump, D.J., & Frappier, M. (2022). Science and hypothesis. Bloomsbury Academic.* ▪ *Popper, K. R. (2014). The logic of Scientific Discovery. Martino Publishing.*

Research Proposal

Module designation	*Research Proposal*
Semester(s) in which the module is taught	*2nd*
Person responsible for the module	*Team Teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 8 x 60 = 480 minutes per week* *2. Independent study: 8 x 60 = 480 minutes per week*
Credit points	*8/14.4 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Integrated Science and Mathematics and Philosophy of Science*
Module objectives/intended learning outcomes	*After taking this course, students are able to evaluate and interpret problems related to chemistry and general based on scientific methods as a problem-solving approach, and are able to compile independent research designs written in research proposals, and present them in front of examiners.*
Course description	*After taking this course, students are able to evaluate and interpret problems related to chemistry and general based on scientific methods as a problem-solving approach, and are able to compile an independent research design written in a research proposal, and present it in front of examiners. Learning activities include discussions with the supervisor in preparing the proposal, as well as presentations of the proposal by students followed by discussions on the feasibility of the proposal. Meanwhile, the assessment includes the level of originality of the research, the weight of the problem and the depth of the research material according to the academic level of the doctor, mastery of knowledge about disciplines related to the research topic, mastery of research methodology, and potential contributions to science and its applications. This course is delivered in Indonesian using online methods for confirmation and consultation, and offline for presentations.*
Examination forms	*Assessment of research proposal results and proposal presentation*

Study and examination requirements	*Students must obtain a minimum grade B (≥ 70) as detailed in S3.12 Research Proposal Exam Assessment Form*
Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017.* *3. Related scientific journal sources.*

Research Progress 1

Module designation	*Research Progress 1*
Semester(s) in which the module is taught	*3rd*
Person responsible for the module	*Team teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 8 x 60 = 480 minutes per week* *2. Independent study: 8 x 60 = 480 minutes per week*
Credit points	*8/14.4 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Research Proposal*
Module objectives/intended learning outcomes	*After taking this course, students are expected to be able to conclude the study of the research process carried out along with the data obtained (minimum 40%) as a guide in planning further research (C6)*
Course description	*After taking this course, students are expected to be able to review the research process carried out and the data obtained for the Scientific Publication course, draw temporary conclusions, and plan further research. The topics of this course include the framework of thought, methodology, data processing and analysis, literature review, and consistency in drawing conclusions. In addition to being delivered in written form (Research Results Report 1/Draft Dissertation), students are also expected to be able to deliver it verbally in the form of presentations and discussions in front of the Research Results Examination 1 committee. This lecture is delivered in Indonesian using online methods for consultations and exams, as well as offline for submitting drafts.*
Examination forms	*Collecting research result exam drafts in the form of temporary results obtained up to semester 3 and conducting research result exams based on the research result exam drafts that have been submitted.*
Study and examination requirements	*A student must have attended at least 75% of the lectures to sit in the exam.*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

Research Progress 2

Module designation	*Research Progress 2*
Semester(s) in which the module is taught	*4th*
Person responsible for the module	*Team teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 10 x 60 = 600 minutes per week* *2. Independent study: 10 x 60 = 600 minutes per week*
Credit points	*10/18 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Research Progress 1*
Module objectives/intended learning outcomes	*After taking this course, students are expected to be able to conclude the study of the research process carried out along with the data obtained (minimum 60%) as a guide in planning further research (C6)*
Course description	*After taking this course, students are expected to be able to review the research process carried out and the data obtained for the Scientific Publication course, draw temporary conclusions, and plan further research. The topics of this course include the framework of thought, methodology, dataprocessing and analysis, literature review, and consistency in drawing conclusions. In addition to being delivered in written form (Research Results Report 2/Draft Dissertation), students are also expected to be able to deliver it orally in the form of presentations and discussions before the Research Results Examination 2 committee.This lecture is delivered in Indonesian using online methods for consultations and exams, as well as offline for submitting drafts.*
Examination forms	*Able to create a systematic Research Results Report 2 that is in accordance with the rules and ethics of writing and can present and be accountable for it in front of the team of lecturers on the Research Results Examination 2 committee and the audience.*
Study and examination requirements	*A student must have attended at least 75% of the lectures to sit in the exam.*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

Scientific Publications

Module designation	*Scientific Publications*
Semester(s) in which the module is taught	*3rd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 6 x 60 = 360 minutes per week* *2. Independent study: 6 x 60 = 360 minutes per week*
Credit points	*6/10.8 (credits/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students can formulate (C6) research results orally and in writing in accordance with writing techniques and ethics, at least in the form of proceedings at international conferences or national journals accredited by SINTA.*
Course description	*The Scientific Publication course examines all activities for scientific publications starting with selecting the journal to be targeted, understanding the guide for authors, creating a writing framework, processing and analyzing data, literature searches, to compiling manuscripts and submitting them to the target journal. Students become the main authors accompanied by a supervisor. The output of this course is at least proceedings at an international conference or a SINTA-accredited national journal or an international journal.*
Examination forms	*Student publications with "accepted" status, at least proceedings at international conferences or SINTA-accredited national journals or international journals.*
Study and examination requirements	*Student publications with "accepted" status, at least proceedings at international conferences or SINTA-accredited national journals or international journals.*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

International Publications 1

Module designation	*International Publications 1*
Semester(s) in which the module is taught	*4th*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 6 x 60 = 360 minutes per week* *2. Independent study: 6 x 60 = 360 minutes per week*
Credit points	*6/10.8 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students can formulate (C6) research results in the form of written/draft publications in accordance with the techniques and ethics of writing SCOPUS indexed international journals.*
Course description	*The International Publication course examines all activities for scientific publications starting with selecting the journal to be targeted, understanding the guide for authors, creating a writing framework, processing and analyzing data, literature searches, to compiling manuscripts and submitting them to the target journal. Students become the main authors accompanied by a supervisor. The output of this course is an international journal indexed by SCOPUS.*
Examination forms	*Writing a draft of a scientific publication that is ready to be submitted to a target journal, at least an international journal indexed by SCOPUS.*
Study and examination requirements	*Students must have an article manuscript in at least an international journal indexed by SCOPUS.*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

International Publications 2

Module designation	*International Publications 2*
Semester(s) in which the module is taught	*5th*
Person responsible for the module	*Team teaching (thesis supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 6 x 60 = 360 minutes per week* *2. Independent study: 6 x 60 = 360 minutes per week*
Credit points	*6/10.8 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*International Publications 1*
Module objectives/intended learning outcomes	*Students can formulate (C6) research results into scientific articles in accordance with the techniques and ethics of writing SCOPUS indexed international journals.*
Course description	*The International Publication course examines all activities for scientific publications starting with selecting the journal to be targeted, understanding the guide for authors, creating a writing framework,* *processing and analyzing data, literature searches, to compiling manuscripts and submitting them to the target journal. Students become the main authors accompanied by a supervisor. The output of this course is an international journal indexed by SCOPUS.*
Examination forms	*Accepted at least in SCOPUS indexed international journals*
Study and examination requirements	*Students must achieve a final grade of B or higher (Having a minimum publication status of "under reviewed" at the International Journal indexed by Scopus).*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

Dissertation Examination 1

Module designation	*Dissertation Examination 1*
Semester(s) in which the module is taught	*5th*
Person responsible for the module	*Team Teaching (Thesis Supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 8 x 60 = 480 minutes per week* *2. Independent study: 8 x 60 = 480 minutes per week*
Credit points	*8/14.4 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Research Progress 2*
Module objectives/intended learning outcomes	*After taking this course, students are expected to be able to conclude the study of the research process carried out along with the data obtained (minimum 80%) as a guide in planning further research (C6)*
Course description	*After taking this course, students are expected to be able to review the research process that has been carried out and the data that has been obtained for the International Paper Publication course, draw temporary conclusions, and plan further research. The main topics in this course include the framework of thought, methodology, data processing and analysis, literature review, and consistency in drawing conclusions. In addition to being delivered in written form (Draft Dissertation), students are also expected to be able to deliver it orally in the form of presentations and discussions before the Research Results Examination - Dissertation committee.* *This lecture is delivered in Indonesian using online methods for consultations and exams, as well as offline for submitting drafts.*
Examination forms	*Formative, summative, and trial exams*
Study and examination requirements	*Based on the S3.26. Assessment Rubric for Dissertation 1, students must achieve a final score of 70 or higher, and their research achievement must be at least 85%.*

Reading list	

Dissertation Examination 2

Module designation	*Dissertation Examination 2*
Semester(s) in which the module is taught	*6th*
Person responsible for the module	*Team teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 12 x 60 = 720 minutes per week* *2. Independent study: 12 x 60 = 720 minutes per week*
Credit points	*12/21.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Dissertation Examination 1*
Module objectives/intended learning outcomes	*Students can build (C6) and combine (A6) research results in oral and written form to solve (P6) human problems in the fields of energy, health and the environment in relation to advanced chemical science.*
Course description	*After taking this course, students are expected to be able to review the research process that has been carried out and the data that has been obtained for the International Paper Publication course, draw temporary conclusions, and plan further research. The main topics in this course include the framework of thought, methodology, data processing and analysis, literature review, and consistency in drawing conclusions. In addition to being delivered in written form (Draft Dissertation), students are also expected to be able to deliver it orally in the form of presentations and discussions before the Research Results Examination - Dissertation committee.* *This lecture is delivered in Indonesian using online methods for consultations and exams, as well as offline for submitting drafts.*
Examination forms	*Formative, summative, and trial exams*
Study and examination requirements	*Based on the S3.26. Assessment Rubric for Dissertation 2, students must achieve a final score of 70 or higher, and their research achievement must be at 100%.*

Reading list	

Doctoral Promotion

Module designation	*Doctoral Promotion*
Semester(s) in which the module is taught	*6th*
Person responsible for the module	*Team Teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 4 x 60 = 240 minutes per week* *2. Independent study: 4 x 60 = 240 minutes per week*
Credit points	*4/7.2 (credits/ECTS)*
Required and recommended prerequisites for joining the module	*Dissertation Examination 2*
Module objectives/intended learning outcomes	*Students can construct and clarify research results in oral and written form so that they can be accounted for and disseminated to the public (C6).*
Course description	*The doctoral promotion course is a special MK in the form of writing and compiling a final assignment at the doctoral level in chemistry which is taken in semester 6 and is related to the management and analysis of data obtained through laboratory research activities.*
Examination forms	*Collecting dissertation drafts and dissertation summary books in the form of final results obtained up to semester 6 and conducting doctoral promotion exams based on the dissertation that has been submitted.*
Study and examination requirements	*Based on the S3.26. Assessment Rubric for Doctoral Promotion, students must achieve a final score of 70 or higher, and their research achievement must be at 100%.*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library sources mainly from recommendations from the University of Indonesia Library*

Photocatalysis

Module designation	*Photocatalysis*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Prof. Dr. Jarnuzi Gunlazuardi*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to create based on phenomena observed from the results of the interaction of metal-oxide semiconductor surfaces with electromagnetic waves and chemicals (C6), and evaluate their management for various applications, as well as improvise (1) metal-oxide semiconductor matrices so that they are responsive to visible light, (2) processes related to photo-electro-catalysis so that they are more effective (C6).*
Course description	*The Photocatalysis course is an elective course (2 credits) for students of the Postgraduate Doctoral Program in Chemistry, FMIPA-UI. After completing the course, students are able to create based on or refer to the phenomena that occur as a result of the interaction of photons with metal-oxide semiconductors, evaluate or justify their management for various applications, and improvise (1) metal-oxide semiconductor matrices to be responsive to visible light, (2) processes related to photo-electro-catalysis to be more effective. The scope of the course includes fundamental and applied aspects of photocatalysis and photo-electro-catalysis phenomena on the surface of titania. The course is presented using active learning methods (e.g. cooperative learning). The spoken language of instruction used is Indonesian, accompanied by written English.*
Examination forms	*Presentation, Assignment (trigger), Mid-Term Exam, and Final Exam*

Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	*1. J. Schneider, D. Bahneman, J. Ye, GL Puma, and DD Dionysiou (Eds) (2016):"Photocatalysis: Fundamentals and Perspectives", Royal Society of Chemistry.* *2. L. Jame et al, : "Light-Driven Heterogeneous Reduction of Carbon Dioxide: Photocatalysts and Photoelectrodes", Chem. Rev. 2015, 115, 12888−12935* *3. U. Diebold: "The Surface Science of Titanium Dioxide", Surface Science Reports 48 (2003) 53-229* *4. DV Baykin and FC Walsh: "Titanate and Titania Nanotubes: Synthesis", (2009), Royal Society of Chemistry* *5. Related journals (ACS, Elsevier)*

Experimental Methods of Photocatalyst Research

Module designation	*Experimental Methods of Photocatalyst Research*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to (1) be creative in compiling research proposals in the field of photocatalysis and photo electrocatalysis, which are comprehensive and contain novelty (C6), (2) evaluate or justify current knowledge or research results, and evaluate and recognize current research methods or approaches; (3) analyze and evaluate the pros and cons or gaps in knowledge or methods, so that they can be creative in compiling appropriate experimental methods. (C6).*
Course description	*The Experimental Methods of Photocatalysis Research course is an elective course (2 credits) for students of the Postgraduate Doctoral Program in Chemistry, FMIPA-UI. After completing the course, students are able to creatively compile research proposals in the field of photocatalysis and photo electrocatalysis, evaluate or justify current knowledge or research results, and evaluate and recognize current research methods or approaches and analyze and evaluate the pros and cons or gaps in knowledge or methods, so that they can be creative in compiling appropriate experimental methods. Lectures are presented through active learning (e.g. cooperative learning). The spoken language of instruction used is Indonesian, accompanied by written English.*
Examination forms	*Presentation, Assignment (trigger), Mid-Term Exam, and Final Exam*

Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	*1. J. Schneider, D. Bahneman, J. Ye, GL Puma, and DD Dionysiou (Eds) (2016):" Photocatalysis: Fundamentals and Perspectives", Royal Society of Chemistry.* *2. L. Jame et al, : "Light-Driven Heterogeneous Reduction of Carbon Dioxide: Photocatalysts and Photoelectrodes", Chem. Rev. 2015, 115, 12888−12935* *3. U. Diebold: "The Surface Science of Titanium Dioxide", Surface Science Reports 48 (2003) 53-229* *4. DV Baykin and FC Walsh: "Titanate and Titania Nanotubes: Synthesis", (2009), Royal Society of Chemistry* *5. Related journals (ACS, Elsevier)*

Homogeneous Catalyst

Module designation	*Homogeneous Catalyst*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Dr.rer.nat Agustino Zulys*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to design catalyst designs on homogeneous catalysts obtained from the interaction of the learning process through the results of the review and evaluation of various current research papers/publications (C6).*
Course description	*After completing this course, students are able to discuss the mechanism of catalysis reactions for various types of reactions and their derivatives so that students can propose experiments, techniques and trials to obtain the concept of mechanisms, analyze and interpret spectroscopic data and kinetic data to evaluate existing mechanisms. Students are able to deduce reaction mechanism pathways, propose hypotheses, optimize catalysts, and can discuss issues related to homogeneous catalysis and elaborate on different types of reactions and the use of metal complexes as homogeneous catalysts.*
Examination forms	*Summary and presentation assignments*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	*1. Catalytic asymmetric reactions in organic* *synthesis, Ryoji Noyori, 1994*

Heterogeneous Catalysis

Module designation	*Heterogeneous Catalysis*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to create examples of research designs on heterogeneous catalysts obtained from the interaction of the learning process through the results of the review and evaluation of various current research papers/publications (C6)*
Course description	*After taking the Heterogeneous Catalyst Chemistry Course, students are expected to be able to create examples of research designs on heterogeneous catalyst preparation, characterization and its applications obtained from the interaction of the learning process and review of various published research papers. The scope of the study materials of the Catalyst Chemistry Course includes the preparation of heterogeneous catalysts and their characterization, applications in heterogeneous catalysis processes associated with the reaction mechanism and kinetics of heterogeneous catalysis reactions. The language of instruction used is Indonesian.*
Examination forms	*Journal review assignments and presenting journal review results as well as journal writing assignments.*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	1. *Heterogeneous Catalysis and its Industrial Applications, Martin Schmal, Springer 2016*

Enantioselective

Module designation	*Enantioselective*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*After taking the Enantioselective Reactions course, students are able to design strategies for the synthesis/transformation of a chemical compound enantioselective (C6).*
Course description	*After taking the Enantioselective Reaction Course, students are expected to be able to design a strategy for the synthesis/transformation of a chemical compound enantioselective based on the learning process and review of various published research papers. The scope of the study material for the Enantioselective Reaction Course includes the concept of chirality, conformation analysis, and application of enantioselective reactions to various types of compounds such as alkenes, carbonyls, aldol reactions, imines and enamines and discussions related to the latest developments in research in the field of enantioselective synthesis. The language of instruction used is Indonesian.*
Examination forms	*Mid-term exams, final exams, papers and paper presentations*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	*1. Catalytic asymmetric reactions in organic synthesis*

Biogeochemistry of Pollutants

Module designation	*Biogeochemistry of Pollutants*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Dr. Asep Saefumillah*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*After completing this course, students are able to design environmental systems resulting from the influence of the presence of hazardous chemicals that pollute the environment (pollutants) (C6)*
Course description	*The Biogeochemistry of Pollutants course is an elective course in the Doctoral Program in Chemistry with a concentration in Environmental Chemistry. This course is not a prerequisite for taking subsequent courses and does not have prerequisites for courses in the Environmental Chemistry concentration. This course provides a fundamental understanding of the redox system in the environment; the effect of pH on chemical speciation; metal biogeochemistry; nutrient biogeochemistry; and heavy metal biogeochemistry. The language of instruction used in lectures is Indonesian.*
Examination forms	*Papers, presentations, mid-term exams, and final exams*
Study and examination requirements	*Students must obtain a minimum grade B ($\geq$ 70)*

Reading list	*1. B Hazardous Waste Chemistry and Toxicology, Stanley E. Manahan, Lewis Publisher, 1990* *2. Environmental Chemistry,Stanley E. Manahan, Lewis Publishers, 6th Edition, 1994* *3. Chemistry of the Environment, Thomas G. Spiro and William M. Stigliani Prentice Hall, 2nd edition, 2003*

Advanced Molecular Biology

Module designation	*Advanced Molecular Biology*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Prof. Sumi Hudiyono*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to connect various current concepts and techniques in the field of molecular biology and their application in human life, which includes OMICs technology, genetic engineering, synthetic biology, drug discovery and medical molecular biology, through a multidisciplinary approach (C6).*
Course description	*Advanced Molecular Biology is an elective course for the postgraduate program in Chemistry. After taking this course, students are able to connect various current concepts and techniques in the field of molecular biology and their applications in human life, including OMICs technology, genetic engineering, synthetic biology, drug discovery and medical molecular biology, through a multidisciplinary approach. Learning activities include lectures and small group discussions; while assessments include presentations, paper review assignments, mid-term and final exams. The language of instruction used is Indonesian.*
Examination forms	*Mid-term exams, final exams, presentations, and assignments*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	

Organometallic Synthesis and Development

Module designation	*Organometallic Synthesis and Development*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Able to design organometallic compounds through the concept of organometallic reactions and able to propose transformation reaction mechanisms using these compounds (C6).*
Course description	*Students are able to interpret the physical and chemical properties of organometallic compounds and the types of bonds, and are able to comprehensively master the synthesis and characterization of organometallic compounds, and examples of their applications as homogeneous catalysts and are able to synthesize homogeneous catalyst research into new hypotheses and their applied features.*
Examination forms	*Summary assignments and presentation assignments*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	*1. Organometallics a concise Introduction, Ch. Elschenbroich, A. Salzer, 2ed, VCH 1992* *2. Application of Organometallic Compounds, Iwao Omae, John Wiley 1998* *3. Applied Organometallic Chemistry, Robyn Whyman, Oxford 2001*

Advanced Carbohydrates

Module designation	*Advanced Carbohydrates*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to design carbohydrate models to obtain new functional materials and foods that have certain properties and characteristics (C6)*
Course description	*Advanced Carbohydrates Course is an elective course for the postgraduate program of Doctoral Program in Chemistry. After taking this course, students are able to design carbohydrate models to obtain new functional materials and foods that have certain properties and characteristics. Learning activities include lectures and small group discussions; while assessments include presentations, paper review assignments, mid-term and final exams. The language of instruction used is Indonesian.*
Examination forms	*Mid-term exams, final exams, assignments, and presentations*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	

Biological Bioindicators

Module designation	*Biological Bioindicators*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Prof. Dr.rer.nat Budiawan*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students are able to construct stages of monitoring exposure to hazardous chemical compounds (Toxic) to humans and the environment by determining biomarkers and the magnitude of risk based on the analysis method of pollutant chemicals and Biomarkers (biological exposure index) as determining factors for human health risks and biota in the environment.* *2. Able to create design examples and develop research innovations regarding the application of biological bioindicators obtained from the interaction of learning processes and reviews of various published research papers.*
Course description	*This course provides students with the skills to be able to use the concepts and principles of toxicology chemistry in monitoring hazardous chemicals (Toxic) in living systems and the environment through the determination of biomarkers and the magnitude of risk based on the method of analyzing pollutant chemicals and Biomarkers (biological exposure index) as a determining factor for human health risks and biota in the environment. The learning process is through Case based learning, literature review, and presentation. After taking the Advanced Toxicology Chemistry Course, students are expected to be able to create examples of research designs on the application of biological bioindicators obtained from the interaction of the learning process and reviews of various published research papers.*

Examination forms	*Assignment presentations, case study exercises, mid-term exams, and final exams.*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	*1. Biological Monitoring – Prospects in Occupational and Environmental Medicine, Deutsche Forschungsgemeinschaft, Round Table Discussions and Colloquia, Jürgen Angerer and Tobias Wei (Eds.), Wiley-VCH.* *2. Biological Monitoring of Chemical Exposure in the Workplace, Volume 1 & 2, WHO, Geneva.* *3. Casarett and Doull's Toxicology - C. Klaassen, editor. McGraw-Hill Companies, Inc., New York* *4. Environmental Toxicology – Volume 1-3, M. Ruchirawat and RC Shank (Eds.), Chulabhorn Research Institute – International Center for Environmental and Industrial Toxicology.* *5. Essentials of Environmental Toxicology - W. Hughes. Taylor & Francis, Washington DC* *6. Essentials of Anatomy and Physiology - C. Scanlon and T. Sanders. F.A. Davis, Philadelphia* *7. Essentials of Human Anatomy and Physiology - EN Marieb. Addison Wesley Longman, Inc. Menlo Park, California* *8. Industrial Chemical Exposure, Guidelines for Biological Monitoring – RR Lauwerys & P. Hoet,, 3rd Edition, CRC Press, 2001* *9. Industrial Toxicology - P. Williams and J. Burson, eds. Van Nostrand Reinhold, New York* *10. Modern Toxicology - E. Hodgson and P. Levi. Elsevier Science Publishing, Co., New York* *11. Principles of Biochemical Toxicology - JA Timbrell. Taylor & Francis LTD, London* *12. Principles of Toxicology - K. Stine and T. Brown* *13. Related scientific journals or other articles required for each discussion topic*

Electrochemical Combination Technique

Module designation	*Electrochemical Combination Technique*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Prof. Dr. Ivandini Tribidasari A.* *Dr. Rahmat Wibowo*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*After completing this course, students are able to evaluate electrochemical instrumentation techniques, differences in electrochemical Spectro systems, the potential of the "quartz crystal microbalance" as an electroanalytical tool, scanning electrochemical microscopy (SEM) instruments, the theoretical basis of electrochemical impedance, the potential of modified electrodes in biological analysis (C6)*
Course description	*After completing this course, students are able to understand, apply, analyze and evaluate the basics and characteristics of electrochemistry and evaluate the use of these methods in research and industry.*
Examination forms	*Summary assignments, review assignments, and presentations*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*

Reading list	*1. Fundamentals (Standard transmission cells: Optically transparent electrodes, Parallel transmission: long-optical-path cells, Bidimensional Spectro electrochemistry Reflection cells, Flow systems. Examples of applications)* *2. Piezoelectricity, The crystal quartz microbalance, The Sauerbrey equation, The quartz oscillator electromechanical model: the Butterworth-van Dyke model, The quartz microbalance in electrochemical experiments.* *3. Electrochemical responses in macro- and microelectrodes: Fundamentals of electrochemical microscopy. SECM operating modes. Amperometric feedback responses: positive and negative feedback. Sweep mode: obtaining images. Applications.* *4. Alternative current in electrochemistry: responses in potential and current through resistances, capacitances and inductances. Resistance-capacitance (RC) circuits. The concept of impedance. The equivalent circuit of an electrochemical cell. Resistance, capacitances and inductances in electrochemical cells. Warburg electrochemical impedance. Measurement techniques. Graphic methods in the analysis of impedances: Nyquist, Bode and Randles diagrams. Some practical cases.* *5. Carbon-paste electrodes. Polymeric electrodes. Polymer conductors: Enzymatic electrodes.* *6. Substrates. Immobilization methods. Transductors. 1st generation biosensors. 2nd generation biosensors. 1st generation biosensors. Applications.*

Bioactivity of Natural Compounds

Module designation	*Bioactivity of Natural Compounds*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to evaluate their understanding of the biosynthesis reactions of the series of formation of natural compounds from precursors (building blocks), and develop natural compounds according to the bioactivity of the natural compounds for the health sector (C5)*
Course description	*After taking the Natural Material Chemistry Course, students are expected to be able to design the relationship between the structure and bioactivity of natural compounds by evaluating the principles and structures of organic compounds synthesized by plants and organisms, the biosynthesis pathways of their formation, the classification of the compounds formed, and the correlation of their character and bioactivity obtained from the interaction of the learning process and the review of various published research papers. The scope of the study materials of the Natural Material Chemistry Course includes introduction, formulation of secondary metabolites, polyketides, terpenoids, aromatics and phenolics, flavonoids, glycosides and alkaloids. The language of instruction used is Indonesian.*
Examination forms	*Journal review assignments and presenting journal review results as well as journal writing assignments.*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*

Reading list	*1. Colegate, MS, Molyneux, RJ "BIOACTIVE NATURAL PRODUCTS Detection, Isolation, and Structural Determination SECOND EDITION". CRC Press, 2008.* *2. Dewick, PM Medicinal natural products : a biosynthetic approach. Willey and Son, 2012.* *3. Fang, WS, Medicinal Chemistry of Bioactive Natural Products, Willey, 2015.* *4. Osbourn A., Plant derived natural products.* *5. Satyajit D. Sarker Zahid Latif Alexander I. Natural Products Isolation Second Edition. Humana Press, 2006.*

Development of Colloidal Chemistry and Nanocomposites

Module designation	*Development of Colloidal Chemistry and Nanocomposites*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Prof Yoki Yulizar*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	
Module objectives/intended learning outcomes	*Students are able to design the synthesis and modification of nanomaterials based on their evaluation of morphology, physical and chemical characteristics, and their applications in various fields (C6)*
Course description	*Development of Colloidal Chemistry and Nanocomposites is an elective course provided for students of the Doctoral Program in Chemistry. The learning outcomes of this course are that students are able to design the synthesis and modification of nanomaterials based on their evaluation of morphology, physical and chemical characteristics, and their applications in various fields. Learning activities include lectures and small group discussions, while assessments include presentations, essay assignments and written exams (UAS). The language of instruction used is Indonesian.*
Examination forms	*Mid-term exams, final exams, assignments, presentations*
Study and examination requirements	*Students must obtain a minimum grade B ($\geq$ 70)*

Reading list	*Journal Nature, JACS, Nanoletters, Langmuir (main references).* *Up to date journals from Physical Chemistry,* *Journal of colloid and interface Science etc.*

Latest Developments in Interface Science

Module designation	*Latest Developments in Interface Science*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students are able to develop modifications to the interface of a material and surface analysis techniques to study the characteristics and phenomena of the interface (C6)*
Course description	*The Chemistry Interface and Applications course is an elective course in the Doctoral Program in Chemistry. After taking this course, students are expected to be able to develop modifications to the interface of a material and surface analysis techniques to study the characteristics and phenomena of the interface. Learning is carried out synchronously through face-to-face and asynchronously (online) using the Microsoft Teams and EMAS platforms. The language of instruction is Indonesian.*
Examination forms	*Mid-term exams, final exams, assignments, and presentations*
Study and examination requirements	*Students must obtain a minimum grade B (≥ 70)*
Reading list	*Adamson, AW 1990. Physical Chemistry of Surfaces. John Wiley & Sons.* *Rossen, Milton J. 1978. Surfactant and Interfacial Phenomena. Willey & Sons, USA.* *Myers, Drew. 2006. Surfactant Science and Technology. Third Edition. Wiley-Interscience.*

Module designation	*Toxicology Assessment*
Semester(s) in which the module is taught	*1st or 2nd*
Person responsible for the module	*Prof. Dr. rer. nat Budiawan*
Language	*Indonesia*
Relation to curriculum	*elective course*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 2 x 60 = 120 minutes per week* *2. Independent study: 2 x 60 = 120 minutes per week*
Credit points	*2/3.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*After taking the Toxicology Assessment course, students are able to recommend the nature of chemical hazards to health & the environment comprehensively based on the basic concepts and principles of chemical behavior in living systems and environmental conditions and efforts to minimize the risks. by using/integrating related relationships with other chemical subdisciplines.*
Course description	*The course "Toxicology Assessment" is an elective course of the Department of Chemistry, and is related to the courses of Analytical Chemistry, Toxicology, Bioinorganic, Chemical Kinetics. This course covers the application of Basic principles in Chemical Toxicology including the Nature of toxic hazards of chemicals, the Relationship between Exposure Dose and Exposure Effects, the Concept of Toxicokinetic and dynamics of Xenobiotics in body organs and examines the Toxic Effects due to exposure to substances/chemicals. This course is given in semester 2 with interactive lecture learning methods, and Case Based Learning (CBL) with the language of instruction used is Indonesian.*
Examination forms	*Presentation of Paper Assignment*
Study and examination requirements	*Students must obtain a minimum grade B ($\geq$ 70)*

Reading list	*1. Casarett, LJ and Doull, J. Toxicology, the Basic Science of Poisons. McGraw-Hill Companies, Inc., New York, 1991* *2. Clayton, GD, and Clayton, FE, Patty's Industrial Hygiene and Toxicology, General Principles, 4th Edition, Volume I, Part B, John Wiley & Sons, Inc., New York, 1991* *3. Dekant, W. and Vamvakas, S., Toxikologie für Chemiker und Biologen, Spektrum Akademischer Verlag GmbH, Oxford, Heidelberg, Berlin, 1994* *4. Eisenbrand, G. and Metzler, M. Toxikologie für Chemiker – Stoffe, Mechanismen, Prüfverfahrer, Georg Thieme Verlag* *Stuttgart, Germany, 1994.* *5. Hayes, W., (ed). Principles and Methods of Toxicology, Raven Press, New York, 1982* *6. Levi, PE, Toxic Action, in: A Textbook of Modern Toxicology, E. Hodgson and PE Levi (ed), Elsevier Publishing Co. Inc. 1987* *7. Lu, F. Basic Toxicology Taylor & Francis, Washington, DC, 1991* *8. Marquardt, H and Schafer, SG Lehrbuch der Toxikologie, 1994* *9. Teaf, CM, Mutagenesis, in: Industrial Toxicology, Safety and Health Applications in the Workplace, PL Williams, and JL Burson (ed), Van Nostrand Reinhold Company, New York, 1985* *10. Timbrell, JA, Principles of Biochemical Toxicology, Second edition, Taylor & Francis LTD, London, 1994* *11. Weisburger, JH, and Williams, GM, Bioassay of Carcinogens: in vitro and in vivo tests, in: Chemical Carcinogens, second edition, volume 2, Charles E. Searle (ed), ACS Monograph 182, American Chemical Society, Washington DC, 1984* *12. Related journals or other articles required for each discussion topic*

Literature Review 1 (R)

Module designation	*Literature Review 1 (R)*
Semester(s) in which the module is taught	*1st*
Person responsible for the module	*Team teaching (Thesis Supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 5 x 60 = 300 minutes per week* *2. Independent study: 5 x 60 = 300 minutes per week*
Credit points	*5/9 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Able to compare, organize, and critically evaluate the latest scientific information sources (C5)* *2. Able to project the relationship between structure, properties, synthesis techniques, and performance of a material for a particular application (C5)* *3. Able to compile appropriate chemical analysis and modeling methods in synthesizing a material (C6)* *4. Able to communicate orally effectively in scientific research groups (C6)*
Course description	*Literature Review 1 is a course that contains presentation activities to explore one of the research topics as preparation for making a research proposal. Students are required to search for, read and analyze reputable scientific journal publications, prepare a research design starting from determining the title, problem, background, literature review, and research method, then present the research design and have scientific discussions periodically. The main topics of this course include the breadth and depth of research topics, mastery of material and scientific systematics. Scientific attitude in analyzing certain research topics with good scientific systematics*
Examination forms	*Writing journal review papers and paper presentations*

Study and examination requirements	*Students must obtain a minimum grade B (≥ 70) as detailed in S3.08 Assessment Rubric - Literature Review 1*
Reading list	▪ *Bryan Greetham (2021), How to Write Your Literature Review, Red Globe Press/Macmillan Education* ▪ *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer* ▪ *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers* ▪ *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*

Literature Review 2 (R)

Module designation	*Literature Review 2 (R)*
Semester(s) in which the module is taught	*1st*
Person responsible for the module	*Team teaching (Thesis Supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Independent activities, discussion and project*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 5 x 60 = 300 minutes per week* *2. Independent study: 5 x 60 = 300 minutes per week*
Credit points	*5/9 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Literature Review 1*
Module objectives/intended learning outcomes	*1. Able to compare, organize, and critically evaluate the latest scientific information sources (C5)* *2. Able to project the relationship between structure, properties, synthesis techniques, and performance of a material for a particular application (C5)* *3. Able to compile appropriate chemical analysis and modeling methods in synthesizing a material (C6)* *4. Able to prepare written reports and communicate orally effectively in scientific research groups (C6)*
Course description	*Literature Review 2 is a course that contains presentation activities to explore one of the research topics as preparation for making a research proposal. Students are required to search for, read and analyze reputable scientific journal publications, prepare a research design starting from determining the title, problem, background, literature review, and research method, then present the research design and have scientific discussions periodically. The main topics of this course include the breadth and depth of research topics, mastery of material and scientific systematics. Scientific attitude in analyzing certain research topics with good scientific systematics*
Examination forms	*Writing journal review papers and paper presentations*

Study and examination requirements	*Students must obtain a minimum grade B (≥ 70) as detailed in S3.09 Assessment Rubric - Literature Review 2*
Reading list	▪ *Bryan Greetham (2021), How to Write Your Literature Review, Red Globe Press/Macmillan Education* ▪ *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer* ▪ *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers* ▪ *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*

Research Proposal (R)

Module designation	*Research Proposal (R)*
Semester(s) in which the module is taught	*2th*
Person responsible for the module	*Team teaching (thesis supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 8 x 60 = 480 minutes per week* *2. Independent study: 8 x 60 = 480 minutes per week*
Credit points	*8/14.4 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Literature Review 2*
Module objectives/intended learning outcomes	*After taking this course, students are able to evaluate and interpret problems related to chemistry and general based on scientific methods as a problem-solving approach, and are able to compile independent research designs written in research proposals, and present them in front of examiners.*
Course description	*After taking this course, students are able to evaluate and interpret problems related to chemistry and general based on scientific methods as a problem-solving approach, and are able to compile an independent research design written in a research proposal, and present it in front of examiners. Learning activities include discussions with the supervisor in preparing the proposal, as well as presentations of the proposal by students followed by discussions on the feasibility of the proposal. Meanwhile, the assessment includes the level of originality of the research, the weight of the problem and the depth of the research material according to the academic level of the doctor, mastery of knowledge about disciplines related to the research topic, mastery of research methodology, and potential contributions to science and its applications. This course is delivered in Indonesian using online methods for confirmation and consultation, and offline for presentations.*
Examination forms	*Draft proposal and research proposal examination*

Study and examination requirements	*Students must obtain a minimum grade B (≥ 70) as detailed in S3.12 Research Proposal Exam Assessment Form*
Reading list	▪ *UI Chancellor's Decree No. 2143 of 2017 concerning Technical Guidelines for Writing Final Assignments for Universitas Indonesia Students.* ▪ *On Being a Scientist: A Guide to Responsible Conduct in Research , Third Edition, National Academy of Sciences, USA, 2009.* ▪ *Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017.* ▪ *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer* ▪ *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers* ▪ *Jay D. Gatrell, Gregory D. Bierly, Ryan R. Jensen, Rajiv R. Thakur (2020), Research Design and Proposal Writing in Spatial Science, Springer* ▪ *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*

Research Progress 1 (R)

Module designation	*Research Progress 1 (R)*
Semester(s) in which the module is taught	*3rd*
Person responsible for the module	*Team Teaching (Thesis Supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 8 x 60 = 480 minutes per week* *2. Independent study: 8 x 60 = 480 minutes per week*
Credit points	*8/14.4 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*After taking this course, students are expected to be able to conclude the study of the research process carried out along with the data obtained (minimum 40%) as a guide in planning further research (C6)*
Course description	*After taking this course, students are expected to be able to review the research process carried out and the data obtained for the Scientific Publication course, draw temporary conclusions, and plan further research. The topics of this course include the framework of thought, methodology, data processing and analysis, literature review, and*
Examination forms	*Research result report 1 and research result exam presentation 1*
Study and examination requirements	*Students must obtain a minimum grade B ($\geq$ 70) as detailed in S3.18 Assessment Rubric for Research Results Examination 1*
Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of* *Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017.* *3. Related scientific journal sources*

Research Progress 2 (R)

Module designation	*Research Progress 2 (R)*
Semester(s) in which the module is taught	*4th*
Person responsible for the module	*Team teaching (thesis supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 10 x 60 = 600 minutes per week* *2. Independent study: 10 x 60 = 600 minutes per week*
Credit points	*10/18 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Research Progress 1*
Module objectives/intended learning outcomes	*After taking this course, students are expected to be able to conclude the study of the research process carried out along with the data obtained (minimum 60%) as a guide in planning further research (C6)*
Course description	*After taking this course, students are expected to be able to review the research process carried out and the data obtained for the Scientific Publication course, draw temporary conclusions, and plan further research. The topics of this course include the framework of thought, methodology, data processing and analysis, literature review, and consistency in drawing conclusions. In addition to being delivered in written form (Research Results Report 2/Draft Dissertation), students are also expected to be able to deliver it orally in the form of presentations and discussions before the Research* *Results Examination 2 committee.* *This lecture is delivered in Indonesian using online methods for consultations and exams, as well as offline for submitting drafts.*
Examination forms	*Research result report 2 and research result exam presentation 2*
Study and examination requirements	*Student must obtain a minimum grade B (≥ 70) as detailed in S3.18B Assessment Rubric for Research Results Examination 2.*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

Scientific Publications (R)

Module designation	*Scientific Publications (R)*
Semester(s) in which the module is taught	*3rd*
Person responsible for the module	*Team teaching (thesis supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 10 x 60 = 600 minutes per week* *2. Independent study: 10 x 60 = 600 minutes per week*
Credit points	*10/18 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*Students can formulate (C6) research results into scientific articles in accordance with writing techniques and ethics in relevant journals, at least in national journals with SINTA category 2 or higher, or at least in international journals indexed by DOAJ.*
Course description	*The Scientific Publication I course examines all activities for scientific publications starting with selecting the journal to be targeted, understanding the guide for authors, creating a writing framework, processing and analyzing data, literature searches, to compiling manuscripts and submitting them to the target journal. Students become the main authors accompanied by a supervisor. The output of this course is at least proceedings at an international conference or a SINTA-accredited national journal.*
Examination forms	*Accepted at least in international conference proceedings or SINTA-accredited national journals*
Study and examination requirements	*Students must have minimum a manuscript under review in an international conference proceeding*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

International Publication 1 (R)

Module designation	*International Publication 1 (R)*
Semester(s) in which the module is taught	*4th*
Person responsible for the module	*Team teaching (thesis supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 8 x 60 = 480 minutes per week* *2. Independent study: 8 x 60 = 480 minutes per week*
Credit points	*8/14.4 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Research Progress 2*
Module objectives/intended learning outcomes	*Students can formulate (C6) research results in the form of written/draft publications in accordance with the techniques and ethics of writing SCOPUS indexed international journals.*
Course description	*The International Publication Draft course examines all activities for scientific publications starting with selecting the journal to be targeted, understanding the guide for authors, creating a writing framework, processing and analyzing data, literature searches, to compiling manuscripts and submitting them to the target journal. Students become the main authors accompanied by a supervisor. The output of this course is an international publication draft that is ready to be submitted to a Scopus-accredited international journal.*
Examination forms	*Draft international publication*
Study and examination requirements	*Students must have an article manuscript with target publication in at least an international journal indexed by SCOPUS.*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

International Publications 2 (R)

Module designation	*International Publications 2 (R)*
Semester(s) in which the module is taught	*5th*
Person responsible for the module	*Team teaching (thesis supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 10 x 60 = 600 minutes per week* *2. Independent study: 10 x 60 = 600 minutes per week*
Credit points	*10/18 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*International Publications 1*
Module objectives/intended learning outcomes	*Students can formulate (C6) research results into scientific articles in accordance with the techniques and ethics of writing SCOPUS indexed international journals.*
Course description	*The International Publication course examines all activities for scientific publications starting with selecting the journal to be targeted, understanding the guide for authors, creating a writing framework, processing and analyzing data, literature searches, to compiling manuscripts and submitting them to the target journal. Students become the main authors accompanied by a supervisor. The output of this course is an international journal indexed by SCOPUS.*
Examination forms	*Scientific publications that have been accepted at least in SCOPUS indexed international journals*
Study and examination requirements	*Students must achieve a final grade of B or higher (Having a minimum publication status of "under reviewed" at the International Journal indexed by Scopus).*

Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

Dissertation Examination 1 (R)

Module designation	*Dissertation Examination 1 (R)*
Semester(s) in which the module is taught	*5th*
Person responsible for the module	*Team Teaching (Thesis Supervisors)*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active Learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 8 x 60 = 480 minutes per week* *2. Independent study: 8 x 60 = 480 minutes per week*
Credit points	*8/14.4 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Research Progress 2*
Module objectives/intended learning outcomes	*After taking this course, students are expected to be able to conclude the study of the research process carried out along with the data obtained (minimum 80%) as a guide in planning further research (C6)*
Course description	*The dissertation exam course 1 is a special MK in the form of writing and compiling a final assignment with 80% progress at the doctoral level in chemistry taken in semester 5 and related to the management and analysis of data obtained through laboratory research activities.*
Examination forms	*Dissertation exam results report 1 (80%) and dissertation exam presentation 1*
Study and examination requirements	*Based on the S3.26. Assessment Rubric for Dissertation 1, students must achieve a final score of 70 or higher, and their research achievement must be at least 85%.*
Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

Dissertation Examination 2 (R)

Module designation	*Dissertation Examination 2 (R)*
Semester(s) in which the module is taught	*6th*
Person responsible for the module	*Team teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 12 x 60 = 720 minutes per week* *2. Independent study: 12 x 60 = 720 minutes per week*
Credit points	*12/21.6 (credit points/ECTS)*
Required and recommended prerequisites for joining the module	*Dissertation Examination 1*
Module objectives/intended learning outcomes	*Students can build (C6) and combine (A6) research results in oral and written form to solve (P6) human problems in the fields of energy, health and the environment in relation to advanced chemical science.*
Course description	*The dissertation exam course 1 is a special MK in the form of writing and compiling a final assignment with 100% progress at the doctoral level in chemistry taken in semester 6 and related to the management and analysis of data obtained through laboratory research activities.*
Examination forms	*Dissertation exam results report 2 (100%) and dissertation exam presentation 2*
Study and examination requirements	*Based on the S3.26. Assessment Rubric for Dissertation 2, students must achieve a final score of 70 or higher, and their research achievement must be at 100%.*
Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*

Doctoral Promotion (R)

Module designation	*Doctoral Promotion (R)*
Semester(s) in which the module is taught	*6th*
Person responsible for the module	*Team Teaching*
Language	*Indonesia*
Relation to curriculum	*Compulsory module for Chemistry Doctoral Program*
Teaching methods	*Active learning*
Workload (incl. contact hours, self-study hours)	*1. Exercises and assignments: 4 x 60 = 240 minutes per week* *2. Independent study: 4 x 60 = 240 minutes per week*
Credit points	*4/7.2 (credits/ECTS)*
Required and recommended prerequisites for joining the module	*International Publications 2 and Dissertation 2*
Module objectives/intended learning outcomes	*Students can construct and clarify research results in oral and written form so that they can be accounted for and disseminated to the public (C6).*
Course description	*The doctoral promotion course is a special MK in the form of writing and compiling a final assignment at the doctoral level in chemistry which is taken in semester 6 and is related to the management and analysis of data obtained through laboratory research activities.*
Examination forms	*The open dissertation trial takes the form of a doctoral promotion*
Study and examination requirements	*Based on the S3.26. Assessment Rubric for Doctoral Promotion, students must achieve a final score of 70 or higher, and their research achievement must be at 100%.*
Reading list	*1. On Being a Scientist: A Guide to Responsible Conduct in Research, Third Edition, National Academy of Sciences, USA, 2009.* *2. Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017* *3. Related digital library resources*