Module Handbook

Module name	Thermodynamics
Module level	Undergraduate
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	3
Module coordinator (s)	Dedi Suyanto, Ph.D
Lecturer (s)	Dedi Suyanto, Ph.D
Language	Bahasa Indonesia
Classification within the curriculum	Compulsory course
Teaching format/class hours per week during the semester	In-class lectures, group and individual assignments, and written tests. 150 minutes per week.
Workload	Individual assignments, group assignments, mid-term and final exam.
Credit points	3 credits
Requirements	Basic Physics, Basic Mathematics 2
Learning goals	Knowledge: Concept of Equilibrium and 0^{th} to 3^{rd} law of thermodynamics, Thermodynamics and its consequences, Thermodynamics potential, kinetic theory, transport phenomena, statistical thermodynamics, application of statistic on some system of gasses Skill: Students are able to understand phenomena in the fields of solids, nuclear and particles,techniques.

Content	This course is designed for discussing the principle and basic concept of thermodynamics. Discussion in thermodynamics will cover knowledge about basic concept of thermodynamics from empirical point of view and the mathematical formulation, and their application on thermodynamic systems.
Study/exam achievements	Individual Assignments (20%), Group Assignments (20%), Mid-Term Exam (30%), Final Exam (30%).
Forms of media	PowerPoint presentation
Literature	1) Zemansky, Dittman: Heat and Thermodynamics 7th ed Mc Graw-Hill 1997 2) Sears,Salinger : Thermodynamics,Kinetics Theory and Statistical Thermodynamics Addison Wesley 1975.French, A. P. *Vibrations and Waves*. WW Norton, 1971. 3) C.J Adkin: Equilibrium Thermodynamics 3rd ed 1984 Cambridge University Press. 4) M.C Potter, C.W Somerton: Theory and Problem of Engineering Thermodynamics, Mc Graw Hill 1993.
Notes	-

Module Handbook

Module name	Mathematical Methods in Physics 2
Module level	Undergraduate
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	3
Module coordinator (s)	1. Dr. Budhy Kurniawan 2. Dr. Vivi Fauzia, M.Si
Lecturer (s)	1. Dr. Budhy Kurniawan 2. Dr. Vivi Fauzia, M.Si
Language	Bahasa Indonesia
Classification within the curriculum	Compulsory course
Teaching format/class hours per week during the semester	In-class lectures, group and individual assignments, and written tests. 200 minutes per week.
Workload	Individual assignments, group assignments, mid-term and final exam.
Credit points	4 credits
Requirements	Basic Mathematics 2, Mathematical Methods in Physics 1
Learning goals	Knowledge: Concept of Fourier Series, Calculus Variation, Complex Analysis, Integral Transform Skill: Students are able to apply mathematical methods in the form Fourier series, integral transformations, calculus of variations,and complex analysis in basic physics problems.
Content	This course is designed for discussing the concept of Mathematical Methods in Physics. Discussion Mathematical Methods will cover

	knowledge about Fourier series, integral transformations, calculus of variations, and complex analysis and apply them to physics problems
Study/exam achievements	Individual Assignments (25%), Group Assignments (25%), Mid-Term Exam (25%), Final Exam (25%).
Forms of media	PowerPoint presentation
Literature	1) M.L. Boas, Mathematical Methods in The Physical Sciences 3rd ed, John Wiley & Sons, 1983 2) B.D. Gupta, Mathematical Physics, Vikas Publishing, 1993 3) G.B. Arfken and H.J. Weber, Mathematical Methods for Physicists, Academic Press, 1995 4) L.A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicist, McGraw Hill,1970.
Notes	-

Module Handbook

Module name	Electronics 2
Module level	Undergraduate
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	4
Module coordinator (s)	1. Drs. Sastra Kusuma Wijaya, MSc. PhD 2. Dr. Prawito 3. Dr. rer.nat. Martarizal
Lecturer (s)	1. Drs. Sastra Kusuma Wijaya, MSc. PhD 2. Dr. Prawito 3. Dr. rer.nat. Martarizal
Language	Bahasa Indonesia
Classification within the curriculum	Compulsory course
Teaching format/class hours per week during the semester	In-class lectures, group and individual assignments, and written tests. 150 minutes per week.
Workload	Individual assignments, group assignments, mid-term and final exam.
Credit points	3 credits
Requirements	Elektronics 1
Learning goals	Knowledge: Introduction of digital electronics, number system in digital, basic logic gates, introduction to digital electronics design with VHDL. Programmable logic device, combination logic circuits and reduction techniques, Multiplexers and Demultiplexers, magnitude comparators, digital electronic families (DTL, TTL, CMOS, ECL), characteristic and their interfacing, Flip-flop and its application

	Skill: Students are able to solve the problems and apply digital electronics
Content	This course is designed for discussing the principle and basic concept of digital electronics for designing of electronic systems.
Study/exam achievements	Individual Assignments (25%), Group Assignments (25%), Mid-Term Exam (25%), Final Exam (25%).
Forms of media	PowerPoint presentation
Literature	1) W. Kleitz, *Digital Electronics, 9th ed*, Prentice Hall, 2012 2) J. Bignell, R. Donovan, *Digital Electronics, 5th ed*, Delmar Cengage Learning, 2006
Notes	-

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Basic Physics</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">1st year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI601110</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">1st semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Djati Handoko, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Djati Handoko, Ph.D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive learning</td><td rowspan="3">50</td><td rowspan="3">2</td><td rowspan="3">Computer assisted learning and project-based learning</td><td>Interactive learning</td><td>28</td></tr>
<tr><td>Self-directed study</td><td>28</td></tr>
<tr><td>Assignments</td><td>28</td></tr>
<tr><td colspan="2">Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 Credits</td></tr>
<tr><td colspan="2">Requirements according to the examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on pretest & posttest (10%), quiz (10%), individual assignment (8%), group assignment (7%), attendance (5%), mid-term exam (30%), and final exam (30%).</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">None</td></tr>
<tr><td colspan="2">Related course</td><td colspan="4">None</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcomes</td><td colspan="4">Intended Learning Outcomes:
Students are able to apply the principle and concepts of basic physics to formulate a solution for a given problems.

Skill & Knowledge:
1. Able to apply mechanics, fluid mechanics, and heat concepts in everyday life.
2. Able to apply waves and vibrations concepts in everyday life.
3. Able to apply electricity and magnetism concepts in everyday life.
4. Able to apply optics concepts in everyday life.
5. Able to apply basic modern physics concepts in everyday life.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">• Motion law, translation, and rotation
• Mechanics, Conservation of Energy, Momentum and Energy
• Static and Dynamic Fluid
• Heat, Expansion, Calor, Termodynamic and Heat Engine
• Vibrations and Waves
• Mechanical Waves and Sound Waves
• Static Electricity and Capacitor
• Current and Dynamic Electricity
• Magnetostatic, Induction, and AC Circuit
• Electromagnetic Waves
• Light Waves and Optics
• Basic Modern Physics and Atom</td></tr>
</table>

Study and examination requirements and forms of examination	Paper Test
Media employed	PowerPoint
Reading list	1. Ostdiek, Inquiry into Physics 7th Edition, John Wiley & Sons, Inc., 2013. 2. Cutnell and Johnson, Physics 9th, Wiley, 2012. 3. E. R. Huggins, Physics 2000, Moose Mountain Digital Press 2000.

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Mechanics and Heat</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">1st year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI601114</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">1st semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Efta Yudiarsah, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Efta Yudiarsah, Ph.D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lecturing, Question based learning, Computer assisted learning dan project based learning</td><td rowspan="3"></td><td rowspan="3">4</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">168 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">4 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Post- and Pre-test (7%), Quiz (15%), Individual assignment (7%), Group assignment (4%), Active (4%),Mid Term Exam (30%), Final Exam (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students understand the basic concepts, analytic skills and numeracy skills. Students also practice to explain and analyze the natural phenomena and technology both qualitatively and quantitatively that exist in the environment by using basic physics concepts and apply it to everyday life.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">This course is one of the compulsory subjects in the Undergraduate Physics Study Program. The subject matter includes: Physics and law nature, magnitude and units, unit conversion and consistency, estimation and order of magnitude, vectors, vector sum and vector multiplication, moving, time and average speed, instantaneous velocity, average and instantaneous acceleration, motion with constant acceleration, and free falling objects, position and speed, acceleration vector, ball move, circular circular motion, relative speed, force, Newton’s Law 1, Newton’s Law II, Newton’s Law III, mass and weight, free item diagrams, Newton's Law 1: particles in equilibrium, usage of Newton's Law 2: particle dynamics, friction style, and circular motion dynamics, work, kinetic energy and working-energy, work and energy Theorem, potential gravity energy, elastic potential energy, conservative and non-conservative force, force and potential energy and energy diagrams, momentum and impulse, momentum and collision</td></tr>
</table>

	moments, elastic and inelastic collisions, mass center, mass moving system changed, torque, torque and acceleration of strong angle, work and motion style rotation, angular momentum, angle momentum angle, gyroscope and precision, balance, gravity Center, settlement of equilibrium balance, voltage, strain, elasticity modulus, elasticity and plasticity, Newton's gravity Law, weight, Kepler's Law and planet motion, gravity potenisial energy, satellite motion, and black holes, density, fluid pressure, Bernouli equation, viscosity and turbulence, ideal gas molecular model, ideal gas molar type heat, ideal gas adiabatic process, energy ecipartition, Botzman distribution law, and average velocity and molecular distribution, heat and energy in caloric type and calorimetry, latent heat, work and heat in the process of thermodynamics, Law I thermodynamics, application of Law I thermodynamics, and energy transfer mechanism, explaining the concept of the calor engine and the law of thermodynamics, pumps of heat and radiation , reversible and irreversible processes, carnot machines, gasoline and diesel engines, entropy and entropy change in irreversible processes as well as entropy in microscopic scale
Study and examination requirements and forms of examination	Post- and pre- test, Group assignment, Individual assignments, quiz, mid-term exam, and final exam.
Media employed	Text books
Reading list	[1] Halliday, Resnick, dan Walker, Principles of Physics 9th Edition, Wiley, 2011. [2] Serway Jewett,Physics for Scientists and Engineers 7th Edition, Thomson Brooks/Cole, 2010. [3] Giancoli, Physics for Scientists and Engineers 4th Edition, Pearson, 2008

Module Handbook

<table>
<tr><td>Module name</td><td colspan="5">Vibrations, Waves and Optics</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">1st year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI601116</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">2nd semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dr. Anawati</td></tr>
<tr><td>Lecturer</td><td colspan="5">Dr. Anawati</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lecrtures and group discussion.</td><td rowspan="3"></td><td rowspan="3">3</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 3 x 14</td><td>42</td></tr>
<tr><td>Assignments: 3 x 14</td><td>42</td></tr>
<tr><td>Independent study: 3 x 14</td><td>42</td></tr>
<tr><td>Total Workload</td><td colspan="5">126 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">3 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Individual Assignment (15%), Discussion (15%), Quiz (10%), Mid Term Exam (30%), Final Term Exam (30%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">-</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students can apply the principles and concepts of physics of vibrations, waves, and optics in everyday life appropriately to formulate solutions in accordance with the applicable laws of physics.</td></tr>
<tr><td>Content</td><td colspan="5">This course is one of the compulsory subjects in the Undergraduate Physics Study Program. The subject matter includes: Simple harmonic motion, damped harmonic motion, mechanical waves, standing waves, superposition and interference, electromagnetic waves and mazwell’s equation, fundamental behavior and propagation of light, reflection and refraction, light polarization, light interference, optical geometry and optical equipment.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Individual assignments, quiz, mid-term exam, and final exam.</td></tr>
<tr><td>Media employed</td><td colspan="5">PowerPoint and text books</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] Halliday, Resnick: Fundamentals of Physics, 10th Ed.
[2] Serway, Jewett: Physics for Scientist and Engineers, 9th Ed.</td></tr>
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Module Handbook

<table>
<tr><td>Module name</td><td colspan="5">Laboratory Work of Basic Physics 1</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">1^{st} year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI601121</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">2^{nd} semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dr. Djoko Triyono</td></tr>
<tr><td>Lecturer</td><td colspan="5">Dr. Djoko Triyono</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td>Practicum</td><td></td><td>3</td><td>Practicum</td><td>Practicum: 3 x 14</td><td>42</td></tr>
<tr><td>Total Workload</td><td colspan="5">3 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">1 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Practicum (70%), presentation (20%) and final exam (10%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">-</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Student are able to apply the basic physics principles and concept and their application</td></tr>
<tr><td>Content</td><td colspan="5">This course is one of the compulsory subjects in the Undergraduate Physics Study Program. The subject matter includes: Measurement of Object Dimensions and Center of Mass and Moment of Inertia of Firms, Free Fall Motion, Density of the Liquid and Viscosity of the Liquid, Coefficient of Friction, The Law of Collision, Twist Swings and Mathematical Swings, Young's Modulus and Advance Tension Coefficient, Perforated Cylinder, Hardness Test, Linear expansion coefficient and thermal conductivity, Calorimetry and Ideal Gas Law, Joule Constants and Solar Collector, Newton cooling and Radiation Constants and Radiation Energy Absorption</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Individual assignments, quiz, mid-term exam, and final exam.</td></tr>
<tr><td>Media employed</td><td colspan="5">Practicum Equipment and Microsoft Excel</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] Basic Physics Practicum Guidebook, UPP IPD, 3rd edition, 2010.
[2] Giancoli, DC., Physics: Principle with Applications, 6th ed., Prentice Hall, 2005</td></tr>
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Physics Compulsory Courses 2nd Year

<table>
<tr><td>Module name</td><td colspan="5">Computational Physics</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">2nd year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI602021</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">4th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Arief Syarifudin Fitrianto, M.Si.</td></tr>
<tr><td>Lecturer</td><td colspan="5">Arief Syarifudin Fitrianto, M.Si.</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lectures and discussions</td><td rowspan="3">50</td><td rowspan="3">4</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td>Total Workload</td><td colspan="5">168 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">4 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on weekly assignments and quizzes (20%), project presentation (30%), mid-term exam (25%), and final exam (25%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">1. Mathematical Physics 2 (prerequisite)
2. Mathematical Physics 3 (prerequisite)</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">After attending this lecture, when students are faced with physics problems that require the help of numerical analysis with computers, students are able to apply the basics of programming algorithms and numerical methods and design computer programs to solve these problems systematically, structurally, and optimally.</td></tr>
<tr><td>Content</td><td colspan="5">Solving Linear and Non-Linear Equation Systems, Data Fitting Methods with Approximation and Interpolation, Derivative and Integral Numerics, and Differential Equations.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Weekly assignments, quizzes, final project, mid-term exam, and final exam.</td></tr>
<tr><td>Media employed</td><td colspan="5">PowerPoint presentation, EMAS UI Platform</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] Burden & Faires, Numerical Analysis, 10 ed.
[2] Stephen Chapra, Numerical Methods for Scientist and Engineer, 7 ed.
[3] Hans P Langtangen, A Primer on Scientific Computing with Python 3, 5ed.</td></tr>
</table>

Module Handbook

Module name	Classical Mechanics
Module level	Undergraduate
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	4
Module coordinator (s)	Dr. Budhy Kurniawan
Lecturer (s)	Dr. Budhy Kurniawan
Language	Bahasa Indonesia
Classification within the curriculum	Compulsory studies
Teaching format/class hours per week during the semester	Cooperative & Self-Directed Learning (150 minutes)
Workload	Individual Assignment, Group Assignment, Exam 1, and Exam 2.
Credit points	4 credits
Requirements	Mathematical Physics 1 and Basic Physics (Mechanics)
Learning goals	Knowledge: To apply the theory of classical mechanics on solving dynamics physics problem Skill: Students are expected to be competent in understanding Newtonian mechanics – single particle, Gravitation, Non-linear vibrations. Some methods of calculus variation, Lagrangian Mechanics, Hamilton's principal, central force, dynamics of a system particle, motion in Non-inertial reference frame, rigid body dynamics.
Content	Overview the concept of Newtonian mechanics – single particle, Gravitation, Non-linear vibrations. Some methods of calculus variation, Lagrangian Mechanics, Hamilton's principal, central force, dynamics of a system particle, motion in Non-inertial reference frame, rigid body dynamics.

Study/exam achievements	Individual Assignment (25%), Group Assignment (25%), Exam 1 (25%), and Exam 2 (25%).
Forms of media	Presentation (ppt)
Literature	1. J.B. Marion and S.T. Thornton, Classical Dynamic of Particles and Systems, Saunder College Publishing, 1995 2. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, 3rd edition, Addison Wesley, 2000
Notes	-

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Physics of Energy</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">3rd year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI602116</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">6th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Eng. YunusDaud, Dipl.Geotherm Tech., M.Sc.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Eng. YunusDaud, Dipl.Geotherm Tech., M.Sc.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive learning</td><td rowspan="3">60</td><td rowspan="3">2</td><td rowspan="3">Interactive learning</td><td>Interactive learning</td><td>28</td></tr>
<tr><td>Self-directed study</td><td>28</td></tr>
<tr><td>Assignments</td><td>28</td></tr>
<tr><td colspan="2">Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 Credits</td></tr>
<tr><td colspan="2">Requirements according to the examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignment (40%), group discussion (10%), mid-term exam (25%), and final exam (25%).</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Introduction to Nuclear Physics, Thermodynamics</td></tr>
<tr><td colspan="2">Related course</td><td colspan="4">None</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcomes</td><td colspan="4">Intended Learning Outcomes:
Students are able to apply physics concepts to the analysis of power generation systems in everyday life to solve existing problems.

Skill & Knowledge:
1. Able to apply thermodynamics concepts to the analysis of power generation systems in everyday life to solve existing problems.
2. Able to apply modern physics concepts to the analysis of power generation systems in everyday life to solve existing problems.
3. Able to apply mechanics and heat concepts to the analysis of power generation systems in everyday life to solve existing problems.
4. Able to apply fluid mechanics concepts to the analysis of power generation systems in everyday life to solve existing problems.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">• Energy Regulations in Indonesia
• Fossil Fuel and Energy Crisis
• New and Renewables Energy
• Nuclear Energy
• Geothermal Energy
• Solar Energy
• Hydro Energy
• Wind Energy
• Biomass Energy
• Wave Energy
• Application of Physics of Energy</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Paper test</td></tr>
</table>

Media employed	PowerPoint
Reading list	1. Abdul Kadir, Energi, UI Press.1982. 2. John A. Duffie and William A. Beckman. Solar Engineering of Thermal Processes, John Willey and Sons. 1980. 3. Sze, S. M. Physics of Semiconductor Devices, John Willey and Sons. 1981

Physics Compulsory Courses 2nd Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Vibrations and Waves</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">2nd year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI602118</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">4th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Djonaedi Saleh</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Djonaedi Saleh</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lectures and discussions</td><td rowspan="3">50</td><td rowspan="3">2</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 2 x 14</td><td>28</td></tr>
<tr><td>Assignments: 2 x 14</td><td>28</td></tr>
<tr><td>Independent study: 2 x 14</td><td>28</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (20%), group assignments (20%), mid-term exam (30%), and final exam (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">1. Electricity and Magnetism (prerequisite)
2. Vibrations, Waves, and Optics (prerequisite)
3. Mathematical Methods in Physics 2 (prerequisite)
4. Mathematical Methods in Physics 3 (prerequisite)</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students are able to explain events related to vibrations and waves when faced with such problems in the field of science and technology.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">Overview of vibration events or oscillation motion and waves both mechanical and electrical either one-dimensional or more; Simple, damped, and forced harmonic motions; coupled oscillation; transverse waves; longitudinal waves; waves on transmission lines.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Individual assignments, group assignments, mid-term exam, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">PowerPoint presentation</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] Pain, H. J. The Physics of Vibrations and Waves. 3rd edition. John Wiley & Sons, 1968.
[2] Bekefi, George, and Alan H. Barrett. Electromagnetic Vibrations, Waves, and Radiation. MIT Press, 1977.
[3] French, A. P. Vibrations and Waves. WW Norton, 1971.
[4] G., Iain. Vibrations and Waves in Physics. Cambridge University Press, 1993.</td></tr>
</table>

Physics Compulsory Courses 2nd Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Laboratory Work of Advanced Physics</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">2nd year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI602122</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">4th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Arief Sudarmaji, M.T.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Arief Sudarmaji, M.T.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Bahasa Indonesia</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td>Laboratory work, data processing, report writing, individual assignment, and written exam.</td><td>50</td><td>3</td><td>Laboratory work and presentation</td><td>Laboratory Work: 3 x 14</td><td>42</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">42 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">1 credit</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on laboratory work (70%), presentation (20%), and the final exam (10%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Modern Physics</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students can analyze (C4) concepts in advanced physics and operate (P3) measuring instruments in daily life correctly to solve (A5) extant problems according to the applicable laws of Physics.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">Torsional Oscillators, Magnetic Torque, Microwaves, Thomson Tube, Thermal Radiation, Zeeman Effect, Radioactive Decay and Half-life, the Franck-Hertz Effect, Nuclear Magnetic Resonance, Rutherford Scattering, Electron Spin Resonance, the Hall Effect (Metal), the Hall Effect (Semiconductor), and Hysteresis</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Laboratory work, presentation, and final exam</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">Laboratory equipment and Gnuplot</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] J.P Holman, Experimental Method for Engineers, 7th ed., McGraw-Hill Book, Inc, 2001.
[2] Ogawa Seiki, Instruction Manual: e/m Demonstration Apparatus, OGAWA SEIKI, Tokyo Central PO Box No.1618 Tokyo Japan, 1987
[3] Leybold-Heraeus, Physics Experiment, vol. 1,2 & 3, Leybold GmBH, 1986.
[4] Pasco Heat conduction Apparatus, Instruction Manual 012-09189A, www.pasco.com, 2012.</td></tr>
</table>

	[5] Teach Spin, Faraday Rotation, Guide to the experiment, Teach Spin.Inc., Tri-Main Centre-Suite 409, 2495 Main Street.Buffalo, NY 14214-2153, 2012

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Electricity and Magnetism</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">1st year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI601115</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">2nd semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Efta Yudiarsah, Ph.D</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Efta Yudiarsah, Ph.D</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lectures, Question based learning, Computer assisted learning, and Project based learning</td><td rowspan="3"></td><td rowspan="3">3</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 3 x 14</td><td>42</td></tr>
<tr><td>Assignments: 3 x 14</td><td>42</td></tr>
<tr><td>Independent study: 3 x 14</td><td>42</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">126 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">3 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Post- and Pre-test (10%), Quiz (10%), Individual assignment (8%), Group Assignment (7%), Activeness (5%), Mid Term exam (30%), Final Exam (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">1. Mechanics and Heat</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Student are able to apply the basic physics principles and concept of magnetism and electricity</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">This course is one of the compulsory subjects in the Undergraduate Physics Study Program. The subject matter includes: Dynamics of many objects, Electric charge and field, Gauss’s law, Electric potential, Capacitance and dielectric, Electric current, resistance and direct current, Magnetic field and magnetic force, source of the magnetic field, Electromagnetic Induction, Inductance, Alternating current and Maxwell's Equations and Electromagnetic Waves</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Individual assignments, group assignments, mid-term exam, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">PowerPoint and text books</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] Halliday, Resnick, and Walker, Principles of Physics 9th Edition, Wiley, 2011.
[2] Serway Jewett,Physics for Scientists and Engineers 7th Edition, Thomson Brooks/Cole, 2010.
[3] Giancoli, Physics for Scientists and Engineers 4th Edition, Pearson, 2008</td></tr>
</table>

Physics Compulsory Courses 3rd Year

<table>
<tr><td>Module name</td><td colspan="5">Statistical Physics</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">3rd year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI603110</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">5th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dedi Suyanto, Ph.D.</td></tr>
<tr><td>Lecturer</td><td colspan="5">1. Dedi Suyanto, Ph.D.
2. Dr. Budhy Kurniawan
3. Dede Djuhana, Ph.D.</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lectures and discussions</td><td rowspan="3">50</td><td rowspan="3">4</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td>Total Workload</td><td colspan="5">168 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">4 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and home work (30%), mid-term exam (35%), and final exam (35%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">1. Thermodynamics (prerequisite)
2. Mathematical Physics 2 (prerequisite)
3. Mathematical Physics 3 (prerequisite)</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students are able to apply the basic concepts of statistical physics in the fields of solids, materials, nuclear and particles, instrumentation, and medicine.</td></tr>
<tr><td>Content</td><td colspan="5">Canonical and microcanonic ensemble, chemical potential, classical partition function, equipartition energy, Gibbs paradox, entropy, ideal gas in large canonical ensemble, Maxwell-Boltzmann distribution, diatomic gas, interacting gas, state density, black body radiation. , Planck distribution, Debye model, Bose-Einstein distribution, Bose-Einstein condensation, fermion, Pauli paramagnetism, Landau diamagnetism, phase change, mean field theory, Ising model, and Landau-Ginzburg theory.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Individual assignments, mid-term exam, and final exam.</td></tr>
<tr><td>Media employed</td><td colspan="5">PowerPoint presentation</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] F. Reif, Fundamentals of Statistical and Thermal Physics, McGraww-Hill Book Company, 1985.
[2] S. R. Salinas, Introduction to Statistical Physics, Springer-Verlag, 2001.
[3] H. B. Callen, Thermodynamics and an Introduction to Thermostatistics 2nd Edition, John Wiley & Sons, 1985.</td></tr>
</table>

Module Handbook

Module name	Electromagnetic Fields 2
Module level	Undergradute
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	5
Module coordinator (s)	Dr. Agus Salam
Lecturer (s)	Dr. Agus Salam
Language	Bahasa Indonesia
Classification within the curriculum	Compulsory studies
Teaching format/class hours per week during the semester	Interactive lectures, independent learning. [150 minutes]
Workload	Assignments, midterm and final exam.
Credit points	3 credits
Requirements	Electromagnetic Fields 1
Learning goals	Knowledge: To understand the application of the concept and principle in electromagnetic field time-dependent on solving physics problem that involves electromagnetic interaction, Skill: Students are competent in applying Maxwell equation, continuity equation, tensor of energy and momentum, Poynting vector, gauge transformation, electromagnetic wave, reflection and refraction, waveguide, Lienard-Wiechert Potential, fields of moving charge, dipole radiation, radiation of accelerated charge, special relativity, and covariant form of Maxwell equation.
Content	Overview of Maxwell's equation in many sorts of electromagnetic fields, either relativistic or non-relativistic.

Study/exam achievements	Individual Assignments (40%), Midterm Exam (30%), Final Exam (30%).
Forms of media	Whiteboard
Literature	**Compulsory:** ● [Griffiths] D.J. Griffiths, *Introduction to Electrodynamics*, 3rd edition, Prentice Hall, 1999. **Optional:** ● [Reitz] J.R. Reitz, F.J. Milford, and R.W. Christy, *Foundations of Electromagnetic Theory*, 4th edition, Addison Wesley, 1993. ● [Jackson] J.D. Jackson, *Classical Electrodynamics*, 3rd edition, John Wiley & Sons, 1999.
Notes	-

Physics Compulsory Courses 3rd Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Quantum Mechanics 2</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">3rd year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI603116</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">5th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Prof. Dr. Drs. Terry Mart</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Prof. Dr. Drs. Terry Mart</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Bahasa Indonesia</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lecture and discussion</td><td rowspan="3">50</td><td rowspan="3">3</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 3 x 14</td><td>56</td></tr>
<tr><td>Assignments: 3 x 14</td><td>56</td></tr>
<tr><td>Independent study: 3 x 14</td><td>56</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">126 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">3 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on weekly assignments (30%), the midterm exam (30%), and the final exam (40%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Quantum Mechanics 1</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students can apply advanced concepts and formulations in quantum mechanics on related problems in physics, such as the interaction between charged particles and an electromagnetic field, perturbation in quantum systems, and particle scattering due to electromagnetic interaction.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">Introduction, classical equation of motion for an electron under an electromagnetic field, Schrödinger equation for an electron under an electromagnetic field, gauge transformation and minimal substitution, effects of a constant magnetic field and its application on the normal Zeeman effect, effects of a strong magnetic field by using the Schrödinger equation, effects of a magnetic field on simple cases: Landau levels, Hall effect, and Aharanov-Bohm effect, harmonic oscillator operator in matrix form, orbital angular momentum operator in matrix form, spin angular momentum operator in matrix form, magnetic moment of a particle with spin-½, paramagnetic resonance, summation of two spins, summation of spin-½ with orbital angular momentum, summation of angular momenta and its application on cases involving identical particles, Clebsch-Gordan coefficient, notation, and how to read coefficient values, application of summing angular momenta on cases involving particle parity, perturbation theory for non-degenerate cases, perturbation theory for degenerate cases, Stark effect, degeneration of a hydrogen atom with n = 2 due to spin-orbit coupling, anomalous Zeeman effect, hyperfine structure, ionization energy of a Helium atom, effects</td></tr>
</table>

	of the repulsive force between electrons, impact of Pauli's exclusion principle, molecule orbitals, expected energy value of an H_2 molecule, molecule rotational and vibrational energy, time-dependent perturbation theory, constant perturbation in time-dependent perturbation theory, atom coupling with electromagnetic fields, phase space and calculation of matrix elements based on selection rules, scattering cross-section, elastic and inelastic scattering, low energy cross-section, Breit-Wigner formula and S-wave scattering in cases involving a square well, formulation of the Born approximation, scattering in general in cases involving identical particles
Study and examination requirements and forms of examination	Weekly assignments, midterm exam, and final exam
Media employed	Whiteboard
Reading list	[1] S. Gasiorowicz, Quantum Physics, John Wiley & Sons, Inc., 1996. [2] A. Goswami, Quantum Mechanics 2nd Ed., Wm. C. Brown Publishers, 1997.

Physics Compulsory Courses 3rd Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Introduction to Solid State Physics</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">3rd year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI603117</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">5th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Efta Yudiarsah, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Efta Yudiarsah, Ph.D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive and collaborative learning</td><td rowspan="3">50</td><td rowspan="3">4</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">168 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">4 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and homework (30%), quizzes (15%), class involvement (5%), mid-term exam (25%), and final exam (25%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">1. Quantum Mechanics 1 (prerequisite)
2. Statistical Physics (prerequisite)</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students are able to explain the concept of the crystalline state of solids, the motion of electrons and the vibrations of atoms in crystals, and their implications for forming the specific properties of solids.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">This course covers eight major topics, namely crystal structure, X-ray diffraction and reciprocal lattice, crystal bonds and elasticity constants, crystal vibration (phonons) and thermal properties, free electron gas models, energy bands, semiconductors, Fermi surfaces. and metal, plasmon, polariton and polaron, and optical excitation processes. After completing this course, when faced with problems in known solid material systems, students are able to explain the concept of the crystalline state of solids, the motion of electrons and vibrations of atoms in crystals, and their implications in forming the specific properties of solids.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Individual assignments/homework, quizzes, mid-term exam, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] C. Kittle, Introduction to Solid State Physics 8th Ed., Wiley, 2005.
[2] J. R. Hook and H. E. Hall, Solid State Physics 2nd Ed, Wiley, 1991.</td></tr>
</table>

	[3] N. W. Ashcroft and N. D. Mermin, Solid State Physics, Saunders College Publishing, 1976. [4] H. Ibach and H. Luth, Solid-State Physics 4th Ed., Springer, 2009.

Physics Compulsory Courses 2nd Year

<table>
<tr><td>Module name</td><td colspan="5">Quantum Mechanics 1</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">2nd year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI603119</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">4th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dr. Adam Badra Cahaya</td></tr>
<tr><td>Lecturer</td><td colspan="5">Dr. Adam Badra Cahaya</td></tr>
<tr><td>Language</td><td colspan="5">Bahasa Indonesia</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Compulsory course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lecture, discussion, and presentation</td><td rowspan="3">50</td><td rowspan="3">4</td><td rowspan="3">Lectures, discussions, and presentation</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td>Total Workload</td><td colspan="5">168 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">4 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (30%), group assignments (20%), the midterm exam (25%), and the final exam (25%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">Elementary Linear Algebra, Modern Physics, Mathematical Methods in Physics 2, Mathematical Methods in Physics 3</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students can apply fundamental concepts in quantum mechanics to simple quantum systems and atoms such as hydrogen.</td></tr>
<tr><td>Content</td><td colspan="5">Black body radiation, the photoelectric effect, Compton scattering, wave-particle duality, the Bohr atom, de Broglie waves, the correspondence principle, wave packets, Heisenberg uncertainty principle, Schrödinger’s equation, wave functions, probability interpretation, normalization, expected value, operators, commutative property, stationary state, eigenvalue and eigenfunction, linear operator, hermiticity, expansion theorems, free wave normalization, parity, degeneration, Dirac notation, representation, problems with one-dimensional potential, simple harmonic oscillator and ladder operators, changes in expected value over time, time-dependence of operators, the Schrödinger picture and Heisenberg picture, N-particle systems, central force, Schrödinger’s equation in three dimensions, angular momentum, hydrogen-like atoms in simple quantum systems, and hydrogen-like atoms.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Individual and group assignments, midterm exam, and final exam</td></tr>
<tr><td>Media employed</td><td colspan="5">Whiteboard</td></tr>
</table>

Reading list	[1] S. Gasiorowicz, Quantum Physics 3rd Ed., John Wiley & Sons, Inc., 2003. [2] A. Goswami, Quantum Mechanics 2nd Ed., Wm. C. Brown Publishers, 1997.

Physics Compulsory Courses 3rd Year

Module name	**Introduction to Nuclear Physics**				
Module level, if applicable	3rd year				
Code, if applicable	SCFI603513				
Semester(s) in which the module is taught	5th semester				
Person responsible for the module	Dr. Imam Fachruddin				
Lecturer	1. Prof. Dr. Terry Mart 2. Prof. Dr. Anto Sulaksono 3. Dr. rer. nat. Agus Salam 4. Dr. Imam Fachruddin				
Language	Indonesian				
Relation to curriculum	Specialization course in Theoretical Nuclear and Particle Physics				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lectures and discussions	50	3	Lectures and discussions	Lectures: 3 x 14	42
				Assignments: 3 x 14	42
				Independent study: 3 x 14	42
Total Workload	126 hours				
Credit points	3 credits				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on group presentations (40%), mid-term exam (30%), and final exam (30%)				
Recommended prerequisites	1. Modern Physics (prerequisite)				
Related Course	-				
Module objectives/intended learning outcome	After completing this lecture, Physics students are expected to be able to describe the properties of the atomic nucleus, nuclear processes, and the benefits of nuclear physics.				
Content	Explain the properties of the atomic nucleus, nuclear processes, and the benefits of nuclear physics. Formation of matter includes Rutherford scattering, nuclear properties, binding energy, bonding fraction, surface effect, energy separation, nuclear radius, semiempirical mass formula, core spin, core electric moment, nuclear magnetic moment, nuclear instability, radioactivity, core models , nuclear force, particle physics, fundamental interactions, quark models, nuclear astrophysics, accelerators, detectors, nuclear reactors, the benefits of nuclear physics.				
Study and examination requirements and forms of examination	Group assignments, mid-term exam, and final exam.				
Media employed	PowerPoint presentation				
Reading list	[1] P. E. Hodgson, E. Gadioli, E. Gadioli Erba, Introductory Nuclear Physics, Oxford U. Press, 2000. [2] W. E. Meyerhof, Elements of Nuclear Physics, McGraw-Hill Book Co., 1989.				

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Physics of Measurement</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">3rd year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI603310</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">5th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Santoso S.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Santoso S.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Collaborative learning</td><td rowspan="3">50</td><td rowspan="3">2</td><td rowspan="3">Collaborative learning</td><td>Collaborative learning</td><td>28</td></tr>
<tr><td>Self-directed study</td><td>28</td></tr>
<tr><td>Assignments</td><td>28</td></tr>
<tr><td colspan="2">Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 Credits</td></tr>
<tr><td colspan="2">Requirements according to the examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on attendance (10%), assignment (30%), presentation (20%), mid-term exam (20%), and final exam (20%).</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Electronics 2</td></tr>
<tr><td colspan="2">Related course</td><td colspan="4">None</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcomes</td><td colspan="4">Intended Learning Outcomes:
Students are able to design a good measurement instrument system that can measure physical quantities.

Skill & Knowledge:
1. Able to apply learning methods.
2. Able to explain basics of physics of measurement.
3. Able to explain measurement system.
4. Able to explain types of instrumentation and its characteristics.
5. Able to explain time dependent characteristics.
6. Able to explain standard units and dimension of measured quantities.
7. Able to explain measurement uncertainties.
8. Able to explain measurement reliability and security systems.
9. Able to solve mid-term exam problems.
10. Able to explain signal conditioning.
11. Able to explain digital measurement.
12. Able to calibrate sensor and measurement instrument.
13. Able to measure analog physical quantities.
14. Able to read and process data.
15. Able to design measurement instrument device.
16. Able to solve final exam problems.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">• Measurement system
• Types of instruments and its characteristics
• Time-dependent characteristics
• Standard unit and dimension
• Measurement uncertainties
• Measurement reliability and security system
• Signal conditioning
• Digital measurement</td></tr>
</table>

	• Sensor and measurement instrument calibration • Analog quantities measurement • Data reading and processing • Measurement instrument system
Study and examination requirements and forms of examination	Paper test
Media employed	PowerPoint
Reading list	1. Robert B. Northrop, Introduction to Instrumentation and Measurements, CRC Press, Taylor Francis Group, 2ed ,2005 2. Alan S Morsis, Measurement & Instrumentation Principles, Butterworth Heinemann, 3rd , 2001. 3. J. G Webster, The Measurement, Instrumentation and Sensors Handbook, A CRC Handbook Published in Cooperation with IEEE Press, 1999 4. T. G. Beckwith, R. D. Marangoni, dan J. H. Lienhard V, Mechanical Measurements (I. Fundamentals of Mechanical Measurement, II. Applied Mechanical Measurements), Addison-Wesley Publishing Company, 5ed , 1993.

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<table>
<tr><td>Module name</td><td colspan="4">Seminar</td></tr>
<tr><td>Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td>Code, if applicable</td><td colspan="4">SCFI604101</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="4">7th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="4">Thesis Committee</td></tr>
<tr><td>Lecturer</td><td colspan="4">Thesis Advisors</td></tr>
<tr><td>Language</td><td colspan="4">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="4">Compulsory Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="2">Seminar</td><td rowspan="2">50</td><td rowspan="2">4</td><td rowspan="2">Discussion</td><td>Collaborative learning</td><td>56</td></tr>
<tr><td>Self-directed study</td><td>28</td></tr>
<tr><td>Workload</td><td colspan="4">84 hours</td></tr>
<tr><td>Credit points</td><td colspan="4">2 Credits</td></tr>
<tr><td>Requirements according to the examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on scientific papers (50%) and presentation (50%).</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="4">>112 Credits</td></tr>
<tr><td>Related course</td><td colspan="4">Undergraduate Thesis</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td colspan="4">Intended Learning Outcomes:
After completing this course, 7th semester physics students will be able to write scientific paper and present their research findings.

Skill & Knowledge:
1. Able to write a thesis in accordance with Universitas Indonesia guideline.
2. Able to write a scientific paper applicable to publication.
3. Able to make a presentation from research results.
4. Able to present the research results well.</td></tr>
<tr><td>Content</td><td colspan="4">• Introduction
• Literature review
• Experiment method
• Data processing
• Discussion
• Conclusion
• References
• Abstract
• Attachment
• Presentation</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="4">Presentation</td></tr>
<tr><td>Media employed</td><td colspan="4">PowerPoint</td></tr>
<tr><td>Reading list</td><td colspan="4">1. Surat Keputusan Rektor UI nomor 628/SK/R/UI/2008, tentang Pedoman Teknis Penulisan Tugas Akhir Mahasiswa Universitas Indonesia, 16 June 2008.</td></tr>
</table>

	2. Format dokumen Naskah Ringkas Tugas Akhir, Perpustakaan Universitas Indonesia, Desember 2012 3. R. Weissberg dan S. Buker, Writing Up Research; Experimental Research, Report Writing for Students of English, Prentice-Hall, Inc, 1990. 4. R. A. Day, How to Write and Publish a Scientific Paper, 3rd ed., Cambridge Univeristy Press, 1991. 5. Examples of scientific paper and the procedures 6. Various source from internet about scientific presentation technique.

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Undergraduate Thesis</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604102</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">8th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Anawati, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Thesis Advisors</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian/English</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Compulsory Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="2">Thesis guidance</td><td rowspan="2">-</td><td rowspan="2">6</td><td rowspan="2">Discussion</td><td>Thesis guidance</td><td>84</td></tr>
<tr><td>Self-directed study</td><td>168</td></tr>
<tr><td colspan="2">Workload</td><td colspan="4">252 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">6 Credits</td></tr>
<tr><td colspan="2">Requirements according to the examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on thesis defense (100%).</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Seminar and >114 Credits</td></tr>
<tr><td colspan="2">Related course</td><td colspan="4">Seminar, Internship in Medical Physics and Biophysics</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcomes</td><td colspan="4">Intended Learning Outcomes:
Students are able to apply solve both theoretical and applied physics problem in a systematic way through an academic paper that is in accordance with scientific writing guidelines and present their findings in an adequate and structured manner.

Skill & Knowledge:
1. Able to write problem formulation for the chosen topic in the thesis.
2. Able to do research and write a comprehensive literature review of the problem in the thesis.
3. Able to write their thesis writing workflow to achieve the desired goal.
4. Able to do laboratory research independently and systematically following the laboratory guideline.
5. Able to discuss and pay attention to thesis advisor and related expert on the topic of the thesis during guidance or scientific seminar.
6. Able to do mathematic calculation to process research data both analytically and numerically.
7. Able to write undergraduate thesis that can be published according to the scientific standard and guideline of academics.
8. Able to present their research findings systematically using good scientific language.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">• Determining research topics
• Writing problem formulation
• Literature review and citation guideline
• Designing research workflow
• Thesis proposal exam
• Research preparation
• Carrying out research in the laboratory
• Data analysis
• Thesis writing</td></tr>
</table>

	• Writing scientific papers that can be published in national or international seminars • Scientific presentations in national or international seminars • Thesis defense
Study and examination requirements and forms of examination	Thesis defense
Media employed	PowerPoint
Reading list	Related articles and papers

Physics Compulsory Courses 1st Year

Module name	**English**				
Module level, if applicable	1st year				
Code, if applicable	UIGE600003				
Semester(s) in which the module is taught	1st semester				
Person responsible for the module	Team of English Lecturers				
Lecturer	Team of English Lecturers				
Language	English				
Relation to curriculum	Compulsory course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Self-directed Learning, Small Group Discussion, and Simulation	50	3	Lectures and discussions	Lectures: 3 x 14	56
				Assignments: 3 x 14	56
				Independent study: 3 x 14	56
Total Workload	126 hours				
Credit points	3 credits				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on assignments (25%), presentations (15%), mid-term exam (25%), and final exam (30%)				
Recommended prerequisites	-				
Related Course	-				
Module objectives/intended learning outcome	Students are able to apply the use of English effectively in an academic environment with an emphasis on the six noble values of characters in various contexts responsibly, whether for listening, speaking, reading, and writing.				
Content	Explain the process of learning English that has been obtained beforehand, understand academic conversations and lecture lectures in English and write back in the form of notes in English, understand academic reading in English and rewrite it in the form of a reading summary, apply good use of English grammar and be correct in composing paragraphs in academic English, simulating the use of academic English in discussions and working together to produce group presentations, adapting appropriate reading strategies for various types of English academic texts and restating them in the form of critical reading of articles, and compiling academic essays in English.				
Study and examination requirements and forms of examination	Individual and group assignments, presentations, mid-term exam, and final exam.				
Media employed	PowerPoint presentation				
Reading list	[1] Grace Wiradisastra, Sisilia Setiawati Halimi, Cintavhati Poerwoto, D.J. Sulichah, Rahmarni Sawitri, Harumi M. Ayu, Nur Basuki Rahmanto, English For Academic Purposes MPK Bahasa Inggris University of Indonesia, Lembaga Penerbit FEUI, 2008.				

Module Handbook

Module name	Solid State Physics 1
Module level	Undergraduate
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	5
Module coordinator (s)	Efta Yudiarsah, Ph.D.
Lecturer (s)	Efta Yudiarsah, Ph.D.
Language	Bahasa Indonesia
Classification within the curriculum	Elective studies
Teaching format/class hours per week during the semester	Collaborative Learning (200 minutes)
Workload	Individual assignments, quiz, participation, mid-term and final exam.
Credit points	4 credits
Requirements	Quantum Mechanics 1, Statistical Physics, Introduction to Solid State Physics
Learning goals	Knowledge: To explain the concept of the state of crystalline solids, the motion of electrons and vibrations of the atoms in the crystal, as well as their implications in forming the unique properties of solids Skill: Students are expected to be competent in understanding the properties of transport of solids (energy dispersion relations, energy bands, effective mass theory, the phenomenon of transport, thermal transport, scattering of electrons and phonons, the phenomenon of magneto-transport, two-dimensional electron gas, quantum wells and semiconductor superlattices, transport in low dimensional systems , implantation and RBS), optical properties (fundamental relations for optical phenomena, Drude-

	theory, interband transitions, the joint density of states and the critical points, the absorption of light in solids).
Content	Overview of the crystal structure of a solid material, the vibrational motion of atoms in solid matter, the electronic structure of solids, and the optical phenomenon of solids.
Study/exam achievements	Individual Assignments (30%), Quiz(15%), Participation(5%), Midterm Exam (25%), Final Exam (25%).
Forms of media	Presentation (ppt, pdf, etc.)
Literature	1. C. Kittle, *Introduction to Solid State Physics* 8th Ed., Wiley, 2005. 2. J. R. Hook and H. E. Hall, *Solid State Physics* 2nd Ed, Wiley, 1991. 3. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Saunders College Publishing, 1976 4. H. Ibach and H. Luth, *Solid-State Physics* 4th Ed., Springer, 2009
Notes	-

Module Handbook

Module name	Solid State Physics 2
Module level	Undergraduate
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	6
Module coordinator (s)	Efta Yudiarsah, Ph.D.
Lecturer (s)	Efta Yudiarsah, Ph.D.
Language	Bahasa Indonesia
Classification within the curriculum	Elective studies
Teaching format/class hours per week during the semester	Collaborative Learning (200 minutes)
Workload	Individual assignments, quiz, participation, mid-term and final exam.
Credit points	4 credits
Requirements	Quantum Mechanics 1, Statistical Physics, Introduction to Solid State Physics
Learning goals	Knowledge: To explain the latest phenomena in solids and mechanisms that lie behind them. Skill: Students are expected to be competent in understanding the optical properties of solids (area with wider frequency, impurity and exciton, luminescence and photoconductivity, optical studies of lattice vibrations, non-linear optics, amorphous semiconductors), the magnetic properties of solids (the angular momentum, magnetic effect in free atoms , diamagnetic and paramagnetic of bound electrons, diamagnetic and paramagnetic of nearly free electrons, magneto-oscillatory and the Landau level, quantum Hall effect, magnetic ordering and magnetic devices).

Content	Overview of the properties of transport in solids, superconductivity, dielectrics and ferroelectrics, diamagnetism and paramagnetism, ferromagnetism and antiferromagnetism, magnetic resonance, non-crystalline solids, point defects, physics surfaces and interfaces, dislocations, alloys.
Study/exam achievements	Individual Assignments (30%), Quiz(15%), Participation(5%), Midterm Exam (25%), Final Exam (25%).
Forms of media	Presentation (ppt, pdf, etc.)
Literature	1. C. Kittle, *Introduction to Solid State Physics* 8th Ed., Wiley, 2005. 2. J. R. Hook and H. E. Hall, *Solid State Physics* 2nd Ed, Wiley, 1991. 3. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Saunders College Publishing, 1976 4. H. Ibach and H. Luth, *Solid-State Physics* 4th Ed., Springer, 2009
Notes	-

Module Handbook

Module name	Green's Function Method in Condensed Matter Physics
Module level	Undergradute
Abbreviation, if applicable	-
Sub-heading, if applicable	-
Courses included in the module, if applicable	-
Semester/term	5
Module coordinator (s)	Muhammad Aziz Majidi, Ph.D.
Lecturer (s)	Muhammad Aziz Majidi, Ph.D.
Language	Bahasa Indonesia
Classification within the curriculum	Elective studies
Teaching format/class hours per week during the semester	Podium Lectures (2x50 minutes)
Workload	Individual assignments, group assignments, mid-term and final exam.
Credit points	2 credits
Requirements	Quantum Mechanics 1, Introduction to Solid State Physics
Learning goals	Knowledge: Understanding the construction and formulation of Green's functions, common approaches, the calculation of density of state, linear response theory, optical conductivity calculations, random phase approach, electron-electron interactions, Hubbard models, phonons and electron-phonon interaction, magnetism. Skill: Students are competent to explain the use of Green's functions to solve the problem of quantum mechanical electron system and/or other quasiparticles-in solids, as well as calculating the various magnitudes associated properties of solids.

Content	Overview of Green's function method in condensed matter physics to solve quantum mechanical and statistical physics problems in solids.
Study/exam achievements	Individual Assignments (20%), Group-Assignments (10%), Midterm Exam (35%), Final Exam (35%).
Forms of media	Whiteboard
Literature	1. K. F. Riley, M. P. Hobson, and S. J. Bence, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, 2006. 2. S. Gasiorowicz, *Quantum Physics* 3rd Ed., John Wiley & Son, 2003. 3. E. Kaxiras and J. D. Joannopoulos, *Quantum Theory of Materials*, Cambridge University Press, 2019. 4. M. A. Majidi, *Lecture Note for Methods of Green Functions in Solid-State Physics* (unpublished) 5. A. L. Fetter and J. D. Walecka, *Quantum Theory of Many-Particle Systems,* Dover Publications Inc., 2003. 6. G. D. Mahan, *Many-Particle Physics* 3rd Ed., Kluwer Academic/Plenum Publishers, 2000.
Notes	-

Specialization Courses 3rd Year

Module name	**Sensors and Actuators 1**				
Module level, if applicable	Undergraduate				
Code, if applicable	SCFI603711				
Semester(s) in which the module is taught	6th Semester				
Person responsible for the module	Dr. Santoso				
Lecturer	Dr. Santoso				
Language	Indonesian				
Relation to curriculum	Concentration Course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lectures and discussions	50	2	Lectures and Discussions	Lectures: 4 x 7	28
				Assignments: 4 x 7	28
				Independent Study: 4 x 7	28
Total Workload	84 hours				
Credit points	2 credits				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments andForms (20%), Student Assignment Sheets (20%), Papers and presentation (First Home Group and Second Home Group) (10%), Presentation (10%), Mid-Term Exam (20%) and Final Exam (20%).				
Recommended prerequisites	Electronics 2 (prerequisite)				
Related Course	-				
Module objectives/intended learning outcome	Students are able to explain the technology behind sensors and actuators, precisely select and chose sensors and actuators needed for certain conditions, and apply it for monitoring and measuring physical units				
Content	Explaining the basic principles of Sensors and Actuators which include Temperature Sensors (Thermistors, Resistance Temperature Sensors, Silicon Resistive Sensors, Thermoelectric Sensors, PN Junction Temperature Sensors, and Optical Temperature Sensors), Mechanical Sensors (Pressure Sensors, Flow Sensors, and Level Sensors), Definitions, Classification and Characteristics of Actuators, Electric Actuators, Stepper Motors, Hydraulic Actuators, and Continuous Drive Actuators				
Study and examination requirements and forms of examination	Forms, Student Assignment Sheet, Papers and Presentation (HG1 and HG2), Presentation, Mid-Term Exam and Final Exam				
Media employed	Books, PowerPoint Presentation, Microsoft Teams				
Reading list	[1] https://scele.ui.ac.id/course/view.php?id=7081 enrollment key:				

	[2] J. G Webster, *The Measurement, Instrumentation and Sensors Handbook*, A CRC Handbook Published in Cooperation with IEEE Press, 1999 [3] Fraden, J. , GAIP Handbook of Modern Sensors, Physics, Designs and Applications, J American Institute of Physics, 2004. [4] Sensors, Volume 5, Magnetic Sensor, W. Gospel, J. Hesse, JN. Zemel, VCH, 1989. [5] Sensors, Volume 6, Optical Sensor, W. Gospel, J. Hesse, JN. Zemel, VCH, 1992. [6] Instrumentation Reference Book, Walt Boyes, Butterwort - Heinemann, 2003 [7] William C. Dunn, Introduction to Instrumentation, Sensors, and Process Control, Artech House, 2006.

Specialization Courses 3^{rd} Year

Module name		**Instrumentational Physics**			
Module level, if applicable		Undergraduate			
Code, if applicable		SCFI603712			
Semester(s) in which the module is taught		6^{th} Semester			
Person responsible for the module		Dr. Adhi Harmoko S			
Lecturer		Dr. Adhi Harmoko S			
Language		Indonesian			
Relation to curriculum		Concentration Course			
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Collaborative Learning	50	2	Lectures and Discussions	Lectures: 2 x 14	28
				Assignments: 2 x 14	28
				Independent Study: 2 x 14	28
Total Workload		84 hours			
Credit points		2 credits			
Requirement according to examination regulations		Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and Online Activity (10%), Final Presentation / Paper (10%), Home Group Presentation (20%), Individual Assignments (10%), Group Assignments (10%), Mid-Term Exam (20%), Final Exam (20%)			
Recommended prerequisites		Electronics 2			
Related Course		-			
Module objectives/intended learning outcome		Students are able to explain the basic concepts of instrumentation based on scientific and physical properties.			
Content		Basic principles of instrumentational systems which will discuss about types of instrumentation, models instrumentational systems, instrument characters, calibration principals, noise measurement and signal processing, indicators, and instruments for testing electrical signals, methods on converting electrical units, protocols in transmitting digital signals, digital computation and smart devices, and also the reliabilities and safety protocols of instrumentational systems.			
Study and examination requirements and forms of examination		Online Activity, Final Presentation / Paper, Home Group Presentation, Individual Assignments, Group Assignments, Mid-Term Exam, and Final Exam			
Media employed		Books, PowerPoint Presentation, Microsoft Teams			
Reading list		[1] Moris, Alan S, *Measurement and Instrumentation Principles, 3rd Ed*, Butterworth – Heinemann, 2001 [2] Boyes, Walt, *Instrumentation Reference Book, 3rd Ed,* Butterworth – Heinemann, 2003.			

	[3]	Webster, John G., *Measurement Instrumentation and Sensor Handbook,* CRC Press, 1999.

Specialization Courses 4th Year

Module name	**Sensors and Actuators 2**					
Module level, if applicable	Undergraduate					
Code, if applicable	SCFI603713					
Semester(s) in which the module is taught	7th Semester					
Person responsible for the module	Dr. Santoso					
Lecturer	Dr. Santoso					
Language	Indonesian					
Relation to curriculum	Concentration Course					
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload		
Lectures and discussions	50	2	Lectures and Discussions	Lectures: 4 x 7	28	
				Assignments: 4 x 7	28	
				Independent Study: 4 x 7	28	
Total Workload	84 hours					
Credit points	2 credits					
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments andForms (20%), Student Assignment Sheets (20%), Papers and presentation (First Home Group and Second Home Group) (10%), Presentation (10%), Mid-Term Exam (20%) and Final Exam (20%).					
Recommended prerequisites	Sensors and Actuators 1 (prerequisite)					
Related Course	-					
Module objectives/intended learning outcome	Students are able to explain the technology behind sensors and actuators, precisely select and chose sensors and actuators needed for certain conditions, and apply it for monitoring and measuring physical units					
Content	Explaining the basic principles of Sensors and Actuators which include Optical Sensors (Infrared and Pyroelectric, UV, Visible, and Image Sensors), Magnetic Sensors (Magneto galvanic Sensors, Magneto resistive Sensors, Inductive Sensors and Eddy Currents), Biological Sensors (Biosensor), Pneumatic Sensors, Piezoelectric Actuators, and Thermal Bimorphs.					
Study and examination requirements and forms of examination	Forms, Student Assignment Sheet, Papers and Presentation (HG1 and HG2), Presentation, Mid-Term Exam and Final Exam					
Media employed	Books, PowerPoint Presentation, Microsoft Teams					
Reading list	[1] https://scele.ui.ac.id/course/view.php?id=8661 enrollment key: [2] Sensors, Volume 6, Optical Sensor, W. Gospel, J. Hesse, JN. Zemel, VCH, 1992.					

	[3] Fraden, J. , GAIP Handbook of Modern Sensors, Physics, Designs and Applications, J American Institute of Physics, 2004. [4] Sensors, Volume 5, Magnetic Sensor, W. Gospel, J. Hesse, JN. Zemel, VCH, 1989. [5] Instrumentation Reference Book, Walt Boyes, Butterwort - Heinemann, 2003 [6] Webster, John G., The Measurement, Instrumentation and Sensors Handbook, CRC Press, 1999.Instrumentation Reference Book, Walt Boyes, Butterwort - Heinemann, 2003 [7] William C. Dunn, Introduction to Instrumentation, Sensors, and Process Control, Artech House, 2006.

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<table>
<tr><td>Module name</td><td colspan="5">Intrumentation Physics 2</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">3rd year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI603714</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">5th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dr. Cuk Imawan</td></tr>
<tr><td>Lecturer</td><td colspan="5">Dr. Cuk Imawan</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Collaborative Learning</td><td rowspan="3"></td><td rowspan="3">2</td><td rowspan="3">Group discussion</td><td>Lectures: 2 x 14</td><td>28</td></tr>
<tr><td>Assignments: 2 x 14</td><td>28</td></tr>
<tr><td>Independent study: 2 x 14</td><td>28</td></tr>
<tr><td>Total Workload</td><td colspan="5">84 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">2 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Activeness (10%), Final paper/presentation (10%), topic presentation (20%), Individual assignment (10%), Group assignment (10%), Mid Term exam (20%), Final exam (20%).</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">Intrumentation Physics 1</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students are able describe the instrumentation methods and techniques that are widely used in Physics.</td></tr>
<tr><td>Content</td><td colspan="5">This course is one of the Elective course for students who majoring in instrumentation physics in the Undergraduate Physics Study Program. The subject matter includes: DC circuit, AC circuit, Semiconductors and semiconductor devices, Ppower supply and regulator, Reading Device, Properties of the Op-Amp, Op-Amp circuit, Transducer signal amplification and measurement, Op-Amp applications for voltage and current control, Op-Amp Application for Mathematical Operations, Analog and Digital Signals, Counting and Arithmetic with Binary Numbers, Basic Digital Circuits, Computers and computerized instruments, Computer Components, Computer Software, Computer Applications, Computer Networks, Signal to noise Ratio (SNR), Sources of noise in Instrumentation Analysis, Signal-to-Noise enhancements, general properties of electromagnetic radiation, the nature of electromagnetic radiation waves, quantum mechanical properties of radiation, The quantitative aspect of spectrochemical measurements, General design of optical instruments, Radiation Sources, Wavelength selector, Sample Containers, Radiation transducer, Signal Processing and Readout, Fiber Optic, Types of Optical Instruments, Fourier Transform Principle in Optical Measurement, Optical atomic spectra,</td></tr>
</table>

	Atomization Method, Introduction to Sample Methods, Sample atomization technique, Atomic Absorption Instrumentation, Interference in Atomic Absorption Spectroscopy, Atomic Absorption Analytical Techniques, Atomic fluorescence spectroscopy, Emission spectroscopy based on plasma source, emission spectroscopy based on Arc and Spark sources, Another source for optical emission spectroscopy, Some general features of atomic mass spectrometry, Mass spectroscopy, Inductively coupled plasma Mass Spectrometry, Source of Mass Spectrometry Spark, Glow discharge Mass Spectrometry, Other Mass Spectrometric Methods, Basic Principles, Instrument Components, X-Ray Fluorescence Method, X-Ray Absorption Method, and Electron microprobe
Study and examination requirements and forms of examination	Assignment, presentation, mid-term exam, and final term exam.
Media employed	Power Point and Text Book
Reading list	[1] Skoog, Douglas A, Principles of Instrumental Analysis, 6th Ed, Thompson Higher Education – Canada, 2007

Specialization Courses 3rd Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Control System</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">Undergraduate</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI6043716</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">6th Semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Arief Sudarmaji</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Arief Sudarmaji</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Concentration Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lectures and discussions</td><td rowspan="3">50</td><td rowspan="3">4</td><td rowspan="3">Lectures and Discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent Study: 5 x 14</td><td>56</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">168 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">4 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and In-class Quizzes (10%), Homework and Simulations (10%), Group Project (20%), Mid-Term Exam (30%) and Final Exam (30%).</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">1. Electronics 1 (prerequisite)
2. Electronics 2 (prerequisite)</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">Laboratory Work of Control System</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students are able to understand problems and apply interfacing and programming methods in embedded systems effectively and efficiently</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">Giving the basic concepts about control systems such as feedback and control systems, Laplace transformation, linear transfer function systems, linearization of unilinear systems, modelling mathematical systems, mechanical and electrical systems, block diagram modelling, graphical signal flow modelling, state variable models, error signal analysis, sensitivity of feedback control system towards the variety of parameters in the control system, signal disturbance in a feedback control system, controlling the transient response of a system, steady state errors, second order system, effects of third pole and zero's in a second order system, work index of control systems, simplification of linear systems, analyzation of loop systems (open and closed loop), testing the stability of control systems using characteristic functions and the Ruth Hurwitz method, control system design: root locus concept, parameter design of control system using the root locus, determining the parameters of PID using trial and error methods, identifying the process of a stable open loop system, determining the parameters of a PID with the Direct Synthesis, Inter Model Control, System Index, Ziegler Nichols, Cohen Coon and Reactive Curve methods, analyzing the frequency response using the Bode</td></tr>
</table>

	and Nyquist plot, designing PI, PID, Lead, Lag, and Lead Lag systems, and finally, designing feedback systems with state variables.
Study and examination requirements and forms of examination	In-Class Quizzes, Homework and Simulations, Group Project, Mid-Term, and Final Exam.
Media employed	Books, PowerPoint Presentation, Microsoft Teams
Reading list	[1] N.S. Nise, M.A, *Control Systems Engineering*, 7th edition, Wiley, 2015. [2] R. C. Dorf and R.H. Bishop, *Modern Control System*, 12th edition, Prentice Hall, 2011 [3] D.E. Seborg, T.F. Edgar, D.A. Mellichamp, and F.J. Doyle, *Process Dynamics and Control*, 4th edition, Wiley, 2017.

Specialization Courses 4th Year

Module name	**Laboratory Work of Embedded System**				
Module level, if applicable	Undergraduate				
Code, if applicable	SCFI603723				
Semester(s) in which the module is taught	7th Semester				
Person responsible for the module	Surya Darma, M.Si.				
Lecturer	Surya Darma, M.Si.				
Language	Indonesian				
Relation to curriculum	Concentration Course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lectures and discussions	50	3	Lectures and Discussions	Laboratory Work: 3 x 14	42
Total Workload	42 hours				
Credit points	1 credit				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and participate in the pre-test (5%) before starting the lab work, Laboratory Work (70%) and Final Project (25%)				
Recommended prerequisites	Electronics 2				
Related Course	-				
Module objectives/intended learning outcome	Students are able to precisely explain the concepts of how sensors and actuators work, select and choose sensors and actuators for certain tasks and apply it for monitoring and measuring physical units.				
Content	After finishing this course, students taking the concentration of Instrumentational Physics in the 7th term is able to precisely explain the concepts of how sensors and actuators work, select and choose sensors and actuators for certain tasks and apply it for monitoring and measuring physical units. (C4). The instructional language used in this course will be the Indonesian language.				
Study and examination requirements and forms of examination	Pre-test, Laboratory Work, Final Project				
Media employed	Direct Practice, Power Point, Ms Teams, Ms Word (for reports)				
Reading list	[1] Departemen Fisika FMIPA UI, Buku Panduan Praktikum Sensor dan Aktuator [2] Beckwith, T. G. , Marangoni, R. D. dan J. H. Lienhard V, Mechanical Measurements (I.				

	Fundamentals of Mechanical Measurement, II. Applied Mechanical Measurements), Addison-Wesley Publishing Company, 6ed , 2006 [3]

Specialization Courses 3rd Year

Module name	**Laboratory Work of Control System**				
Module level, if applicable	Undergraduate				
Code, if applicable	SCFI603726				
Semester(s) in which the module is taught	6th Semester				
Person responsible for the module	Surya Darma, M.Si.				
Lecturer	Surya Darma, M.Si.				
Language	Indonesian				
Relation to curriculum	Concentration Course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lectures and discussions	50	3	Lectures and Discussions	Laboratory Work: 3 x 14	42
Total Workload	42 hours				
Credit points	1 credit				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and participate in the pre-test (5%) before starting the lab work, Laboratory Work (70%) and Final Project (25%)				
Recommended prerequisites	Electronics 2				
Related Course	-				
Module objectives/intended learning outcome	After finishing this course, students are ably to apply the basic principles of control systems for identifying and designing a continuous linear process that is continuous and simple that has a fast and slow response towards time				
Content	After finishing this course, students taking the concentration of Instrumentational Physics in the 7th term is able to explain the principals of a control system, select and chose the transfer function and the control system for specific applications, and is able to design a control system for a certain proces. The instructional language used in this course will be the Indonesian language.				
Study and examination requirements and forms of examination	Pre-test, Laboratory Work, Final Project				
Media employed	Direct Practice, Power Point, Ms Teams, Ms Word (for reports)				
Reading list	[1] National Instruments Corporation, LabVIEW Fundamentals, ni.com, 2005				

	[2] Sulaymon Eshkabilov, Beginning MATLAB and Simulink: From Novice to Professional, Apress, Fargo, USA, 2019 [3] Dorf, Richard C., and Bishop, Robert H., Modern Control System, 13th ed., Prentice Hall, 2017. [4] Golnaraghi, Farid., and Kuo, Benjamin C., Automatic Control System, 10th ed. McGraw Hill Education., 2017. [5] Seborg, Dale E., Edgar, Thomas F., and Mellichamp, Duncan A., Process Dynamics and Control, 4th ed., John Wiley & Son., 2017. [6] Quanser, QNET DC Motor Trainer, QNET Rotary Pendulum Trainer, QNET Heating and Ventilation Trainer, 2011.

Specialization Courses 3rd Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Computer-Based Data Acquisition</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">Undergraduate</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604713</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">5th Semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Prawito Prajitno</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Prawito Prajitno</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Concentration Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lectures and discussions</td><td rowspan="3">50</td><td rowspan="3">2</td><td rowspan="3">Lectures and Discussions</td><td>Lectures: 2 x 14</td><td>28</td></tr>
<tr><td>Assignments: 2 x 14</td><td>28</td></tr>
<tr><td>Independent Study: 2 x 14</td><td>28</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and Individual Assignments (30%), Mid-Term Exam (35%), and Final Exam (35%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Electronics 2 (prerequisite)</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students are able to apply a range of basic instrumentation techniques for data acquisition using computers through the software of LabView or other programming languages.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">Basic instrumentation techniques, LabVIEW programming techniques, computer inputs and outputs, instrumentation concepts for signal conditioning, communication mechanics of computer systems and designing techniques in data acquisition.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Individual assignments, mid-term, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">Books, PowerPoint Presentation, Microsoft Teams</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] Cotfas, P.A., Cotfas, D.T., Ursutiu, D. and Samoila, C., NI ELVIS Computer-Based Instrumentation, NTS, 2012.
[2] Travis, J., and Kring, J. LabVIEW for Everyone, 3rd Ed., Prentice Hall, 2006
[3] Sumathi, S. and Surekha, P., LabVIEW based Advanced Instrumentation Systems, Springer, 2007.</td></tr>
</table>

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Digital Signal Processing</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604715</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Adhi Harmoko Saputro, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Adhi Harmoko Saputro, Ph.D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Collaborative Learning</td><td rowspan="3"></td><td rowspan="3">2</td><td rowspan="3">Group discussion</td><td>Lectures: 2 x 14</td><td>28</td></tr>
<tr><td>Assignments: 2 x 14</td><td>28</td></tr>
<tr><td>Independent study: 2 x 14</td><td>28</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Assignment (30%), Mid term exam (35%), Final exam (35%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Modern Physics, Mathematical Method in Physics 2, Electronics 2</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students are able describe the instrumentation methods and techniques that are widely used in Physics.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">This course is one of the Elective courses for students who majoring in instrumentation physics in the Undergraduate Physics Study Program. The subject matter includes: digital signals and systems, convert ADC and DAC signals, discrete time systems and signals and their differences, Z transformation method, continuous time signal sampling method, Z transformation for a linear time-invariant (LTI) system, continuous time signal frequency analysis method, discrete time signal frequency analysis method, the Fourier transform principle for discrete time signals, the methods and results of Fourier analysis for discrete time signals, basic principles of filters for digital systems, FIR type digital filter, IIR type digital filter</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Assignment, mid-term exam, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">Power Point and Text Book</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] Kehtarnavas, N., Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming, Academic Press, 2008.
[2] Ingle, V.K., and Proakis, J.G., Digital Signal Processing using Matlab, Cengage Learning, 4th Ed., 2012.</td></tr>
</table>

	[3] Oppenheim, A.V. and Schafer, R.W., Discrete-Time Signal Processing (3rd Ed), Prentice Hall, 2009.

Specialization Courses 3rd Year

<table>
<tr><td>Module name</td><td colspan="5">Embedded System</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">Undergraduate</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI604723</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">5th Semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dr. Prawito Prajitno</td></tr>
<tr><td>Lecturer</td><td colspan="5">Dr. Prawito Prajitno</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Concentration Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lectures and discussions</td><td rowspan="3">50</td><td rowspan="3">4</td><td rowspan="3">Lectures and Discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent Study: 4 x 14</td><td>56</td></tr>
<tr><td>Total Workload</td><td colspan="5">168 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">4 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and In-class quiz (10%), homework and simulations (10%), group project (20%), mid-term exam (30% and final exam (30%).</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">Electronics 1 and Electronics 2</td></tr>
<tr><td>Related Course</td><td colspan="5">Laboratory Work of Embedded Systems</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students are able to apply a range of basic techniques needed in making an embedded system while being thought 2 types of programming language (Assembly language and C language) and is able to create a simple project for embedded systems using a microcontroller.</td></tr>
<tr><td>Content</td><td colspan="5">Basic concepts about embedded systems, examples of embedded systems, microprocessors and microcontrollers, microcontroller architecture, memory organization, minimum systems based on microcontrollers, instruction sets, parallel inputs and outputs, interrupts, Counters and Timers, Analog to Digital Converter (ADC) and Digital to Analog Converter (DAC), interfacing external memory, interfacing external peripherals and devices, serial data communication such as : USART, SPI, I2C, 1-Wire, and Real-time Operating Systems (RTOS)</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Individual assignments, in-class quizzes, group project, mid-term, and final exam.</td></tr>
<tr><td>Media employed</td><td colspan="5">Books, PowerPoint Presentation, Microsoft Teams</td></tr>
</table>

Reading list	[1]	Mazidi, M.A, Naimi, S., *The AVR Microcontroller and Embedded Systems Using Assembly and C*, Prentice Hall, 2011.
	[2]	Barnett, R.H, Cox, S, O'Cull, L, *Embedded C Programming and The Atmel AVR, 2nd edition*, Thomson Delmar Learning, 2007
	[3]	Maxim Integrated, *DS-1820 High-Precision 1-Wire Digital Thermometer*, Maxim Integrated Product, 2015.
	[4]	Barrr, R, *Mastering the Free RTOS Real Time Kernel, A Hands-On Tutorial Guide*, Real Time Engineers Ltd. 2016

Specialization Courses 3rd Year

Module name	**Laboratory Work of Embedded System**				
Module level, if applicable	Undergraduate				
Code, if applicable	SCFI604723				
Semester(s) in which the module is taught	6th Semester				
Person responsible for the module	Surya Darma, M.Si.				
Lecturer	Surya Darma, M.Si.				
Language	Indonesian				
Relation to curriculum	Concentration Course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lectures and discussions	50	3	Lectures and Discussions	Laboratory Work: 3 x 14	42
Total Workload	42 hours				
Credit points	1 credit				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and participate in the pre-test (5%) before starting the lab work, Laboratory Work (70%) and Final Project (25%)				
Recommended prerequisites	Electronics 2				
Related Course	-				
Module objectives/intended learning outcome	Students are able to analyze (C4) concepts used in embedded systems and operation systems as well as apply (P4) the Assembly and C programming language in a day-to-day basis to solve problems				
Content	After finishing this course, students taking the concentration of Instrumentational Physics in the 7th term is able to analyze (C4) the concepts used in embedded systems and its operations and uses (P4) while using the Assembly and C programming language for daily uses and solving (A5) problems based on computer logic. The instructional language used in this course will be the Indonesian language.				
Study and examination requirements and forms of examination	Pre-test, Laboratory Work, Final Project				
Media employed	Direct Practice, Power Point, Ms Teams, Ms Word (for reports)				
Reading list	[1] Mazidi, M.A, Naimi, S., *The AVR Microcontroller and Embedded Systems Using Assembly and C*, Prentice Hall, 2011.				

	[2] Barnett, R.H, Cox, S, O'Cull, L, *Embedded C Programming and The Atmel AVR, 2nd edition*, Thomson Delmar Learning, 2007 [3] Noergaard, T., Embedded Systems Architecture: A Comprehensive Guide for Engineers and Prgrammers, Newnes Elsevier, 2005. [4] Catsoulis, J., Designing Embedded Hardware, O'Reilly, 2005

Specialization Courses 4th Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Internship</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">Undergraduate</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604742</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7th Semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Drs. Sastra Kusuma Wijaya Ph. D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Drs. Sastra Kusuma Wijaya Ph. D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Concentration Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lectures and discussions</td><td rowspan="3">50</td><td rowspan="3">2</td><td rowspan="3">Lectures and Discussions</td><td>Lectures: 4 x 7</td><td>28</td></tr>
<tr><td>Assignments: 4 x 7</td><td>28</td></tr>
<tr><td>Independent Study: 4 x 7</td><td>28</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments and a Logbook (20%), an Attendance List (20%), Presentation (30%) and a Final Report (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Has previously taken 64 credits</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">Undergraduate Thesis</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">After finishing this course, students are able to tackle Physics based problems experimentally, numerically, or analytically and analyse the problem comprehensively</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">This internship course is a form of conversion into credits from the result of students having taken in an internship, working or instrument-based research projects under a teacher or a professional in a certain institution. There are no specific prerequisite courses to take this course, but students are required to have passed 64 credits throughout their study. This course can be taken in the 7th term and can also be integrated with the Undergraduate Thesis course.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Logbook, Attendance List, Presentation and Final Report</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">Direct Practice</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] Articles and Journals related to the topic students are working on.</td></tr>
</table>

Module Handbook

<table>
<tr><td>Module name</td><td colspan="5">Introduction to Materials Science</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">3rd year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI603511</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">5th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Anawati, PhD</td></tr>
<tr><td>Lecturer</td><td colspan="5">1. Anawati, PhD
2. Ariadne L Juwono, PhD</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Blended learning with Collab & Coop</td><td rowspan="3"></td><td rowspan="3">3</td><td rowspan="3">Group discussion</td><td>Lectures: 3 x 14</td><td>42</td></tr>
<tr><td>Assignments: 3 x 14</td><td>42</td></tr>
<tr><td>Independent study: 3 x 14</td><td>42</td></tr>
<tr><td>Total Workload</td><td colspan="5">126 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">3 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Individual Assignment (10%), Discussion (10%), Presentation (10%), Quiz (10%), Mid Term Exam (30%), Final Exam (30%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">-</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">students are able to solve simple structured questions about the structure of metals and alloys, ceramics, polymers, and composites according to the basic principles of materials</td></tr>
<tr><td>Content</td><td colspan="5">This course is one of the Elective course for students who majoring in material sciences in the Undergraduate Physics Study Program. The subject matter includes: atomic models, atomic structure, and the periodic table arrangement system, seven crystal systems, unit cells, and lattice parameters, calculate atomic density and atomic packing factor, point and crystal plane as well as the direction of the plane, point defects, intestines and substitutions in crystals. to calculate the atomic composition and weight percent of the alloy material. dislocations in crystals, distinguish crystalline, non-crystalline, and amorphous structures, explain various types of metal crystal structures, explain the crystal structure in ceramics and the types of crystal defects, explain the mechanical, electrical, and magnetic properties of metals and alloys, explain and use metal phase diagrams to complete simple calculations in determining the composition, temperature, and type of alloy phase, the phenomenon of deformation and metal strengthening mechanisms, properties of ceramics based on the crystal structure and explain the effect of atomic defects on the properties of ceramics, polymer properties</td></tr>
</table>

	in terms of bonding, weight, shape and molecular structure, identify the types of bonds of various types of polymers.
Study and examination requirements and forms of examination	Individual assignments, discussion, quiz, presentation, mid-term exam, and final exam.
Media employed	Power Point and Text Book
Reading list	[1] W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007. [2] L.H. Van Vlack, Materials Science for Engineers, 6th Ed, Addison-Wesley Pub. Co., Bab 1 – 7, 1975. 3.

Physics Specialization Courses 4th Year

<table>
<tr><td>Module name</td><td colspan="5">Materials Properties</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">4th year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI603512</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">7th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dr. Anawati
Dr. Bambang Soegijono
Dr. Vivi Fauzia
Dr. Dede Djuhana</td></tr>
<tr><td>Lecturer</td><td colspan="5">Dr. Anawati
Dr. Bambang Soegijono
Dr. Vivi Fauzia
Dr. Dede Djuhana</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Specialization course for Material Physics</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lectures, cooperative learning, individual assignments, and written exams</td><td rowspan="3">50</td><td rowspan="3">3</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 3 x 14</td><td>42</td></tr>
<tr><td>Assignments: 3 x 14</td><td>42</td></tr>
<tr><td>Independent study: 3 x 14</td><td>42</td></tr>
<tr><td>Total Workload</td><td colspan="5">126 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">3 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on assignments (41%), presentations (17%), discussions (33%), and exams (9%).</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">1. Introduction to Material Science (prerequisite)</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">After participating in the Material Properties course, 7th semester students of the physics undergraduate study program with a special interest in materials physics are able to identify and examine material properties as well as metal corrosion and material degradation.</td></tr>
<tr><td>Content</td><td colspan="5">Students are expected to be able to study in an integrated manner the structure, properties, and processing critically to keep up with the latest developments in the science and technology of metallic, ceramics, polymers and composites materials and their proper applications. The scope of this course is to explain fundamentally the mechanical, electrical, optical, magnetic, and thermal properties, as well as metal corrosion and material degradation.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Interactive lectures, cooperative learning, individual assignments, and written exams.</td></tr>
<tr><td>Media employed</td><td colspan="5">PowerPoint presentation, EMAS UI Platform</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007</td></tr>
</table>

	[2] L.H. Van Vlack, Materials Science for Engineers, 6th Ed, Addison-Wesley Pub. Co., Bab 1 – 7, 1975 [3] Donald R. Askeland, The Science and Engineering of Materials, 2nd S.I. Ed, Chapman & Hall, 1990.

Physics Specialization Courses 3rd Year

Module name	**Thermodynamics of Materials**				
Module level, if applicable	3rd year				
Code, if applicable	SCFI603513				
Semester(s) in which the module is taught	6th semester				
Person responsible for the module	Dr. Nurlely, M.Si.				
Lecturer	Dr. Nurlely, M.Si.				
Language	Indonesian				
Relation to curriculum	Specialization course for Material Physics				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Interactive lectures, question-based learning, self-directed study, and discussions	50	3	Lectures and discussions	Lectures: 3 x 14	42
				Assignments: 3 x 14	42
				Independent study: 3 x 14	42
Total Workload	126 hours				
Credit points	3 credits				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (40%), mid-term exam (30%), and final exam (30%)				
Recommended prerequisites	1. Introduction to Material Science (prerequisite)				
Related Course	-				
Module objectives/intended learning outcome	After completing this lecture, students are able to apply the concepts of thermodynamic physics and evaluate the results of thermal treatment on materials appropriately in accordance with the applicable laws of physics				
Content	Laws of thermodynamics, conservation of energy, heat and work, entropy, heat capacity, thermoelastic and magnetic effects, statistical thermodynamics, heat flow, phase diagram, diffusion, reaction kinetics.				
Study and examination requirements and forms of examination	Individual assignments, mid-term exam, and final exam.				
Media employed	PowerPoint presentation, EMAS UI Platform				
Reading list	[1] D. R. Gaskell, Thermodynamics Material, McGraw Hill, 1981. [2] D. V. Ragone, Thermodynamics of Materials, Vol. I, John Wiley & Sons, Inc., 1995. [3] J. Bevan Ott dan J. Boerio-Goates, Chemical Thermodynamics, Elsevier, 2000.				

Module Handbook

<table>
<tr><td>Module name</td><td colspan="5">Research Methods of Materials</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">3rd year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI603514</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">6th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Dr. Azwar Manaf, M.Met.</td></tr>
<tr><td>Lecturer</td><td colspan="5">Dr. Azwar Manaf, M.Met.</td></tr>
<tr><td>Language</td><td colspan="5">Indonesian</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Collaborative Learning</td><td rowspan="3"></td><td rowspan="3">2</td><td rowspan="3">Group discussion</td><td>Lectures: 2 x 14</td><td>28</td></tr>
<tr><td>Assignments: 2 x 14</td><td>28</td></tr>
<tr><td>Independent study: 2 x 14</td><td>28</td></tr>
<tr><td>Total Workload</td><td colspan="5">84 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">2 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Assignment (20%), Mid Term Exam (40%), Final Term Exam (40%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">Modern Physics</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students are able to design and start material research activities based on scientific methods in everyday life to solve existing problems</td></tr>
<tr><td>Content</td><td colspan="5">This course is one of the Elective course for students who majoring in material sciences in the Undergraduate Physics Study Program. The subject matter includes: types of research, research flow, ways of taking samples, statistical techniques for research, material testing methods, sample quality and process data, communicate research results well, how to publish research results, write research proposals, the process of getting the UI Grant, the details of a good research proposal.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Assignment, mid-term exam, and final term exam.</td></tr>
<tr><td>Media employed</td><td colspan="5">Power Point and Text Book</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] Lecturer personal notes
[2] Nicholas Walliman, “Research Methods The Basics”, Taylor & Francis e-Library, 2011
[3] The 2018 PITTA (Indexed International Publication for UI Student Final Project) Grant, DRPM UI
[4] Technical Guidelines for Student Final Project Writing UI, 2017
[5] Various articles, journals, related references Nanocomposite related scientific publications</td></tr>
</table>

Physics Specialization Courses 3rd Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Methods of Materials Characterization</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">3rd year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI603515</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">6th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Azwar Manaf, M.Met.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Azwar Manaf, M.Met.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Specialization course for Material Physics</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lectures, question-based learning, self-directed study, and discussions</td><td rowspan="3">50</td><td rowspan="3">4</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">168 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">4 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (20%), mid-term exam (40%), and final exam (40%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">1. Introduction to Material Science (prerequisite)</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">After completing this lecture, students are able to apply physics principles to test instruments and evaluate standard methods for testing and characterizing materials in processing material properties data appropriately</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">Basic principles of: physics to measurement methods and test instruments, nuclear and particle physics for material characterization, electric and magnetic physics for material characterization, the microstructure of the material on the characterization of the material, optical physics principles for material characterization, thermodynamic physics principles for material characterization, the principles of vibration and wave physics for material characterization, and the principles of physics and mechanics for material characterization.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Individual assignments, mid-term exam, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">PowerPoint presentation, EMAS UI Platform</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] Characterization of Materials (Materials Science and Technology: A Comprehensive Treatment, Vl 2A &2B, VCH (1992).
[2] Materials Characterization Techniques, S Zhang, L.Li and Ashok and RK Wild, IOP Publishing (2003).</td></tr>
</table>

	[3] Analytical Method Validatioan and Instrument Perfomance Verification. Chan C.C., Lam, H., Lee, Y.C., dan Zhang, X..John Willey and Sons. Canada. (2004) [4] Fundamental of Analytical Chemistry, seventh edition, Douglas A. Skoog Stanford University, Donald M. West Sna Jose State University, F. James Holler University of Kentucky. [5] Introduction to NMR Spectroscopy, R.J. Abraham (University of Liverpool), J. Fisher (University of Leicester), P.Lotfus (Stuart Pharmacetuticals, Wilmington, USA), Jhon Wiley & Sons. [6] Fundamentals of Molecular Spectroscopy, second edition, CN Banwell, Lecture in Chemistry University of Sussex, Falmer, Sussex, Perfik [7] Semiconductor Material and Device Characterization, 3rd edition,D.K. Schroder, Wiley – IEEE Press (2006). [8] Reaction Kinetics in Differential Thermal Analysis, Homer E. Kissinger , National Bureau of Standards, Washington, D. C. [9] Characterization of Nanophase Materials, Ed. Z L Wang, Wilet-VCH(2000). [10] ASM Handbook Vol.10: Materials Characterization, ASM International

Physics Specialization Courses 4th Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Phase Transformation of Materials</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604511</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dr. Azwar Manaf, M.Met.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dr. Azwar Manaf, M.Met.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Specialization course for Material Physics</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lectures, question-based learning, self-directed study, and discussions</td><td rowspan="3">50</td><td rowspan="3">3</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 3 x 14</td><td>42</td></tr>
<tr><td>Assignments: 3 x 14</td><td>42</td></tr>
<tr><td>Independent study: 3 x 14</td><td>42</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">126 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">3 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (40%), mid-term exam (30%), and final exam (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">1. Introduction to Material Science (prerequisite)</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">After completing this lecture, students are able to correctly analyze the process of material phase formation and the phenomena that occur in the material during thermal application.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">Systematic material kinetics principles in stages from basic principles to application, the response of the material with a given thermal effect and phase diagram, thermodynamic principles in the solidification process (liquid-solid phase transformation), Temperature Transformation (TTT) and Continuous Cooling Transformation (CCT) diagrams, and thermodynamic principles in analyzing phase diagrams.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Individual assignments, mid-term exam, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">PowerPoint presentation, EMAS UI Platform</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] D.A. Porter and K.F. Easterling, Phase Transformation in Metals and Alloys, Van Nostrand Reinhold, New York, 1981.
[2] A.K. Jena and M.C. Chaturvedi, Phase Transformations in Materials, Prentice Hall, New Jersey, 1982.
[3] Lecture notes / Phase Transformation power points from the internet; Publications related to phase transformation kinetics.</td></tr>
</table>

Module Handbook

Module name	**Ceramics Physics**				
Module level, if applicable	4^{th} year				
Code, if applicable	SCFI604512				
Semester(s) in which the module is taught	7^{th} semester				
Person responsible for the module	1. Dr. Bambang Soegijono 2. Dra. Ariadne L. Juwono, M.Eng., Ph.D.				
Lecturer	1. Dr. Bambang Soegijono 2. Dra. Ariadne L. Juwono, M.Eng., Ph.D.				
Language	Indonesian				
Relation to curriculum	Elective course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Collaborative Learning		3	Group discussion	Lectures: 3 x 14	42
				Assignments: 3 x 14	42
				Independent study: 3 x 14	42
Total Workload	126 hours				
Credit points	3 credits				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Individual Assignment (20%), Discussion/Presentation (20%), Mid Term Exam (30%), and Final Exam (30%)				
Recommended prerequisites	-				
Related Course	-				
Module objectives/intended learning outcome	Student are able to apply the basic physics principles and concept and their application				
Content	This course is one of the Elective course for students who majoring in material sciences in the Undergraduate Physics Study Program. The subject matter includes: definition of ceramics, constituent elements, crystal structure, applications and general properties of ceramics, melting point relationship, the thermal expansion coefficient relationship, Young's modulus, surface energy with ionic and covalent bonds, Describes the diffusion and electrical conductivity of ceramic materials, Law of Fick I, II and the law of conductivity, formation stages, structure, glass properties, crystal growth, formation kinetics using the TTT curve and Avrami equation, glass transition temperature, Distinguish network formers and network modifiers, sintering process, grain growth kinetics, sintering kinetics, densification in solid-state sintering, factors that influence solid-state sintering, the relationship between growth and solid state sintering, Describe brittle and ductile mechanical properties, fracture toughness, Griffith's criteria, stress intensity factor, Distinguishing crack deflection, crack bridging, and transformation toughning. Using the Weibull distribution on structured problems, Describe thermal properties, residual stress concepts, thermal shock, tempering,				

	Applies the formula for thermal expansion and thermal conductivity, dielectric properties, polarization concept, power dissipation factor, dielectric spectrum, capacitor, polarization, dipole moment formulas to a structured problem, concept of magnetic fields, hysteresis curves, and microscopic magnets of magnets, Distinguishing magnetic materials, namely diamagnetic, paramagnetic, ferromagnetic, ferrimagnetic and antriferromagnetic, spectrum of electromagnetic waves, electromagnetic radiation, absorption / transmission phenomena, Rayleigh scattering and critical angle phenomena, Apply electromagnetic formulas (intensity equation, Snellius's Law, Fresnel equation, Beer-Lambert).
Study and examination requirements and forms of examination	Individual assignments, presentation, mid-term exam, and final exam.
Media employed	Power Point and Text Book
Reading list	[1] M. W. Barsoum, Fundamentals of Ceramics, Inst. of Publishing, 2003. [2] W.D Kingery, H.K. Bowen dan D.R. Uhlmann, Introduction to Ceramics, John Wiley & Son 1976.

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Composite Materials</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4^{th} year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604513</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7^{th} semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">1.Dr. Suhardjo Poertadji
2. Ariadne L. Juwono, M.Eng., PhD</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">1. Dr. Suhardjo Poertadji
2. Ariadne L. Juwono, M.Eng., PhD</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Collaborative Learning</td><td rowspan="3"></td><td rowspan="3">3</td><td rowspan="3">Group discussion</td><td>Lectures: 3 x 14</td><td>42</td></tr>
<tr><td>Assignments: 3 x 14</td><td>42</td></tr>
<tr><td>Independent study: 3 x 14</td><td>42</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">126 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">3 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on Presentation (10%), Homework (20%), Discussion (10%), Mid Term Exam (30%), Final exam (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students are able to apply the Rule of Mixtures for particle and fiber reinforcing composites to simple structured questions, differentiate between types of composites and nanocomposites, classify composite fabrications, select materials for simple applications, and explain the mechanical properties of lamina and laminate.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">This course is one of the Elective course for students who majoring in material sciences in the Undergraduate Physics Study Program. The subject matter includes: definition, concept, classification, and mechanical properties (in general) of composites, calculate volume fraction, weight fraction, and weight to ratio on simple structured questions, Rule of Mixture (ROM) for particle reinforced composites in simple structured problems, matrix and fiber interfaces, calculate Poisson's ratio and critical fiber length, Rule of Mixture (ROM) for composites with fiber reinforced composites, distinguish types of structural composites, classify composite fabrications, select composite constituent materials for simple applications, differentiate types of nanocomposites, mechanical properties of lamina and laminate as well as hygrothermal properties.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Homework, discussion, presentation, mid-term exam, and final exam.</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">Power Point and Text Book</td></tr>
</table>

Reading list	[1] R. F. Gibson, Principle of Composite Material Mechanics, McGraw-Hill Book [2] Co., Int. Ed, 1994. Bab 1 – 4 dan 10. [3] D. Hull, An Introduction to Composite Materials, Cambridge University Press, 6th. [4] Ed., 1992. Bab 1 – 5. [5] Callister Jr, W.D., “Materials Science and Engineering: An Introduction”, 7th. Ed., [6] John Wiley & Sons. Inc., 2007, bab16. [7] Composite related scientific publications [8] Nanocomposite related scientific publications

Physics Specialization Courses 4th Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Internship in Materials Physics</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604514</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Anawati, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Anawati, Ph.D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Specialization course for Material Physics</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="2">Collaborative learning</td><td rowspan="2">50</td><td rowspan="2">7</td><td rowspan="2">Internship</td><td>Structured assignments: 3 x 16</td><td>48</td></tr>
<tr><td>Independent assignments: 4 x 16</td><td>64</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">112 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Final score is evaluated based on activity logbook (20%), attendance (20%), presentation (30%), and report (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Has completed/acquired 64 credits (prerequisite)</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">After completing this course students have the ability to systematically solve Physics or Applied Physics problems using experimental, numerical, and analytical methods and analyze the results comprehensively.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">This course is a form of credit conversion for students who specialize in Material Physics at practical institutions for one semester in working on research projects under the guidance of lecturers, professionals, or experts. Practical work can be done in practical institutions.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Activity logbook, attendance, presentation, and report</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">PowerPoint presentation</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] Related articles and journals</td></tr>
</table>

Module Handbook

Module name	Introduction to Radiology Physics
Module level	Undergraduate
Abbreviation, if applicable	
Sub-heading, if applicable	
Courses included in the module, if applicable	
Semester/term	5
Module coordinator (s)	
Lecturer (s)	Supriyanto Ardjo Pawiro, Ph.D.
Language	Bahasa Indonesia
Classification within the curriculum	Elective studies
Teaching format/class hours per week during the semester	
Workload	
Credit points	2 credits
Requirements	
Learning goals	
	Knowledge: Skill:
Content	
Study/exam achievements	
Forms of media	
Literature	
Notes	

Module Handbook

<table>
<tr><td>Module name</td><td colspan="5">Advanced Biophysics</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604918</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Dra. Nurlely, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Dra. Nurlely, Ph.D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Elective Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive learning</td><td rowspan="3">30</td><td rowspan="3">2</td><td rowspan="3">Interactive learning</td><td>Interactive learning</td><td>28</td></tr>
<tr><td>Self-directed study</td><td>28</td></tr>
<tr><td>Assignments</td><td>28</td></tr>
<tr><td colspan="2">Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 Credits</td></tr>
<tr><td colspan="2">Requirements according to the examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignment (40%), mid-term exam (30%), and final exam (30%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Introduction to Biophysics</td></tr>
<tr><td colspan="2">Related course</td><td colspan="4">None</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcomes</td><td colspan="4">Intended Learning Outcomes:
Students are able to apply physics concepts of electricity, magnetism, and optics on biological system and human body for development of medical instrument device and biosensor.

Skill & Knowledge:
1. Able to apply electricity and magnetism concepts as well as biophysics in the physiology of human body.
2. Able to apply principles of electric and magnetic interaction in human tissue.
3. Able to explain the basic principle of optics on biomedical device and biosensor
4. Able to apply principles of biomedical optics and biosensor for biology imaging.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">• Propagation of electric and magnetic field in tissue
• Physiology and biophysics phenomena
• Biophysics of neuron and brain cell
• Principle of bioelectromagnetic
• Application of biophysical stimulation therapy
• Biomedical optics
• Biosensor
• Biophotonic
• Optical Coherence Tomography (OCT)</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Paper Test</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">PowerPoint</td></tr>
</table>

Reading list	1. Robert O. Becker. The Body Electric: Elektromagnetism and the foundation of life. Wiliam Morrow, 1995 2. Jaakko malmivuo. Bioelctromagnetism: Principle and Applications of Bioelectric and Biomagnetic Fields.Oxford University Press, 1995 3. Wang, LV and Wu HI, Biomedical Optics, Principles and Imaging, (Wiley-VCH), 2007 4. Prasad, P.N., "Introduction to Biophotonics", (Wiley-VCH), 2003 5. Popp,Tuchin, Chiou, Heinemann (Editors)Handbook of Biophotonics, 3 Volume Set, (Wiley-VCH), 2012 6. Leahy, M.J. editor, Microcirculation Imaging, (Wiley-VCH), 2012.

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Introduction to Medical Instrumentation</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI604919</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Drs. Sastra Kusuma Wijaya, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Drs. Sastra Kusuma Wijaya, Ph.D.</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Elective Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive learning</td><td rowspan="3">50</td><td rowspan="3">2</td><td rowspan="3">Interactive learning</td><td>Interactive learning</td><td>28</td></tr>
<tr><td>Self-directed study</td><td>28</td></tr>
<tr><td>Assignments</td><td>28</td></tr>
<tr><td colspan="2">Workload</td><td colspan="4">84 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">2 Credits</td></tr>
<tr><td colspan="2">Requirements according to the examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignment (30%), mid-term exam (30%), and final exam (30%).</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Electronics 2</td></tr>
<tr><td colspan="2">Related course</td><td colspan="4">None</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcomes</td><td colspan="4">Intended Learning Outcomes:
Students are able to apply physics concepts of advanced electronics on measurement instruments and medical instruments in their everyday life appropriately to solve existing problems.

Skill & Knowledge:
1. Able to apply basic instrumentation concepts to measurement instruments and medical equipment in everyday life to solve existing problems.
2. Able to apply the concept of a biopotential signal amplifier to measurement instruments and medical equipment in everyday life to solve existing problems.
3. Able to apply the concepts of impedance, capacitance and tomography methods to measurement instruments and medical equipment in everyday life to solve existing problems.
4. Able to apply medical imaging concepts to measurement instruments and medical equipment in everyday life to solve existing problems.
5. Able to apply biophysical concepts to physiotherapy instruments and prosthetic equipment in everyday life to solve existing problems.
6. Able to apply radiotherapy concepts to therapeutic instruments and radiation equipment in everyday life to solve existing problems.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">• Basic concept of medical instrumentation
• Basic concepts and principle of sensors
• Signal amplifier and processing
• Biopotential
• Blood pressure and sound measurement
• Blood flow and volume measurement and respiratory measurement
• Clinical medical instruments
• Medical imaging system</td></tr>
</table>

	• Therapy instrument and prosthetics • Electric safety • Radiation detector • Radiotherapy machine • Particle accelerator
Study and examination requirements and forms of examination	Paper test
Media employed	PowerPoint
Reading list	J. G. Webster, Medical Instrumentation: Application and Design, John Wiley & Sons, New York, 1998.

Module Handbook

<table>
<tr><td colspan="2">Module name</td><td colspan="3">Laboratory Work of Radiology Physics</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="3">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="3">SCFI604921</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="3">7th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="3">Supriyanto Ardjo Pawiro, Ph.D.</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="3">Supriyanto Ardjo Pawiro, Ph.D.
Kristina Tri Wigati, M.Si.</td></tr>
<tr><td colspan="2">Language</td><td colspan="3">Indonesian</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="3">Elective Course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class size</td><td>Attendance time (hour per week per semester)</td><td>Forms of active participation</td><td>Workload</td></tr>
<tr><td>Laboratory work</td><td>40</td><td>3</td><td>Collaborative learning</td><td>42</td></tr>
<tr><td colspan="2">Workload</td><td colspan="3">42 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="3">1 Credit</td></tr>
<tr><td colspan="2">Requirements according to the examination regulations</td><td colspan="3">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on quiz (20%), group assignment (35%), individual assignment (10%), and exam (35%).</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="3">Introduction to Radiology Physics</td></tr>
<tr><td colspan="2">Related course</td><td colspan="3">None</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcomes</td><td colspan="3">Intended Learning Outcomes:
Students will experiment on things related to radiology diagnostic physics at hospitals, quality assurance method, and dosimetry measurement.

Skill & Knowledge:
1. Study the relationship between KERMA and mA/mAs, time, and filter on the radiodiagnostic x-ray.
2. Test the correctness and consistency of voltage and timing on radiodiagnostic x-ray.
3. Determine the Half Value Layer (HVL) of radiodiagnostic x-ray.
4. Study the effect of changes in kV, mA/mAs to the blackness of film with or without intensifying screen.
5. Test the correctness of the light beam against radiation and the alignment of the radiation beam.
6. Measure the effective focal spot of an x-ray machine.
7. Study the characteristics of radiodiagnostic film used in x-ray examination.
8. Study medical fluoroscopy imaging which consists of image quality assurance and dosimetry.
9. Conduct ultrasound image quality control which consist of uniformity, dead zone, penetration depth, beam profile, focal zone, lateral response, vertical and horizontal distance accuracy, axial and lateral resolution, anechoic mass, and contrast sensitivity.
10. Check the linearity of dose calibrator readings as a determinant for radiopharmaceutical dose used in nuclear medicine.
11. Test the relation between a dose calibrator to the sample geometry.
12. Test the intrinsic and extrinsic responses of a gamma camera toward a uniform spatial flux from photons captured in the field of view (FOV).</td></tr>
</table>

	13. Test the intrinsic spatial resolution of a gamma camera in relation to FWHM for each line spread function. 14. Verify the effect of distance and rotation during scanning with SPECT mode toward scintillation events.
Content	• Radiography • Fluoroscopy • Ultrasonography • Nuclear Medicine
Study and examination requirements and forms of examination	Paper test
Media employed	PowerPoint
Reading list	1. J. T. Bushberg, J. A. Seibert, E. M. Leidhodt, Jr., J. M. Boone. The Essential Physics of Medical Imaging. 2nd ed., Williams and Wilkins, Baltimore, MD, 2002. 2. P.P Dendy and B. Heaton. Physics of Diagnostic Radiology, Institute of Physics Publishing, London, UK, 1999. 3. P. Sprawl. Physical Principles of Medical Imaging, Aspen Publishers,. Gaithersburg, Maryland, 1987. 4. Buku Panduan Praktikum Fisika Radiologi Diagnostik, Departemen Fisika FMIPA UI

Module Handbook

Module name		Internship in Medical Physics and Biophysics		
Module level, if applicable		4th year		
Code, if applicable		SCFI604941		
Semester(s) in which the module is taught		7th semester		
Person responsible for the module		Dr. rer. nat. Musaddiq Musbach		
Lecturer		Dr. rer. nat. Mussadiq Musbach Prof. Djarwani S. Soejoko Kristina Tri Wigati, M.Si. Supriyanto Ardjo Pawiro, Ph.D.		
Language		Indonesian		
Relation to curriculum		Elective Course		
Types of teaching and learning	Class size	Attendance time (hour per week per semester)	Forms of active participation	Workload
Internship	-	6	Collaborative learning	84
Workload		84 hours		
Credit points		2 Credits		
Requirements according to the examination regulations		Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on pretest & quiz (20%), work performance (20%), laboratory report (30%), and presentation (30%).		
Recommended prerequisites		Introduction to Radiology Physics, Radiobiology		
Related course		Undergraduate Thesis		
Module objectives/intended learning outcomes		Intended Learning Outcomes: Students get to know some important facilities in hospitals such as radiotherapy, radiology diagnostic, and nuclear medicine facilities. Skill & Knowledge: 1. Learn about components of radiotherapy and radiology diagnostic machine and its auxiliary equipment. 2. Learn about how radiotherapy and radiology diagnostic machine works. 3. Learn how to use radiotherapy and radiology diagnostic machine. 4. Perform quality control on radiotherapy and radiology diagnostic machine. 5. Evaluate various room shielding requirement. 6. Learn about treatment planning system and dose/image quality optimization. 7. Perform dosimetry calculation for radiotherapy and radiology diagnostic machine.		
Content		• Immobilization equipment • Conventional radiotherapy • Simulator machine • LINAC machine • Teletherapy machine (Co-60) • Brachytherapy • Radiography (conventional, fluoroscopy, mammography, dental) • CT machine • MRI machine • USG • Nuclear medicine imaging (SPECT, PET, Gamma)		
Study and examination requirements and forms of examination		Presentation		

Media employed	PowerPoint
Reading list	1. IAEA Training Course Series No 37, Clinical Training of Medical Physicist Specializing in Radiation Oncology, Vienna, 2009. 2. IAEA Training Course Series No 47, Clinical Training of Medical Physicist specializing in Diagnostic Radiology, Vienna, 2009. 3. IAEA Training Course Series No 50, Clinical Training of Medical Physicist specializing in Nuclear Medicine, Vienna, 2009.

Physics Specialization Courses 4th Year

<table>
<tr><td colspan="2">Module name</td><td colspan="4">Angular Momentum Theory</td></tr>
<tr><td colspan="2">Module level, if applicable</td><td colspan="4">4th year</td></tr>
<tr><td colspan="2">Code, if applicable</td><td colspan="4">SCFI602114</td></tr>
<tr><td colspan="2">Semester(s) in which the module is taught</td><td colspan="4">7th semester</td></tr>
<tr><td colspan="2">Person responsible for the module</td><td colspan="4">Prof. Dr. Terry Mart</td></tr>
<tr><td colspan="2">Lecturer</td><td colspan="4">Prof. Dr. Terry Mart</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">Bahasa Indonesia</td></tr>
<tr><td colspan="2">Relation to curriculum</td><td colspan="4">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lecturing, individual assignment, and written exam</td><td rowspan="3">20</td><td rowspan="3">4</td><td rowspan="3">Lectures and discussions</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td colspan="2">Total Workload</td><td colspan="4">168 hours</td></tr>
<tr><td colspan="2">Credit points</td><td colspan="4">4 credits</td></tr>
<tr><td colspan="2">Requirement according to examination regulations</td><td colspan="4">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (30%), the midterm exam (30%), and the final exam (40%)</td></tr>
<tr><td colspan="2">Recommended prerequisites</td><td colspan="4">Quantum Mechanics 2</td></tr>
<tr><td colspan="2">Related Course</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Module objectives/intended learning outcome</td><td colspan="4">Students can derive relations in angular momentum theory and apply them in problem within physics that includes quantum mechanics, nuclear physics, particle physics, and few-body physics.</td></tr>
<tr><td colspan="2">Content</td><td colspan="4">The definition of angular momentum, commutative properties, and eigenvalue commutators, the summation of two angular momenta, the definition of the Clebsch-Gordan coefficient, relations for the Clebsch-Gordan coefficient, calculation of the Clebsch-Gordan coefficient, the 3-j, 6-j, and 9-j symbols, rotation operators and their orthogonal properties, spherical harmonic functions, irreducible tensors, the Wigner-Eckart theorem, Racah coefficients, Maxwell’s equations and multipole fields in spherical coordinate, static interactions and spin-½ interactions, and applications for nuclear systems and alpha particle emission by the nucleus.</td></tr>
<tr><td colspan="2">Study and examination requirements and forms of examination</td><td colspan="4">Individual assignments, midterm exam, and final exam</td></tr>
<tr><td colspan="2">Media employed</td><td colspan="4">Whiteboard</td></tr>
<tr><td colspan="2">Reading list</td><td colspan="4">[1] M. E. Rose, Elementary Theory of Angular Momentum, Dover Books on Physics, reprint edition, 2011.
[2] R. Edmonds, Angular Momentum in Quantum Mechanics, Princeton University Press, Reissue edition,1996.</td></tr>
</table>

Physics Specialization Courses 3rd Year

Module name	**Scattering Theory**				
Module level, if applicable	3rd year				
Code, if applicable	SCFI603412				
Semester(s) in which the module is taught	6th semester				
Person responsible for the module	Dr. Imam Fachruddin				
Lecturer	Dr. Imam Fachruddin				
Language	Bahasa Indonesia				
Relation to curriculum	Elective course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lecturing	20	3	Lectures	Lectures: 3 x 14	42
				Assignments: 3 x 14	42
				Independent study: 3 x 14	42
Total Workload	126 hours				
Credit points	3 credits				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (20%), group assignments (20%), the midterm exam (30%), and the final exam (30%)				
Recommended prerequisites	Quantum Mechanics 1, Introduction to Nuclear Physics				
Related Course	-				
Module objectives/intended learning outcome	Students can apply (C3) quantum mechanics to formulate the scattering process of two particles, both for neither particle having spin and for particles having spin of ½ each, up to the point where the equations for the scattering cross-section and spin magnitudes are derived.				
Content	Scattering kinematics, scattering wave function, scattering amplitude, scattering cross-section, Born approximation, Lipmann-Schwinger equation, propagators, scattering matrix, partial wave analysis, phase shift, density matrix, spin magnitude, the numerical calculation to solve the Lippmann-Schwinger equation for scattering matrix T.				
Study and examination requirements and forms of examination	Individual and group assignments, midterm exam, and final exam				
Media employed	Whiteboard				
Reading list	[1] , R.L., Introductory Quantum Mechanics, 2nd Ed., Addison-Wesley, Reading, Massachusetts (1992). [2] Davydov, A.S., Quantum Mechanics, 2nd Ed., Pergamon Press, Oxford (1965). [3] Glöckle, W., The Quantum Mechanical Few-Body Problem, Springer Verlag, Berlin (1983). [4] Rose, M.E., Elementary Theory of Angular Momentum, Wiley, New York (1957). [5] Okubo, S. dan R.E. Marshak, Ann. Phys. 4, 166 (1958).				

	[6] Malfliet, R.A. dan J.A. Tjon, Nucl. Phys. A127, 161 (1969). [7] Machleidt, R., Adv. Nucl. Phys. 19, 189 (1989). [8] Wiringa, R.B., V.G.J. Stoks, R. Schiavilla, Phys. Rev. C51, 38 (1995).

Physics Specialization Courses 3rd Year

Module name	**Classical Field Theory**				
Module level, if applicable	3rd year				
Code, if applicable	SCFI603414				
Semester(s) in which the module is taught	5th semester				
Person responsible for the module	Handhika Satrio Ramadhan, Ph.D.				
Lecturer	Handhika Satrio Ramadhan, Ph.D.				
Language	Bahasa Indonesia				
Relation to curriculum	Elective course				
Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lecturing	20	4	Lectures and presentation	Lectures: 4 x 14	56
				Assignments: 4 x 14	56
				Independent study: 4 x 14	56
Total Workload	168 hours				
Credit points	4 credits				
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (20%), group assignments (30%), the midterm exam (30%), and the final exam (40%)				
Recommended prerequisites	Classical Mechanics, Electromagnetic Field 1				
Related Course	-				
Module objectives/intended learning outcome	Students can understand classical fundamental fields (electromagnetic, scalar, and gravitational) and able to apply covariant terms (Special Theory of Relativity) and the Lagrangian of continuous systems in their analysis; and use non-Euclidean (curved) geometry mathematical tools to analyze gravitational fields in the framework of the General Theory of Relativity, along with several phenomena related to it (exact solution of the Einstein field equations, black holes, cosmology).				
Content	Special Theory of Relativity; Lagrangian and Hamiltonian formulation for continuous systems; conservation theorem for continuous systems; the energy-momentum tensor; Lagrangian of classical relativistic fields such as scalar fields and electromagnetic fields. The general theory of relativity, consisting of differential geometry; geodesics, and curvature; the Einstein field equations; the exterior Schwarzschild solution; the interior Schwarzschild solution; black holes; gravitational collapse; and several topics on cosmology.				
Study and examination requirements and forms of examination	Individual and group assignments, midterm exam, and final exam				
Media employed	Whiteboard				

Reading list	[1] Lewis H. Ryder, Introduction to General Relativity, Cambridge University Press 2009. [2] Moshe Carmeli, Classical Fields: General Relativity and Gauge Theories, John-Wiley and Sons 1982. [3] Lewis H. Ryder, Quantum Field Theory, Cambridge University Press. [4] Sean M. Carroll, Lecture Notes on General Relativity, http://itp.ucsb.edu/~carroll/notes, ArXiv: gr-qc/9712019. [5] Sean M. Carroll, Spacetime and Geometry: Introduction to General Relativity, Addison Wesley 2004.iversity

Physics Specialization Courses 3rd Year

Module name	**Nuclear and Particle Physics**
Module level, if applicable	3rd year
Code, if applicable	SCFI603415
Semester(s) in which the module is taught	5th semester
Person responsible for the module	Dr. Agus Salam
Lecturer	Dr. Agus Salam
Language	Bahasa Indonesia
Relation to curriculum	Elective course

Types of teaching and learning	Class Size	Attendance time (hours per week per semester)	Forms of active participation	Workload	
Lecturing	20	4	Lectures and presentation	Lectures: 4 x 14	56
				Assignments: 4 x 14	56
				Independent study: 4 x 14	56

Total Workload	168 hours
Credit points	4 credits
Requirement according to examination regulations	Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (20%), group assignments (30%), the midterm exam (30%), and the final exam (40%)
Recommended prerequisites	Quantum Mechanics 1, Introduction to Nuclear Physics
Related Course	-
Module objectives/intended learning outcome	Students will have a greater and wider understanding of nuclear and particle phenomena, both theoretically and experimentally, so that they are prepared to study nuclear and particle physics in greater detail and more quantitatively.
Content	Nuclear phenomena; nuclear models; nuclear radiation; applications of nuclear physics; energy deposition in a medium; particle detection; accelerators; characteristics and interactions of elementary particles; symmetry; discrete transformations; neutral kaons; oscillations; CP violation; formulation of the standard model; the standard model and experimental data; beyond the standard model.
Study and examination requirements and forms of examination	Individual and group assignments, midterm exam, and final exam
Media employed	Whiteboard
Reading list	[1] A. Das and T. Ferbel, Introduction to Nuclear and Particle Physics, 2nd ed., World Scientific, 2003.

Physics Specialization Courses 3rd Year

<table>
<tr><td>Module name</td><td colspan="5">Advanced Computational Physics</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">3rd year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI603416</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">6th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Muhammad Aziz Majidi and Imam Fachruddin</td></tr>
<tr><td>Lecturer</td><td colspan="5">Muhammad Aziz Majidi and Imam Fachruddin</td></tr>
<tr><td>Language</td><td colspan="5">Bahasa Indonesia</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Lecturing</td><td rowspan="3">20</td><td rowspan="3">3</td><td rowspan="3">Lectures</td><td>Lectures: 3 x 14</td><td>42</td></tr>
<tr><td>Assignments: 3 x 14</td><td>42</td></tr>
<tr><td>Independent study: 3 x 14</td><td>42</td></tr>
<tr><td>Total Workload</td><td colspan="5">126 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">3 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (40%), the midterm exam (30%), and the final exam (30%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">Computational Physics</td></tr>
<tr><td>Related Course</td><td colspan="5">Computational Physics</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students can apply numerical methods in calculations to solve problems in Physics and use the Fortran programming language or its equivalent to do calculations using numerical methods.</td></tr>
<tr><td>Content</td><td colspan="5">Finding the roots of functions, solving systems of linear equations, fitting using the least-square method, interpolation, numerical integration, solving ordinary and partial differential equations with boundary conditions, solving eigenvalue problems using the power method, solving secular equations or characteristic polynomial matrices.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Individual assignments, midterm exam, and final exam</td></tr>
<tr><td>Media employed</td><td colspan="5">PowerPoint presentation</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] . L. DeVries, A First Course in Computational Physics (John Wiley & Sons, Inc., New York, 1994)</td></tr>
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Physics Specialization Courses 4th Year

<table>
<tr><td>Module name</td><td colspan="5">Relativistic Quantum Mechanics</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">4th year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI604411</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">7th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Prof. Dr. Terry Mart</td></tr>
<tr><td>Lecturer</td><td colspan="5">Prof. Dr. Terry Mart</td></tr>
<tr><td>Language</td><td colspan="5">Bahasa Indonesia</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lecture, discussion, and presentation</td><td rowspan="3">20</td><td rowspan="3">4</td><td rowspan="3">Lectures, discussions, and presentation</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td>Total Workload</td><td colspan="5">168 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">4 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (20%), group assignments (30%), the mid-term exam (30%), and the final exam (40%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">Quantum Mechanics 2</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students can apply the concepts and formulations in relativistic quantum mechanics for problems in nuclear and particle physics, such as relativistic scattering involving fermions and bosons.</td></tr>
<tr><td>Content</td><td colspan="5">Calculating changes in observable values (such as the expectation value for energy) due to time-dependent and time-independent perturbation; writing down and explaining the relativistic notation; explaining and using the Klein-Gordon equation; and explaining and using the Dirac equation.</td></tr>
<tr><td>Study and examination requirements and forms of examination</td><td colspan="5">Individual and group assignments, midterm exam, and final exam</td></tr>
<tr><td>Media employed</td><td colspan="5">Whiteboard</td></tr>
<tr><td>Reading list</td><td colspan="5">[1] F. Halzen and A. D. Martin, Quarks & Leptons, John Wiley & Sons, 1984.
[2] J. D. Bjorken and S. D. Drell, Relativistic Quantum Mechanics, Mc Graw-Hill, 1964.
[3] I. J. R. Aitchison, Relativistic Quantum Mechanics, Macmillan, 1982.
[4] F. Gross, Relativistic Quantum Mechanics and Field Theory, John Wiley & Sons, 1993.</td></tr>
</table>

Physics Specialization Courses 4th Year

<table>
<tr><td>Module name</td><td colspan="5">Quantum Field Theory</td></tr>
<tr><td>Module level, if applicable</td><td colspan="5">4th year</td></tr>
<tr><td>Code, if applicable</td><td colspan="5">SCFI604413</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td colspan="5">7th semester</td></tr>
<tr><td>Person responsible for the module</td><td colspan="5">Handhika Satrio Ramadhan, Ph.D.</td></tr>
<tr><td>Lecturer</td><td colspan="5">Handhika Satrio Ramadhan, Ph.D.</td></tr>
<tr><td>Language</td><td colspan="5">Bahasa Indonesia</td></tr>
<tr><td>Relation to curriculum</td><td colspan="5">Elective course</td></tr>
<tr><td>Types of teaching and learning</td><td>Class Size</td><td>Attendance time (hours per week per semester)</td><td>Forms of active participation</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="3">Interactive lecture</td><td rowspan="3">20</td><td rowspan="3">4</td><td rowspan="3">Lectures</td><td>Lectures: 4 x 14</td><td>56</td></tr>
<tr><td>Assignments: 4 x 14</td><td>56</td></tr>
<tr><td>Independent study: 4 x 14</td><td>56</td></tr>
<tr><td>Total Workload</td><td colspan="5">168 hours</td></tr>
<tr><td>Credit points</td><td colspan="5">4 credits</td></tr>
<tr><td>Requirement according to examination regulations</td><td colspan="5">Minimum attendance of 75% (according to UI regulation). Final score is evaluated based on individual assignments (20%), group assignments (20%), the midterm exam (30%), and the final exam (30%)</td></tr>
<tr><td>Recommended prerequisites</td><td colspan="5">Classical Mechanics, Electromagnetic Field Theory, Classical Field Theory, Quantum Mechanics 1, Quantum Mechanics 2</td></tr>
<tr><td>Related Course</td><td colspan="5">-</td></tr>
<tr><td>Module objectives/intended learning outcome</td><td colspan="5">Students can understand the quantization of fundamental fields through the second quantization formalism. Students are also able to connect the relationship between the symmetry of a Lagrangian with conserved quantities, specifically, between phase transformation invariance (both global and gauge) and the conservation of Noether's charge. It is also hoped that students understand the concept of invariance towards U(1) (Abelian) transformations which is the foundation of QED (quantum electrodynamics) theory, and non-Abelian transformations which is the foundation of the Standard Model. Students understand the Path Integral formalism as an alternative to quantizing fields, are introduced to the fundamentals of renormalization, and recognize the importance of Spontaneous Symmetry Breaking in the unification of fundamental interactions in nature.</td></tr>
<tr><td>Content</td><td colspan="5">Special Theory of Relativity; Lagrangian and Hamiltonian formulation for continuous systems; conservation theorem for continuous systems, and the energy-momentum tensor; Lagrangian of classic relativistic fields such as scalar and electromagnetic fields; Fermion field Lagrangian; Internal symmetry; Global transformation; Local transformation; Quantum Electrodynamics (QED); non-Abelian group transformation; Renormalization.</td></tr>
</table>

Study and examination requirements and forms of examination	Individual and group assignments, midterm exam, and final exam
Media employed	Whiteboard
Reading list	[1] Lewis H. Ryder, Quantum Field Theory, Cambridge University Press. [2] Michael E. Peskin and Daniel V. Schroeder, Introduction to Quantum Field Theory, Addison-Wesley Publishing.