UNIVERSITAS INDONESIA

FMIPA

**Department of Physics**
Faculty of Mathematics and Natural Sciences
Universitas Indonesia

# Module Handbook

## Doctoral Programme in Physics

revised June 2025

*Curriculum 2024*

**UNIVERSITAS INDONESIA**
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## Contents

# Literature Review 1 (R)

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| 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 | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Literature review*<br>2. *Summarizing* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 5 × 60 minutes per week = 300 minutes per week*<br>2. *Independent study = 5 × 60 minutes per week = 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. *Students are able to apply logical, critical, systematic, and creative thinking in the field of science and technology relevant to the competencies in physics.*<br>2. *Students are able to explore new scientific issues relevant to aspects of physics knowledge and its applications comprehensively and thoroughly.*<br>3. *Students are able to examine physical laws, theories, or formulas and their relevant applications to solve new scientific problems comprehensively and scientifically.*<br>4. *Students are able to apply methods and tools to solve physics problems through analytical, numerical, or experimental approaches in applying physics knowledge and its applications.*<br>5. *Students are able to optimize information technology in the context of work implementation by using a computer-based application.* |

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| Course Description | *The Literature Review 1 course is designed to develop doctoral students' foundational skills in systematically searching, analyzing, and synthesizing scientific literature relevant to their research themes. Students learn to critically evaluate fundamental theories, physics concepts, and supporting research materials, grounding their work in a comprehensive understanding of current knowledge.*<br><br>*This course emphasizes the importance of distinguishing credible sources, recognizing biases, and identifying gaps and trends within the literature. Students engage in periodic scientific discussions with their supervisors to deepen their understanding and refine their analytical skills.*<br><br>*Tailored to the specific needs of each student's research focus, the module equips students with effective literature search techniques, including the use of academic databases and digital tools, enabling them to build a robust theoretical framework for their dissertation research.*<br><br>*By the end of the course, students will be proficient in synthesizing diverse scientific information, positioning their research within the broader academic discourse, and preparing for subsequent stages of their doctoral journey.* |
| Examination forms | 1. *Independent Assignment*<br>2. *Active Participation in Discussion*<br>3. *Presentation* |
| Study and examination re-quirements | *To pass Literature Review 1, students must achieve a final score of 70 or higher based on the S3.08. Assessment Rubric for the course.* |
| Reading list | *Names of textbooks, articles, etc.*<br>1. *Bryan Greetham (2021), How To Write Your Literature Review, Red Globe Press/Macmillan Education*<br>2. *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer*<br>3. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>4. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>5. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press* |

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| | 6. *Additional discipline-specific articles and textbooks relevant to the research theme of the students* |

# Literature Review 2 (R)

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| 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 | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Literature review*<br>2. *Summarizing* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 5 × 60 minutes per week = 300 minutes per week*<br>2. *Independent study = 5 × 60 minutes per week = 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. *Students are able to analyze all aspects of problems faced based on conceptual physics and its relevant applications.*<br>2. *Students are able to compare data, observations, or calculation results using theoretical, conceptual, or related calculation methods.*<br>3. *Students are able to formulate recommendations for scientific problems and sustainable development based on comprehensive studies involving various fields within the scope of mathematics and science.*<br>4. *Students are able to implement sustainability principles in applying scientific methods and problem-solving strategies in any professional field.*<br>5. *Students are able to summarize the latest literature relevant to scientific problems or research topics from* |

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| | *reputable international journals in sufficient quantity.*<br>6. *Students are able to analyze trends and developments in a research topic through expert discussions, recent literature, and other relevant reading sources.*<br>7. *Students are able to critically assess various recent literature related to the research topic and critique to find potential for the development and renewal of knowledge in one field of physics.*<br>8. *Students are able to clarify the presentation of research plans and results systematically using proper sentence structure and good language.* |
| Course Description | *The Literature Review 2 course builds on foundational literature review skills to deepen doctoral students' capacity for critical analysis, synthesis, and scholarly discussion of research topics. Students engage in extensive literature searching, reading, database management, and evaluation of at least 50 reputable international journal articles related to their specific research focus.*<br><br>*This course emphasizes the development of a comprehensive literature review plan, including defining the title, research problem, background, review methodology, and synthesis of findings. Students critically assess recent studies to identify research gaps, emerging trends, and opportunities for innovation within their field of physics.*<br><br>*Through presentations and periodic academic discussions with their supervisor, students refine their ability to articulate complex ideas clearly and systematically, using appropriate scientific language and structure. The module fosters a scientific attitude grounded in rigorous methodology and encourages continuous engagement with the evolving research landscape.*<br><br>*By the end of the course, students will be proficient in producing a well-structured, critical literature review that forms a solid foundation for their dissertation research and contributes to advancing knowledge in their discipline.* |
| Examination forms | 1. *Independent Assignment*<br>2. *Active Participation in Discussion*<br>3. *Presentation* |

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| Study and examination re-quirements | *To pass Literature Review 2, students must achieve a final score of 70 or higher on the S3.09. Assessment Rubric for the course, and they must submit their presentation and literature review.* |
| Reading list | 1. *Bryan Greetham (2021), How To Write Your Literature Review, Red Globe Press/Macmillan Education*<br>2. *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer*<br>3. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>4. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>5. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>6. *Additional discipline-specific articles and textbooks relevant to the research theme of the students* |

# Research Proposal (R)

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| Module designation | *Research Proposal (R)* |
| Semester(s) in which the module is taught | *2nd* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory Physics Doctoral Program* |
| Teaching methods | 1. *Literature Review*<br>2. *Summarizing*<br>3. *Analizing, Enhanching, and Writing* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 8 × 60 minutes per week = 480 minutes per week*<br>2. *Independent study = 8 × 60 minutes per week = 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 | 1. *Students are able to critically analyze various current literature related to the research topic and critique to identify potential developments and innovations in a specific field of physics.*<br>2. *Students are able to formulate new ideas and concepts in the form of a research proposal in line with scientific issues and the topics to be addressed responsibly, based on academic ethics.*<br>3. *Students are able to design the distribution of workload and work time effectively for both independent work and teamwork.*<br>4. *Students are able to systematically prepare a proposal book following the writing techniques determined by the guidelines in effect at the university.*<br>5. *Students are able to clarify the research proposal* |

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| | *systematically using proper sentence structure and language.* |
| Course Description | *The Research Proposal course equips students with the essential skills to plan, write, and present a high-quality research proposal. This course covers: Formulating research questions and hypotheses, developing theoretical frameworks and literature reviews, designing research methodologies and data analysis plans, addressing ethical considerations and academic integrity, writing and formatting the proposal according to the university standards, and presenting and defending the proposal in a scholarly setting. Students engage in writing assignments and presentations to build competence in crafting a robust foundation for their doctoral research.* |
| Examination forms | 1. *Quality of content*<br>2. *Quality of writing*<br>3. *Presentation skills* |
| Study and examination requirements | *To pass the Research Proposal course, students must achieve a final score of 70 or higher on the S3.12. Research Proposal Exam Assessment Form. Additionally, they must submit their presentation and literature review.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Jay D. Gatrell, Gregory D. Bierly, Ryan R. Jensen, Rajiv R. Thakur (2020), Research Design and Proposal Writing in Spatial Science, Springer*<br>4. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>5. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>6. *Additional discipline-specific articles and textbooks relevant to the research theme of the students* |

# Research Progress 1 (R)

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| 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 | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 8 × 60 minutes per week = 480 minutes per week*<br>2. *Independent study = 8 × 60 minutes per week = 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 | 1. *Students are able to implement the principles of sustainability in applying scientific methods and problem-solving strategies in any professional field.*<br>2. *Students are able to apply scientific methodology in conducting research, considering guidelines, ethics, safety, and environmental impacts.*<br>3. *Students are able to update their knowledge of physics and its applications through research to contribute to solving problems in industry and society.*<br>4. *Students are able to evaluate relationships with colleagues in completing a research and development project.*<br>5. *Students are able to determine the objectives, strategies, and tasks of each research team member to achieve research targets.* |

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| Course Description | *The Research Progress 1 module supports doctoral students in effectively communicating their ongoing research progress through structured presentations and comprehensive reports. This course emphasizes the development of critical skills in organizing and presenting complex scientific data clearly and cohesively, using visual aids such as images, tables, and graphs to enhance understanding.*<br><br>*Students will engage in problem-based and project-based learning activities that foster the application of scientific methodologies within the context of sustainability, ethics, safety, and environmental impact considerations. The course also cultivates collaboration skills by encouraging students to evaluate and manage team dynamics and responsibilities to achieve research objectives.*<br><br>*Through iterative feedback and constructive supervisor evaluations, students will refine their oral and written communication skills, gaining confidence in presenting research findings and responding to questions. This process prepares students to meet the academic standards expected in doctoral research dissemination and contributes to their professional development as researchers.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination requirements | *Based on the S3.18. Assessment Rubric for Research Results Examination 1, students must achieve a final score of 70 or higher and achieve a minimum of 50% of the research progress.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis* |

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# Scientific Publication (R)

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| Module designation | *Scientific Publication (R)* |
| Semester(s) in which the module is taught | *3rd* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 10 × 60 minutes per week = 600 minutes per week*<br>2. *Independent study = 10 × 60 minutes per week = 600 minutes per week* |
| Credit points | *10/18 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to deepen or expand their knowledge in physics or applied physics by generating a model, method, or development of original, accurate, tested, and innovative theories that are beneficial for industry and society.*<br>2. *Students are able to clearly convey valuable insights and knowledge accurately and comprehensively in the form of scientific writing.*<br>3. *Students are able to create innovative and tested works as a realization of ideas, scientific thoughts, and arguments that are beneficial for the academic community and the wider society.* |
| Course Description | *The Scientific Publication course prepares doctoral students to produce and critically evaluate high-quality scientific* |

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| | *publications essential for their academic and professional success. This course covers the full publication process, including selecting appropriate publication types, structuring manuscripts according to international standards (abstract, introduction, methods, results, discussion, references), and mastering effective scientific writing techniques.*<br><br>*Students will engage in problem-based and project-based learning activities that develop their ability to communicate complex scientific ideas clearly and accurately. The course also emphasizes ethical considerations in publishing, such as plagiarism avoidance, authorship criteria, and research integrity.*<br><br>*Additionally, students will learn strategies for identifying suitable journals and conferences, navigating the peer-review process, and responding to reviewer feedback. Through discussions, writing assignments, and critical analysis of existing publications, students will enhance their skills as both authors and discerning readers.*<br><br>*The ultimate goal is to equip students with the competence and confidence to successfully publish their original research findings in a reputable international journal, thereby contributing valuable knowledge to the academic community and society.* |
| Examination forms | *Reports* |
| Study and examination requirements | *Students must have at least one manuscript under review for an international conference proceeding.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic* |

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| | *reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Research Progress 2 (R)

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| 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 | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 10 × 60 minutes per week = 600 minutes per week*<br>2. *Independent study = 10 × 60 minutes per week = 600 minutes per week* |
| Credit points | *10/18 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to internalize the spirit of independence, struggle, and entrepreneurship based on values, norms, and academic ethics.*<br>2. *Students are able to apply scientific methodology in conducting research by considering guidelines, ethics, safety, and environmental impact.*<br>3. *Students are able to solve new scientific problems and sustainable development through an interdisciplinary or multidisciplinary approach, characterized by the generation of insights, methods, knowledge, and comprehensive valuable technologies.*<br>4. *Students are able to direct work effectively in research and development projects.*<br>5. *Students are able to monitor and evaluate the goals, strategies, and tasks of each research team member in* |

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| | *carrying out research periodically.*<br>6. *Students are able to elaborate information from data, observations, or calculation results in detail using images, tables, and graphs that support the research findings.* |
| Course Description | *The Research Progress 2 module is designed to advance doctoral students' ability to communicate their ongoing research findings effectively through structured presentations and comprehensive reports. This course emphasizes the development of critical skills in organizing and presenting complex scientific data clearly and cohesively, using visual aids such as images, tables, and graphs to support and illustrate research outcomes.*<br><br>*Students engage in problem-based and project-based learning, applying scientific methodologies with a strong focus on research ethics, safety, and environmental considerations. The course also fosters interdisciplinary and multidisciplinary approaches to address new scientific problems and sustainable development challenges.*<br><br>*Through regular progress monitoring, team coordination, and constructive feedback from supervisors, students will enhance their skills in research management, oral communication, and critical self-evaluation. This process prepares them to meet the rigorous standards of doctoral research dissemination and to contribute valuable insights to their academic and professional communities.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *Based on the S3.18B. Assessment Rubric for Research Results Examination 2, students must achieve a final score of 70 or higher and achieve a minimum of 75% of the research progress.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How* |

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| | *to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# International Publication 1 (R)

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| 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 | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 8 × 60 minutes per week = 480 minutes per week*<br>2. *Independent study = 8 × 60 minutes per week = 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 | 1. *Students are able to analyze data, observations, and results from calculations or simulations obtained through research, supported by related theory.*<br>2. *Students are able to deepen or expand their knowledge of physics or applied physics by producing an original, accurate, tested, and innovative model, method, or theory development that is beneficial for industry and society.*<br>3. *Students are able to elaborate on information, data, observations, or calculation results in detail using images, tables, and graphs that support the research results.*<br>4. *Students are able to clarify contributions to valuable insights and knowledge accurately and comprehensively in the form of scientific writing.* |

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| Course Description | *The International Publication 1 course equips doctoral students with the comprehensive skills and knowledge required to produce and critically evaluate high-quality scientific publications suitable for international dissemination. This course guides students through the entire publication process, including selecting appropriate publication types, crafting well-structured manuscripts (abstract, introduction, methods, results, discussion, references), and mastering effective scientific writing tailored to international journals.*<br><br>*Students will engage in problem-based and project-based learning activities that emphasize the ethical principles of scientific publishing, including plagiarism prevention, authorship criteria, and research integrity. The course also covers strategies for identifying reputable journals indexed in Scopus and other databases, navigating the peer-review process, and responding professionally to reviewer feedback.*<br><br>*Through critical analysis of existing publications, writing assignments, and periodic discussions with the supervisor, students will develop the ability to communicate their original research findings clearly, accurately, and persuasively. The ultimate goal is to prepare students to successfully draft and submit manuscripts to high-impact international journals, thereby contributing valuable knowledge to the global scientific community and advancing their academic careers.* |
| Examination forms | *Reports* |
| Study and examination re-quirements | *Students must have an article manuscript with a target publication in Scopus-indexed journals* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press* |

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| | 5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Dissertation Examination 1 (R)

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| 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 | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 8 × 60 minutes per week = 480 minutes per week*<br>2. *Independent study = 8 × 60 minutes per week = 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 | 1. *Students are able to analyze data, observations, calculation results, or simulations obtained through research, supported by related theories.*<br>2. *Students are able to update knowledge of physics and its applications through research to contribute to solving problems in industry and society.*<br>3. *Students are able to manage professional networks with colleagues within institutions and the broader physics research community.*<br>4. *Students are able to resolve problems and technical challenges of team members in the research process to meet targets within the established timeframe.*<br>5. *Students are able to clearly present research findings systematically, using appropriate sentence structure and language.* |

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| Course Description | *The Dissertation Examination 1 course represents a critical milestone in the doctoral journey, where students demonstrate their original contribution to knowledge in physics through a comprehensive dissertation. This course assesses the student's ability to design, conduct, analyze, and present rigorous scientific research that advances the field and addresses real-world problems.*<br><br>*Students receive guidance on structuring their dissertation, ensuring coherence and alignment across key chapters, including introduction, literature review, methodology, results, analysis, and conclusion. Emphasis is placed on integrating theoretical frameworks with empirical findings to produce a cohesive and impactful scholarly work.*<br><br>*The course prepares students for the dissertation defense, a formal examination where they present their research findings to an expert committee, respond to critical questions, and engage in scholarly discussion. This defense balances assessment and academic ceremony, marking the transition from candidate to expert researcher.*<br><br>*Evaluation criteria are transparent and comprehensive, focusing on the originality, methodological rigor, clarity of presentation, and scholarly significance of the dissertation. Constructive feedback is provided to support further refinement and successful completion.*<br><br>*This course also encourages the development of professional networks and collaboration skills essential for ongoing research and career advancement within the physics community.* |
| Examination forms | *Public Defense and reports* |
| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to* |

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| | *Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# International Publication 2 (R)

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| Module designation | *International Publication 2 (R)* |
| Semester(s) in which the module is taught | *5th* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 10 × 60 minutes per week = 600 minutes per week*<br>2. *Independent study = 10 × 60 minutes per week = 600 minutes per week* |
| Credit points | *10/18 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to compile research results accurately, including a thorough discussion of the findings, addressing the research problem, and fulfilling the research objectives.*<br>2. *Students are able to solve new scientific problems and promote sustainable development through an inter- or multidisciplinary approach, resulting in valuable insights, methods, knowledge, and comprehensive technology.*<br>3. *Students are able to clarify the contribution to valuable insights and knowledge accurately and comprehensively in the form of scientific writing.*<br>4. *Students are able to compose scientific papers suitable for publication in international and/or national journals.* |

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| | 5. *Students are able to produce innovative and validated works that realize ideas, thoughts, and scientific arguments beneficial to the academic community and society at large.* |
| Course Description | *The International Publication 2 course advances doctoral students' competencies in producing and disseminating high-quality scientific publications in international and national journals. Building upon foundational skills, this module guides students through the comprehensive process of compiling research results, including detailed discussions that address research problems and fulfill research objectives.*<br><br>*Students will engage in problem-based and project-based learning that encourages interdisciplinary and multidisciplinary approaches to solving new scientific problems and promoting sustainable development. The course emphasizes the production of innovative, validated scientific works that contribute valuable insights and knowledge to both the academic community and society at large.*<br><br>*Through critical analysis, writing assignments, and periodic discussions with the supervisor, students will refine their scientific writing skills, focusing on clarity, accuracy, and coherence in manuscript preparation. Ethical principles in publishing, such as plagiarism prevention and responsible authorship, are integral components of the course.*<br><br>*The ultimate goal is to prepare students to successfully publish their research findings in reputable international journals indexed by Scopus or equivalent databases, thereby enhancing their academic profile and contributing to global scientific progress.* |
| Examination forms | *Reports* |
| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English* |

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| | *Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Dissertation Examination 2 (R)

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| Module designation | *Dissertation Examination 2 (R)* |
| Semester(s) in which the module is taught | *6th* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 12 × 60 minutes per week = 720 minutes per week*<br>2. *Independent study = 12 × 60 minutes per week = 720 minutes per week* |
| Credit points | *12/21.6 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to compile research findings accurately, including discussing research results and addressing the research problems and objectives.*<br>2. *Students are able to solve new scientific problems and sustainable development challenges through an interdisciplinary or multidisciplinary approach, characterized by the creation of valuable, comprehensive insights, methods, knowledge, and technologies.*<br>3. *Students are able to be accountable for the outcomes of research and development projects.*<br>4. *Students are able to resolve problems and technical issues faced by team members during the implementation of research to meet targets within the established timeframe.*<br>5. *Students are able to compile a final project report* |

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| | *systematically according to the writing techniques specified in the university's guidelines.*<br>6. *Students are able to defend arguments and opinions when presenting work and research results, concisely, accurately, and politely, based on data evidence.* |
| Course Description | *The Dissertation Examination 2 course represents the final and most comprehensive stage of the doctoral program, where students demonstrate the full maturity and rigor of their original research contributions in physics. This course evaluates the student's ability to compile, analyze, and present research findings systematically, addressing research problems and objectives with clarity and scholarly depth.*<br><br>*Students are guided in producing a coherent and well-structured dissertation that meets university standards, including essential chapters such as introduction, literature review, methodology, results, analysis, and conclusion. Emphasis is placed on interdisciplinary and multidisciplinary approaches that contribute to solving scientific problems and advancing sustainable development.*<br><br>*The course prepares students for the final dissertation defense, a formal examination conducted privately before a committee of experts. During this defense, students must clearly and confidently articulate their research arguments, respond to critical questions, and demonstrate accountability for their work and its broader impact.*<br><br>*Evaluation criteria are transparent and rigorous, focusing on the originality, methodological soundness, clarity, and scholarly significance of the dissertation, as well as the student's performance during the defense. Constructive feedback is provided to support any final refinements.*<br><br>*This course also encourages students to develop professional responsibility and problem-solving skills essential for leading research projects and collaborating effectively within the scientific community.* |
| Examination forms | *Public Defense and Reports* |

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| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Doctoral Promotion (R)

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| Module designation | *Doctoral Promotion (R)* |
| Semester(s) in which the module is taught | *6th* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 4 × 60 minutes per week = 240 minutes per week*<br>2. *Independent study = 4 × 60 minutes per week = 240 minutes per week* |
| Credit points | *6/10.8 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to compile research findings carefully, including a detailed discussion of the research results that address the research problems and objectives.*<br>2. *Students are able to solve new scientific problems and contribute to sustainable development through inter- or multidisciplinary approaches, characterized by the generation of valuable, comprehensive insights, methods, knowledge, and technology.*<br>3. *Students are able to produce innovative and validated works as a realization of ideas, thoughts, and scientific arguments that benefit the academic community and the broader public.*<br>4. *Students are able to defend arguments and opinions effectively when presenting work and research results in a clear, precise, direct, and respectful manner, based on* |

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| | *data evidence.* |
| Course Description | *The Doctoral Promotion course marks the culminating phase of the doctoral program, where students finalize their dissertation and prepare to publicly defend their original research contributions. This course focuses on developing advanced oral presentation skills, enabling students to structure their defense materials effectively and deliver them with confidence, clarity, and professionalism.*<br><br>*Students will consolidate their research findings into a comprehensive dissertation that addresses the research problems and objectives with depth and scholarly rigor. Emphasis is placed on articulating scientific arguments clearly, precisely, and respectfully, supported by robust data evidence.*<br><br>*The public Doctoral Promotion Defense serves as the formal academic event where candidates present and defend their research before an examination panel, demonstrating their expertise and readiness to contribute as independent researchers. Successful completion of this module signifies the awarding of the doctoral degree.*<br><br>*This course also encourages students to reflect on their interdisciplinary and multidisciplinary research approaches, the societal impact of their work, and their role as emerging scholars within the academic community and beyond.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press* |

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| | 4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Integrated Science and Mathematics

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| Module designation | *Integrated Science and Mathematics* |
| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Team teaching* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory module for the Doctoral Physics Program* |
| Teaching methods | *Lecture-Based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 4 × 50 minutes per week = 250 minutes per week*<br>2. *Independent exercises and assignments = 4 × 60 minutes per week = 300 minutes per week*<br>3. *Independent study = 4 × 60 minutes per week = 300 minutes per week* |
| Credit points | *4/7.2 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to apply logical, critical, systematic, and creative thinking in the fields of science and technology following the competencies of physics.*<br>2. *Students are able to develop recommendations on scientific issues and sustainable development based on comprehensive studies that involve various fields within mathematics and science.*<br>3. *Students are able to adapt to the latest scientific developments by continuously learning new things relevant to any job or profession.* |
| Course Description | *The Integrated Science and Mathematics course offers a* |

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| | *comprehensive interdisciplinary study that bridges key concepts and methodologies from both science and mathematics to address complex scientific problems. This course transcends traditional disciplinary boundaries, emphasizing how mathematical principles underpin scientific inquiry and how integrated approaches enhance problem-solving capabilities in physics and related fields.*<br><br>*Students will develop advanced analytical, critical thinking, and problem-solving skills essential for tackling contemporary scientific challenges. The course highlights the synergy between mathematics and science, demonstrating the role of mathematical modeling, quantitative analysis, and scientific reasoning in advancing research and innovation.*<br><br>*Through lectures, independent assignments, and exercises, students engage with diverse topics that illustrate the interconnectedness of scientific and mathematical knowledge. This foundation prepares doctoral candidates to approach research questions with a multidisciplinary perspective, fostering adaptability and creativity in their scientific endeavors.*<br><br>*This course also encourages continuous learning and adaptation to emerging scientific developments, equipping students with the intellectual tools to contribute effectively to sustainable development and technological progress.* |
| Examination forms | 1. *Formative: Discussions, Independent and group assignments*<br>2. *Summative: Midterm (Progress Report) and Final (Final Report) Exam* |
| Study and examination re-quirements | 1. *Students must have attended at least 75% of the lectures to be able to sit in the final exam and submit a final report.*<br>2. *Students must achieve a final grade of B or higher (≥70).* |
| Reading list | 1. *Scientific articles*<br>2. *Textbooks and monographs related to the specific topics* |

# Research Methodology

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| Module designation | *Research Methodology* |
| Semester(s) in which the module is taught | *1st* |
| Person responsible for the module | *Team teaching* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Student-centered Learning*<br>2. *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 2 × 50 minutes per week = 100 minutes per week*<br>2. *Independent exercises and assignments = 2 × 60 minutes per week = 120 minutes per week*<br>3. *Independent study = 2 × 60 minutes per week = 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 ara able to analyze laws, theories, or physical formulas and their relevant applications to solve new scientific problems comprehensively and scientifically.*<br>2. *Students ara able to maximize information technology in the context of performing tasks by using a computer-based application.*<br>3. *Students ara able to adapt to the latest scientific developments by continuously learning new things relevant to any job or profession.*<br>4. *Students ara able to enhance their capacity for learning physics and its applications independently and sustainably.* |
| Course Description | *The Research Methodology course equips doctoral students* |

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| | *in physics with a comprehensive understanding of research principles, enabling them to design and conduct valid, rigorous, and relevant scientific investigations. The course covers foundational concepts such as formulating research problems, developing hypotheses, and defining clear research objectives.*<br><br>*Students will explore a range of quantitative and qualitative data analysis techniques, including statistical methods and advanced analytical tools suited to their specific research approaches. Emphasis is placed on integrating theoretical frameworks with empirical data to produce scientifically sound and innovative research outcomes.*<br><br>*Through student-centered and research-based learning activities, students will develop the skills to design comprehensive research proposals that include background, objectives, methodology, and implementation timelines. The course also encourages continuous adaptation to emerging scientific developments and the effective use of information technology and computer-based applications to enhance research productivity.*<br><br>*This course fosters independent and sustainable learning capacities, preparing students to address complex scientific problems and contribute meaningfully to their field.* |
| Examination forms | 1. *Formative: Discussions, Independent and group assignments*<br>2. *Summative: Midterm (Progress Report) and Final (Final Report) Exam* |
| Study and examination re-quirements | 1. *Students must have attended at least 75% of the lectures to be able to sit in the final exam and submit a final report.*<br>2. *Students must achieve a final grade of B or higher (≥70).* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer*<br>2. *Patrick X. W. Zou, Xiaoxiao Xu (2023), Research Methodology and Strategy: Theory and Practice, Wiley-Blackwell*<br>3. *Shyama Prasad Mukherjee (2020), A Guide To Research Methodology: An Overview Of Research Problems, Tasks And Methods, Taylor & Francis Group* |

# Capita Selecta in Physics A

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| Module designation | *Capita Selecta in Physics A* |
| Semester(s) in which the module is taught | *1st* |
| Person responsible for the module | *Team teaching* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory module for Physics Doctoral Program* |
| Teaching methods | 1. *Student-centered Learning*<br>2. *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 4 × 50 minutes per week = 200 minutes per week*<br>2. *Independent exercises and assignments = 4 × 60 minutes per week = 240 minutes per week*<br>3. *Independent study = 4 × 60 minutes per week = 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 | 1. *Students are able to explore new scientific issues that are relevant to aspects of physics knowledge and its applications comprehensively and thoroughly.*<br>2. *Students are able to calculate physical quantities based on laws or theories of physics that are relevant to scientific or work-related issues.*<br>3. *Students are able to compare data, observations, or calculation results using theoretical, conceptual, or related calculation methods.*<br>4. *Students are able to solve problems in the field of physics, its applications, and new sustainable development collaboratively and comprehensively using an interdisciplinary or multidisciplinary approach.* |

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| | 5. *Students are able to validate problem-solving solutions based on scientific studies in the field of physics competencies to address issues relevant to society or industry (C5) (Sub CPL 3.2).* |
| Course Description | *This course presents selected advanced topics in physics and related interdisciplinary fields, aiming to broaden the perspective of doctoral students and support the development of their research. Topics will vary each semester, delivered by faculty members and invited researchers, and may include recent developments, specialized techniques, and applications of physics in new domains.*<br>*Content Modules:*<br>1. *Frontiers in Fundamental Physics*<br>*This topic covers: Quantum field theory, Current challenges in cosmology and astrophysics, Advances in particle physics, Gravitational waves and general relativity updates.*<br>2. *Advanced Materials and Condensed Matter Physics*<br>*This topic covers: Topological insulators and 2D materials, Strongly correlated electron systems, Nano-materials synthesis and characterization, Quantum materials and their applications.*<br>3. *Computational and Data-Driven Physics*<br>*This topic covers: Machine learning for physics applications, High-performance computing in simulations, Data analytics in experimental physics, and Physics-informed neural networks (PINNs)* |
| Examination forms | 1. *Formative: Discussions, Independent and group assignments*<br>2. *Summative: Midterm (Progress Report) and Final (Final Report) Exam* |
| Study and examination re-quirements | 1. *Students must have attended at least 75% of the lectures to be able to sit in the final exam and submit a final report.*<br>2. *Students must achieve a final grade of B or higher (≥70).* |
| Reading list | 1. *Core Textbooks (General & Advanced Physics)*<br>*The foundational books which can support broad and deep understanding across many topics:*<br>• *Modern Quantum Mechanics – J. J. Sakurai & Jim Napolitano*<br>• *Quantum Field Theory – Mark Srednicki* |

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| | • *Statistical Mechanics – R. K. Pathria & Paul D. Beale*<br>• *Introduction to Solid State Physics – Charles Kittel*<br>• *Classical Electrodynamics – J. D. Jackson*<br>• *Gravitation – Charles W. Misner, Kip S. Thorne, John Archibald Wheeler*<br>• *Computational Physics – Nicholas J. Giordano & Hisao Nakanishi*<br>2. *Topical Review Papers (High-Impact Journals)*<br>*Highly recommended journals for in-depth study and discussion:*<br>• *Reviews of Modern Physics (American Physical Society)*<br>• *Nature Physics Review Articles*<br>• *Physics Reports (Elsevier)*<br>• *Reports on Progress in Physics (IOP Publishing)*<br>• *Annual Review of Condensed Matter Physics*<br>• *Example articles:*<br>• *"The rise of quantum materials" – Nature Materials, 2021*<br>• *"Machine learning in physical sciences" – Nature Reviews Physics, 2020*<br>3. *Research Journals (For Latest Developments)*<br>*Highly recommended journals for in-depth study and discussion:*<br>• *Physical Review Letters*<br>• *Nature Physics*<br>• *Science*<br>• *Journal of High Energy Physics*<br>• *Applied Physics Letters*<br>• *IEEE Transactions on Instrumentation and Measurement (for applied topics)*<br>4. *Interdisciplinary and Applied Physics References*<br>• *Physics of the Human Body – Irving P. Herman (biophysics and medical applications*<br>• *Energy Harvesting Technologies – Shashank Priya & Daniel J. Inman*<br>• *Environmental Physics – Egbert Boeker & Rienk van Grondelle*<br>• *Artificial Intelligence for Scientific Discovery – Nature and Science special issues*<br>5. *Online and Open Resources*<br>• *arXiv.org – Preprints in physics and related disciplines*<br>• *Stanford Online / MIT OpenCourseWare –* |

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| | *Advanced physics lectures*<br>• *Scholarpedia and PhysicsToday.org – Overview and commentary*<br>• *CERN Document Server – Technical documents, lectures, reports* |

# Capita Selecta in Physics B

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| Module designation | *Capita Selecta in Physics B* |
| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Team teaching* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Student-centered Learning*<br>2. *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 4 × 50 minutes per week = 200 minutes per week*<br>2. *Independent exercises and assignments = 4 × 60 minutes per week = 240 minutes per week*<br>3. *Independent study = 4 × 60 minutes per week = 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 | 1. *Students are able to examine laws, theories, or physics formulas and their relevant applications to solve new scientific problems comprehensively and scientifically.*<br>2. *Students are able to apply methods and tools for solving physics problems through analytical, numerical, or experimental approaches in applying physics knowledge and its applications.*<br>3. *Students are able to maximize information technology in the context of executing tasks by using a computer-based application.*<br>4. *Students are able to collaboratively and comprehensively solve problems in physics, its applications, and sustainable development through an* |

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| | *interdisciplinary or multidisciplinary approach.* |
| Course Description | *This course presents selected advanced topics in physics and related interdisciplinary fields, aiming to broaden the perspective of doctoral students and support the development of their research. Topics will vary each semester, delivered by faculty members and invited researchers, and may include recent developments, specialized techniques, and applications of physics in new domains.*<br>*Content Modules:*<br>1. *Instrumentation and Measurement*<br>*This module includes: Advanced sensor technologies, Precision measurement techniques, Experimental design in complex systems, and Internet of Things (IoT) in physics research*<br>2. *Interdisciplinary and Applied Physics*<br>*This module includes: Biophysics and medical imaging, Environmental physics and climate modeling, Plasma and nuclear fusion research, Energy harvesting and conversion technologies*<br>3. *Philosophy and Ethics in Physics Research*<br>*This module includes: Philosophy of science and theory change, Ethical issues in emerging technologies, Responsible conduct of research* |
| Examination forms | 1. *Formative: Discussions, Independent and group assignments*<br>2. *Summative: Midterm (Progress Report) and Final (Final Report) Exam* |
| Study and examination re-quirements | 1. *Students must have attended at least 75% of the lectures to be able to sit in the final exam and submit a final report.*<br>2. *Students must achieve a final grade of B or higher (≥70).* |
| Reading list | 1. *Core Textbooks (General & Advanced Physics)*<br>*The foundational books which can support broad and deep understanding across many topics:*<br>• *Modern Quantum Mechanics – J. J. Sakurai & Jim Napolitano*<br>• *Quantum Field Theory – Mark Srednicki*<br>• *Statistical Mechanics – R. K. Pathria & Paul D. Beale* |

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| | • *Introduction to Solid State Physics – Charles Kittel*<br>• *Classical Electrodynamics – J. D. Jackson*<br>• *Gravitation – Charles W. Misner, Kip S. Thorne, John Archibald Wheeler*<br>• *Computational Physics – Nicholas J. Giordano & Hisao Nakanishi*<br>2. *Topical Review Papers (High-Impact Journals)*<br>*Highly recommended journals for in-depth study and discussion:*<br>• *Reviews of Modern Physics (American Physical Society)*<br>• *Nature Physics Review Articles*<br>• *Physics Reports (Elsevier)*<br>• *Reports on Progress in Physics (IOP Publishing)*<br>• *Annual Review of Condensed Matter Physics*<br>• *Example articles:*<br>• *"The rise of quantum materials" – Nature Materials, 2021*<br>• *"Machine learning in physical sciences" – Nature Reviews Physics, 2020*<br>3. *Research Journals (For Latest Developments)*<br>*Highly recommended journals for in-depth study and discussion:*<br>• *Physical Review Letters*<br>• *Nature Physics*<br>• *Science*<br>• *Journal of High Energy Physics*<br>• *Applied Physics Letters*<br>• *IEEE Transactions on Instrumentation and Measurement (for applied topics)*<br>4. *Interdisciplinary and Applied Physics References*<br>• *Physics of the Human Body – Irving P. Herman (biophysics and medical applications*<br>• *Energy Harvesting Technologies – Shashank Priya & Daniel J. Inman*<br>• *Environmental Physics – Egbert Boeker & Rienk van Grondelle*<br>• *Artificial Intelligence for Scientific Discovery – Nature and Science special issues*<br>5. *Online and Open Resources*<br>• *arXiv.org – Preprints in physics and related disciplines*<br>• *Stanford Online / MIT OpenCourseWare – Advanced physics lectures*<br>• *Scholarpedia and PhysicsToday.org – Overview and* |

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| | *commentary*<br>*CERN Document Server – Technical documents, lectures, reports* |

# Philosophy of Science

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| Module designation | *Philosophy of Science* |
| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Team teaching* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Student-centered Learning*<br>2. *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 2 × 50 minutes per week = 100 minutes per week*<br>2. *Independent exercises and assignments = 2 × 60 minutes per week = 120 minutes per week*<br>3. *Independent study = 2 × 60 minutes per week = 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 apply logical, critical, systematic, and creative thinking in the field of science and technology relevant to physics competencies.*<br>2. *Students are able to explore new scientific issues relevant to aspects of physics knowledge and its applications in a comprehensive and thorough manner.*<br>3. *Students are able to analyze physics laws, theories, or formulas and their applications relevant to solving new scientific problems in a comprehensive and scientific manner.*<br>4. *Students are able to adapt to the latest scientific developments by continuously learning new things relevant to any job or profession.* |

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| Course Description | *The Philosophy of Science course explores foundational questions about the nature, scope, and methodology of scientific inquiry, providing doctoral students with a critical framework to understand how scientific knowledge is developed, validated, and contextualized. This course examines classical and contemporary philosophical theories related to concepts such as reality, truth, justification, reasoning, and the scientific method.*<br><br>*Students will engage with the historical evolution of scientific thought and its philosophical underpinnings, including the relationship between science and other domains such as religion and broader epistemological perspectives. The course encourages critical thinking and analytical skills by challenging students to evaluate arguments, identify assumptions, and reflect on the limits and possibilities of scientific knowledge.*<br><br>*Through student-centered and research-based learning activities, students will develop a deeper understanding of the philosophical foundations that inform scientific practice and its societal implications. This course also fosters the ability to navigate complex interdisciplinary research contexts by appreciating diverse theoretical frameworks and methodological pluralism.*<br><br>*The course aims to prepare doctoral candidates to critically engage with the epistemological and ethical dimensions of their research, enhancing their capacity to contribute thoughtfully and rigorously to the advancement of physics and science at large.* |
| Examination forms | 1. *Formative: Discussions, Independent and group assignments*<br>2. *Summative: Midterm (Progress Report) and Final (Final Report) Exam* |
| Study and examination re-quirements | 1. *Students must have attended at least 75% of the lectures to be able to sit in the final exam and submit a final report.*<br>2. *Students must achieve a final grade of B or higher (≥70).* |
| Reading list | 1. *Kuhn, T. S., Sautoy, D. M., & Hacking, I. (2020). The structure of Scientific Revolutions. Folio Society Ltd.*<br>2. *Poincaré, H., Smith, A. E., Stump, D. J., & Frappier, M. (2022). Science and hypothesis. Bloomsbury Academic.* |

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| | 3. *Popper, K. R. (2014). The logic of Scientific Discovery. Martino Publishing* |

# Literature Review

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| Module designation | *Literature Review* |
| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Student-centered Learning*<br>2. *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 2 × 50 minutes per week = 100 minutes per week*<br>2. *Independent exercises and assignments = 2 × 60 minutes per week = 120 minutes per week*<br>3. *Independent study = 2 × 60 minutes per week = 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 analyze all aspects of problems encountered by grounding them in relevant physics concepts and applications.*<br>2. *Students are able to maximize information technology in the context of job execution by using a computer-based application.*<br>3. *Students are able to validate problem-solving solutions based on scientific studies in the field of physics competence to address relevant issues in society or industry.*<br>4. *Students are able to implement the principle of sustainability in applying scientific methods and problem-solving strategies in any professional field.* |

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| | 5. *Students are able to summarize recent literature relevant to scientific issues or research topics sourced from a sufficient number of reputable international journals.* |
| Course Description | *The Literature Review course provides doctoral students with essential skills to critically explore, evaluate, and synthesize existing scientific literature relevant to their research area. This course develops students' ability to conduct comprehensive and systematic searches using academic databases, scholarly journals, books, and other credible sources.*<br><br>*Students learn to distinguish credible from non-credible information, identify bias, and assess the relevance and contribution of various works to their field. The course emphasizes the development of analytical and synthetic thinking to recognize patterns, trends, and gaps in the literature, enabling students to position their research within the broader scientific context.*<br><br>*Through student-centered and research-based learning activities, including peer discussions, supervisor assessments, assignments, and presentations, students will refine their academic writing skills to produce coherent, well-structured literature reviews. This preparation is critical for formulating research questions and designing rigorous doctoral research projects.*<br><br>*The goal of this course is to equip students with the competence to navigate and critically engage with the scientific literature, laying a strong foundation for their dissertation research and academic scholarship.* |
| Examination forms | 1. *Formative: Discussions, Independent and group assignments*<br>2. *Summative: Midterm (Progress Report) and Final (Final Report) Exam* |
| Study and examination re-quirements | 1. *Students must have attended at least 75% of the lectures to be able to sit in the final exam and submit a final report.*<br>2. *Students must achieve a final grade of B or higher (≥70).* |
| Reading list | 1. *Bryan Greetham (2021), How To Write Your Literature Review, Red Globe Press/Macmillan Education* |

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| | 2. *Lawrence A Machi; Brenda T McEvoy (2022), The literature review: six steps to success, Corwin Press*<br>3. *Bryan Greetham (2021), How To Write Your Literature Review, Macmillan Education*<br>4. *David J. Harris (2020), Literature Review And Research Design: A Guide To Effective Research Practice, Taylor Francis Group*<br>5. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>6. *Additional discipline-specific articles and textbooks relevant to the research theme of the students* |

# Scientific Writing

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| Module designation | *Scientific Writing* |
| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Student-centered Learning*<br>2. *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 2 × 50 minutes per week = 100 minutes per week*<br>2. *Independent exercises and assignments = 2 × 60 minutes per week = 120 minutes per week*<br>3. *Independent study = 2 × 60 minutes per week = 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 apply logical, critical, systematic, and creative thinking in the field of science and technology relevant to the field of physics competence.*<br>2. *Students are able to analyze all aspects of the encountered problems based on relevant physics concepts and their applications.*<br>3. *Students are able to maximize information technology in the context of work implementation using a computer-based application.*<br>4. *Students are able to solve new problems in physics and its applications analytically and/or numerically using a computer-based application.* |

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| Course Description | *The Scientific Writing course equips doctoral students with the essential skills and knowledge to produce clear, coherent, and high-quality scientific texts. This course emphasizes the structure and style of scientific writing, fostering logical, critical, and creative thinking necessary to construct persuasive scientific arguments and effectively present research data and findings.*<br><br>*Students engage in student-centered and research-based learning activities, including writing exercises, peer and instructor feedback, and iterative editing, which support the development of writing proficiency and confidence. The course also addresses challenges commonly faced by doctoral writers, such as overcoming writing apprehension and building self-efficacy through continuous practice and constructive feedback.*<br><br>*In addition, the course explores the use of information technology and digital tools to enhance writing productivity and quality. It prepares students to communicate their research effectively within academic and professional contexts, contributing to their intellectual maturation and professional identity as scientists.*<br><br>*This course is designed to support doctoral candidates in meeting the rigorous demands of scientific communication, laying a strong foundation for the successful publication and dissemination of their research.* |
| Examination forms | 1. *Formative: Discussions, Independent and group assignments*<br>2. *Summative: Midterm (Progress Report) and Final (Final Report) Exam* |
| Study and examination re-quirements | 1. *Students must have attended at least 75% of the lectures to be able to sit in the final exam and submit a final report.*<br>2. *Students must achieve a final grade of B or higher (≥70).* |
| Reading list | 1. *Bryan Greetham (2021), How To Write Your Literature Review, Red Globe Press/Macmillan Education*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press* |

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| | 4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis* |

# Research Proposal

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| Module designation | *Research Proposal* |
| Semester(s) in which the module is taught | *2* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Summarizing*<br>2. *Analizing, enhancing and writing* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 8 × 50 minutes per week = 400 minutes per week*<br>2. *Independent exercises and assignments = 8 × 60 minutes per week = 480 minutes per week*<br>3. *Independent study = 8 × 60 minutes per week = 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 | 1. *Students are able to analyze trends and developments in a research topic through expert discussions, recent literature, and other relevant reading sources.*<br>2. *Students are able to critically evaluate various recent literature related to the research topic and critique it to identify potential development and advancement opportunities in a specific area of physics.*<br>3. *Students are able to develop new ideas and concepts in the form of a research proposal, responsibly addressing scientific problems and topics, based on academic ethics.*<br>4. *Students are able to plan workload distribution and time management effectively for both independent and team work.* |

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| | 5. *Students are able to prepare a proposal document following the structure and writing techniques required by university guidelines.*<br>6. *Students are able to clarify the presentation of a research proposal systematically, using well-constructed sentences and proper language.* |
| Course Description | *The Research Proposal course equips students with the essential skills to plan, write, and present a high-quality research proposal. This course covers: Formulating research questions and hypotheses, developing theoretical frameworks and literature reviews, designing research methodologies and data analysis plans, addressing ethical considerations and academic integrity, writing and formatting the proposal according to the university standards, and presenting and defending the proposal in a scholarly setting. Students engage in writing assignments and presentations to build competence in crafting a robust foundation for their doctoral research.* |
| Examination forms | 1. *Quality of content*<br>2. *Quality of writing*<br>3. *Presentation skills* |
| Study and examination re-quirements | *Based on the S3.12. Research Proposal Exam Assessment Form, students must achieve a final score of 70 or higher. Additionally, their presentation and literature review must be submitted.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Jay D. Gatrell, Gregory D. Bierly, Ryan R. Jensen, Rajiv R. Thakur (2020), Research Design and Proposal Writing in Spatial Science, Springer*<br>4. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>5. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>6. *Additional discipline-specific articles and textbooks relevant to the research theme of the students* |

# Research Progress 1

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| Module designation | *Research Progress 1* |
| Semester(s) in which the module is taught | *3* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 8 × 50 minutes per week = 400 minutes per week*<br>2. *Independent exercises and assignments = 8 × 60 minutes per week = 480 minutes per week*<br>3. *Independent study = 8 × 60 minutes per week = 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 | 1. *Students are able to implement the principles of sustainability in applying scientific methods and problem-solving strategies in any professional field.*<br>2. *Students are able to apply scientific methodology in conducting research while considering guidelines, ethics, safety, and environmental impact.*<br>3. *Students are able to update knowledge of physics and its applications through research to contribute to solving problems in industry and society.*<br>4. *Students are able to evaluate the relationships among colleagues in completing a research and development project.*<br>5. *Students are able to determine the objectives, strategies, and tasks of each research team member to achieve* |

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| | *research targets.* |
| Course Description | *The Research Progress 1 module supports doctoral students in effectively communicating their ongoing research progress through structured presentations and comprehensive reports. This course emphasizes the development of critical skills in organizing and presenting complex scientific data clearly and cohesively, using visual aids such as images, tables, and graphs to enhance understanding.*<br><br>*Students will engage in problem-based and project-based learning activities that foster the application of scientific methodologies within the context of sustainability, ethics, safety, and environmental impact considerations. The course also cultivates collaboration skills by encouraging students to evaluate and manage team dynamics and responsibilities to achieve research objectives.*<br><br>*Through iterative feedback, constructive peer and supervisor evaluations, students will refine their oral and written communication skills, gaining confidence in presenting research findings and responding to questions. This process prepares students to meet the academic standards expected in doctoral research dissemination and contributes to their professional development as researchers.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *Based on the S3.18. Assessment Rubric for Research Results Examination 1, students must achieve a final score of 70 or higher and achieve a minimum of 50% of the research progress.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How* |

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| | *to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Scientific Publications

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| Module designation | *Scientific Publication* |
| Semester(s) in which the module is taught | *3* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 6 × 50 minutes per week = 300 minutes per week*<br>2. *Independent exercises and assignments = 6 × 60 minutes per week = 360 minutes per week*<br>3. *Independent study = 6 × 60 minutes per week = 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 | 1. *Students are able to deepen or expand knowledge in physics or applied physics by producing a model, method, or theoretical development that is original, accurate, tested, and innovative, beneficial for industry and society.*<br>2. *Students are able to clarify contributions in valuable insights and knowledge accurately and comprehensively in the form of scientific writing.*<br>3. *Students are able to compile innovative and tested works as a realization of ideas, results of thinking, and scientific arguments beneficial for the academic community and the wider society.* |

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| Course Description | *The Scientific Publication course prepares doctoral students to produce and critically evaluate high-quality scientific publications essential for their academic and professional success. This course covers the full publication process, including selecting appropriate publication types, structuring manuscripts according to international standards (abstract, introduction, methods, results, discussion, references), and mastering effective scientific writing techniques.*<br><br>*Students will engage in problem-based and project-based learning activities that develop their ability to communicate complex scientific ideas clearly and accurately. The course also emphasizes ethical considerations in publishing, such as plagiarism avoidance, authorship criteria, and research integrity.*<br><br>*Additionally, students will learn strategies for identifying suitable journals and conferences, navigating the peer-review process, and responding to reviewer feedback. Through discussions, writing assignments, and critical analysis of existing publications, students will enhance their skills as both authors and discerning readers.*<br><br>*The ultimate goal is to equip students with the competence and confidence to successfully publish their original research findings in a reputable international journal, thereby contributing valuable knowledge to the academic community and society.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *Students must have at least one manuscript under review for an international conference proceeding.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How* |

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| | *to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Research Progress 2

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| Module designation | *Research Progress 2* |
| Semester(s) in which the module is taught | *4* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 10 × 50 minutes per week = 500 minutes per week*<br>2. *Independent exercises and assignments = 10 × 60 minutes per week = 600 minutes per week*<br>3. *Independent study = 10 × 60 minutes per week = 600 minutes per week* |
| Credit points | *10/18 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to internalize the spirit of independence, struggle, and entrepreneurship based on academic values, norms, and ethics.*<br>2. *Students are able to apply scientific methodology in conducting research while considering guidelines, ethics, safety, and environmental impact.*<br>3. *Students are able to solve new scientific problems and sustainable development through inter- or multidisciplinary approaches characterized by the generation of valuable insights, methods, knowledge, and comprehensive technology.*<br>4. *Students are able to effectively direct work in research and development projects.* |

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| | 5. *Students are able to monitor and evaluate the goals, strategies, and tasks of each research team member in the implementation of research periodically.*<br>6. *Students are able to elaborate on data information, observations, or calculation results in detail using images, tables, and graphs that support research findings.* |
| Course Description | *The Research Progress 2 module is designed to advance doctoral students' ability to communicate their ongoing research findings effectively through structured presentations and comprehensive reports. This course emphasizes the development of critical skills in organizing and presenting complex scientific data clearly and cohesively, using visual aids such as images, tables, and graphs to support and illustrate research outcomes.*<br><br>*Students engage in problem-based and project-based learning, applying scientific methodologies with a strong focus on research ethics, safety, and environmental considerations. The course also fosters interdisciplinary and multidisciplinary approaches to address new scientific problems and sustainable development challenges.*<br><br>*Through regular progress monitoring, team coordination, and constructive feedback from peers and supervisors, students will enhance their skills in research management, oral communication, and critical self-evaluation. This process prepares them to meet the rigorous standards of doctoral research dissemination and to contribute valuable insights to their academic and professional communities.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *Based on the S3.18B. Assessment Rubric for Research Results Examination 2, students must achieve a final score of 70 or higher and achieve a minimum of 75% of the research progress.* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to* |

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| | *Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# International Publication 1

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| Module designation | *International Publication 1* |
| Semester(s) in which the module is taught | *4* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learing* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 6 × 50 minutes per week = 300 minutes per week*<br>2. *Independent exercises and assignments = 6 × 60 minutes per week = 360 minutes per week*<br>3. *Independent study = 6 × 60 minutes per week = 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 | 1. *Students are able to analyze data, observations, calculation results, or simulations obtained through research, supported by related theories..*<br>2. *Students are able to deepen or expand knowledge in physics or applied physics by producing an original, accurate, tested, and innovative model, method, or theory development that is beneficial for industry and society.*<br>3. *Students are able to elaborate on information from data, observations, or calculation results in detail using images, tables, and graphs that support the research findings.*<br>4. *Students are able to clarify contributions to valuable* |

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| | *insights and knowledge precisely and comprehensively in the form of scientific writing.* |
| Course Description | *The International Publication 1 course equips doctoral students with the comprehensive skills and knowledge required to produce and critically evaluate high-quality scientific publications suitable for international dissemination. This course guides students through the entire publication process, including selecting appropriate publication types, crafting well-structured manuscripts (abstract, introduction, methods, results, discussion, references), and mastering effective scientific writing tailored to international journals.*<br><br>*Students will engage in problem-based and project-based learning activities that emphasize the ethical principles of scientific publishing, including plagiarism prevention, authorship criteria, and research integrity. The course also covers strategies for identifying reputable journals indexed in Scopus and other databases, navigating the peer-review process, and responding professionally to reviewer feedback.*<br><br>*Through critical analysis of existing publications, writing assignments, peer discussion, and supervisor assessments, students will develop the ability to communicate their original research findings clearly, accurately, and persuasively. The ultimate goal is to prepare students to successfully draft and submit manuscripts to high-impact international journals, thereby contributing valuable knowledge to the global scientific community and advancing their academic careers.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *Students must have an article manuscript with a target publication in Scopus-indexed journals* |
| Reading list | 1. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to* |

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| | *Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Dissertation Examination 1

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| Module designation | *Dissertation Examination 1* |
| Semester(s) in which the module is taught | *5* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 8 × 50 minutes per week = 400 minutes per week*<br>2. *Independent exercises and assignments = 8 × 60 minutes per week = 480 minutes per week*<br>3. *Independent study = 8 × 60 minutes per week = 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 | 1. *Students are able to analyze data, observations, and results from calculations or simulations obtained through research, supported by related theories.*<br>2. *Students are able to update their knowledge of physics and its applications through research to contribute to solving problems in industry and society.*<br>3. *Students are able to manage work networks with colleagues and peers within institutions and the broader physics research community.*<br>4. *Students are able to solve problems and technical challenges faced by team members during research to meet targets within the set timeframe.*<br>5. *Students are able to present research plans and results* |

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| | *systematically, using proper sentence structure and good language.* |
| Course Description | *The Dissertation Examination 1 course represents a critical milestone in the doctoral journey, where students demonstrate their original contribution to knowledge in physics through a comprehensive dissertation. This course assesses the student's ability to design, conduct, analyze, and present rigorous scientific research that advances the field and addresses real-world problems.*<br><br>*Students receive guidance on structuring their dissertation, ensuring coherence and alignment across key chapters, including introduction, literature review, methodology, results, analysis, and conclusion. Emphasis is placed on integrating theoretical frameworks with empirical findings to produce a cohesive and impactful scholarly work.*<br><br>*The course prepares students for the dissertation defense, a formal examination where they present their research findings to an expert committee, respond to critical questions, and engage in scholarly discussion. This defense balances assessment and academic ceremony, marking the transition from candidate to expert researcher.*<br><br>*Evaluation criteria are transparent and comprehensive, focusing on the originality, methodological rigor, clarity of presentation, and scholarly significance of the dissertation. Constructive feedback is provided to support further refinement and successful completion.*<br><br>*This course also encourages the development of professional networks and collaboration skills essential for ongoing research and career advancement within the physics community.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer* |

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| | 2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# International Publication 2

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| Module designation | *International Publication 2* |
| Semester(s) in which the module is taught | *5* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | 1. *Problem-based Learning*<br>2. *Project-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 6 × 50 minutes per week = 300 minutes per week*<br>2. *Independent exercises and assignments = 6 × 60 minutes per week = 360 minutes per week*<br>3. *Independent study = 6 × 60 minutes per week = 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 | 1. *Students are able to analyze data, observations, results from calculations or simulations obtained through research, supported by relevant theory.*<br>2. *Students are able to deepen or expand knowledge in physics or applied physics by producing a model, method, or development of theory that is original, accurate, tested, and innovative, benefiting industry and society.*<br>3. *Students are able to elaborate on data, observations, or results of calculations in detail using images, tables, and graphs that support the research findings.*<br>4. *Students are able to clarify contributions to valuable insights and knowledge in a precise and comprehensive* |

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| | *manner in the form of scientific writing.*<br>5. *Students are able to write a scientific paper that can be published in international and/or national publications.* |
| Course Description | *The International Publication 2 course advances doctoral students' competencies in producing and disseminating high-quality scientific publications in international and national journals. Building upon foundational skills, this module guides students through the comprehensive process of compiling research results, including detailed discussions that address research problems and fulfill research objectives.*<br><br>*Students will engage in problem-based and project-based learning that encourages interdisciplinary and multidisciplinary approaches to solving new scientific problems and promoting sustainable development. The course emphasizes the production of innovative, validated scientific works that contribute valuable insights and knowledge to both the academic community and society at large.*<br><br>*Through critical analysis, writing assignments, peer discussions, and supervisor assessments, students will refine their scientific writing skills, focusing on clarity, accuracy, and coherence in manuscript preparation. Ethical principles in publishing, such as plagiarism prevention and responsible authorship, are integral components of the course.*<br><br>*The ultimate goal is to prepare students to successfully publish their research findings in reputable international journals indexed by Scopus or equivalent databases, thereby enhancing their academic profile and contributing to global scientific progress.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English* |

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| | *Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Dissertation Examination 2

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| Module designation | *Dissertation Examination 2* |
| Semester(s) in which the module is taught | *6* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Lecture: 12 × 50 minutes per week = 600 minutes per week*<br>2. *Independent exercises and assignments = 12 × 60 minutes per week = 720 minutes per week*<br>3. *Independent study = 12 × 60 minutes per week = 720 minutes per week* |
| Credit points | *12/21.6 (Credit Points/ECTS)* |
| Required and recommended prerequisites for joining the module | - |
| Module objectives/intended learning outcomes | 1. *Students are able to organize research findings carefully related to the discussion of research results and clearly answer the research problems and objectives.*<br>2. *Students are able to solve new scientific problems and sustainable development through an interdisciplinary or multidisciplinary approach characterized by the production of valuable, comprehensive insights, methods, knowledge, and technology.*<br>3. *Students are able to be accountable for the results of research and development project work.*<br>4. *Students are able to resolve problems and technical constraints of each team member during the research process to meet targets within the established timeframe.* |

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| | 5. *Students are able to systematically write a final report according to the writing techniques specified by the guidelines in force at the university.*<br>6. *Students are able to defend arguments and opinions when presenting work and research results clearly, concisely, accurately, and politely based on data evidence.* |
| Course Description | *The Dissertation Examination 2 course represents the final and most comprehensive stage of the doctoral program, where students demonstrate the full maturity and rigor of their original research contributions in physics. This course evaluates the student's ability to compile, analyze, and present research findings systematically, addressing research problems and objectives with clarity and scholarly depth.*<br><br>*Students are guided in producing a coherent and well-structured dissertation that meets university standards, including essential chapters such as introduction, literature review, methodology, results, analysis, and conclusion. Emphasis is placed on interdisciplinary and multidisciplinary approaches that contribute to solving scientific problems and advancing sustainable development.*<br><br>*The course prepares students for the final dissertation defense, a formal examination conducted privately before a committee of experts. During this defense, students must clearly and confidently articulate their research arguments, respond to critical questions, and demonstrate accountability for their work and its broader impact.*<br><br>*Evaluation criteria are transparent and rigorous, focusing on the originality, methodological soundness, clarity, and scholarly significance of the dissertation, as well as the student's performance during the defense. Constructive feedback is provided to support any final refinements.*<br><br>*This course also encourages students to develop professional responsibility and problem-solving skills essential for leading research projects and collaborating effectively within the scientific community.* |
| Examination forms | *Public Defense and Reports* |

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| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology And Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |

# Doctoral Promotion

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| Module designation | *Doctoral Promotion* |
| Semester(s) in which the module is taught | *6th* |
| Person responsible for the module | *Team teaching (thesis supervisors)* |
| Language | *Bahasa Indonesia* |
| Relation to curriculum | *Compulsory for Physics Doctoral Program* |
| Teaching methods | *Research-based Learning* |
| Workload (incl. contact hours, self-study hours) | 1. *Independent exercises and assignments = 4 × 60 minutes per week = 240 minutes per week*<br>2. *Independent study = 4 × 60 minutes per week = 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 | 1. *Students are able to carefully organize research results related to the discussion of research findings and clearly answer the research problems and objectives.*<br>2. *Students are able to solve new scientific problems and sustainable development through an interdisciplinary or multidisciplinary approach, characterized by the generation of valuable, comprehensive insights, methods, knowledge, and technology.*<br>3. *Students are able to create innovative and proven works as the realization of ideas, thoughts, and scientific arguments that are beneficial to the academic community and the wider society.*<br>4. *Students are able to defend arguments and opinions in presenting work and research results clearly, concisely, accurately, and politely based on data evidence.* |

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| Course Description | *The Doctoral Promotion course marks the culminating phase of the doctoral program, where students finalize their dissertation and prepare to publicly defend their original research contributions. This course focuses on developing advanced oral presentation skills, enabling students to structure their defense materials effectively and deliver them with confidence, clarity, and professionalism.*<br><br>*Students will consolidate their research findings into a comprehensive dissertation that addresses the research problems and objectives with depth and scholarly rigor. Emphasis is placed on articulating scientific arguments clearly, precisely, and respectfully, supported by robust data evidence.*<br><br>*The public Doctoral Promotion Defense serves as the formal academic event where candidates present and defend their research before an examination panel, demonstrating their expertise and readiness to contribute as independent researchers. Successful completion of this module signifies the awarding of the doctoral degree.*<br><br>*This course also encourages students to reflect on their interdisciplinary and multidisciplinary research approaches, the societal impact of their work, and their role as emerging scholars within the academic community and beyond.* |
| Examination forms | *Public Defense and Reports* |
| Study and examination re-quirements | *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. *C. George Thomas (2021), Research Methodology and Scientific Writing, Springer*<br>2. *Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers*<br>3. *Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press*<br>4. *Brandon R. Brown (2023), Sharing Our Science: How to Write and Speak STEM, MIT Press*<br>5. *Dely L. Elliot, A 'doctoral compass': strategic reflection, self-assessment and recalibration for* |

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| | *navigating the 'twin' doctoral journey, Studies in Higher Education (2022), Vol. 47, No. 8, 1652-1665. Taylor and Francis Group* |