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DEPARTMENT OF PHYSICS

1. History

Department of Physics, Faculty of Mathematics and Natural Sciences, University of Indonesia (UI), has long history and traditions in education and research field since it was established by the Decree of Ministry of Education and Culture of the Republic of Indonesia (MEC) No. 108.094 / 1960 issued on 21 December 1960. Looking back through these five decades and more, Department of Physics has grown thanks to the encouragement and collaboration of many parties, both from public and private sectors. The acceleration of the development of Department of Physics was triggered by collaboration between National Atomic Energy (BATAN) in 1970s in order to prepare experts for course of radiation protection and nuclear instrumentation. This program has succeeded in graduating more than 200 bachelors of sciences, who have been employed by mostly BATAN and some other public institutions, such as: Indonesian Institute of Sciences (LIPI) and National Institute of Aeronautics and Space (LAPAN). In 1980s, similar collaboration also involved Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) in order to improve qualification standard of their resources to bachelor. Many graduates who participated in those collaborations play active roles in those national institutions. Similar collaboration also involved Forum of Physics Teacher in the Special Capital Region of Jakarta in 2004 and Total Indonesia oil company in 2010. Department of Physics was located at the UI Salemba campus Jakarta. In 1987 the UI new campus was established in Depok, approximately 30 km South from Jakarta. At the same time the center of administration of Department of Physics was moved to the new UI Depok campus, where better facilities were available. Some facilities, either academic or research, were, nevertheless remain kept in the UI Salemba campus in Jakarta. Since then Department of Physics has two sites, one is in UI Depok campus, where its main activities are conducted, and the other is in UI Salemba campus.

In line with the dynamics of job market, in which competitions in private sector are getting intensive, Department of Physics becomes aware of the importance of an up-to-date education orientation that matches demands of the job market, without sacrificing quality and competency aspects of graduates in Physics. While there is demand for Department of Physics to deliver graduates that can fulfill roles in formal sector, such as higher education and research institutions, Department of Physics also needs to focus on demand of human resources on applicative sector, such as energy company, telecommunication sector, electronic industry, healthcare, etc. Because of the reason, Department of Physics developed six groups of knowledge fields (specialization) as follows.

1. Theoretical Nuclear & Particle Physics
2. Materials Physics
3. Condensed Matter Physics
4. Instrumentation Physics
5. Medical Physics & Biophysics
6. Geophysics

Currently, Department of Physics organizes five study programs as can be viewed in its website, http://physics.ui.ac.id. These five study programs are:

1. Undergraduate in Physics,
2. Master in Physics,
3. Master in Materials Science,
4. Doctor in Materials Science.
5. Doctor in Physics.

2. Vision and Mission of Department of Physics

Vision:

To become an excellent center of education and research in the field of Physics and Applied Physics at national and global level towards the best in South-East Asia being competitive and competent to solve problems and challenges.

Mission:

- To keep and strengthen the excellence in education and research in the field Physics and Applied Physics,
- To fix up and update internal management that supports staff and students to increase their national and international scientific activities and productivities in the field of Physics and Applied Physics,

- To actively take part as an embodiment of Physics and Applied Physics contributions to serving the community,
- To set up graduates being able to compete in global market.

3. Organization Structure (2018 -2022)

- Head of Department : Dr. rer.nat. Agus Salam
- Head of Undergraduate Program : Djati Handoko, Ph.D.
- Head of Graduate Program on Physics : M. Aziz Majidi, Ph.D.
- Head of Graduate Program on Materials Science : Dr. Vivi Fauzia

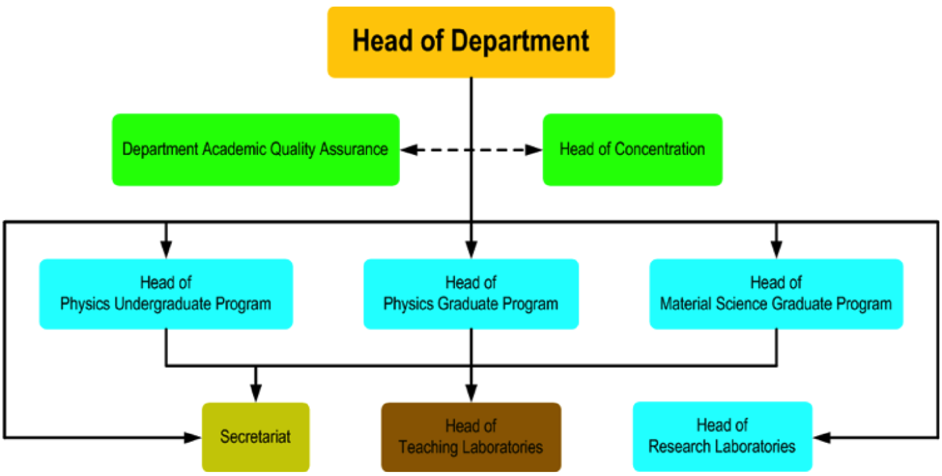


Figure 1. Organization Structure of Department of Physics

4. Facility

Department of Physics has 4 education laboratories, 16 research laboratories, and 4 project rooms with a total area of approximately 1200 m^2. All laboratories are accessible to all students and lecturers. The average laboratory utilization is 40 hours/week. Both the education and research laboratories are supported by laboratory technicians and cleaning services. Each research laboratories organized by our lecturer from each research group.

1. Laboratory of Basic Physics
2. Laboratory of Intermediate Physics

3. Laboratory of Electronics
4. Laboratory of Instrumentation and Control
5. Computer Room
6. Laboratory of Mechanical Preparation
7. Laboratory of Microscopy
8. Laboratory of Chemical Physics
9. Laboratory of Thermal Preparation
10. Laboratory of Magnetic Characterization
11. Laboratory of Functional Materials
12. Laboratory of Materials Preparation 1
13. Laboratory of Medical Physics
14. Laboratory of Spectroscopy
15. Laboratory of Biophysics
16. Laboratory of Materials Preparation 2
17. Mechanical Workshop
18. Laboratory of Exploration Geophysics
19. Laboratory of Modeling and Computing
20. Nuclear & Particles Physics Project Room
21. Instrumentation Physics Project Room
22. Biomedical Instrumentation Project Room
23. Reading Room for Post Graduate Discussion

5. Teaching Staff & Specialities

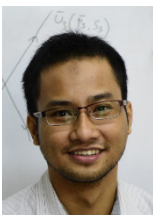
a. Theoretical Particle and Nuclear Physics

This specialization aims to produce graduates who have analytical skills as well as competence in the field of Theoretical Nuclear- and Particle Physics and are capable to analyze and predict natural events in the field. The areas of competence of these graduates are: Nuclear Physics and Particles, Computer Programming, as well as other related fields.

The topics studied in this specialization include the production of electromagnetic kaon, hyperon, and hypernuclear, as well as the interactions of nucleons, mesons, and the hyperons. In addition, several topics such as cosmology, neutron stars, gravity, parity violations, SU symmetry (6), and quark-gluon plasma are also actively studied by the members of this specialization. The facilities include a cluster computer with 32 CPU cores, a theoretical laboratory, and more important is the collaboration with related researchers from developed countries such as America, Japan, Korea, Germany, and England.

The specialization of Nuclear Physics and Theoretical Particles together with the consortium of Theoretical Physics Group of Indonesia (GFTI) participated in trying to promote theoretical physics in Indonesia to the international level.

	**Prof. Dr. Anto Sulaksono (anto.sulaksono@sci.ui.ac.id)** Theoretical studies on compact objects and nuclear structure using modified matter models and modified gravity theories C. Wibisono and A. Sulaksono, *Information-entropic method for studying the stability bound of nonrelativistic polytropic stars within modified gravity theories*, International Journal of Modern Physics D (2018, in press). I. Prasetyo, I. Husin, A.I. Qauli, H.S. Ramadhan and A. Sulaksono, *Neutron stars in the braneworld within the Eddington-inspired Born-Infeld gravity*, Journal of Cosmology and Astroparticle Physics **01**, 027 (2018).
	**Prof. Dr. Terry Mart (terry.mart@sci.ui.ac.id)** Theoretical hadronic physics, strangeness production and production of hypernuclear states. • Kaon photoproduction • Kaon electroproduction • Electromagnetic form factors of hadrons • Photoproduction and electroproduction of hypernucleus, for instance hypertriton. • heoretical formulation of spin-3/2 propagator and interactions.

<table>
<tr><td></td><td>T. Mart and A. Rusli, Predicting K^0 photoproduction observables by using the multipole approach, Progress of Theoretical and Experimental Physics 2017, 123D04 (2017).
S. Clymton and T. Mart, Isobar model for kaon photoproduction with spin-7/2 and -9/2 nucleon resonances, Physical Review D 96, 054004 (2017).</td></tr>
<tr><td></td><td>Dr. Agus Salam (agus.salam@sci.ui.ac.id)
• Meson photo- and electroproduction
• Meson-baryon interaction and scattering
• Stopping power of matter
.c
A. Salam and I. Fachruddin, KN scattering in 3D formulation, Few-Body Systems 54, 1625-1628 (2013).
I. Fachruddin and A. Salam, Scattering of a spin-1/2 particle off a spin-0 target in a simple three-dimensional basis, Few-Body Systems 54, 221-224 (2013).
A. Salam, T. Mart and K. Miyagawa, Role of the K1 meson in K0 photoproduction off the deuteron, Few-Body Systems 54, 261-264 (2013).</td></tr>
<tr><td></td><td>Dr. Handhika Satrio Ramadhan (hramad@ui.ac.id)
Theoretical study of non-perturbative phenomena in high energy physics (cosmology, particle physics, and nuclear astrophysics). Research topics include:
• topological defects (domain walls, cosmic strings, monopoles, textures)
• instanton and vacuum decay
• classical and semi-classical aspects of black holes in General Relativity and other modified gravity theories
• neutron stars in modified gravity

R. D. Lambaga and H. S. Ramadhan, Gravitational field of global</td></tr>
</table>

	monopole within the Eddington-inspired Born-Infeld theory of gravity, The European Physical Journal C **78**, 436 (2018). H. S. Ramadhan, I. Prasetyo, and A. M. Kusuma, *Higher-dimensional black holes with Dirac-Born-Infeld (DBI) global defects*, General Relativity and Gravitation **50**, 96 (2018).
	**Dr. Imam Fachruddin (imam.fachruddin@sci.ui.ac.id)** Theoretical study and investigation on systems of and processes involving few hadrons to better understand the interactions between hadrons. Current topics are on: • Systems of two spin-half particles, like nucleon-nucleon (NN) scattering, • Three nucleon (3N) scattering, • System of spin-zero and spin-half particles, like kaon-nucleon (KN) scattering. A. Salam and I. Fachruddin, *KN scattering in 3D formulation,* Few-Body Systems **54**, 1625-1628 (2013). I. Fachruddin, *Scattering of two spin-half particles in a three-dimensional approach,* Few-Body Systems **54**, 1621-1624 (2013). F. Maulida and I. Fachruddin, *Scattering of two spinless particles in 3D formulation with coulomb admixtures,* Few-Body Systems **54**, 217-219 (2013).

b. Materials Physics

The Materials Physics focuses on understanding and manipulating the physical properties of materials to discover new features and develop new devices. It includes the mechanical, thermal, electronic, optical, and magnetic properties in bulk and nano-scale materials, quantum phenomena in materials, and soft condensed matter physics. New experimental and computational tools how s systems are modeled and studied are constantly developed. This specialization covers the whole spectrum of materials, ranging from a basic concept of the relationship among physical properties, microstructure, and strategies to control materials at nanometer and atomic scales for novel functional devices.

	**Prof. Dr. A. Harsono Soepardjo (harsono.msc@ui.ac.id)** • Copper indium diselenide solar cells • Marine renewable energy A.H. Soepardjo, *Ingot Fabrication of Base Material for Solar Cell $CuInSe_2$*, Journal of Applied Sciences 9, 593-596 (2009). A.H. Soepardjo, *$CuInSe_2$ thin film for solar cell by flash evaporation*, MAKARA of Science Series 13, 2 (2009).
	**Dr. Anawati (anawati@sci.ui.ac.id)** • Corrosion mechanism on light metals and coatings • Improving adhesion and properties of anodizing layer • Controlling degradation rate of biodegradable Mg alloys Anawati, H. Asoh, S. Ono, *Effects of Alloying Element Ca on the Corrosion Behaviour and Bioactivity of Anodic Films Formed on AM60 Mg Alloys,* Materials **10**(1), 11 (2017). Anawati, H. Asoh, S. Ono, *Role of Ca in Modifying Corrosion Resistance and Bioactivity of Plasma Anodized AM60 Magnesium alloys*, Corrosion Science and Technology, **15** (3), 126-130 (2016).
	**Dr. Ariadne Lakshmidevi (ariadne.laksmidevi@ui.ac.id)** Polymer-based composites and nanocomposites A. L. Juwono, R. Sihombing, Y. K. Krisnandi, Sutarno, H. Subawi, N. Chitraningrum, *The Application of Tapanuli Clay as Nanofiller in Nanocomposites: Synthesis and Their Characterization*, International Journal of Modern Physics B **24**, 148 -156 (2010). A. Juwono, G. Edward, *Mechanism of Fatigue Failure of Clay Epoxy Nanocomposites*, Journal of Nanoscience and Nanotechnology **12**,

	3943-3946 (2006).
	**Dr. Azwar Manaf (azwar@ui.ac.id)** • Exploration of characteristics of dielectric properties and magnetocaloric effect (MCE) in oxide and metal-based magnetic and dielectric Materials • Exploration of PANi conductive polymers as a matrix of electromagnetic wave absorbing material B. Kurniawan, S. Winarsih, A. Imaduddin, A. Manaf, *Correlation between microstructure and electrical transport properties of* $La_{0.7}(Ba_{1-x}Ca_x)_{0.3}MnO_3$ *(x = 0 and 0.03) synthesized by sol-gel*, Physica B: Condensed Matter **532** 161-165 (2018). S. Budi, B. Kurniawan, D. M. Mott, S. Maenosono, A. A. Umar, A. Manaf, *Comparative trial of saccharin-added electrolyte for improving the structure of an electrodeposited magnetic FeCoNi thin film*, Thin Solid Films **642**, 51-57 (2017).
	**Dr. Bambang Soegijono (bambangsg11@yahoo.com)** • Polyferroic materials D. Nanto, B. Kurniawan, B. Soegijono, N. Ghosh, J.-S. Hwang, and S.-C. Yu, *Critical exponent analysis of lightly germanium-doped* $La_{0.7}Ca_{0.3}Mn_{1-x}Ge_xO_3$ *(x = 0.05 and x = 0.07)*, AIP Advances **8**, 047204 (2018). D. Nanto, H. Akbar, B. Soegijono, B. Kurniawan, N. Ghosh, J.-S. Hwang, S.-C. Yu, *Temperature span of magnetocaloric effect in Nb-doped* $La_{0.7}Ca_{0.3}Mn_{1-x}Nb_xO_3$ *(x=0, 0.002 and 0.01)*, Physica B: Condensed Matter **526**, 160-165 (2017).
	**Dr. Dede Djuhana (dede.djuhana@sci.ui.ac.id)** • Micromagnetic modeling to observe domain and domain wall structure in ferromagnetic materials • Plasmonic modeling to observe the plasmonic spectrum with respect to size, shape, and dielectric function, and polarization.

	H.-G. Piao, D. Djuhana, J.-H. Shim, S.-H. Lee, S.-C. Yu, S. K. Oh, S.-M. Ahn, S.-B. Choe, & D.-H. Kim, *Translational Positioning of Magnetic Domain Wall in Ferromagnetic Nanowires Using Stray Field Filter*, J. Nanosci. Nanotech, **11**, 6122-6125 (2011) . D. Djuhana, *et al.*, *Interaction of antiparallel transverse domain walls in ferromagnetic nanowires*, J. Nanosci. Nanotech, **11**, 6237-6240 (2011) .
	**Dr. Budhy Kurniawan (bkuru@fisika.ui.ac.id)** • LMO-base materials as colossal magnetoresistance, magnetocaloric effect, microwave absorbers and thermoelectric materials. • Phenomenon of muon spin resonance for identifying of magnetic properties of LSCO and MgB_2-based superconductors • Dynamics of electron spin interaction on superconductor, magnetic and multiferroic materials. B. Kurniawan, S. Winarsih, A. Imaduddin, A. Manaf, *Correlation between microstructure and electrical transport properties of $La_{0.7}(Ba_{1-x}Ca_x)_{0.3}MnO_3$ (x = 0 and 0.03) synthesized by sol-gel*, Physica B: Condensed Matter **532** 161-165 (2018). D. Nanto, B. Kurniawan, B. Soegijono, N. Ghosh, J.-S. Hwang, and S.-C. Yu, *Critical exponent analysis of lightly germanium-doped $La_{0.7}Ca_{0.3}Mn_{1-x}Ge_xO_3$* (x = 0.05 and x = 0.07), AIP Advances **8**, 047204 (2018).
	**Dr. Nurlely (nurlely.ayat@ui.ac.id)** • Synthesis composite of calcium phosphate - Collagen with microwave irradiation methode as bonegraft materials and dental restoration • Biosensors A Rachim, AP Sari, Nurlely, V Fauzia, *Fabrication and optimisation of optical biosensor using alcohol oxidase enzyme to evaluate detection of formaldehyde*, AIP Conference Proceedings 1862 (1), 030047

	AA Ruddyard, DS Soejoko, Nurlely, *Effect of the quantity of carbonate components and sintering parameters on the quality of hydrothermally synthesized carbonate hydroxyapatite*, AIP Conference Proceedings 1862 (1), 030070
	**Dr. Vivi Fauzia (vivi@sci.ui.ac.id)** • Nanocomposite of metal oxide and noble metal nanostructure for photocatalysts, sensors and optoelectronic device applications • Organic semiconductor-based optoelectronic devices N. A. Putri, V. Fauzia, S. Iwan, L. Roza, A. A. Umar, S. Budi, *Mn-doping-induced photocatalytic activity enhancement of ZnO nanorods prepared on glass substrates*, Applied Surface Science **439**, 285–297 (2018). V. Fauzia, Nurlely, C. Imawan, N.M.M.S. Narayani, A.E. Putri, *A localized surface plasmon resonance enhanced dye-based biosensor for formaldehyde detection*, Sensors and Actuators B: Chemical **257**, 1128-1133 (2018).
	**Isom Mudzakir, M. Si. (isom.mudzakir@ui.ac.id)** • Multiferroic materials M. Hikam, B. Soegijono, Y. Iriani, I. Mudzakir, D. Fasquelle, *Study of barium strontium titanate thin film doped by indium*, AIP Conference Proceedings **1169**, 155-160 (2009).

c. **Condensed Matter Physics**

Condensed Matter Physics is a field of physics that deals with the exploration and manipulation of phenomena and physical properties of matter, in solid or liquid form, based on the principles of quantum mechanics and statistical physics. This specialization aims to produce competent physicists in modeling and theoretical calculations and/or synthesis, characterization, and analysis of electrical, magnetic, and optical properties of crystalline, amorphous, or liquid systems. These competencies are shaped through learning experiences in advanced courses such as Quantum Mechanics, Electromagnetic Field, Statistical Physics, Solid Physics, and Spectroscopy, as well as experimental or experimental theoretical / experimental practical experience in the workings of Advanced Laboratory topics and project final assignments.

<table>
<tr>
<td></td>
<td>Prof. Dr. Rosari Saleh (rosarisaleh90@gmail.com)
• Magnetic plasmonic photocatalyst as a technology for textile dye waste treatment, biomass conversion and anti bacteria
• Study of the effect of addition Au and Ag materials on structural, optical, thermal, electrical and magnetic properties of semiconductor-graphene materials

A. Taufik, R. Saleh, Organic dyes removal using magnetic Fe3O4–nanographene platelets composite materials, Physica B: Condensed Matter 526, 166-171 (2017).
A. Taufik, A. Albert, R. Saleh, Sol-gel synthesis of ternary CuO/TiO2/ZnO nanocomposites for enhanced photocatalytic performance under UV and visible light irradiation, Journal of Photochemistry and Photobiology A: Chemistry 344, 149-162 (2017).
A. Taufik, R. Saleh, Synthesis of iron(II,III) oxide/zinc oxide/copper(II) oxide (Fe3O4/ZnO/CuO) nanocomposites and their photosonocatalytic property for organic dye removal, Journal of Colloid and Interface Science 491, 27-36 (2017).</td>
</tr>
<tr>
<td></td>
<td>Dr. Dedi Suyanto
S. Jha, M. I. Youssif, D. Suyanto, G. M. Julian, R. A. Dunlap, S.-W. Cheong, ^{57}Fe emission Mossbauer spectroscopy study of single crystal La_2CuO_{4-y}, Journal of Physics: Condensed Matter 3, 3807-3812 (1991).
S. Jha, D. Suyanto, R. Hogg, G. M. Julian, R. A. Dunlap, S.-W. Cheong, Z. Fisk, J. D. Thompson, Mössbauer study of magnetic ordering in ^{57}Co-doped Eu_2CuO_4 and Gd_2CuO_4, Hyperfine Interactions 61, 1143-1146 (1990).</td>
</tr>
</table>

Dr. Djoko Triyono (djoko.triyono@sci.ui.ac.id)

- Modification Orthoferrite-based perovskite material for energy and environment application
- Electrical, optical and thermal properties of perovskite material, La(Fe,Ti)O3, (La,Bi) FeO_3 and La(Fe,Mn)O_3, La(Fe,Mo)O_3

R. Sato Turtelli, D. Triyono, R. Grössinger, H. Sassik, J. Fidler, T. Matthias, G. Badurek, C. Dewhurst, W. Steiner, G. Wiesinger, *The microstructure of Nd-Fe, Co-Al,* Materials Science and Engineering: A **375-377,** 1129-1132 (2004).

R. Sato Turtelli, J.P. Sinnecker, W. Steiner, G. Wiesinger, R. Grössinger, D. Triyono, *Non-equilibrium magnetic properties of melt-spun Nd60Fe30Al10 alloys,* Physica B: Condensed Matter **327**, 198-201 (2003).

Dr. Efta Yudiarsah (e.yudiarsah@sci.ui.ac.id)

- Theoretical study of the molecular transport of DNA under the electric and magnetic fields

D. K. Suhendro, E. Yudiarsah, R. Saleh, *Effect of phonons and backbone disorder on electronic transport in DNA*, Physica B 405, 4806-11 (2010).

H. Castellini, E. Yudiarsah, L. Romanelli, and H. A. Cerdeira, *Coupled Chaotic Oscillators and their relation to Artificial Quadrupeds Central Pattern Generator*, Pramana: Journal of Physics 64, 525-534, 2005.

Dr. Herbert P. Simanjuntak (herbert@ui.ac.id)

H. P. Simanjuntak, *Transitions of the magnetization in the presence of a polarized current*, Journal of Magnetism and Magnetic Materials **468**, 185 (2018).

H. P. Simanjuntak, P. Pereyra, *On the generalized Hartman effect presumption in semiconductors and photonic structures*, Nanoscale Research Letters **8**, 145 (2013).

P. Pereyra and H.P. Simanjuntak, *Time evolution of electromagnetic wave*

	packets through superlattices: Evidence for superluminal velocities, Physical Review E **75**, 056604 (2007).
	**Dr. Muhammad Aziz Majidi (aziz.majidi@sci.ui.ac.id)** Theoretical modeling and computation to investigate transport, magnetic, optical, and other properties, as well as ordering phenomena in strongly-correlated systems, including transition-metal oxides, two-dimensional materials, Heusler alloys and Van der Waals heterostructures, etc. A. D. Fauzi, M. A. Majidi, and A. Rusydi, *Mechanisms of Spin-Flipping and Metal-Insulator Transition in Nano-Fe_3O_4*, Journal of Physics: Condensed Matter, **29**, 13 (2017). T. C. Asmara, Y. Zhao, M. A. Majidi, C.T. Nelson, M. C. Scott, Y. Cai, D-Y. Wan, D. Schmidt, M. Yang, P. E. Trevisanutto, M. R. Motapothula, M. B. H. Breese, M. Sherburne, M. Asta, A. Minor, T. Venkatesan, A. Rusydi, New Tunable and Low-Loss Correlated Plasmons in Mott-Like Insulating Oxides, Nature Communication.

d. Instrumentation Physics

This specialization aims to produce graduates who are competent in analyzing, duplicating, modifying, developing, designing, innovating and creating prototypes of scientific and industrial electronic instrumentation instruments. The competence areas of the graduates are: Sensors and Applications, Measurements and Interfacing, Microcontrollers, Microprocessors, Computers (Hardware and Programming), Non Destructive Testing, Metrology, Analog and Digital Signal Processing, Instrumentation Measurement of Physics, as well as special expertise in areas of interest (Instrumentation of Information and Communication Technology, Measurement Instrumentation, and Control Instrumentation).

	**Dr. Sastra Kusuma Wijaya (skwijaya@sci.ui.ac.id)** • Development of Biomedical Data Acquisition System by Utilizing Feature Extraction and Machine Learning S.K. Wijaya, H. Oka, K. Saratani, T. Sumikawa, T. Kawazoe, *Development of implant movement checker for determining dental implant stability*, Medical Engineering and Physics **26**, 513-522 (2004) S.K. Wijaya, T. Sumikawa, K. Saratani, T. Kawazoe, H. Oka, *Development of dental implant movement (IM) checker for dental implant mobility assessment*, Technology and Health Care **12**, 11-23 (2004). K. Saratani, H.Oka, S.K.Wijaya, T.Fujii, N.Ueda and T. Kawazoe, *Development and Clinical Trials of a Dental Implant Movement Checker,* Journal of Dental Research **81**, 473 (2002).
	Dr. Martarizal Martarizal, R. I. Wijaya, D. B. Artaputra, *Design & Implementation of KWH-meter's Measurement Data Transmission to Processing-Server through SMS-media*, Asian Physics Symposium, Asian Physics Symposium 2005.
	**Dr. Prawito Prajitno (prawito@sci.ui.ac.id)** • Development of multimodal tomography systems based on magnetic-induction, magneto/photo-acoustic, and microwave for non-invasive/non-destructive material evaluations. Toresano, L. O. H. Z.; Wijaya, S. K.; Prawito, Sudarmaji, A.; Badri, C., *Data acquisition system of 16-channel EEG based on ATSAM3X8E ARM Cortex-M3 32-bit microcontroller and ADS1299,* AIP Conference Proceedings, 1862, 1 (2017) H A Adhi, S K Wijaya, Prawito, C Badri and M Rezal, *Automatic detection of ischemic stroke based on scaling exponent electroencephalogram using extreme learning machine*, Journal of Physics: Conference Series, 820, (2017)

	**Dr. Adhi Harmoko S. (adhi@sci.ui.ac.id)** • Image-based measurement principles and instrumentation • Computational imaging in bio-imaging and biomedical imaging M.A. Zulkifley, A. Nazari, S. Khadijah, A.H. Saputro, *On application of gaussian kernel to retinal blood tracing*, Journal of Theoretical and Applied Information Technology, **77**(1), 19-24 (2015). A.H. Saputro, *et al.*, *Global feature for left ventricular dysfunction detection based on shape deformation tracking*, Biomedical Engineering – Applications, Basis and Communications **27**(2),1550017 (2015).
	**Dr. Santoso Soekirno (santoso.s@sci.ui.ac.id)** Instrumentation System base on oscillator and sensor
	**Dr. Arief Sudarmadji (arief8500@gmail.com)** • Magneto-optic, Electro-optic, Ferroelectric, and Multiferroic Material Instrumentation Characterization • Biomedical Instrumentation L Soedarmawan, A Hifzhi, S Pambudi, M Aman, A Sudarmaji, D Handoko, *An enhanced laser beam deflection measurement system for refractive index gradient and diffusivity*, International Seminar on Sensors, Instrumentation, Measurement and Metrology (ISSIMM), 69-72 (2017) L Toresano, SK Wijaya, Prawito, A Sudarmaji, C Badri, *Data acquisition system of 16-channel EEG based on ATSAM3X8E ARM Cortex-M3 32-bit microcontroller and ADS1299*, AIP Conference Proceedings 1862 (1), 030149

Dr. Djati Handoko (djati.handoko@ui.ac.id)

- Magneto-optics material; instrumentation and characterization
- Dynamics properties of nano-particles and fluid characterization

D.-T. Quach, D.-T. Phamb, D. Handoko, J.-H. Shim, D. E. Kim, K.-M. Lee, J.-R. Jeong, N. Kim, H.-J. Shin, D.-H. Kim, *Nanometer-scale local probing of X-ray absorption spectra of Co/Pt multilayer film*, Physica B: Condensed Matter **532**, 221-224 (2018)

D. Handoko, D.-T. Quach, S.-H. Lee, K. M. Lee, J.-R. Jeong, D. S. Yang, and D.-H. Kim, *Dynamic Scaling Behavior of Nucleation and Saturation Field During Magnetization Reversal of Co/Pt Multilayers*, IEEE Transactions on Magnetics 52, 6100105 (2016).

Dr. Cuk Imawan (imawan@fisika.ui.ac.id)

- Colorimetric sensors for sensing physical and chemical quantities. Application in smart packaging, radiochromic and chemo-responsive sensors
- Nanoparticles synthesis as a functional material for environmental and medical applications

B Amalia, C Imawan, A Listyarini, *Effect of nanofibril cellulose isolated from pineapple leaf on the mechanical properties of chitosan film,* AIP Conference Proceedings 2023 (1), 020034 (2018)

S Syarifah, C Imawan, W Handayani, D Djuhana, *Biosynthesis of ferric oxide nanoparticles using Pometia pinnata J.R.Frost. & G.Forst. leaves water extract*, AIP Conference Proceedings 2023 (1), 020054

Arief S Fitrianto, M. Si.

Instrumentation of Information and Communication Technology

	Surya Darma, M. Sc. • Image Processing for Drone Application • Control System of Drone • Artificial Intelligence in Drone Application Ruliputra, R. N.; Darma, S, *Control system of hexacopter using color histogram footprint and convolutional neural network,* AIP Conference Proceedings, 1862, 1,(2017) S. Darma, J.L. Buessler, G. Hermann, J.P. Urban, B. Kusumoputro, *Visual servoing quadrotor control in autonomous target search, Proceedings* – 2013 IEEE 3rd International Conference on System Engineering and Technology, ICSET 2013, **6650192**, 319-324 (2013).

e. Biophysics and Medical Physics

According to the International Organization for Medical Physics (IOMP), Medical Physics is a branch of Applied Physics, pursued by medical physicists, that uses physics principles, methods and techniques in practice and research for the prevention, diagnosis and treatment of human diseases with a specific goal of improving human health and well-being. Medical physics may further be classified into a number of sub-fields (specialties), including Radiation Oncology Physics, Medical Imaging Physics, Nuclear Medicine Physics, Medical Health Physics (Radiation Protection in Medicine), Non-ionizing Medical Radiation Physics, and Physiological Measurement. It is also closely linked to neighboring sciences such as Biophysics, Biological Physics, and Health Physics. In our division, our focuses within the field are Radiation Oncology Physics, Medical Imaging Physics, and Nuclear Medicine Physics.

The Biophysical Society refers to Biophysics as the field that applies the theories and methods of physics to understand how biological systems work. Biophysics has been critical to understanding the mechanics of how the molecules of life are made, how different parts of a cell move and function, and how complex systems in our bodies—the brain, circulation, immune system, and others— work. Biophysics is a vibrant scientific field where scientists from many fields including math, chemistry, physics, engineering, pharmacology, and materials sciences, use their skills to explore and develop new tools for understanding how biology—all life—works. Staff members in our division concentrates within the subfields of Biomaterial, Biosensors, and Bioenergy.

	**Dr.Musaddiq Musbach (musaddiq.musbach@ui.ac.id)** M. Musbach, *Sensitivity of the Absorbance and Capacitance Methods in Measurement the Number of Cells In-vivo*, Journal of Biophysics and Medical Physics **2**, 1 (2015).
	**Dr. Supriyanto Ardjo Pawiro (supriyanto.p@sci.ui.ac.id)** The development and implementation radiation dosimetry in Radiotherapy. The research areas are the impact of interplay effect in dosimetry of photon and neutron during radiotherapy treatment, the asessment of multileaf collimator (MLC) accuracy of linear accelerator, and the challenge implementation on small field dosimetry. MRA Gani, DS Soejoko, SA Pawiro, *Body Size and Organ Volume of Indonesian Patients Generated from CT Images: Preliminary Study,* Journal of Physics: Conference Series 1097 (1), 012010 (2018) LAN Fatimah, N Nasution, WE Wibowo, SA Pawiro, *Point dose measurement on center and peripheral target for stereotactic treatment using Helical Tomotherapy Hi-Art,* Journal of Medical Physics and Biophysics 5 (1), 180-183 (2018)
	**Dr. Dwi Seno K.Sihono, M. Si.** • 4-dimensional ultrasound for real-tine image-guided radiation therapy • Radiotherapy dosimetry and quality assurance • Organ motion in radiotherapy DSK Sihono, M Ehmann, S Heitmann, SV Swietochowski, M Grimm, J Boda-Heggemann, F Lohr, F Wenz, H Wertz, *Determination of*

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	**Lukmanda Evan Lubis (lukmanda.evan@sci.ui.ac.id)** • Radiation dosimetry, image quality evaluation, and optimization on adult and pediatric interventional radiology/cardiology • Development of tools and phantoms for quantifying technical quality of diagnostic and interventional radiology systems L. E. Lubis, L. A. Craig, H. Bosmans, D. S. Soejoko, *Task-based phantom evaluation of cardiac catheterization imaging modes*, Physica Medica **46**, 114–123 (2018). L. E. Lubis and M.K. Badawy, *Measuring radiation dose to patients undergoing fluoroscopically-guided interventions*, J. Phys. Conf. Ser. **694**(1), 012049 (2016). S. Mubarok, L.E. Lubis, and S.A. Pawiro, *Parameter-based estimation of CT dose index and image quality using an in-house androidTM-based software*, J. Phys. Conf. Ser. **694**(1), 012037 (2016).
	**Kristina Tri Wigati, M. Si. (ch_wigati@yahoo.com)** • Quality assurance and evaluation methods in diagnostic radiology, particularly mammography • Model observer for mammography clinical image quality evaluation and optimization K.T. Wigati, L. Cockmartin, N. Marshall, D.S. Soejoko, and H. Bosmans, *Towards a Phantom for Multimodality Performance Evaluation of Breast*

	Imaging: A 3D Structured Phantom with Simulated Lesions Tested for 2D Digital Mammography, Lecture Notes in Computer Science **9699**, 243-253 (2016).

f. Geophysics

The only department at the University of Indonesia that is conducting research and education in the subsurface earth science is the Department of Physics. Geophysics is the study of the earth based on the Physics principles, including mechanics, waves, electromagnetic, and heat. This specialization aims to produce competent graduates in Geophysical Exploration (Data Acquisition, Processing, Data Analysis and Interconnection), which is based on strengthening of the aspects of Basic Concepts of Geosciences, Numerical Computing and Direct Applications in the field in Oil and Gas Exploration, Geothermal, Coal and Minerals. Research in this field is carried out by utilizing physical parameters such as rock resistivity, mechanical wave propagation, and dielectric constant of rocks. It includes studying and mapping the condition of subsurface rocks, from the surface to the center of the earth, for oil and gas exploration, geothermal, mineral as well as exploration of environmental issues.

	Dr. rer.nat. Abdul Haris • Analysis of the Effect of Conductive Minerals (Magnetites, Hematites and Glauconites) in the Case of Low Resistivity Pay Zone Reserves Using the Pseudo Core Data Approach • Analysis of Geomechanical Parameters and Reservoir Facies for Oil and Gas Exploration in Frontier Areas <u>A Haris</u>, SP Silaban, A Riyanto, R Syahputra, S Mardiyati, Adriansyah, *Time Reverse Modeling of hydrocarbon detection for passive seismic source localization : a case study of synthetics and real data from the south Sumatra basin, Indonesia*, International Journal of GEOMATE 13 (Issue 39), pp.185-190, 2017 A Haris, TW Sari, L Lisapaly, N Isniarny, A Riyanto, Sujito, *Delineating*

	stratigraphic trap reservoir using RGB color blending of spectral decomposition method: Case study in the West Natuna Basin, AIP Conference Proceedings 1862 (1), 030182, 2017
	Dr. Eng. Supriyanto S (supriyanto@sci.ui.ac.id) • Anisotropy Approach of Seismic Data for Prediction of Lithology and Hydrocarbons Potential Under Soil Surface • Petrological and stratigraphic studies of geothermal characteristics of Mount Endut AA Kaswandi, I Mahmuddin, S Suparno, *Reflector Analysis between Melange Rock with Scaley Clay (Karang Sambung Formation) by Using Ground Penetrating Radar (GPR) Survey at Jatibungkus*, Central Java, Indonesia, GEO 2012 S. Suparno, Y. Daud, S. Rosid, D. Djuhana, Y. Sofyan, *New Interpretation of DC Resistivity Data in the Sibayak Geothermal Field, Indonesia*, Proceedings of the World Geothermal Congress, 2010.
	Dr. Syamsu Rosid, MT. (syamsu.rosid@gmail.com) • Identification the parameters and characteristics of anisotropic layers through seismic and gravity data. H. A. Nugroho, M. S. Rosid, and A. Guntoro, *Identification of coal bed methane layer in Riau area based on inversion study of acoustic impedance, spectral decomposition and seismic attribute*, AIP Conference Proceedings 2023, 020247 (2018). C. Darmawan, M. S. Rosid, and R. Rulliyansyah, *Characterization of carbonate reservoir by using nuclear magnetic resonance (NMR) logging analysis at hydrocarbon field C South Sumatera*, AIP Conference Proceedings 2023, 020261 (2018)

	Dr. Eng. Yunus Daud (ydaud@sci.ui.ac.id) • Investigation of Demagnetization Zones Associated with High Temperature Reservoirs in the Blawan-Ijen Geothermal Prospect Area Using 3-Dimensional Geomagnetic Data Inversion Y. W. Pratama, W. W. Purwanto, T. Tezuka, B. C. McLellan, D. Hartono, A. Hidayatno, Y. Daud, *Multi-objective optimization of a multiregional electricity system in an archipelagic state: The role of renewable energy in energy system sustainability*, Renewable and Sustainable Energy Reviews 77, 423-439 (2017). Nasruddin, M.I. Alhamid, Y. Daud, A. Surachman, A. Sugiyono, H.B.Aditya, T.M.I. Mahli, *Potential of geothermal energy for electricity generation in Indonesia: A review*, Renewable and Sustainable Energy Reviews 53, 733-740 **(2016)**

UNDERGRADUATE IN PHYSICS

Graduate profile

Undergraduate Program in Physics of UI aims to shape graduates with strong physics background and special skill in one of special field, who are needed either directly to pave career in goods and services industry, or to pursue higher degree in physics or other related field. These specialities, despite having different focus, share the same fundamental standard of curriculum. For undergraduate degree, the curriculum refers to national curriculum of bachelor of physics, which has been established by Directorate General of Higher Education in 1995. Because of the reason, qualifications of the graduates of Department of Physics are not differentiated by their specializations, except the deep knowledge of certain field based on each specialization. Every graduate will acquire same degree, Sarjana Sains (S.Si. equal to B. Sc.) of Physics.

Expected Learning Outcome (ELO)

1. To formulate general physics problems and solutions.
2. To apply basic concepts of physics in solving general physics problems.
3. To apply concepts of one of the following field of physics and applied physics:
    a. Theoretical Nuclear & Particle Physics
    b. Materials Physics
    c. Condensed Matter Physics
    d. InstrumentationPhysics
    e. Medical Physics & Biophysics
4. To disseminate results of scientific works.
5. To build insight of current development of science and technology related to physics.
6. To apply the knowledge of physics in the community and in everyday life.
7. To learn and to adapt to new things.
8. To have attitude and skill supporting success in work as well as in taking part in the community activities.

Table. 1 Curriculum structure

Courses Groups	Curriculum 2016	
	Credit	Percentage
University Compulsory Courses (UCC)	18	12.50
Science and Technology Cluster Compulsory Courses (STCCC)	2	1.39
Faculty Compulsory Courses (FCC)	8	5.55
Physics Compulsory Courses (PCC)	90	62.50
Concentration Courses (CC)	26	18.06
Total Study Load	144	100.00

Table 2. Generic and specific ELOs

No	Courses Groups	ELOs							
		1	2	3	4	5	6	7	8
1	UCC	X				X	X	X	X
2	STCCC	X	X				X		
3	FCC	X	X			X	X	X	
4	PCC	X	X		X	X	X	X	X
5	CC			X		X	X	X	

In Table 3 we show the contribution made by each course, from year 1 to year 4 of study, to achieve ELOs. The year and semester are put in the first column. There are 2 semesters in each year. For example, 1(2) means the second semester of the first year. The second, third, and fourth columns show respectively the course's code, name, and credit. The last 8 columns show the ELOs correlated with the courses.

Tabel 3 Courses per semester and their correlation with ELOs

Year (Term)	Code	Course	Credit	ELOs							
				1	2	3	4	5	6	7	8

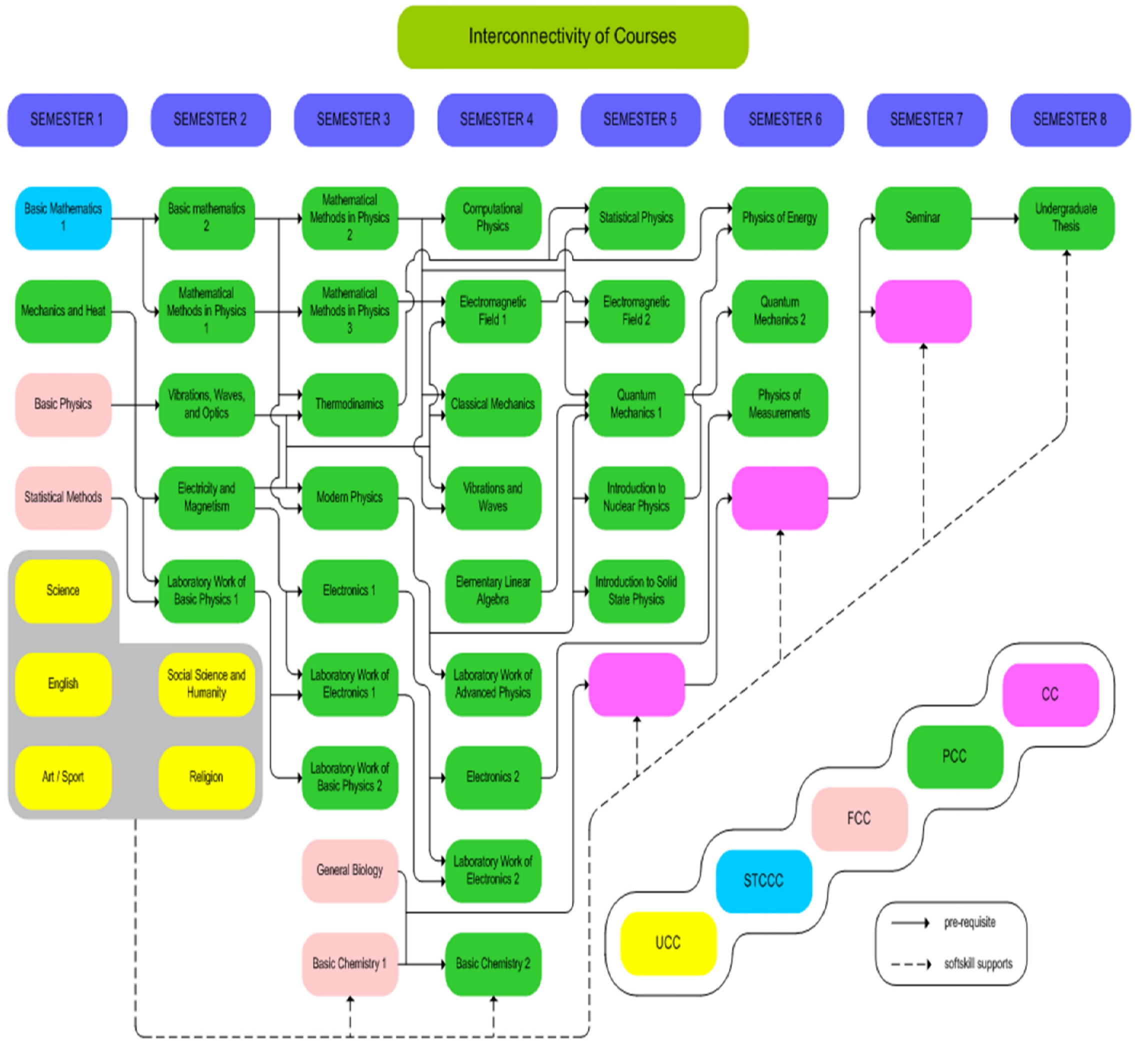
1 (1)	UCC										
	UIGE600002	Science	6	X				X	X	X	X
	UIGE600003	English	3							X	X
	UIGE60xxxx	Art / Sport	1								X
	STCCC										
	UIST601110	Basic Mathematics 1	2	X	X				X		
	FCC										
	SCMA601200	Statistical Methods	2					X	X	X	
	SCFI601110	Basic Physics	2	X	X			X	X	X	
	PCC										
	SCFI601114	Mechanics and Heat	4	X	X			X	X	X	
1(2)	UCC										
	UIGE600001	Social Science and Humanity	6					X		X	X
	UIGE60xxxx	Religion	2								X
	PCC										
	SCFI601121	Laboratory Work of Basic Physics 1	1	X	X				X		X
	SCMA601111	Basic Mathematics 2	4	X	X				X		
	SCFI601115	Electricity and Magnetism	3	X	X			X	X	X	
	SCFI601116	Vibrations, Waves, and Optics	3	X	X			X	X	X	
	SCFI602214	Mathematical Methods in Physics 1	3	X	X				X		
2(1)	FCC										
	SCCH601101	Basic Chemistry 1	2					X	X	X	
	SCBI601112	General Biology	2					X	X	X	
	PCC										
	SCFI601122	Laboratory Work of Basic Physics 2	1	X	X				X		X

	SCFI602117	Modern Physics	3	X	X			X	X	X	
	SCFI602112	Thermodynamics	3	X	X			X	X	X	
	SCFI602215	Mathematical Methods in Physics 2	4	X	X				X		
	SCFI602216	Mathematical Methods in Physics 3	3	X	X				X		
	SCFI602311	Electronics 1	3		X			X	X	X	
	SCFI602321	Laboratory Work of Electronics 1	1		X			X	X	X	X
2(2)	PCC										
	SCFI602122	Laboratory Work of Intermediate Physics	1		X			X	X	X	X
	SCFI602113	Classical Mechanics	4	X	X			X	X	X	
	SCFI602114	Electromagnetic Field 1	3	X	X			X	X	X	
	SCFI602021	Computational Physics	4		X			X	X	X	X
	SCFI602312	Electronics 2	3		X			X	X	X	
	SCFI602322	Laboratory Work of Electronics2	1		X			X	X	X	X
	SCCH601103	Basic Chemistry 2	2					X	X	X	
	SCFI602118	Vibrations and Waves	2	X	X			X	X	X	
	SCMA601120	Elementary Linear Algebra	2	X	X				X		
3(1)	PCC										
	SCFI603117	Introduction to Solid State Physics	3	X	X			X	X	X	
	SCFI603118	Introduction to Nuclear Physics	3	X	X			X	X	X	
	SCFI603110	Quantum Mechanics 1	4	X	X			X	X	X	
	SCFI603110	Statistical Physics	4	X	X			X	X	X	
	SCFI603115	Electromagnetic Field 2	3	X	X			X	X	X	
	CC										

	SCFI603414	Classical Field Theory	4			X		X	X	X	
	SCFI603511	Introduction to Materials Science	3			X		X	X	X	
	SCFI603514	Research Methods of Materials	2			X		X	X	X	
	SCFI603613	Spectroscopy 1	3			X		X	X	X	
	SCFI603614	Green’s Function Method in Condensed Matter Physics	2			X		X	X	X	
	SCFI604713	Embedded System	3			X		X	X	X	
	SCFI604712	Computer Based Data Acquisition	2			X		X	X	X	
	SCFI603911	Introduction to Radiology Physics	2			X		X	X	X	
	SCFI603912	AnatomyandPhysiology	2			X		X	X	X	
3(2)	PCC										
	SCFI603116	Quantum Mechanics 2	3	X	X			X	X	X	
	SCFI602116	Physics of Energy	2	X	X			X	X	X	
	SCFI603310	Physics of Measurements	2		X			X	X	X	
	CC										
	SCFI603416	Advanced Computational Physics	3			X		X	X	X	X
	SCFI603415	Nuclear and Particle Physics	4			X		X	X	X	
	SCFI604411	Relativistic Quantum Mechanics	4			X		X	X	X	
	SCFI603412	Scattering Theory	3			X		X	X	X	
	SCFI604512	Ceramic Physics	3			X		X	X	X	
	SCFI604513	Composite Materials	3			X		X	X	X	
	SCFI603513	Thermodynamics of Materials	3			X		X	X	X	

	SCFI603515	Methods of Materials Characterization	4			X		X	X	X	
	SCFI603611	Solid State Physics 1	4			X		X	X	X	
	SCFI604611	Spectroscopy 2	3			X		X	X	X	
	SCFI603622	Advanced Laboratory	4			X		X	X	X	X
	SCFI603711	Sensorsand Actuators 1	2			X		X	X	X	
	SCFI603712	InstrumentationPhysics 1	2			X		X	X	X	
	SCFI603716	Control System	4			X		X	X	X	
	SCFI603726	Laboratory Work of Control System	1			X		X	X	X	X
	SCFI604723	Laboratory Work of Embedded System	1			X		X	X	X	X
	SCFI604915	Introduction to Radiotherapy Physics	3			X		X	X	X	
	SCFI603919	Introduction to Biophysics	2			X		X	X	X	
	SCFI603914	Health Physics & Radiation Protection	2			X		X	X	X	
	SCFI603915	Radiobiology	2			X		X	X	X	
	SCFI603927	Laboratory Work of Medical Physics and Counter System	1			X		X	X	X	X
	SCFI604916	Introduction to Medical Imaging and Nuclear Medicine	3			X		X	X	X	
4(1)	PCC										
	SCFI604101	Seminar	2				X	X		X	X
	CC										
	SCFI604413	Quantum Field Theory	4			X		X	X	X	
	SCFI604414	Theory of Angular Momentum	4			X		X	X	X	

	SCFI604511	Phase Transformationof Materials	3			X		X	X	X	
	SCFI603512	Materials Properties	3			X		X	X	X	
	SCFI604514	Internship in MaterialsPhysics	2			X		X	X	X	X
	SCFI603612	Solid State Physics 2	4			X		X	X	X	
	SCFI604613	Capita Selection of Condensed Matter	3			X		X	X	X	
	SCFI604742	Internship	2			X		X	X	X	X
	SCFI603713	Sensorsand Actuators 2	2			X		X	X	X	
	SCFI603723	Laboratory Work of Sensors and Actuators	1			X		X	X	X	X
	SCFI604715	Digital Signal Processing	4			X		X	X	X	
	SCFI603714	InstrumentationPhysics 2	2			X		X	X	X	
	SCFI604917	Introduction to Biomaterials	2			X		X	X	X	
	SCFI604918	Advanced Biophysics	2			X		X	X	X	
	SCFI604919	Introduction to Medical Instrumentation	2			X		X	X	X	
	SCFI604921	Laboratory Work of Radiology Physics	1			X		X	X	X	X
	SCFI604941	Internship	2			X		X	X	X	X
4(2)	PCC										
	SCFI604102	Undergraduate Thesis	6	X	X	X	X	X	X	X	X


Interconnectivity of Courses
SEMESTER 1
SEMESTER 2
SEMESTER 3
SEMESTER 4
SEMESTER 5
SEMESTER 6
SEMESTER 7
SEMESTER 8
Basic Mathematics 1
Mechanics and Heat
Basic Physics
Statistical Methods
Science
English
Art / Sport
Basic mathematics 2
Mathematical Methods in Physics 1
Vibrations, Waves, and Optics
Electricity and Magnetism
Laboratory Work of Basic Physics 1
Social Science and Humanity
Religion
Mathematical Methods in Physics 2
Mathematical Methods in Physics 3
Thermodinamics
Modern Physics
Electronics 1
Laboratory Work of Electronics 1
Laboratory Work of Basic Physics 2
General Biology
Basic Chemistry 1
Computational Physics
Electromagnetic Field 1
Classical Mechanics
Vibrations and Waves
Elementary Linear Algebra
Laboratory Work of Advanced Physics
Electronics 2
Laboratory Work of Electronics 2
Basic Chemistry 2
Statistical Physics
Electromagnetic Field 2
Quantum Mechanics 1
Introduction to Nuclear Physics
Introduction to Solid State Physics
Physics of Energy
Quantum Mechanics 2
Physics of Measurements
Seminar
Undergraduate Thesis
CC
PCC
FCC
STCCC
UCC
pre-requisite
softskill supports

MASTER IN PHYSICS

Vision

Be one of the leading centers of education and research of physics and applied science, able to play an important role at national and international levels, and able to provide supports for technological developments required by the domestic industries.

Mission

In general, the main missions of Master of Science in Physics Program of UI are as follows:

- To produce graduates with excellent character who have competencies in science, culture and technology in order to be able to compete internationally.
- To build an academic atmosphere and scientific community in various sciences.
- To develop international standards in human resources professionalism in order to be able to deliver Indonesia to the global era.
- To give service to the community in the form of developing knowledge, models, and various problem solving.

Additionally, Master of Science in Physics Program of UI also formulates special missions:

- To implement the application and development of science and technology in physics to the community.
- To implement the development and application of science and technology in physics towards new innovations that can be applied to national industries.

Goals

The main goals of Master of Science in Physics Program of UI are to produce:

- Teachers and researchers who are able to teach in undergraduate programs in physics, and are able to plan and carry out research in the areas of physics.
- Researchers who are able to plan and carry out research in the areas of physics.
- Graduates who have the ability to work in industry, are adaptable, are able to learn quickly, and are competent in the problems faced, especially in the application of physics or in systematic use of scientific thinking to solve these problems.

Graduates Profiles

The standards by the Indonesian National Qualifications Framework (INQF) are used in compiling the profile of graduates of Master of Science in Physics Program to be produced through the application of the Curriculum for the Master of Science in Physics Program. The curriculum for The Master of Science in Physics Program is designed to produce graduates that are capable of:

- Developing physics in order to be recognized globally
- Solving the problems in the community which are related to physics by using inter- and multi discipline approaches
- Communicating the results of the faculties thoughts to the community both orally and in writing
- Adapting to the development of science and technology through the process of self-sustaining and independent learning

Graduates' Competencies of Master in Physics

The graduates of Master in Physics Program must have the ability to:

- Plan a research according to problems in one of areas of physics and its applications.
- Correlate the basic concepts of physics with the results of calculations or measurements in research in one area of physics and its applications.
- Formulate the problem solving of the development of physics and its applications.
- Develop physics with logical, critical, systematic, and creative thinking through scientific research in one of the areas of physics and its application.
- Compose research reports in the form of thesis as well as articles and scientific presentation materials.
- Show the results of the research by presenting at international conference (oral or poster presentation) or equivalent in both Indonesian and foreign language (English).
- Publish the results of the research in one of nationally accredited scientific journals or international journals and international scientific conferences or equivalent.
- Perform academic or study validation with scientific methodologies and physical laws in solving problems in society.

- Illustrate ideas, thoughts, and scientific arguments so that they are easy to understand.
- Demonstrate sensitivity and concern over environmental, social, national and state issues.
- Communicate ideas, thoughts, and scientific arguments that are prepared responsibly and in accordance with academic ethics about the problems in the community to the wider community as a form of sensitivity to environmental, society, nation and State issues.
- Identify the object of research in the areas of physics and its applications in describing the phenomena, findings and topics of contemporary & current science.
- Project the role of physics and its applications in interdisciplinary or multidisciplinary research in the future.
- Categorize objects of research in physics related to phenomena, findings, and topics of contemporary & current science on interdisciplinary or multidisciplinary research maps.
- Consider to solve the problems with integrity, critical thinking, creative and innovative, as well as based on intellectual curiosity.
- Develop knowledge in the use of computer and information technology in order to keep up with the times.
- Develop knowledge about new methods and technologies that support their work.
- Adapt to the development of science and technology.
- Manage a network with colleagues both in the institution and in the wider work community.
- Manage the time well when working independently or in teams under stressful conditions.
- Use spoken and written language in Indonesian and English.
- Conduct the learning process independently and sustainably.
- Conduct the work in accordance with OSH principles (Occupational Safety and Health).
- Demonstrate a sense of confidence in social interaction and in adapting to technological advances at work.
- Document the research data well and securely.
- Be able to rediscover the research data.

- Manage the documentation of research data in the efforts of validation and prevention of plagiarism.

Curriculum Structure

To achieve the competencies, a series of courses is developed as a learning tool that allows students to get various activities to sharpen their skills. The Master of Science in Physics Program provides two sets of courses to train these competencies. The two sets of courses are each distributed in the Course & Research Program and Research Program.

Curriculum Structure of Master in Physics by Course and Research Program

Curriculum Structure of Master in Physics by Research Program

To provide opportunities for students who excel academically in the undergraduate program, the Master in Physics Program opens a Research Program. This program is carried out by deepening the basic concepts of Physics and specializations in the usage of methods and techniques in the field of Physics and Applied Physical. The curriculum structure that is implemented in this program follows the structure stated in the University President's Decree No: 2199 / SK / R / UI / 2013. It is structured as follows: participation of 4 Credits-worth of scientific seminar / conference was distributed to Scientific Seminar 1 and Scientific Seminar 2 courses. Both of these courses each weigh 2 credits. This distribution is because of the requirement of the Course and Research Program is 2 Credits.

Distribution of Courses of Master in Physics by Research Program

Semester 1		
Code	**Course**	**Credit**
SCFI801001	Advanced Physics	8
SCFI801101	Proposal Defense	4

Semester 2		
Code	**Course**	**Credit**
SCFI801002	Scientific Seminar 1	2
SCFI801102	Research Results Defense	8

Total	12
Total credit at the end of Semester 1	12

Total	10
Total credit at the end of Semester 2	22

Semester 3		
Code	**Course**	**Credit**
SCFI802103	Scientific Seminar 2	2
SCFI802103	Published Paper	10
Total		12
Total credit at the end of Semester 3		34

Semester 4		
Code	**Course**	**Credit**
SCFI801003	Thesis Defense	8
Total		8
Total credit at the end of Semester 4		42

DOCTOR IN PHYSICS PROGRAM

Vision

Become an internationally reputable and superior graduate program in Southeast Asia.

Mission

- Organize learning programs that integrate education and research through high quality research-based curriculum.
- Produce graduates who are able to do original research with research knowledge and competencies that are internationally recognized and have an analytical, critical, creative, innovative, conceptual mindset, oriented towards problem solving and have an objective, professional and ethical attitude.
- Facilitate academic freedom for academics in the Doctor in Physics program to create a condusive academic climate conducive to the development of attitudes and mindset of students.
- Increase research resources through partnerships and networking with researchers, research institutions, and industries nationally and internationally.

Research Fields

1. Theoretical Nuclear and Particle Physics
2. Condensed Matter Physics
3. Instrumentation Physics
4. Medical Physics and Biophysics
5. Geophysics

Graduate Profile

The main competencies of graduates are

- Create innovative, original and tested works through research in the field of physics and its applications.
- Develop science and technology through research in physics and its applications.

- Disseminate research results in the field of physics so as to gain national and international recognition
- Solve the problems of science and technology in the community with the principles of physics and communicate the results to the community.

Curriculum Structure

The Physics Study Program S3 curriculum is competency based which is commensurate with the Indonesian National Qualification Framework (KKNI) Level 9.

The curriculum is designed to produce graduates who are able to develop physics and their applications through nationally and internationally recognized research with a multidisciplinary, interdisciplinary and transdisciplinary approach.

Distribution of Courses of Doctor in Physics Program

Semester	Research Program		Course and Research Program	
	Course	**Credit**	**Course**	**Credit**
1	Postgraduate Seminar	8	Philosophy of Science	2
	Research Proposal Defense	6	Research Method	2
			Postgraduate Seminar	6
2	National Scientific Seminar	4	Advanced Research Method in Physics	8
3	International Scientific Seminar	6	Research Proposal Defense	6
	National Journal Publication	4	Scientific Seminar	4
4	International Journal Publication	8	International Journal Publication	8
5	Research Defense	10	Research Defense	10
6	Promotion Defense	6	Promotion Defense	6
Total		52		52

MASTER IN MATERIALS SCIENCE

Vision

To become Master in Materials Science program with international standard, by playing an active role in education, research, and becoming the center of innovation in Material Science and its application, while maintaining environmental sustainability on behalf of humanity.

Mission

- Conduct education to bear graduates with high morals that acquire competency in science and technology and are capable to compete in international world.
- Conduct research and create new research groups, in order to bear graduates who are capable to conduct research activities and innovations in Material Science, including specialization fields: metal and alloy, ceramics, polymer, electronic and magnetic materials, and composite materials, as well as spread the result to in order to move forward Materials Science.
- Educate students to become decision-maker individual in various field that are related to Materials Science and acquire capability to be independent with reliable entrepreneurial passion and soul.
- Conduct professional services in order to improve public welfare through utilization of Materials Science while watching environmental sustainability.

Graduate Profile

Master in Materials Science Program aims to bear graduates who are capable to study materials science and technology through independent research activities, by applying innovative work method, while honoring scientific ethics.

General competencies

- Capable to analyse advancement of materials science and technology.
- Capable to analyse specific problems of materials science through research activities both in independent setting and/or in groups, while honouring scientific ethics.

- Capable to communicate and disseminate results of research in community of materials science.
- Capable to apply research results in the form of prototype that is beneficial for society and materials science.
- Capable to apply entrepreneurship concept to solve problems of business management in materials science coverage.

Specific competencies:

- Capable to analyze various functional materials in various products.
- Capable to apply principles of materials science and technology.
- Capable to quantify physics and chemical measures of materials and to apply these measures on various use cases.
- Capable to study work principle of various fabrication techniques and materials characterization.
- Capable to select fabrication technique and materials characterization based on research requirements.
- Capable to theoretically analyze solution in order to solve problems in materials science.
- Capable to detail the general and specific problems in materials science.
- Capable to create logical, systematic, and practical solutions, that are supported by scientific methods in order to solve problems of materials science.
- Capable to construct scientific publication with either national or international standards.
- Capable to execute scientific methods in research procedure.
- Acquire basic managerial skill for effective and efficient work.

The Master in Materials Science program implements Master by Reasearch & Course and Master by Research Programs. Master by Research & Course program is conducted in Regular and Non Regular classes with the following conditions:

Regular Class

• Study period: 2-6 semester (normal study period :4 semester)

• Time: Monday-Friday

• Place: UI Depok Campus

Non Regular Class

• Study period : 3-7 semester (normal study period : 5 semester)

• Time: Saturday

• Place of Study: UI Salemba Campus

Curriculum Structure

A. Master in Materials Science by Research & Course

Group	Code	Course	Credit
Compulsory Courses	SCMS801101	General Materials Science	4
	SCMS801102	Materials Thermodynamics	3
	SCMS801103	Crystallography of Materials and Diffraction Techniques	3
	SCMS801104	Materials Phase Transformation	3
	SCMS801105	Technical Economics	2
	SCMS801106	Advanced Laboratory Work	4
	SCMS802001	Seminar	2
	SCMS802002	Scientific Seminar	2
	SCMS802003	Thesis Defense	8
Elective Courses	SCMS801107	Corrosion and Materials Protection	3
	SCMS801108	Polymer Materials	3
	SCMS801109	Composite Materials	3
	SCMS801110	Ceramic Materials	3
	SCMS801111	Electronic Materials	3
	SCMS801112	Magnetic Materials	3
	SCMS801113	Materials Computation Method	3
	SCMS801114	Manufacturing Process of Metal and Alloys	3
	SCMS801115	Thin Layer Materials	3
	SCMS801116	Nano Materials	3

Percentage of courses groups

Compulsory courses	31 Credits	77%
Elective courses	9 Credits	23%
Total	40 Credits	100%

Distribution of Courses

<table>
<tr><th>Semester 1</th><th>Semester 2</th><th>Semester 3</th><th>Semester 4</th><th>Semester 5</th></tr>
<tr><td colspan="5">REGULER CLASS</td></tr>
<tr><td rowspan="2">5 Compulsory Courses (15 Credits)</td><td rowspan="2">1 Compulsory (4 Credits) + 3 Elective Courses (13 Credits)</td><td>Research Result Seminar (0 Credits)</td><td>Scientific Seminar (2 Credits)</td><td rowspan="2"></td></tr>
<tr><td>Seminar (2 Credits)</td><td>Thesis Defense (8 Credits)</td></tr>
<tr><td colspan="5">NON REGULAR CLASS</td></tr>
<tr><td rowspan="2">3 Compulsory Courses (9 Credits)</td><td rowspan="2">3 Compulsory Courses (10 Credits)</td><td rowspan="2">3 Compulsory Courses (9 Credits)</td><td>Scientific Seminar (2 Credits)</td><td>Research Result Seminar (0 Credits)</td></tr>
<tr><td>Seminar (2 Credits)</td><td>Thesis Defense (8 Credits)</td></tr>
</table>

B. Master in Materials Science by Research Program

Code	Course	Credit
SCMS801120	Periodic Seminar	8
SCMS801121	Research Proposal Defence	4
SCMS801122	Research Result Defense	8
SCMS801123	Scientific Seminar 2	4
SCMS802120	Scientific Publication	10
SCMS802002	Thesis Defence	8
	Total	42

Distribution of Courses

<table>
<tr><th>Semester 1</th><th>Semester 2</th><th>Semester 3</th><th>Semester 4</th></tr>
<tr><td>Periodic Seminar (8 Credits)</td><td rowspan="2">Scientific Seminar 2 (4 Credits)</td><td>Research Result Defense (10 Credits)</td><td>Thesis Defense (8 Credits)</td></tr>
<tr><td>Research Proposal Defense (4 Credits)</td><td colspan="2">Scientific Publication (6 Credits)</td></tr>
</table>

DOCTOR IN MATERIALS SCIENCE

Vision

To become Doctorate of Materials Science Program with international standard, by playing an active role on education, research, and becoming centre of innovation in materials science and its application, while maintaining environmental sustainability for the benefits of humanity.

Mission

- Conduct education to bear graduates with high morals who acquire competency in materials science and technology amd are able to compete in international world.
- Conduct research and create new research groups, in order to bear graduates who are capable to conduct research activities and innovations in Materials Science, including specialization fields: metal and alloy, ceramics, polymer, electronic and magnetic materials, and composite materials, as well as spread the result to in order to move forward Materials Science.
- Educate students to become decision-maker individual in various field which are related to materials science and become capable to be independent with reliable entrepreneurship passion and soul.
- Conduct professional services in order to improve public welfare through utilization of materials science while maintaining environmental sustainability.

Graduate Profile

Doctorate in Materials Science by Course and Research Program aims to produce graduate who are capable to produce innovative and original independent research creation that are acknowledged by international materials community as results of materials science and technology development that are beneficial for humanity.

Main competencies:

- Capable to formulate solutions to problems that are related to science and technology of materials, by applying multidisciplinary and interdisciplinary approaches.
- Capable to design independent research according to scientific ethics.
- Capable to present research result in national and international materials communities.
- Capable to create new knowledge and technologies that are useful for humanities.

Doctor in Materials Science program implements Doctor by Research & Course and Doctor by Research Programs.

Curriculum Structure

A. Doctor by Research & Course Program

Classification of Course

Group	Code	Course	Credit
Compulsory Courses	SCMS901001	Research Proposal Defense	6
	SCMS902001	International Publication	8
	SCMS903001	Research Result Defense	10
	SCMS903002	Promotion Defense	8
	SCMF901001	Phylosophy of Science	2
	SCMF901002	Research Method	2
	SCMS901103	Analytic method in Materials Characterization	4
	SCMS901104	Special Topics	6
Elective Courses	SCMS901105	Advanced Ceramic	4
	SCMS901106	Advanced Polymer	4
	SCMS901107	Science and Technology of Metal/Alloy	4
	SCMS901108	Electronic and Magnetic Materialss	4

Percentage of Courses Groups

Compulsory courses	46 Credits	92 %
Elective courses	4 Credits	8 %

Total	50 Credits	100%

Distribution of Courses

<table>
<tr><th>Semester 1</th><th>Semester 2</th><th>Semester 3</th><th>Semester 4</th><th>Semester 5</th><th>Semester 6</th></tr>
<tr><td rowspan="3">12 Compulsory + 4 Elective Courses (16 Credits)</td><td rowspan="2">Proposal Research Defense (6 Credits)</td><td rowspan="2">Research Result Seminar (0 Credits)</td><td>Research Result Seminar (0 Credits)</td><td>Research Result Defense (10 Credits)</td><td rowspan="3">Promotion (8 Credits)</td></tr>
<tr><td colspan="2" rowspan="2">International Publication (8 Credits)</td></tr>
<tr><td colspan="2">Scientific Publication 1 (4 Credits)</td></tr>
</table>

B. Doctor by Research Program

Group	Code	Course	Credit
Compulsory Courses	SCMS901001	Research Proposal Defense	6
	SCMS902001	International Publication	8
	SCMS903001	Research Result Defense	10
	SCMS903002	Promotion Defense	8
	SCMS901201	Periodic Seminar	8
	SCMS901202	Scientific Publication 1	4
	SCMS902201	Scientific Publication 2	6

Percentage of Courses Groups

Compulsory courses	50 Credits	100%
Elective courses	0 Credits	0%
Total	50 Credits	100%

Distribution of Courses

<table>
<tr><th>Semester 1</th><th>Semester 2</th><th>Semester 3</th><th>Semester 4</th><th>Semester 5</th><th>Semester 6</th></tr>
<tr><td>Periodic Seminar (6 Credits)</td><td></td><td>Research Result Seminar (0 Credits)</td><td>Research Result Seminar (0 Credits)</td><td>Research Result Defense (10 Credits)</td><td rowspan="2">Promotion (8 Credits)</td></tr>
<tr><td>Research Proposal Defense (6 Credits)</td><td colspan="2">Scientific Publication 1 (4 Credits)</td><td>Scientific Publication 2 (6 Credits)</td><td>International Publication (8 Credits)</td></tr>
</table>

SYLLABUS

UNDERGRADUATE IN PHYSICS

1. Course : Basic Mathematics 1

Code / Credit / Pre-req. : UIST601110 / 2 SKS / -

Objective:

To explain the basic concept of one variable calculus and get used to solve calculus application problems

Subjects:

Introduction: real number system, inequality and absolute value; One variable function: definitions and variety, graph (Cartesian), function operation; Limit: definitions and limit theorems, continuity; Transcendent function, differential: definitions, geometry meaning, differential formulas, chain rule, high rank differentiation, implicit differentiation, application of differential: maximum and minimum, mean value theorem; Integral: definitions, certain and uncertain integral, basic calculus theorem, basic characteristic of integral, integration techniques, application of integral: area and volume of rotational object.

Bibliography:

1. D. Varberg & E.S Purcell, 9^{th} ed, *Calculus*, Prentice-Hall, 2007.
2. G.B Thomas & R.L Finney, *Calculus and Analytic Geometry*, 9^{th} ed, Addison-Wesley, 1996.

2. Course : Statistical Methods

Code / Credits / Pre-req. : SCMA601200 / 2 SKS / -

Objective:

To explain the basic concepts of statistics and its applications

Subjects:

Probability, conditional probablity; Random variable and probability distribution; Introduction to distribution: random discrete variable probability distribution (binomial distribution, Poisson distribution, hyoergeometric distribution), random continuous variable probability distribution (normal distribution), sampling, post limit theorem, chi square distribution, T distribution, F distribution; Statistical Interferences: interval evaluation and hypothesis testing for one population and two population; Chi square test: independence test, homogenity test, suitability test; Simple linear regression; one way variance analysis.

Bibliography:

1. R. E. Walpole, R. H. Myers, S.L. Myers & K.Ye. *Probability & Statistics for Engineers and Scientists*, 7th ed, Prentice Hall International Edition, 2002.
2. J. T. Mc Clave & F. H. Dietruch., *Statistics*, 9th ed., Prentice Hall, 2003.
3. R. A. Johnson, & G. K. Bhattacharyya, *Statistics: Principles and Methods*, 3rd ed., John Willey & Sons, 1996.

3. Course : Basic Physics

Code / Credit / Pre-req. : SCFI601110 / 2 SKS / -

Objective:

To explain the basic concepts of Physics and its application in daily life, including mechanical, thermodynamic, electromagnetic, wave and optics.

Subjects:

Law of object motion, translation and rotation motion, mechanical energy conservation law, momentum, energy, static and dynamic fluid, heat, expansion, heat transportation, thermodynamic, heat engine, mechanical vibration, sound, electricity, electric capacity, electric current, magnetization, electromagnetic wave, light, optic, modern physics, atom.

Bibliography:

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.

4. Course : Mechanics and Heat

Code / Credit / Pre-req. : SCFI601114 / 4 SKS / -

Objective:

After finishing this course, students are expected to be able to solve simple and well defined physical problem in mechanic and thermodynamic, first year students are expected to apply the concept and principles of mechanic and thermodynamic in daily life and formulate the solution.

Subjects:

Unit, physical quantities and vector, linear one dimensional motion, two and three dimensional motion, Newton Law and its application, Work and kinetic energy, potential energy and its conservation, momentum, impulse and collision, rigid body rotation, rotational dynamic, equilibrium and elasticity, gravity, fluids mechanic, temperature, heat, kinetic theory of gasses, Thermodynamic 1^{st} law, heat engine, entropy, and Thermodynamic 2^{nd} law.

Bibliography:

1. Halliday, Resnick, dan Walker, *Principles of Physics 10th Edition*, Wiley, 2014.

2. Serway Jewett, *Physics for Scientists and Engineers 9th Edition*, Thomson Brooks/Cole, 2014.

3. Giancoli, *Physics for Scientists and Engineers 7th Edition*, Pearson, 2014

Course : Basic Mathematics 2

Code / Credit / Pre-req : SCMA601111 / 4 SKS / Basic Mathematics 1

Objective:

To explain the concept of parametric function, infinite sequance and series, and many variable calculus.

Subjects:

Parametric function, polar coordinate, area in polar coordinate; function in vector, curvature (R^2 and R^3); integral application: curve length and rotational object surface area; uncertain form (L'Hospital) and improper integral; real infinite series and sequence; many variables function: limit, continuity, partial derivative, differentiation, vector differential, tangent plane, maximum and minimum; double and triple integral, Jacobian.

Bibliography:

1. D. Varberg and E.S Purcell, *Calculus*, 9th ed, Prentice-Hall, 2007.
2. G.B Thomas and R.L Finney, *Calculus and Analytic Geometry*, 9th ed, Addison-Wesley, 1996.

Course : **Mathematical Methods in Physics 1**

Code / Credit / Pre-req. : SCFI602214 / 3 SKS / Basic Mathematics 1

Objective:

To apply mathematical methods in form of vector analysis, tensor analysis, and ordinary differential equation to second order linear differential equation in Physical problems.

Subjects:

Vector differential (gradient, divergence, curl, and Laplacian), vector integral, Gauss and Green Theorem, Stokes Theorem, tensor operation delta Kronecker and Levi-civita, ordinary first order differential equation, exact differential equation, ordinary second order differential equation, Laplace transformation, Delta Dirac function.

Bibliography:

1. M.L. Boas, *Mathematical Methods in the Physical Sciences*, 3rd Ed, John Wiley and Sons, 2006.
2. G.B. Arfken and H.J. Weber, *Mathematical Methods for Physicists*, 5th Ed, Hartcourt Academic Press, 2001.

Course : **Electricity and Magnetism**

Code / Credit / Pre-req. : SCFI601115 / 3 SKS / Mechanics and Heat

Objective:

After finishing this course, first year students are expected to be able to apply electromagnetic principles and concepts to a simple-well-defined basic physics problems, also be able to formulate the solution.

Subjects:

Electric charge and field, Gauss Law, Electric potential, Capacitor and Dielectric, Electric current, Resistance and direct current, Magnetic field and Magnetic force, Magnetic field source, Electromagnetic induction, inductance, electromagnetic oscillation, Alternative current, Maxwell equation.

Bibliography:

1. Halliday, Resnick, dan Walker, *Principles of Physics 10th Edition*, Wiley, 2014.
2. Serway Jewett, *Physics for Scientists and Engineers 9th Edition*, Thomson Brooks/Cole, 2014.
3. Giancoli, *Physics for Scientists and Engineers 7th Edition*, Pearson, 2014

Course : **Vibrations, Waves and Optics**

Code / Credit / Pre-req. : SCFI601116 / 3 SKS / Mechanics and Heat

Objective:

After finishing this course, first year students are expected to be able to apply principles and concepts of vibration, wave and optics, to a simple-well-defined basic physics problems, also be able to formulate the solution.

Subjects:

Simple Harmonic Motion, Damped Harmonic Motion, Mechanical Wave, Sound, Superposition, Standing Wave, Maxwell Equation, Electromagnetic Wave, Basic properties and Propagation of Light, Light Polaritation, Reflection and Refraction, Light Waves Interference, Light Waves Diffraction, Optic Geometry, Optic-based Equipment.

Bibliography:

1. Halliday, Resnick, dan Walker, *Principles of Physics 10th Edition*, Wiley, 2014.
2. Serway Jewett, *Physics for Scientists and Engineers 9th Edition*, Thomson Brooks/Cole, 2014.
3. Giancoli, *Physics for Scientists and Engineers 7th Edition*, Pearson, 2014

Course : **Laboratory Work of Basic Physics 1**

Code / Credit / Pre-req. : SCFI601121 / 1 SKS / Physics of Mechanics and Heat, Statistical Methods

Objective:

To calculate, make graph, analyze and conclude based on basic physics experiments, including Mechanics and Heat, in order to explaining the basic physics concepts through the experiment and theory.

Subjects:

Measurements techniques; Mechanics: Inertia, Free Fall Motion, Density of Liquids, Coefficient of Fraction, Collision, Swing Twist, Viscosity of Liquids, Young Modulus, Mathematical Swing, Surface Tension, hardness test; Heat: linear expansion coefficient, thermal conductivity, calorimeter, Joule constant, solar collector, ideal gasses law, Newton coolant, radiation constant, radiation absorption.

Bibliography :

1. Buku Pedoman Praktikum Fisika Dasar, UPP IPD, edisi ke-3, 2010.
2. Giancoli, DC., Physics: Principle with Applications, 6th ed., Prentice Hall, 2005.

Course : **General Biology**

Code / Credit / Pre-req. : SCBI601112 / 2 SKS / -

Objective:

To explain the basic concepts of biology comprehensively and and connecting the basic concepts with other disciplines, especially with disciplines in the same field like chemistry, physics, and mathematics. To explain about diversity in Indonesia and the conservation effort. To explain the important role of human as a manager of environment, to build cooperation behavior and work as a team in solving problems especially environmental problems, and to build honesty, independently, and creative behavior.

Subjects:

Basic concepts of biology including characteristics of life, biology of cell, inheritance, evolution, biodiversity, structure and function of animal, structure and function of plants, biodiversity in Indonesia, and interaction between human with other living creature and environment, principles of ecology, conservation, and biotechnology.

Bibliography:

1. Campbell, N.A. & J.B. Reece., L.A.Urry., M.L. Chain., S.A. Wasserman., P.V. Minorsky., D. Ferry., and R.B. Jackson, *Biology* 9th ed., Pearson Education, Inc., San Fransisco, 2010.
2. Johnson, G.B, *The living world*, Wm.C. Brown Publishers, Dubuque, 1995.
3. Starr, C. & R. Taggart, *Biology*: *The unity and diversity of life* 8th ed., Wadsworth Publishing Company, Belmont, 1998.

Course : **Basic Chemistry 1**

Code / Credit / Pre-req. : SCCH601101 / 2 SKS / -

Objective:

To explain about matters and its components, properties of matters and its transformation, history of development of atom theories and electron configuration, using stoichiometry, chemical reaction and mole concept in explaining the properties of matters and its transformation.

Subjects:

Matters and its transformation, components of atom, ion and molecules, atomic electronic structure, stoichiometry, main chemical reaction, kinetic gas theory, solution and colligative, thermochemistry, field integration, integrated science.

Bibliography:

1. L. Brown and Bursten, *Chemistry: The Central Science,* Prentice Hall, NJ,
2. Silberberg, *Chemistry: The Molecular Nature of Matter and Change,* Mc-Graw Hill, 5ed.
3. J.E. Brady, *General Chemistry: Principles & Stucture*, John Wiley & Sons

Course : **Mathematical Methods in Physics 2**

Code / Credit / Pre-req. : SCFI602215 / 4 SKS / Basic Mathematics 2, Mathematical Methods in Physics 1

Objective:

To apply mathematical methods in form of complex variable function, Fourier series, and calculus variation in Physics problems.

Subjects:

Complex function, Cauchy-Riemann theorem, Laurent series, Cauchy contour integral, Residue theorem, conformal mapping, Fourier series and coefficient, Dirichlet condition, Parseval theorem, minimum area, Hamilton principle (least action principle), Euler-Lagrange equation with problems.

Bibliography:

1. M.L. Boas, *Mathematical Methods in the Physical Sciences*, 3rd Ed, John Wiley and Sons, 2006.

2. G.B. Arfken and H.J. Weber, *Mathematical Methods for Physicists*, 5th Ed, Hartcourt Academic Press, 2001.

Course : **Mathematical Methods in Physics 3**

Code / Credit / Pre-req. : SCFI602216 / 3 SKS / Basic Mathematics 2, Mathematical Methods in Physics 1

Objective:

To apply mathematical methods in form of special functions and partial differential equation in Physics problems.

Subjects:

Error function, Gamma function, Beta function, Stirling formula, Legendre equation, Rodrigues formula, Legendre series, isolated Legendre polynomial, Bessel equation, Second kind Bessel function, Hermite function, Laguerre function, separation variable method in partial differential equation, Poisson equation, Green function, Integral transformation method.

Bibliography

1. M.L. Boas, *Mathematical Methods in the Physical Sciences*, 3rd Ed, John Wiley and Sons, 2006.
2. G.B. Arfken and H.J. Weber, *Mathematical Methods for Physicists*, 5th Ed, Hartcourt Academic Press, 2001.

Course : **Laboratory Work of Basic Physics 2**

Code / Credit / Pre-req. : SCFI601122 / 1 SKS / Laboratory Work of Basic Physics 1

Objective:

To calculate, make graph, analyze and conclude based on basic physics experiments, including Electricity, Magnetism and Optics, in order to explaining the basic physics concepts through the experiment and theory.

Subjects:

Electricity – Magnetism: electrolysis, Wheatsone Bridge, Kirchoff Law, Earth Magnetic Field, Temperature Coefficient, AC – RLC circuit, inner resistance, transformer, Ohmic Materials, RC transient circuit, diode; Optics: Polarimeter, Optic Geometry on lens, Photometry, refractive index of prism, spectrometer, Newton Rings, grid diffraction, standing wave.

Bibliography:

1. Buku *Pedoman Praktikum Fisika Dasar*, UPP IPD, edisi ke-3, 2010.

2. Giancoli, DC, *Physics: Principle with Applications*, 6th ed., Prentice Hall, 2005.

Course : **Modern Physics**

Code / Credit / Pre-req. : SCFI602117 / 3 SKS / Electricity and Magnetism, Vibrations, Waves, and Optics, Basic Mathematics 2, Mathematical Methods in Physics 1

Objective:

To formulate the solution of a well-defined-simple modern physics problem, including relativity, wave-particle dualism, quantum physics, atom and molecules and statistical physics.

Subjects:

Special relativity theory: photon-particle dualism: particle-like behavior, electromagnetic wave and wave-like behavior, matters; Quantum Mechanics; Physics of Atoms; Hydrogen atom Model, 3D Hydrogen Atom and many-electrons Atoms; Molecules; Statistical Physics.

Bibliography:

1. S. P. Thornton & A. Rex, , Modern Physics 3rd ed., Thomson Brooks/Cole, 2006.

2. K. Krane, Modern Physics 3rd ed, Wiley, 2012.

3. R. Harris, Modern Physics 2nd ed., Pearson, 2008.

4. J. Bernstein, P. M. Fishbane, and S. Gasiorowicz, Modern Physics, Prentice Hall, 2000.

Course : **Thermodynamics**

Code / Credit / Pre-req. : SCFI602112 / 3 SKS / Electricity and Magnetism, Vibrations, Waves, and Optics, Basic Mathematics 2, Mathematical Methods in Physics 1

Objective:

To explain the basic concept of Thermodynamics (0^{th} law to 3^{rd} law of Thermodynamics) from empirical point of view and the mathematical formulation, and their application on thermodynamic systems.

Subjects:

Concept of Equilibrium and 0th law of Thermodynamics, equation of state, 1st law of Thermodynamics and its consequences, entropy and 2nd law of thermodynamics, combination of 1st and 2nd law of Thermodynamics, Thermodynamics potential and 3rd law of thermodynamics, application of thermodynamics on some simple system, kinetic theory, transport phenomena, statistical thermodynamics, application of statistic on some system of gasses.

Bibliography:

1. F. W. Sears and L. G. Salinger, *Thermodynamics, Kinetic Theory, and Statistical Thermodynamics* 3rd Ed., Addison-Wesley Publishing Company, 1975

Course : Electronics I

Code / Credit / Pre-req. : SCFI602311 / 3 SKS / Electricity and Magnetism

Objective:

To understand discrete electronic principles: Power supply, diode, bipolar transistor, field effect transistor and operational amplifier, and be able to apply the concepts in electronic building system.

Subjects:

Power supply, semiconductor, theory of diode and the circuits, diode for specific needs, bipolar-junction transistor (BJT), pre-voltage transistor, basic transistor amplifier circuit, voltage amplifier, junction field effect transistor (JFET), MOSFET, Basic structure of operational amplifier (Op-Amp) and its properties, linear Op-Amp circuits: Inverting and non-inverting amplifier, summing amplifier, DC imperfections, differential amplifiers, instrumentation amplifiers, voltage-controlled current sources (VCCS), Op-Amp operation with single supply, active filters, nonlinear Op-Amp circuits: Comparators, Integrators, Differentiators, Active Diode Circuits, directional oscillators and power supply.

Bibliography:

1. A. P. Malvino and D. J. Bates, Electronic Principles, 8th edition, McGraw-Hill Book Co., 2015
2. T.L. Floyd and D.M. Buchla, Analog Fundamentals; A System Approach, Pearson Prentice-Hall, 2013

3. L. M. Faulkenberry, An Introduction to Operational Amplifier, with Linear Applications, 2nd edition, John Wiley & Sons, 1982.

Course : Laboratory Work of Electronics 1

Code / Credit / Pre-req. : SCFI602321 / 1 SKS / Electricity and Magnetism, Laboratory Work of Basic Physics 1

Objective:

To apply discrete electronic principles and operational amplifier: diode, transistor, Field Effect Transistor (FET), Op-Amp to analyze and building electrical circuit.

Subject:

Using measurement tools and testing electrical circuit, diode; properties, application, and Zenner, Transistor; transistor circuits, application and FET properties, OP-Amp properties; Inverting Op-Amp, non-inverting Op-Amp and Op-Amp as adder, Mathematic operation circuit using Op-Amp; inverting, scaling and Adder-Subtracter Amplifier, Active Filter Op-Amp-based; differentiator, integrator, low-pass and high pass filter, nonlinear Op-Amp, sensor circuit and its amplifier Op-Amp-based, Project Assignment and Project presentation.

Bibliography:

1. A. P. Malvino, D. J. Bates, *Experiments Manuals for Electronic Principles*, 7th ed, McGraw-Hill Co., 2006.
2. A. P. Malvino, D. J. Bates, *Electronic Principles*, 8th ed, McGraw-Hill Book Co., 2015.

Course : Elementary Linear Algebra

Code / Credit / Pre-req. : SCMA601120 / 2 SKS / -

Objective:

To explain the basic concept of linear algebra by focusing on computing/calculation.

Subjects:

Linear equation; determinant; vector in R^2 and R^3; Euclid space; general vector space.

Bibliography:

1. Howard Anton, *Elementary Linear Algebra*, 9th ed., John Wiley, 2005.
2. Paul R. Halmos, *Finite Dimensional Vector Spaces*, Springer Verlag, New York, 1987.

Course : **Basic Chemistry 2**

Code / Credit / Pre-req. : SCCH601103 / 2 SKS / Basic Chemistry 1

Objective :

To describe the simple equation of chemical reaction rate, the phenomenon of acid-bases reaction, the changing of mass and energy which occur to chemical reaction system (Equilibrium, thermodynamics, and electro-chemistry), to understand existence of natural element, characteristics (metal, non-metal, and radioactive) and how to apply on daily activity and industry.

Subjects :

Chemical Kinetics, Chemical Equilibrium, Acids and Bases, chemical thermodynamics, Electrochemistry, the chemistry of metal and its processing, the chemistry of non-metal, nuclear chemistry, integrated field, integrated science

Bibliography :

1. L. Brown and Bursten, *Chemistry: The Central Science,* Prentice Hall, NJ,
2. Silberberg, *Chemistry: The Molecular Nature of Matter and Change,* Mc-Graw Hill, 5ed.
3. J.E. Brady, *General Chemistry: Principles & Stucture*, John Wiley & Sons

Course : Vibrations and Waves

Code / Credit / Pre-req. : SCFI602118 / 2 SKS / Electricity and Magnetism, Vibrations, Waves, and Optics, Mathematical Methods in Physics 2, Mathematical Methods in Physics 3

Objective :

To apply the theory and principle of vibration and wave on solving the physics of vibration and wave problems

Subjects :

Simple, damped, and forced harmonic motions : coupled oscillation, transverse waves, longitudinal waves, waves on transmission Lines.

Bibliography :

1. H.J. Pain, *The Physics of Vibrations and waves,* 3rd edition John Wiley &Son
2. French, A. P. *Vibrations and Waves*. New York, N.Y, W.W. Norton & Company, . ISBN: 9780393099362
3. Iain G, Main, *Vibrations and Waves in Physics,* Cambridge University Press, ISBN: 9780521447010

Course : Classical Mechanics

Code / Credit / Pre-req. : SCFI602113 / 4 SKS / Electricity and Magnetism, Vibrations, Waves, and Optics, Mathematical Methods in Physics 2, Mathematical Methods in Physics 3

Objective :

To apply the theory of classical mechanics on solving dynamics physics problem

Subjects :

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.

Bibliography :

1. S.T. Thornton and J.B. Marion, *Classical Dynamics of Particles and Systems*, 5th ed, Thomson Brooks/Cole, 2004.
2. V. Barger and M. Olsson, *Classical Mechanics: A Modern Perspective*, 2nd ed, McGraw-Hill, 1995.

Course : Electromagnetic Field 1

Code / Credit / Pre-req. : SCFI602114 / 3 SKS / Electricity and Magnetism, Vibrations, Waves, and Optics, Mathematical Methods in Physics 2, Mathematical Methods in Physics 3

Objective :

To apply the concept of time-independent electromagnetic field (static and steady) on solving the questions of physics related to electric and magnetic.

Subjects :

Electrostatic, problem-solution of electrostatic, electrostatic field in dielectric medium, electrostatic energy, electric current, magnetic field from steady current, the magnetic characteristic of matter, magnetic energy, electromagnetic induction

Bibliography :

1. J.R. Reitz, F.J. Milford, and R.W. Christy, *Foundations of Electromagnetic Theory*, 4th edition, Addison Wesley, 1993.
2. J. Vanderlinde, *Classical Electromagnetic Theory* 2nd ed, Kluwer Academics Publishers, 2005.
3. R. K. Wangness, *Electromagnetic Fields*, Willey, 1986
4. H. J. W. M. Kirsten, Electrodynmics *: An Introduction Including Quantum Effects*, World Scientific, 2004.
5. D.J. Griffiths, *Introduction to Electrodynamics*, 3rd edition, Prentice Hall, 1999.

Course : Laboratory Work of Advanced Physics

Code / Credit / Pre-req. : SCFI602122 / 1 SKS / Modern Physics

Objective :

To do the simple experiment of modern physics and analyze the result.

Subjects :

Hall effect experiment : to calculate Hall coefficient of a material, Photoelectric effect experiment, Planck coefficient in blackbody radiation, Zeeman effect, Franck-Hertz experiment, the calculation of the charge t- mass ratio of the electron in cathode ray deflection experiment, the experiment of gamma-ray absorption and Geiger – Muller detector, the experiment of Michelson interferometer, thermal conductivity in metal using newton method, Millikan experiment in charge electron measurement, Stefan Boltzmann experiment in emissivity of radiator surface, and the experiment of Faraday rotation to calculate Verdet coefficient.

Bibliography :

1. J.P Holman, *Experimental Method for Engineers*, 7th ed., McGraw-Hill Book,Inc,. 2001
2. Ogawa Seiki, *Instruction Manual: Franck-Hertz demonstration*, OGAWA SEIKI, Tokyo Central PO Box No.1618 Tokyo,Japan, 1987.
3. Ogawa Seiki, *Instruction Manual: e/m Demonstration Apparatus*, OGAWA SEIKI, Tokyo Central PO Box No.1618 Tokyo Japan, 1987

4. Leybold-Heraeus, *Physics Experiment*, vol. 1,2 & 3, Leybold GmBH, 1986.

5. Krane,Kenneth, *Modern Physics*, 2nd ed., Mc Graw Hill, 1996.

6. H.D. Resnick dan J. Walker, *Fundamental of Physics,* 6th ed., John Wiley & Son, Inc, 2001.

7. Pasco *Heat conduction Apparatus*, Instruction Manual 012-09189A, www.pasco.com, 2012.

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

Course : Electronics 2

Code / Credit / Pre-req. : SCFI602312 / 3 SKS / Electronics 1

Objective :

To understand the principles of digital electronics and able to apply its method in designing the latest electronics system.

Subjects :

Introduction of digital electronics, number system in digital, basic logic gates, introduction to digital electronics design with VHDL. Programmable logic device : CPLDs, FPGAs with VHDL design, combination logic circuits and reduction techniques : Boolean algebra, Karnaugh map, Quine McCluskey tabular method, arithmetic circuit, IC with MSI circuit design : decoder, encoders, Multiplexers and Demultiplexers, magnitude comparators, digital electronic families (DTL, TTL, CMOS, ECL), characteristic and their interfacing, Flip-flop and its application : shift registers, Asynchronous (Ripple) Counter, Synchronous (Parallel) Counter, Algorithmic State Machines (ASM) or Finite Sate Machine (FSM), Multivibrator and Timer 555, ADC and DAC, microprocessor fundamentals and The 8501 microcontroller.

Bibliography :

1. W. Kleitz, Digital Electronics, A Practical Approach, 9th edition, Prentice Hall, 2012.
2. R. J. Tocci, N.S. Widmer, G.L. Moss, Digital Systems; Principles and Applications, Pearson Prentice-Hall, 2015.
3. J. Bignell, R. Donovan, Digital Electronics, 5th edition, Delmar Cengage Leraning, 2006.

Course : Laboratory Work of Electronics 2

Code / Credit / Pre-req. : SCFI602322 / 1 SKS / Electronics 1, Laboratory Work of Electronics 1

Objective :

To apply the principles of digital electronics for analyzing and designing digital electronics circuit system.

Subjects :

Basic logic-gates circuit, combinational digital electronics circuits, applying Boolean algebra and Karnaugh map, encoder, decoder, multiplexer, de-mutiplexer, flip-flop counter, shift register, arithmetic circuit, VDHL for combinational circuit, VHDL for encoder, decoder, multiplexer, Demultiplexer, flip-flop and counter, VHDL for FSM, project, and presentation.

:Bibliography :

1. W. Kleitz, Digital Electronics, A Practical Approach, 9th edition, Prentice Hall, 2012.
2. R. J. Tocci, N.S. Widmer, G.L. Moss, Digital Systems; Principles and Applications, Pearson Prentice-Hall, 2015.

Course : Computational Physics

Code / Credit / Pre-req. : SCFI602021 / 4 SKS / Mathematical Methods in Physics 2. Mathematical Methods in Physics 3

Objective :

To apply the basics of programming algorithm and numerical method using software Matlab/Octave/Scilab or kind of, to finish physical problems in algebra or calculus form.

Subjects :

Introduction to programming algorithms, introduction to Matlab/Octave/Scilab, the introduction of matrix and matrices operation numerically, solution of root function theory using bisection method, False-Position and Newton-Raphson, solution of linier equation using gauss elimination method, LU decomposition and Jacobi iteration, fitting using least-square method, lagrangian interpolation, and cubic spline, solution of eigenvalue by using square and QR methods, first and second order numerical differential using Quadrature: Gauss-Lagrange, solution of differential equation with initial condition by Euler and Runge-Kutta order 4 method, solution of ordinary and partial differential equation (elliptic, parabolic, and hyperbolic) with boundary conditions using finite-difference approximation method.

Bibliography :

1. R.L Burden dan J. Douglas Faires, Numerical Analisys, 9^{th}, Cengage Learning, 2015
2. A. Gilat dan V. Subramaniam, Numerical Methods for Scientists and Engineers, 3th, John Wiley & Sons, 2014
3. A. Quarteroni, F. Saleri, P. Gervasio, Scientific Computing with Matlab and Octave, 3th, Springer, 2010
4. S. J. Chapra dan R.P. Canale, Numerical Methods for Engineers, 6^{th}, Mc. Graw Hill, 2009

Course : Electromagnetic Field 2

Code / Credit / Pre-req. : SCFI603115 / 3 SKS / Electromagnetic field 1, Mathematical Methods in Physics 2, Mathematical Methods in Physics 3

Objective :

To apply the concept and principle in electromagnetic field time-dependent on solving physics problem that involve electromagnetic interaction,

Subjects :

Maxwell equation, continuity equation, tensor of energy and momentum, poynting vector, gauge transformation, electromagnetic wave, reflection and refraction, wave guide, Lienard-Wiechert Potential, fields of moving charge, dipole radiation, radiation of accelerated charge, special relativity, and covariant form of Maxwell equation,.

Bibliography :

1. J.R. Reitz, F.J. Milford, and R.W. Christy, *Foundations of Electromagnetic Theory*, 4^{th} edition, Addison Wesley, 1993.
2. J. Vanderlinde, *Classical Electromagnetic Theory* 2^{nd} ed, Kluwer Academics Publishers, 2005.
3. Roald K Wangness, Electromagnetic Fields, Willey, 1986
4. Harald J W Muler Kirsten, Electrodynmics : An Introduction Including Quantum Effects, World Scientific, 2004

5. D.J. Griffiths, *Introduction to Electrodynamics*, 3rd edition, Prentice Hall, 1999.

Course : Statistical Physics

Code / Credit / Pre-req. : SCFI603110 / 4 SKS / Thermodynamics, Mathematical Methods in Physics 2, Mathematical Methods in Physics 3

Objective :

To apply the statistics principles, quantum mechanics theory, and semi-classical approximation toward systems which are consisted of many particles, to give microscopic explanation to macroscopic principles and phenomena, the generally know thermodynamics, and to provide simulation procedure, systematically microscopic to predict various thermodynamics characteristics of a system. Gases interaction, density of state, relativistic system, blackbody radiation, Planck distribution, Debye model, Bose-Einstein model, Bose-Einstein condensate, fermion, Pauli paramagnetism, landau diamagnetism, phase transition, liquid-gas transition, Ising model, mean-field theory, Landau theory, first-order phase transition, second-order phase transition, Landau-Ginzburg theory.

Subjects :

Microcanonical ensemble, canonical ensemble, chemical potential, classical partition function, equipartition energy, the Gibbs paradox and entropy, ideal gas on the grand canonical ensemble, Maxwell distribution, diatomic gas, interaction of gas, density of state, Relativistic system, black body radiation, Planck distribution, model Debye, Bose-Einstein distribution, Bose-Einstein condensation, fermion, paramagnetism Pauli, diamagnetism Landau, phase transition, liquid-gas transition, Ising model, the average field theory, Landau Theory, the transition phase of the first order, the transition phase of the second order, Landau-Ginzburg theory

Bibliography :

1. Reif, *Fundamentals of Statistical and Thermal Physics*, McGraw-Hill Book Company, 1985.
2. M. Guenault, *Statistical Physics*, Routledge, 1988.

Course : Quantum Mechanics 1

Code / Credit / Pre-req. : SCFI603110 / 4 SKS / Elementary Linear Algebra, Mathematical Methods in Physics 2, Mathematical Methods in Physics 3

Objective :

To explain the basic ideas of quantum mechanics and to apply on systems of simple quantum and atom such as hydrogen

Subjects :

Blackbody radiation, photoelectric effect, Compton scattering, wave-particle duality, Bohr atom, de Broglie wave, correspondence principle, wave packet, Heisenberg uncertainty principle, Schrödinger equation, wave function, normalization, expectation value, operator, commutation relation, stationer state, eigenvalue and eigenfunction, linier operator, Hermiticity, expansion theorem, the normalization of free wave, parity, degeneration, Dirac notation, representation, one-dimensional potential problems, simple harmonic oscillator and ladder operator, alteration of time-dependent expectation value, time-dependent operator, Schrödinger and Heisenberg model, N-particle system, central force, three-dimension Schrödinger equation, angular momentum, atom such as hydrogen.

Bibliography :

1. S. Gasiorowicz, *Quantum Physics* 2nd Ed., John Wiley & Sons, Inc., 1996.
2. A. Goswami, *Quantum Mechanics* 2nd Ed., Wm. C. Brown Publishers, 1997.

Course : Introduction to Nuclear Physics

Code / Credit / Pre-req. : SCFI603118 / 3 SKS / Modern Physics

Objective :

To explain the characteristic of atom, nuclear process, and the benefit of nuclear physics.

Subject :

Rutherford Scattering, nuclear Characteristics, binding energy, biding fraction, surface effect, separation energy, nuclear radius, the formulation of semi-empiric mass, nuclear spin, nuclear-electric moment, nuclear-magnetic moment, nuclear instability, radioactivity, nuclear models, nuclear force, particle physics, fundamental interaction, quark model, nuclear astrophysics, accelerator, detector, nuclear reactor, the benefit of nuclear physics.

Bibliography :

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.

Course : Introduction to Solid State Physics

Code / Credit / Pre-req. : SCFI603117 / 3 SKS / Modern Physics

Objective :

To formulate the solution of modern physics problem related to solid state and well-defined

Subject :

Solid state structure, solid state vibration/phonon, electronic structure, superconductivity, magnetism, dielectric, ferroelectric

Bibliography :

1. R. K. Puri dan V. K. Babbar, Solid State Physics, S. Chand & Company Ltd, 1997
2. C. Kittle, *Introduction to Solid State Physics* 8th Ed., Wiley, 2005.
3. J. R. Hook and H. E. Hall, *Solid State Physics* 2nd Ed, Wiley, 1991.
4. S. P. Thornton dan A. Rex, , *Modern Physics* 3rd Ed., Thomson Brooks/Cole, 2006.
5. K. Krane, *Modern Physics* 3rd Ed, Wiley, 2012.
6. R. Harris, *Modern Physics* 2nd Ed., Pearson, 2008.
7. J. Bernstein, P. M. Fishbane, and S. Gasiorowicz, *Modern Physics*, Prentice Hall, 2000.

Course : Quantum Mechanics 2

Code / Credit / Prereq. : SCFI603116 / 3 SKS / Quantum Mechanics 1

Objective :

To explain the implication of charged particle interaction with electromagnetic field, spin theory, and perturbation theory for solving non-relativistic quantum mechanics problems.

Subject :

The interaction of charged particle with electromagnetic field, gauge transformation, minimal coupling, matrix, spin, basis and representation mechanics, additional of angular momentum, Clebsch-Gordan coefficient, Spectroscopic notation, parity and the orbital angular momentum, time-independent perturbation theory, non-degenerate and degenerate, the real hydrogen atom, helium atom, the structure of atom, molecule, time-dependent perturbation theory, scattering theory, density matrix, pure and mixed state.

Bibliography :

1. S. Gasiorowicz, *Quantum Physics*, John Wiley & Sons, Inc., 1996.
2. A. Goswami, *Quantum Mechanics 2nd Ed*., Wm. C. Brown Publishers, 1997.

Course : Physics of Energy

Code / Credit / Pre-req. : SCFI602116 / 2 SKS / Introduction to Nuclear Physics, Thermodynamics

Objective :

To explain all of the energy source types, especially renewable energy

Subjects :

The utilization of source energy generally; fission nuclear energy, fusion nuclear energy, coal energy, oil and gas; water energy, micro hydro energy, tidal energy, wave energy, OTEC (Ocean Thermal Energy Conversion); biomass energy, biogas energy, thermal solar energy, solar cell energy, wind energy horizontal axis, wind energy vertical axis, geo-thermal energy, synthetic energy. Energy audit; co-generation.

Bibliography :

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
4. Journals about energy.

Course : Physics of Measurements

Code / Credit / Pre-req. : SCFI603310 / 2 SKS / Electronics 2

Objective :

To explain the theory and principle of physical measurements to do research experimentally in the laboratory

Subjects :

Measurement system (architecture, error, measurement standard), noise and coherent interference in measurement, principles of physical sense, sensor characteristic, DC Null measurement, AC Null Measurement, signal conditioning, digital technique in mechanics measurement, read out and data processing, examples of measurement system.

Bibliography :

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications., 3[ed], Springer-Verlag New York, Inc. 2004.
2. 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, 5[ed] , 1993.
3. Robert B. Northrop, Introduction to Instrumentation and Measurements, Taylor & Francis, 2[ed] , 2005.

Course : Seminar

Code / Credit / Pre-req. : SCFI604101 / 2 SKS / at least completed 112 SKS

Objective :

To explain how to write research proposal and thesis based on UI's rule and scientific journal and to do a good scientific presentation

Subjects :

Research project

Bibliography :

1. Decision letter of rector UI No. 628/SK/R/UI/2008 about handbook for thesis writing for Universitas Indonesia Student, June, 16 2008.
2. Summary form of thesis, Library of 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.

Course : Undergraduate Thesis

Code / Credit / Pre-req. : SCFI604102 / 6 SKS / at least completed 114 SKS

Objective :

To write thesis and scientific journal, and to defend the presentation at the final seminar project

Subjects :

Research project

Bibliography :

1. Decision letter of rector UI No. 628/SK/R/UI/2008 about handbook for thesis writing for Universitas Indonesia Student, June, 16 2008.
2. UI Rector Decree number 2276/SK/R/UI/2013, about the Organization of the Undergraduate Program at the University of Indonesia, November 1, 2013.
3. The decision letter of the Dean of the SCIENCE FACULTY UI number 111/UN2. F3. D/HKP. 19/2014, about the completion of the categorization Guidelines 8 September 2014.
4. The procedure of collecting the final project (Thesis) S1, S2 and S3 (thesis) (Dissertation), Bibliography of the University of Indonesia, December 2012

Concentration of Theoretical Nuclear and Particle Physics

Course : Classical Field Theory

Code / Credit / Pre-req. : SCFI603414 / 4 SKS / Electromagnetic Field I, Classical Mechanics

Objective :

To Describes the fundamental classical fields, apply the covariant in the Lagrangian formulation of classical field, as well as using the mathematics of curved space-time geometry (non-Euclid) to analyze the gravitational field within the framework of general relativity as the curvature of space time phenomenon.

Subjects :

The Lorentz transformation, algebra and tensor calculus, a formulation of covariant electromagnetic field Maxwell, Lagrangian formulation, and the principle system for

Minimum continuous Action (field), the equations of Euler-Lagrange to scalar fields and Maxwell field (Klein-gordon), Noether's theorem, the energy-momentum tensor, transformation gauge, invariance gauge symmetry for Abelian and non-Abelian, the inertial mass of the equivalence of gravitational mass, field tensor and tensor calculus on manifolds is flat, the metric tensor, Christoffel symbol, covarian derivatives, the geodesic equation, curvature of the Riemann tensor, the Ricci tensor, Einstein equations for the gravitational field, the Schwarzschild solution, the Reissner-Nordstrom solution, de Sitter and anti-de Sitter black hole, topics, topics in cosmology.

Bibliography :

1. Lewis H. Ryder, *Introduction to General Relativity*, Cambridge University Press ,2009.
2. Sean M. Carroll, S*pacetime and Geometry: Introduction to General Relativity*, Addison-Wesley, 2004.
3. Moshe Carmeli, *Classical Fields: General Relativity and Gauge Theories*, John-Wiley and Sons,1982.

Course : Advanced Computational Physics

Code / Credit / Pre-req. : SCFI603416 / 3 SKS / Computational Physics

Objective:

To apply numerical approaches, making micro-programming algorithm, and translates them into a computer program using the programming language Fortran, or equivalent, to solve the problems of physics.

Subjects :

Search roots function, the completion of system of equations linear, fittings with the methods least-square, interpolation, numerical integration, solving an equation differential ordinary and partial with the boundary conditions, eigenvalue problem solving by using power method, the secular equation method.

Bibliography :

1. P. L. DeVries, *A First Course in Computational Physics*, John Wiley &Sons, Inc., New York, 1994.

2. W. H. Press, *et. al*., *Numerical Recipes in Fortran 77*, 2nd Ed., CambridgeUniversity Press, New York, 1992. (online / free download: http://www.nrbook.com/a/bookfpdf.php)
3. R. H. Landau & M. J. Paez, *Computational Physics: Problem Solving with Computers*, John Wiley & Sons, Inc., New York, 1997.
4. S. E. Koonin, *Computational Physics*, Addison-Wesley Publishing Co., Inc.,Redwood City, 1986.

Course : Nuclear and Particle Physics

Code / Credit / Pre-req. : SCFI603415 / 4 SKS / Quantum Mechanics 1, Introduction to Nuclear Physics

Objective:

To understand phenomena and the concept of the basis of nuclear physics and particle.

Subjects :

nuclear and particle physics experiments: measurements of mass and geometry of the core, types of particle detectors, particle accelerators and current status; nuclear physics: the Rutherford scattering, nuclear phenomena (global properties from the core), core models (microscopic model types and collective), nuclear radiation (alpha decay, beta and gamma); particle physics: properties and interaction of elementary particles, the concept of symmetry and transformation-discrete transformations in particle physics, the standard model for particle physics, the standard model predictions of confrontation with the experimental data, the model beyond the standard model of particle physics.

Bibliography:

1. A. Das and T. Ferbel, *Nuclear and Particle Physics*, World Scientific, 2003.
2. B. Povh, K. Rith, C. Scholz, F. Zetsche, *Particle and Nuclei, An Introduction to Physical Concepts*, Springer-Verlag, 2006.

Course : Relativistic Quantum Mechanics

Code / Credit / Pre-req. : SCFI604411 / 4 SKS / Quantum Mechanics 1

Objective :

To Apply the concepts and formulas of relativistic quantum mechanics to the problems of nuclear and particle.

Subjects :

review of non-relativistic quantum mechanics, Dirac operators, harmonic oscillator, â and $â^†$, Dirac delta functions, theory of interference do not depend of time, the oscillator is not harmonious, time dependent disorder theory, Fermi's the golden rule, the cross section scattering of Rutherford, relativistic notation, a natural unit, Maxwell's equations in the form of the relativistic wave equation, free photons, minimal substitution as well as its use to obtain the equation of the Lorentz force equation of free particles, the Mandelstam variables s , t, and u, as well as cross-symmetry, Klein-Gordon equation, solutions free particles, charged particle in an electromagnetic field A^μ , Scattering Amplitude two point particle without the spin with the electromagnetic field A^μ, scattering amplitude two point particles without the spin, Compton scattering point particle without spin, the cross-section scattering particle Coulomb point latitude without spin, Feynman rule for Coulomb scattering point particles without spin, Dirac equation and the Dirac matrices γ^μ , properties and algebra the Dirac matrices γ^μ, current opportunities and density for particle Dirac, Dirac equation for a free particle Dirac, interpretation for negative energy, particle scattering amplitude the Dirac field electromagnetic with A^μ , Coulomb scattering amplitude two particle Dirac, Coulomb scattering cross section of the latitude of the two particle Dirac, Feynman rules for particle Scattering of Dirac, Compton Dirac particles.

Bibliography :

1. J. D. Bjorken and S.D. Drell, *Relativistic Quantum Mechanics*, McGraw-Hill, 1964.

2. F. Halzen and A. D. Martin, *Quarks and Leptons*, John Wiley & Sons, 1984.

Course : Scattering Theory

Code / Credit / Pre-req. : SCFI603412 / 3 SKS / Quantum Mechanics 1, Introduction to Nuclear Physics

Objective:

To describe the scattering process using nonrelativistic quantum mechanics.

Subjects :

scattering kinematics, scattering wave function, scattering amplitude, cross section, the Born approximation, the Lippmann-Schwinger equation, propagator, scattering matrix, partial-wave technique, phase shift, density matrix, spin observables, numerical steps to solve the Lippmann-Schwinger equation for T-matrix.

Bibliography :

1. A. S. Davydov, *Quantum Mechanics*, 2nd Ed., Pergamon Press, 1976.
2. W. Glöckle, *The Quantum Mechanical Few-Body Problem*, Springer-Verlag, 1983.
3. R. L. Liboff, *Introductory Quantum Mechanics*, 2nd Ed., Addison-Wesley, Reading,Massachusetts ,1992.
4. M. E. Rose, *Elementary Theory of Angular Momentum*, Wiley, New York, 1957.

Mata kuliah : Quantum Field Theory

Code / Credit / Pre-req. : SCFI604413 /4 SKS / Relativistic Quantum Mechanics

Objective:

To explains the basic concepts and apply the practical formulation of quantum field theory in simple problems in nuclear and particle physics.

Subjects :

Equations of Euler-Lagrange equations for particles, Euler-Lagrange formalism to field, Hamiltonian formalism, Noether's theorem, quantization of harmonic oscillator, quantization of scalar field, the normal arrangement, space Fock, particles and anti-particles, propagator, the Dirac field quantization, projection operator, S-matrix, field interact, evolution operator, Wick's theorem, Feynman diagrams, the rate of decay, cross section , quantize the electromagnetic field, the invariant teralocal, electron-positron scattering, the scattering of Compton, discrete symmetry of the CPT, the electromagnetic form factors, renormalization Ward-Takahashi identity.

Bibliography:

1. A. Lahiri and P.B. Pal, *A First Book of Quantum Field Theory*, 2nd ed., Alpha Science Intl. Publ., 2005.
2. L.H. Ryder, *Quantum Field Theory*, 2nd ed., Cambridge Univ. Press, 1996.
3. S.M. Bilenky, *Introduction to Feynman Diagrams*, Pergamon Press, 1974.

Course : Theory of Angular Momentum

Code / Credit / Pre-req. :SCFI604414 / 4 SKS / Quantum Mechanics 2

Objective :

To explain the concepts related to the angular momentum and apply it to systems that have angular momentum.

Subjects :

Operators and transformations unitary, diagonalization the exponential form of the operator, the definition of angular momentum, eigenvalue relations commutation and commutes, the physical interpretation of angular momentum, angular momentum, the sum of two angular momentum, definitions of Clebsch-Gordan coefficients, relations on Clebsch-Gordan coefficients, calculation of coefficients of Clebsch-Gordan, symbols of 3j, 6j, and 9j, operator rotation and properties of ortogonalism harmonic functions of balls, iredusibel tensor, the Wigner-Eckart theorem, the sum of the two angular momentum, Racah coefficients, Maxwell's equations and multipole field in the form sferis, static interactions, and interaction of spin 1/2, application of nuclear systems, emissions of alpha particles by nuclei.

Bibliography :

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.
3. A. de-Shalit and I. Talmi, *Nuclear Shell Theory*, Dover Publications , 2004.

Concentration of Materials Physics

Course : Introduction to Materials Science

Code / Credit / Pre-req. : SCFI603511 / 3 SKS / Modern Physics

Objective :

To explain the basics of materials science and the application of physics to solve common problems in the field of materials

Subjects :

Overview of materials science, types of materials, process-nature relationship-materials structure, materials structure (structure: macro, micro, sub, crystal and electronic structure of atoms); bonding of atoms in the crystal, the binding energy; the unit cell; allotropy; directions and crystal planes; defects in the crystal; materials: metals and alloys, ceramics, polymers, composites, electronic and magnetic materials

Bibliography :

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. Donald R. Askeland, *The Science and Engineering of Materials*, 2nd S.I. Ed, Chapman & Hall, 1990.

Course : Research Methods of Materials

Code / Credit / Pre-req. : SCFI603514 / 2 SKS / Modern Physics

Objective :

To understand different methods and equipment for fabrication materials and explain important results from materials testings

Subjects :

Overview of the lab work materials, the principle stoichiometry in design composition materials, knowing preparation techniques materials: the integration of mechanical, solidification, sol gel, high power sonication: Laboratory work activities include the design and manufacture as well as ferroelectric and ferromagnetic materials testing.

Bibliography :

1. C. Suryanarayana and M. Grant Norton, *X-Ray Diffraction A Practical Approach*, Plenum Press, New York and London, 1998.
2. C. Suryanarayana, *Mechanical alloying and milling*, Progress in Materials Science 46, Pergamon Press, Elsevier Science Ltd., 2001.
3. Publication related scientific of sol gel rocess and ultrasonic.

Course : Ceramics Physics

Code / Credit / Pre-req. : SCFI604512 / 3 SKS / Introduction to Materials Science

Objective :

To explain the effects of the physical natures of chemical bonding, diffusion and the electrical conductivity, properties of glass, sintering, mechanical properties, thermal properties, dielectric properties, magnetic properties, and optical properties of ceramic materials.

Subjects :

Effects on the physical nature of chemical bonding, diffusion and electrical conductivity, formation, structure, and properties of glass, solid sintering, liquids sintering, and grain growth, mechanical properties, thermal properties, dielectric properties, magnetic properties and optical properties.

Bibliography :

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.

Course : Composite Materials

Code / Credit / Pre-req. : SCFI604513 / 3 SKS / Introduction to Materials Science

Objective :

To explains the basics of composites and their applications, matrix and reinforcement, the selection of matrix materials and reinforcement, reinforcement-matrix interface, and mechanical properties of composite isotropic.

Subjects :

Introduction, various types of composites and his application, various types of matrix and reinforcement, matrix and reinforcement materials selection, interface matrix - reinforcement, mechanical properties of composite isotropic and Rule of Mixtures, as well as the anisotropic model introduction in fiber amplifier is not interrupted.

Bibliography :

1. R. F. Gibson, *Principle of Composite Material Mechanics*, McGraw-Hill Book Co., Int. Ed, 1994.
2. D. Hull, *An Introduction to Composite Materials*, Cambridge University Press, 6th. Ed., 1992.

3. Scientific publication related composite.

Course : Thermodynamics of Materials

Code / Credit / Pre-req. : SCFI603513 / 3 SKS / Introduction to Materials Science

Objective:

To explain the principle thermodynamics in the materials to understand response materials
against the effects of treatment thermal.

Subjects :

The Law thermodynamics; property relationships; the equilibrium, electrochemistry, solution and the introduction of diagram the phase, defective solids , surface and interface , diffusion and kinematics reaction.

Bibliography :

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.

Course : Methods of Materials Characterization

Code / Credit / Pre-req. : SCFI603515 / 4 SKS / Introduction to Materials Science

Objective :

To Explains physics principle on various instruments test materials and apply various raw method for testing and characterization materials and be able to process data for the amount of the decline in various material properties

Subjects :

Basic principle X-Ray, XRD, XRF, TEM, SEM, EDS, DTA, TGA, DSC, UTM, Impact Test, LPSA, AAS, ESR. Permeameter, VSM. Various testing standards (including ASTM E 975-95), phase identification materials, heat capacity, heat conductivity, programme APD, Match and GSAS, mechanical properties testing and standardization, and application of ultrasonic, radiography and its application, *Eddy Current* techniques and applications, diffraction optical and applications, magnetic properties and standardization.

Bibliography :

1. B.D. Cullity, *Introduction to X-Ray Diffraction*, Addition Wesley, 1978

2. P.J. Goodhew dan F.J. Humphreys, *Electron Microscopy and Analysis*, Taylor & Francis, 1988
3. ASM Handbook Volume 10, *Materials Characterization*, ASM International, 1992
4. Puclications related scientific and materials characterization methods.

Course : Phase Transformation of Materials

Code / Credit / Pre-req. : SCFI604511 / 3 SKS / Introduction to Materials Science

Objective :

Students are expected to know the principle of the preparation of the materials mainly metal and inorganic materials and alloy generally as well as the process of the formation of the phase materials, primarily through the process of thermal; understanding the phenomena that occur in materials for thermal applications include the problem of diffusion and phase transformation kinetics; understand the principles and application of the phase diagram, a diagram of the TTT diagram of IT and or CCT (Continuous Cooling Transformation) as well as the technique of determination of the fraction of the phase transformation. This study will hopefully improve the analysis of the research results in the processing of students associated with phase transformation in materials issues.

Subjects :

The sense of Composition in Materials and the principle of Stoichiometry in the preparation of materials, the concept of Thermodynamics in Liquid-solid Phase Transformation, Phase Diagrams/balance, Transformation and Diffusion Without diffusion, Phase transformation kineti , Readout and processing of Data, examples of measurement system design.

Bibliography :

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/PPT Phase Transformation from internet; Publications related to the kinetics of phase transformations

Course : Materials Properties

Code / Credit / Pre-req. : SCFI603512 / 3 SKS / Introduction to Material Science

Objective :

To explain some general materials properties and importantly includes mechanical properties, physical and chemical properties, electrical properties, ionic and magnetic.

Subjects :

Mechanic Properties: *stress – strain* concept, the elastics deformation, plastic, dislocation and *strengthening mechanism*, *failure*; Electrical Nature, Ionic and Magnetic: conductivity, resistivity, semi conductivity, dielectric, magnetism and superconductivity; Physical and Chemical properties: thermal, optic, corrosion, and materials degradation.

Bibliography :

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*, 6^{th} Ed, Addison-Wesley Pub. Co., Bab 1 – 7, 1975
3. Donald R. Askeland, *The Science and Engineering of Materials*, 2^{nd} S.I. Ed, Chapman & Hall, 1990.
4. Scientific publications related to the properties of materials

Course : Internship in Materials Physics

Code / Credit / Pre-req. : SCFI604514 / 2 SKS / Introduction to Materials Science

Objective :

To apply the materials in lectures, theories and insights for learning on campus against the real applications are implemented in the field both in industry, research, services etc. Provide initial supply before students get into the world of work.

Subjects :

introduction of the mechanism of implementation Practice for student field work of Particular of Materials Science (PKLM), introduction to the place PKLM, K3 system applied and placement on the designated departments, preparation of the design of the program implementation, the determination of PKLM topics and topics for reports, data collection activities and the study of literature, a review of the implementation of PKLM, analyze the data and information obtained, additional more detailed data collection, analysis and experimentation if needed preparation of the draft report, PKLM, conducting literature reviews, and discussion are comprehensive, PKLM activity reporting & presentation

Bibliography :

Concentration of Condensed Matter Physics

Course : Spectroscopy 1

Code / Credits / Pre-req : SCFI603613 / 3 Credits/ Modern Physics, Vibrations and Waves, Electromagnetic Field 1, Classical Mechanics

Objective:

To explain the atomic and molecular spectroscopy methods, including spectroscopy rotation, vibration, electronic and analyze the results of spectroscopic experiments, as well as a review to the elements and surface spectroscopy

Subjects:

Interaction of electromagnetic waves (theory and experiments methods), rotational spectroscopy, vibrational spectroscopy, electron spectroscopy, atomic spectroscopy and analyzing surface spectroscopy.

Bibliography:

1. Collin N Banwell and Elaine M McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., McGraw-Hill Book Co.,Singapore, 1995.
2. J. Michael Hollas, *Modern Spectroscopy* 4th Ed., John Wiley& Sons, Ltd., Chichester, 2004.
3. James W Robinson, Eillen M Skelly Frame, George M Frame II, Undergraduate Instrumental Analysis 6th. Ed., Marcell Dekker, New York, 2005.
4. David W. Ball, *The Basic of Spectroscopy,* SPIE Publications, Washington, 2001.

Course : Solid State Physics I

Code / Credit / Pre-req : SCFI603611 / 4 Credits/ Quantum Mechanics 1, Statistical Physics, Introduction to Solid State Physics

Objective:

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

Subjects:

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).

Bibliography:

1. C. Kittel, *Introduction to Solid State Physics* 8th Ed., John Wiley& Sons, Inc., New York, 2005.
2. J. R. Hook and H. E. Hall,*Solid State Physics* 2nd Ed., John Wiley & Sons, Chichester, 1991.
3. N. W. Ashcroft and N. D. Mermin, *Solid State Physics,* Saunders College Publishing, Philadelphia, 1976
4. H. Ibach and H. Lüth, *Solid-State Physics* 4th Ed., Springer, New York, 2009

Course : Spectroscopy 2

Code / Credit / Pre-req : SCFI604611 / 3 Credits / Introduction to Solid State Physics, Quantum Mechanics 1,Vibrations and Waves, Thermodynamics

Objective:

Explain the magnetic spectroscopy method, electron spin resonance and nuclear, as well as Mossbauer spectroscopy, mass spectroscopy, chromatography, scanning tunneling spectroscopy, thermal analysis and analyzing the results of the spectroscopic experiments.

Subjects:

Characterization analytical materials with thermal radiation and electromagnetic interaction with the external field and the particles and methods of experiments, spectroscopic magnetic spectroscopy electron spin resonance (ESR) spectroscopy resonance nuclear spin (NMR) spectroscopy Mossbauer, mass spectroscopy, chromatography (GC and HPLC) , scanning tunneling spectroscopy and thermal analysis.

Bibliography:

1. James W Robinson, Eillen M Skelly Frame, George M Frame II, Undergraduate Instrumental Analysis 6th. Ed., Marcell Dekker, New York, 2005.
2. Collin N Banwell and Elaine M McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., McGraw-Hill Book Co., Singapore, 1995.
3. D.R. Vij, *Handbook of Applied Solid State Spectroscopy,* Springer, New York, 2006.
4. T. Hatakeyama, Z. Liu (Eds.), *Handbook of Thermal Analysis,* John Wiley and Son, Inc.,New York, 1998.
5. G. Gauglitz dan T. Vo-Dinh (Eds.), *Handbook of Spectroscopy,* Wiley-VCH Verlag GmbH & o, KGaA, Wienheim, 2003.

Course : Advanced Laboratory

Code/ Credits/ Pre-req : SCFI603622 / 4 Credits / Quantum Mechanics 1, Statistical Physics, Introduction to Solid State Physics

Objective:

To apply the skills of theoretical/ computational and/or experimental in a small research project on a topic from the field of condensed matter physics

Subjects:

Topics of theoretical / computational: the calculation of the structures of the energy bands using a variety of methods (tight-binding, linear combination of atomic orbitals, density functional theory, etc.), the calculation of various physical properties of solids (density state, conductivity optics, etc.), using the techniques of Green functions; Experimental topics: measurement and analysis of optical spectroscopy, ferromagnetic hysteresis, ferroelectric hysteresis, etc.

Bibliography:

1. Scientific journals / books in the field of physics and condensed matter physics that support and corresponding about research topics

Course : Advanced Computational Physics

Code / Credits / Pre-req : SCFI603416 / 3 Credits / Computational Physics

Objective:

To apply numerical approaches, making micro-programming algorithm, and translates them into a computer program using the programming language "'Fortran" or equivalent, to solve the problems of physics.

Subjects:

Finding root function, solving the system of linear equations, fitting with the least-squares method, interpolation, numerical integration, solving the ordinary differential equations and partial with the boundary conditions, solving eigenvalue problem by using the power method, the secular method equation.

Bibliography:

1. P. L. DeVries, *A First Course in Computational Physics*, John Wiley &Sons, Inc., New York, 1994.
2. W. H. Press, *et. al*., *Numerical Recipes in Fortran 77*, 2nd Ed., CambridgeUniversity Press, New York, 1992. (online / free download: http://www.nrbook.com/a/bookfpdf.php)
3. R. H. Landau & M. J. Paez, *Computational Physics: Problem Solving withComputers*, John Wiley & Sons, Inc., New York, 1997.
4. S. E. Koonin, *Computational Physics*, Addison-Wesley Publishing Co., Inc.,Redwood City, 1986.

Course : Solid State Physics 2

Code/ Credits/ Pre-req : SCFI603612 / 4 Credits / Quantum Mechanics 1, Statistical Physics, Introduction to Solid State Physics

Objective:

To explain the latest phenomena in solids and mechanisms that lie behind them

Subjects:

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)

Bibliography:

1. C. Kittel, *Introduction to Solid State Physics* 8th Ed., John Wiley& Sons, Inc., New York, 2005.
2. J . R. Hook and H. E. Hall,*Solid State Physics* 2nd Ed., John Wiley& Sons, Chichester, 1991.
3. N. W. Ashcroft and N. D. Mermin, *Solid State Physics,* Saunders College Publishing, Philadelphia, 1976
4. H. Ibach and H. Lüth, *Solid-State Physics* 4th Ed., Springer, New York, 2009

Course : Capita Selection of Condensed Matter

Code/ Credits/ Pre-req : SCFI604613/ 3 Credits/ Quantum Mechanics 1, Statistical Physics, Introduction to Solid State Physics

Objective :

To explain the latest phenomena in condensed matter physics and its applications for the technology of the future, including the concepts, the analytical and the numerical methods for calculating physical quantities associated.

Subjects :

Strong electron correlation system, nanoscience, mesoscopic system, analytical and numerical method such as Green's functions, linear response theory, the average of field approach in static and dynamic, etc.

Bibliography :

1. Scientific journals / books in the sphere of physics and condensed matter physics

Course (Elective) : Green’s Function Method in Condensed Matter Physics

Code/ Credits/ Pre-req : SCFI603614 / 2 Credits / Mathematical Physics 1, Mathematical Physics 2, Mathematical Physics 3

Objective :

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.

Subjects :

Why Green function is required, 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.

Bibliography :

1. G. Rickayzen, *Green's Functions and Condensed Matter*, Academic Press, 1980.
2. S. Doniach and E.H. Sondheimer, *Green's Functions for Solid State Physicists*, Imperial College Press, 1998.
3. Gerald D. Mahan, *Many-Particle Physics* 3rd Ed, Kluwer Academic/Plenum Publishers, 2000.

Concentration of Instrumentation Physics

Course : Embedded System

Code/ Credits/ Pre-req : SCFI604713/ 3 Credits/ Electronics 2

Objective :

To explain the design principles of embedded systems, real-time operating systems, and its programming and be able to apply them in the design of embedded system applications.

Subjects :

Introduction to Embedded Systems: Embedded System definition, examples of embedded systems, microprocessors and microcontrollers; microcontroller architecture; memory organization; The minimum system microcontroller based; sets of instructions; Parallel Input / Output; 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: USART, SPI, I2C, 1-Wire; Multi-tasking and Real-time Operating Systems (RTOS); Connectivity and Networking: USB, Bluetooth, Zigbee, Controller Area Network (CAN).

Bibliography :

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.

Course : Computer-Based Data Acquisition

Code / Credits / Pre-req : SCFI604714/ 2 Credits / Electronics 2

Objective :

To explain various basic technique for data acquisition using LabVIEW software or programming language based computer.

Subjects :

The introduction of data acquisition system based computers, the introduction of graphical programming with LabVIEW, Input - Output on the computer system, the techniques - techniques of signal conditioning, conversion Signal Analog to Digital (ADC) and Digital to Analog (DAC), the data communication system of serial and parallel, example - a simple example of the acquisition of computer-based design techniques.

Bibliography :

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.

Course : Sensors and Actuators 1

Code / Credit / Pre-req : SCFI603711/ 2 Credits / Electronics 2

Objective :

To explain the working principle of sensors and actuators, selecting and choosing the right sensors and actuators for specific uses, and applying it to a monitoring and measurement of physical quantities.

Subjects :

Temperature sensors (Thermistors, Resistance temperature sensors, Silicon resistive sensors, Thermoelectric sensors, PN junction temperature sensors, and optical temperature sensors), Mechanics Sensors (pressure sensors, flow sensors, level sensors), definitions, classifications, and characteristic of actuator like electric and hydraulic actuator.

Bibliography :

1. Webster, John G., *The Measurement, Instrumentation and Sensors Handbook*, CRC Press, 1999.
2. Fraden, J. , *GAIP Handbook of Modern Sensors, Physics, Designs and Applications*, J American Institute of Physics, 2004.
3. 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, 6^{ed} , 2006.

Course : Instrumentation Physics 1

Code / Credits / Pre-req : SCFI603712/ 2 Credits / Electronics 2

Objective :

To explain the basic principles of instrumentation system.

Subjects :

Types of instrumentation, modeling of instrumentation systems, RLC Meter, Lock-In Amplifier, Impedance meters, Bioimpedance Analyzer, Spectrum Analyzer, Vector Network Analyzer

Bibliography :

1. Boyes, Walt, *Instrumentation Reference Book, 3rd Ed,* Butterworth – Heinemann, 2003.

2. Webster, John G., *Measurement Instrumentation and Sensor Handbook,* CRC Press, 1999.

Course : Control Systems

Code / Credits / Pre-req : SCFI603716 / 4 Credits / Electronics 2

Objective :

To analyze and design control systems for continuous linear systems.

Subjects :

Analysis of Control Systems : introduction to the concept of feedback and control system, the Laplace transform, the transfer function of linear system, linearized the nonlinear system, mathematical modeling system, the system of mechanical and electrical, block diagram model, graph model of flow signal, state variables model, the analysis of signal error, the sensitivity of the control system feedback to the variation of the parameter control, Signal interference in the feedback control system, control the transient response of the system, the error at steady state (steady state error), system performance in second-order, effect of the third pole and zero in response of second-order system, the performance index of the control system, the simplification of the linear system, analyzing the system stability of open loop and closed loop, testing the stability of the system using the method of characteristic functions and Ruth Hurwitz methods; Design of Control Systems: the concept of root locus, design parameter control using root locus method, Determination of PID parameters with the trial and error method, the identification process for the open-loop stable system, the determination of PID parameters to the method: Direct Synthesis, Inter Model Control, the performance index system , Ziegler Nichols, Cohen Coon and curves reaction; performance analysis of the frequency response of the system using Bode and Nyquist plots, the design of the control system Pi, PID, Lead, lag and Lead Lag, designing feedback systems with state variable.

Digital Control Systems

Bibliography :

1. Dorf, Richard C., and Bishop, Robert H., *Modern Control System*, Prentice Hall, 2011

2. Golnaraghi, Farid., and Kuo, Benjamin C., *Automatic Control System*, John Wiley & Son., 2010.

3. Seborg, Dale E., Edgar, Thomas F., and Mellichamp, Duncan A., *Process Dynamics and Control*, John Wiley & Son., 2004.

Course : Laboratory Work of Control System

Code/ Credits/ Pre-req : SCFI603726 / 1 Credits / Electronics 2

Objective :

To apply the principles of process control system for the identification and design of simple linear continuous system of a process that has a quick response and slower over time.

Subjects :

The introduction of a control system and programming language Matlab and LabVIEW, the representation of system using transfer function, state variables including linearization technique system, the system responds to a variety of standard signals, and its control techniques, determining PID parameters by methods 1. Trial and Error, 2. Direct synthesis, 3. Nichols Zieler reaction curve. Its application to control system of DC motor, inverted pendulum control, HVAC (heating, ventilation and air conditioning).

Bibliography :

1. Dorf, Richard C., and Bishop, Robert H., *Modern Control System*, Prentice Hall, 2011
2. Golnaraghi, Farid., and Kuo, Benjamin C., *Automatic Control System*, John Wiley & Son., 2010.
3. Seborg, Dale E., Edgar, Thomas F., and Mellichamp, Duncan A., *Process Dynamics and Control*, John Wiley & Son., 2004.
4. Quanser, *QNET DC Motor Trainer, QNET Rotary Pendulum Trainer, QNET Heating and Ventilation Trainer*, 2009

Course : Laboratory Work of Embedded System

Code / Credits / Pre-req : SCFI604723 / 1 Credits / Electronics 2

Objective :

To apply the design principles of embedded system, operating and programming systems; to analyze and design the applications of embedded systems.

Subjects :

The introduction of minimum system microcontroller and programming in Assembly language and C language; Parallel Input / Output; interrupts; Counters and Timers; Analog to Digital Converter (ADC) and Digital to Analog Converter (DAC); Interfacing External Peripherals and Devices: LCD, Keypad, Relay, DC Motor, Stepper Motor, Servo Motor, Real Time Clock (RTC); Serial Data Communication: USART, SPI, I2C, 1-Wire; Connectivity and Networking: USB, Controller Area Network (CAN)

Bibliography :

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*, 2^{nd} edition, Thomson Delmar Leraning, 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.

Course : Sensors and Actuators 2

Code / Credits / Pre-req : SCFI603713/ 2 Credits / Sensors and Actuators 1

Objective :

To explain sensors and actuators technology, selecting and choosing the best sensors and actuators for specific uses, and to apply it to monitoring and measured the physical quantities and chemistry quantities.

Subjects :

The optical sensor (Infrared and pyroelectric, UV, Visible, image sensor), a magnetic sensor (Magnetogalvanic Sensors, Magnetoresistive Sensors, Inductive and Eddy Current Sensor), biological sensors (Biosensors), pneumatic actuators, piezoelectric actuators, thermal bimorphs

Bibliography :

1. Webster, *The Measurement, Instrumentation and Sensors Handbook*, A CRC Handbook Publihed in Cooperation with IEEE Press, 1999.
2. J. Fraden, *GAIP Handbook of Modern Sensors, Physics, Designs and Applications*, J American Institute of Physics, 2004.

3. 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.

Course : Laboratory Work of Sensors and Actuators

Code / Credits / Pre-req : SCFI603723/ 1 Credits / Sensors and Actuators 1

Objective :

To design the electrical circuits for applications of sensor and actuators and used it for monitoring and measuring the physical quantities, making calculations, charts, analysis and conclusions based on experimental results and explains the physics concepts through experimentation and theory.

Subjects :

The design of electronic circuits and measured using temperature sensors, pressure sensors, flow sensors, level sensors, proximity sensors, load sensors, light sensors, magnetic sensors, chemical sensors, electric actuators, hydraulic actuators, and pneumatic actuators.

Bibliography :

1. Departemen Fisika FMIPA UI, Buku Panduan Praktikum Sensor dan Aktuator
2. Webster, John G., *The Measurement, Instrumentation and Sensors Handbook*, A CRC Handbook Publihed 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. 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.

Course : Digital Signal Processing

Code/ Credits/ Pre-req : SCFI604715/ 4 Credits / Modern Physics, Mathematical Methods of Physics 2, Electronics 2

Objective :

To explain the processing of digital system and able to perform signal processing in a discrete time domain and discrete frequencies, as well as applying for a digital filter applications.

Subjects :

The introduction of signal-system, the conversion of analog signals to digital signals and vice versa, discrete-time signal, Transformation Z and its application to systems of linear time invariant (LTI), the analysis of signal frequency continuous time, frequency analysis of discrete-time signal, Fourier transform for discrete-time signal, filter concept, FIR digital filter, IIR.

Bibliography :

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

Course : Instrumentation Physics 2

Code / Credits / Pre-req : SCFI603714/ 2 Credits / Instrumentation Physics 1

Objective :

To describe the instrumentation methods and techniques that are widely used in Physics

Subjects :

Introduction of instrumentation systems for equipment test analized. Thermal analysis test tools, spectroscopic (UV-Vis_IR, AAS, GC, HPLC, FTIR), XRD, XRF, SEM, TEM, AFM, NMR, EPR, and mechanical vibration,

Bibliography :

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.
4. Ahuja, S. and Jespersen, N. (Ed), *Modern Instrumental Analysis, Volume 47*, Elsevier, 2006

Course : Internship
Code / Credits / Pre-req : SCFI604742 / 2 Credits / -
Objective :

To apply the principles and practice in the observation, practice skills, train the student community in the work field both in industry, research or engineering technology.

Subjects :

Writing internship proposal for industries, research institutions (research laboratories, engineering and technology) or manufacturing industry, with an appropriate theme with concentration of Instrumentation Physics. Making observations, to the rhythm of work in the workplace practice, to make the analysis of the system, and recommend results in presentation format either in place or in the department work practices.

Bibliography : -

Concentration of Medical Physics & Biophysics

Course : Introduction to Radiology Physics
Code / Credits / Pre-req : SCFI603911/ 2 Credits / Modern Physics
Objective :

To explain the basic principles and concepts of radiation physics and dosimetry.

Subjects :

Classification of radiation, quantities and units of radiation, ionizing radiation directly and indirectly, the interaction of radiation with matter, exponential attenuation, radioactive decay, particle charged and the balance of radiation, radiation dosimetry, cavity theory, ionization chamber, calibration of photons and electrons with ionization chamber, relative dosimetry techniques, and absolute dosimetry techniques

Bibliography :

1. F. H. Attix. *Introduction of Radiological Physics and Radiation Dosimetry*,John Willey and Sons, New York, NY, 1986.
2. H. E. Johns and J. R. Cunningham. *The Physics of Radiology*, 4th ed., Charles C. Thomas, Springfield, IL, 1983.
3. J. F. Knoll. *Radiation Detection and Measurement*. 3rd. ed., John Willey and Sons, New York, NY, 2000.
4. Podgorsak, *Radiation Oncology Physics: Handbook for Teacher and Student*, IAEA, 2005.
5. Metcalfe, *et al*, *The Physics of Radiotherapy X-rays and Electron,* Medical Physics Publishing, 2007.

Course : Anatomy and Physiology

Code / Credits / Pre-req : SCFI603912 / 2 Credits / General Biology

Objective :

To define the medical terminology, identify roughly the anatomical structure, defining most of the organ systems, as well as describe the physiological mechanisms for the improvement, maintenance, and growth.

Subjects :

Nomenclature anatomy, bones, spinal column, thorax, abdomen, respiratory system, digestive system, urinary system, reproductive system, circulatory system, and pathology

Bibliography :

1. R. Putz dan R. Pabst, *Atlas Anatomi Manusia Sobotta,* EGC, 2010.
2. Serwood, *Fisologi Manusia: dari sel ke sistem,* EGC, 2001

Course : Introduction to Radiotherapy Physics

Code / Credits / Pre-req : SCFI604915 / 3 Credits / Introduction to Radiology Physics

Objective :

To explain the application of external and internal radiation beam produced by the therapy.

Subjects :

Introduction of radiation oncology, Radiobiology basic in radiotherapy, descriptions of clinical photon beam; Clinical photon beam: dose calculation; Clinical photon beam: basic clinical dosimetry; The electron beam clinical, basic physics characteristics in brachytherapy and clinical aspects brachytherapy

Bibliography :

1. AAPM Report No. 46. *Comprehensive QA for Radiation Oncology*, American Institute of Physics, New York, 1994
2. AAPM Report No. 47. *AAPM Code of Practice for Radiotherapy Accelerator*, American Institute of Physics, New York, 1994
3. AAPM Report No. 67. *Protocol for Clinical Reference Dosimetry of High Energy Photon and Electron Beams*, American Institute of Physics, New York, 1999.
4. IAEA Report No. 23. *Absorbed Dose Determination in Photon and Electron Beams. An International Code of Practice*, International Atomic Energy Agency, Vienna, Austria, 1987.
5. ICRU Report No. 38. *Dose and Volume Specifications for Reporting Intracavitary Therapy in Ginecology,* International Commission on Radiation Unit and Measurements, Bethesda, MD, 1985.
6. ICRU Report No. 50. *Prescribing, Recording and Reporting Photon Beam Therapy,* International Commission on Radiation Unit and Measurements, Bethesda, MD, 1993.
7. H. E. Johns and J. R. Cunningham. *The Physics of Radiology*, 4th ed., Charles C. Thomas, Springfield, IL, 1983
8. S. C. Klevenhagen, *Physics and Dosimetry of Therapy Electron Beams*, Medical Physics Publishing, Madison, WI, 1993
9. W. J. Meredith and J. B. Massey. *Fundamental Physics of Radiology*. 3rd ed., J. Wright, Bristol, UK, 1977
10. J. Van Dyk (Editor). *The Modern Technology of Radiation Oncology* (Medical Physics Publishing, Philadephia, PA, 1999
11. J. R. Williams dan D. I. Thwaites. *Radiotherapy Physics in Practice*, Oxford University Press, New York, 1994
12. Siamak Shahabi (Editor). *Blackburn's Introduction to Clinical Radiation Therapy Physics*, Medical Physics Publishing Corporation, Madison, Wisconsin, 1989

13. P. M. K. Leung. *The Physical Basis of Radiotherapy*, The Ontario Cancer Institute incorporating The Princess Margaret Hospital, 1990.
14. G. C. Bentel, C. E. Nelson, dan K.T. Noell. *Treatment Planning Dose Calculation in Radiation Oncology*. McGraw Hill, New York, NY, 1989.

Course : Introduction to Biophysics

Code / Credits / Pre-req : SCFI603919 / 2 Credits / General Biology

Objective :

To explain the concept of biophysics especially physics processes in living organisms and the application of the physical sciences in the study of living things.

*Subject*s :

Cells, the physics of the human body, the application of physics methods in the study of living creatures

Bibliography :

1. John R. Cameron. Physics of the Body, Medical Physics Publishing Corp, 1999
2. Roland Glaser, *Biophysics*, Springer, 2001.
3. V. Pattabhi. Biophysics, Springer, 2002

Course : Health Physics and Radiation Protection

Code/ Credits/ Pre-req : SCFI603914/ 2 Credits/ Introduction to Radiotherapy Physics

Objective :

To explain the knowledge about the relationship between microscopic interactions with cell responses, deterministic and stochastic effects, radiation detection equipment and radiation protection.

Subjects :

Introduction, Shielding: properties and design, nuclear counting statistic, radiation monitoring for personnel, internal exposure, environmental dispersion, biological effect, Regulation about radiation protection, garbage disposal of low and high degree, and non-ionizing radiation

Bibliography :

1. ICRP No. 60. 1990 *Recommendations of International Commission on Radiological Protection*, Elsevier Science, 1990.
2. Herman Cember, *Introduction to Health Physics*. 2nd ed., Pergamon Press Inc. New York, NY. 1983.
3. RL. Kathren, *Radiation Protection*, Adam Hilger LTD., Bristol, 1985.
4. D. A. Gollnick. Basic Radiation Protection Technology. 2nd ed., Pacific Radiation Corporation, Altadena, CA, 1993.

Course : Radiobiology

Code / Credits / Pre-req : SCFI603915 / 2 Credits / Anatomy and Physiology

Objective :

To explain the radiation effects on living cells occur in all the medical activities that utilize ionizing radiation, in the areas of diagnostics, radiotherapy and nuclear medicine

Subjects :

Review the interaction of radiation with matter, radiation injuries to DNA, DNA damage repair and repair of chromosome induced by radiation, the theory of the survival curve, cell death: the concept of cell death (apoptosis and reproductive cell death), the healing process of cellular, cell cycle, modifiers responses radiation-sensitizer and protector, RBE, OER, and LET, kinetic cell, tissue radiation injuries, pathology radiasi- acute and late effects, histopathology, tumor Radiobiology, TDF (time, dose, and fractionation), radiation genetics: the effects of radiation on fertility and mutagenesis and molecular mechanisms

Bibliography :

1. G. Gordon Steel (Editor). *Basic Clinical Radiobiology*, Edward Arnold,London, UK, 1993.
2. Eric J. Hall . *Radiobiology for the Radiologist*. 5th ed., Lippincott Williams and Wilkins,Philadelphia, PA, 2000.

Course : Laboratory Work of Medical Physics and Counter System

Code / Credits / Pre-req : SCFI603927 / 1 Credits / Introduction to Radiology Physics

Objective :

To conduct an experiment of scintillation measurements, nuclear spectroscopy, the use of diode detector, TLD etc.

Subjects :

Design Shielding space plane X-ray characterization of various materials shielding against X-ray energy, calibration of Nuclear Spectroscopy MCA, readings about monitoring individual dose film badge, calibration surveymeter, Nuclear spectroscopy Single Channel Analyzer (SCA), characterization of detector Geiger Mueller, the determination of the type of radionuclides and dose readings TLD

Bibliography :

1. ICRP No. 60. 1990 *Recommendations of International Commission on Radiological Protection*, Elsevier Science, 1990
2. Herman Cember, *Introduction to Health Physics*. 2nd ed., Pergamon Press Inc. New York, NY. 1983.
3. RL. Kathren, *Radiation Protection*, Adam Hilger LTD., Bristol, 1985.
4. D. A. Gollnick. *Basic Radiation Protection Technology*. 2nd ed., Pacific Radiation Corporation, Altadena, CA, 1993.

Course : Introduction to Medical Imaging and Nuclear Medicine

Code/ Credits/ Pre-req : SCFI604916 / 3 Credits / Introduction to Radiology Physics

Objective :

To explain the basic principles of radiography, mammography, dental radiography, computed tomography, ultrasound, magnetic resonance imaging (MRI) and nuclear medicine.

Subjects :

To make image and contrast, radiography receptor, the film-screen radiography and fluoroscopy, radiography and digital fluoroscopy, mammography, and dental radiology. To make CT image, CT image quality, Imaging Resonance Magnetic Physics. To make MRI image, the principle of Ultrasonography Physics, making ultrasonography image, the principle of Gamma camera, radiopharmacy and pharmacokinetics, Internal dosimetry, SPECT-CT, PET and cyclotron, and QA of nuclear medicine equipment.

Bibliography :

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. Adrienne Finch (Editor). *Assurance of Quality in the Diagnostic Imaging Department*, The British Institute of Radiology, London, 2001
5. G. ter Haar and F. A. Duck (Editor). *The Safe Use of Ultrasound in Medical Diagnostic*, The British Institute of Radiology, London, 2001.
6. AAPM Report No. 39. *Specification and Acceptance Testing of Computed Tomography Scanners*, American Institute of Physics, New York,1993.
7. AAPM Report no. 76. *Quality Control in Diagnostic Radiology*, American Institute of Physics, New York, 2002.

Course : Introduction to Biomaterials

Code / Credits / Pre-req : SCFI604917 / 2 Credits / Introduction to Solid State Physics

Objective :

To explain the concept and the application of biomaterials

Subjects :

Introduction to materials, ceramics, metals, polymers, composition and structure of the mineral components of hard tissue, synthesis materials biomimetic, dan microstructure of materials. The effect of simple ion and complex ion in HAP, Materials Tri Calcium Phosphate, biocomposites, bioactive glass and ceramic glass, Biocompatibility of materials, the use of clinical calcium phosphate.

Bibliography :

1. Buddy D. Ratner. Biomaterials Science : An Introduction to Materials in Medicine , Academic Press, 2012
2. C. Mauli Agrawal. Introduction to Biomaterials: Basic Theory with Engineering Application. Cambridge Press, 2013

Course : Advanced Biophysics

Code / Credits / Pre-req : SCFI604918 / 2 Credits / Introduction to Biophysics

Objective :

To understand the electromagnetics and optics applications in biological and human systems.

Subjects :

Electric-magnetic propagation network, biophysical physiology phenomenon, biophysical of nerve cells and brain, biosensor applications, medical imaging applications, application of biophysical stimulation therapy, biosensors, biosensor applications, OCT

Bibliography :

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. Prasad, P.N., “Introduction to Biophotonics”, (Wiley-VCH), 2003
4. Wang, LV and Wu HI, Biomedical Optics, Principles and Imaging, (Wiley-VCH), 2007
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.

Course : Introduction to Medical Instrumentation

Code / Credits / Pre-req : SCFI604919 / 2 Credits / Electronics 2

Objective :

To explain the basic of instrumentations and electronics, especially on medical equipments.

Subjects :

The basic of electronic instrumentation and sensors basic with its principles and applications, amplifiers and signal processing, Biopotensial: blood pressure and sound, flow and blood volume measurements, the respiratory system measurement, chemistry biosensor, clinical laboratories instrumentation, prosthetic and physiotherapy equipment, electrical safety, radiation detectors, radiotherapy machine (Co 60 and kV X-ray) and LINAC

Bibliography :

1. J. G. Webster, *Medical Instrumentation: Application and Design*, John Wiley & Sons, New York, 1998.

Course : Laboratory Work of Radiology Physics

Code / Credits / Pre-req : SCFI604921 / 1 Credits / Introduction to Radiology Physics

Objective :

To conduct experiments related to radiological physics and dosimetry measurements

Subjects :

Kerma and X-rays dose measurements, HVL determination of diagnostic radiological planes, Radiochromic Film Calibration, TLD Calibration, Kerma and Co-60 Output Measurements, Output Calibration of Photon and Linac Electrons.

Bibliography :

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. Podgorsak, *Radiation Oncology Physics: Handbook for Teacher and Student*, IAEA, 2005.
5. Metcalfe, *et al*, *The Physics of Radiotherapy X-rays and Electron*, Medical Physics Publishing, 2007.

Course : Internship

Code/ Credits/ Pre-req : SCFI604941 / 2 Credits / Introduction to Radiology Physics, Radiobiology

Objective :

To understand some important facilities in hospitals such as radiotherapy, diagnostic radiology and medical nuclear.

Subjects :

Clinics Orientation, introduction to diagnostic radiology equipment, introduction to radiotherapy equipment, introduction to radiology and radiotherapy dosimetry, quality assurance of diagnostic and therapy radiology equipment, and planning radiotherapy

Bibliography :

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 spwcializing in Nuclear Medicine* , Vienna, 2009

SYLLABUS

MASTER IN MATERIALS SCIENCE

A. Compulsory Courses of Master by Research Programs

1. Course: General Materials Science

Code / Credits / Prerequisites: SCMS801101 / 4 Credits / -

Objective:

The aim of this course is to provide a basic understanding and broad scope of materials science. Debriefing general materials science can make it easier for participants to follow other subjects in more detail and depth according to the topic to be taken

Subjects:.

This course discusses the nature and structure of atoms and crystals of materials, electronic configurations, chemical bonds, metallic, covalent, crystallographic foundations, impurity of materials, impurability in materials, dislocations and interactions, and defects on the surface. This section also describes the types of failure in materials such as fatigue, brittle creep faults and embrittlement. Surface energy, ceramics vitrification and the sintering process are also discussed. Diffusion theory, magnetic properties in materials, dielectric materials, electronic materials, ceramics, polymers and composites are also discussed.

Bibliography:

- William D. Callister, Jr., Materials Science and Engineering: An Introduction, Third Edition, Toronto, John Wiley & Sons, Inc., 1994
- Lawrence H. Van Vlack, Materials Science for Engineers , Sixth Printing 1975, Amsterdam, Addison-Wesley Publ.Co

2. Course: Materials Thermodynamics

Code / Credits / Prerequisites: SCMS801102 / 3 Credits / -

Objective:

The materials thermodynamics course discusses state functions, process variables, intensive and extensive properties of materials. Specifically, the notion of the use of parallel differentials in thermodynamics is discussed, equilibrium criteria and analytic relationships of several variables related to materials thermodynamic processes.

Subjects:

Use of the first thermodynamic law, work concept, equation of state, application of the second law of thermodynamics, heat capacity, Joule-Thompson calculation, binary phase diagram with application of Claussius-Clapeyron equation, concept of vapor pressure, enthalpy calculation, entropy, Gibbs free energy , Gibbs-Helmholtz equation, specifically thermodynamics statistics which are related to the randomness of entropy. Binary system and phase diagram calculation, using Elingham diagram, calculation of activity coefficients, fugacity concept, Raoult's law. Henry's law concerning the deviation of the nature of ideality, as well as calculating the equilibrium coefficient for metallurgy process reactions. The third thermodynamic law, empirical rules from Richard and Trouton, multi-component systems, oxidation processes, Gibbs-Duhem equations and ternary phase calculations, the concept of surface energy and the process of crystal defects occurring by thermal processes, and calculation of materials resistivity.

Bibliography:

- David V. Ragone: Thermodynamics of Materials, Vol I and Vol II, John Wiley & Sons, 1995
- Gaskel, Introduction to Metallurgical Thermodynamics , 3rd ed., London: Taylor & Francis, 1995
- Swalin, Thermodynamics of Solid , Hoboken, New Jersey: Wiley, 1972
- R. Q. DeHoff, Thermodynamics in Materials Science , McGraw-Hill, 1993

3. **Courses : Crystallography of Materials and Diffraction Techniques**

Code / Credits / Prerequisites: SCMS801103 / 3 Credits / None

Objective:

Provide the basics of crystallography and diffraction techniques.

Subjects:

History and understanding of crystallographic science, aspects of crystal geometry and crystal structure, crystalline symmetry, space group and group groups, x-rays, initial studies of crystal system determination, scattering intensity, determination of lattice parameters for powder methods, x-ray diffraction on polycrystalline and amorphous, modeling on data analysis (example: rietveld smoothing method), other diffraction techniques (neutron diffraction, electron diffraction, SAXS), and similar techniques (SEM / EDAX, XRF, EXAFS)

Bibliography:

- BD Cullity and SR Stock, Element of X-ray Diffraction , Prentice Hall, 2001
- FC Phillips, An Introduction to Crystallography , Longman, London, 1970
- C. Suryanarayana and M. Grant Norton, X-ray Diffraction a Practical Approach , Plenum Press, 1998
- Q. Hahn (editor), International Table for Crystallography, Reidel, Dordrecht,
- AR West, Solid State Chemistry and Its Application, John Wiley & Sons, 1995
- C. Giacovazzo et al., Fundamental of Crystallography, IUCr, Oxford Science, 2001
- EF Kaelble (ed.), Handbook of X-rays: for diffraction, emission, absorption and microscopy , McGraw-Hill Book Company, New York, 1967

4. **Course : Materials Phase Transformation**

Code / Credits / Prerequisites: SCMS801104 / 3 Credit / None

Objective:

Students are expected to be able to know the principle of materials preparation, especially metals and alloys and generally inorganic materials and the process of forming materials phases, especially through thermal processes, understanding the phenomena that occur in materials during thermal applications including diffusion problems and phase transformation kinetics; understand the principles and applications of phase diagrams, TTT diagrams or IT and CCT (Continuous Cooling Transformation) diagrams and techniques for determining transformation phase fractions. This learning is expected to improve students' analytical skills in processing their research results related to the problem of phase transformation in materials.

Subjects:

In this course, the first concept of materials preparation includes the principle of conservation of mass in materials composition, composition conversion between percent atom (at.%) And weight percent (wt.%) And vice versa and introduced materials preparation techniques such as arc melting, induction melting , solid state reaction or powder metallurgy etc. An overview of several topics in classical thermodynamics will be carried out to understand the mechanism of formation of materials phases in the solidification process.

The thermodynamic concepts will also be used for understanding the phase diagrams as well as the analysis of transformations in one-component and multi-component systems. The students are taught how to read, analyze (take the case of the Fe single-component system and the Fe-C binary system) and construct the phase diagram from thermodynamic data.

The next discussion is a review of the basic concepts of kinetic phenomena in the materials including understanding the diffusion mechanism and diffusion theory (Fick I and II) followed by a physical review of the basic transformation kinetic equation (Avrami) and its application especially in constructing Time Temperature Transformation (TTT) or Isothermal Trans (IT) diagrams. Several methods of determining the phase fraction of transformation are also introduced in detail.

Bibliography:

- DA Porter and KE Easterling, Phase Transformations in Metals and Alloys , Van Nostrand Reinhold, New York, 1981
- AK Jena and MC Chaturvedi, Phase Transformations in Materials, Prentice Hall, New Jersey, 1992

5. **Course: Technical Economics**

Code / Credits / Prerequisites: SCMS801105 / 2 Credit / None

Objective:

Provide insights to students who have a non-financial background to understand the concept of investment, business feasibility, business risk, business value, shareholder value, management of corporate wealth, long-term funding strategies, short-term funding strategies, understanding the market conditions of financial markets capital and financial markets, macroeconomic conditions in Indonesia. This learning is expected to improve the analytical skills and abilities of students' management decision making in the business activities that they will later engage in.

Subjects:

Company financial statements, earnings (loss), cash flow reports, project feasibility studies or investment activities, how to determine Free Cash Flows to Free Cash Flows to Equity, calculate the Net Present Value of free cash flows, determine the value of the company, shareholder value, review the conditions of the capital market and money market in Indonesia.

6. **Course : Advanced Laboratory Work**

Code / Credits / Prerequisites: SCMS801106 / 3 Credits / SCMS801101

Objective:

Students are expected to be able to understand how to work, use, analyze data on several analytical equipment such as DTA-DSC, XRD, SEM / EDAX, FTIR, XRF. At the beginning of the semester students are given *unknown samples* to be identified qualitatively and quantitatively with appropriate tools.At the end of the semester students are required to make a report and present the results obtained.

Subjects:

Introduction (overview, assignment, group division, sample preparation), How to work and XRD and XRF analysis; How it works and analyzes the Optical Microscope, SEM / EDS; Optical Spectroscopy (UV-vis, IR, AAS); Thermal Analysis (DTA-DSC); XRD and XRF Practicum; Structure Analysis with XRD; GSAS; How it works and Analysis with SEM; How to work and analysis with FTIR; SEM Practicum; Practicum FTIR or DTA / DSC; Analysis and Presentation.

Bibliography:

- C. Suryanarayana and M. Grant Norton, X-ray Diffraction a Practical Approach , Plenum Press, 1998
- HH Willard, LI Merrett Jr., JA Dean and FA Settle Jr., Instrumental Methods of Analysis , Wadsworth Publishing Company, Belmont, 1988
- Robert D. Braun, Introduction to Instrumental Analysis , McGraw-Hill Editions, 1987
- L. B. McCusker et al., Rietveld Refinement Guidelines , J.Appl. Cryst., 32 , 36-50, 1999
- Allen C. Larson and Robert B. Von Dreele, GSAS: General Structure Analysis System , LAUR 86-748, Los Alamos National Laboratory, 1998
- http://www.ncnr.nist.gov/programs/crystallography/software/downloads.html
- M. Hikam, Training Running GSAS , Lecture Notes for Materials Science Study Program, 2006

7. **Course: Seminar**

Code / Credits / Prerequisites: SCMS802101 / 4 Credits / SCMS801101

Objective:

Equip students to be able to make good research proposals, thesis writing, written and oral communication, presentation presentation techniques and giving presentation exercises.

Subjects:

Writing proposals, writing theses, procedures for oral and written communication, practice presentations.

Bibliography:

- Effionora (ed.), Guidelines for Making Theses and Dissertations at FMIPA UI , UI-Press, 2006

8. **Course: Scientific Seminar**

Code / Credits / Prerequisites: SCMS802001 / 2 Credits /

Objective:

To disseminate the results of their research, students are required to present their work in a reputable international / international scientific seminar.

Subjects:

Presentation framework, background, research scope, experimental methods, results and conclusions.

9. **Course: Thesis Defense**

Code / Credits / Prerequisites: SCMS802002 / 8 Credits / Already ≥ 34 credits

Objective:

A research process so that students can write scientific work at the end of the study period of the master's program in Materials Science and present in front of a board of examiners.

Subjects:

Research, writing and final presentation of students under the guidance of one or two counselors.

Bibliography:

- Effionora (ed.), Guidelines for Making Theses and Dissertations at FMIPA UI , UI-Press, 2006

Elective Courses

1. **Courses: Corrosion and Materials Protection**

Code / Credits / Prerequisites: SCMS801107 / 3 Credits / SCMS801101

Objective:

Students are expected to be able to know the principle of corrosion, corrosion mechanism, type of corrosion, type of corrosion that occurs, corrosion prevention and analysis of the occurrence of corrosion in the materials.

Subjects:

Principles of Corrosion, Thermodynamics Electronicsimia Corrosion and Potential Electrodes, Electrochemical Kinetics Corrosion, Passivity, Corrosion Measurement Methods, Galvanic Corrosion, Pitting and Crevice Corrosion, Environmental Effects, Metallurgical Structure Effects, Hydrogen Effect, Erosion and Wear Resistance, Selective Corrosion, Selective Corrosion, Atmospheric Corrosion and Temperature Corrosion Height, Cathodic Corrosion, Coating and Inhibitor and Materials Selection

Bibliography:

- Denny A. Jones, Principles and Prevention of Corrosion , Macmallian Publishing Company, New York, 1992.
- Mars G. Fontana, Corrosion Engineering , Eds., Mac Graw Hill, Singapore, 1986.
- Johny S. Newman, Electrochemical System , 2 nd Prentice Hall Int.Eds., Singapore, 1991.

2. **Course : Polymer Materials**

Code / Credits / Prerequisites: SCMS801108 / 3 Credits / SCMS801101

Objective:

This course aims to give a special understanding of polymers which is a specific choice for participants. This course discusses polymeric materials with several classifications of polymeric materials such as bonds, single molecules and explanations of cohesive energy density.

Subjects:

The scope of the discussion includes the physical state of the polymer, amorphous polymer, plasticization and crystallinity of the polymeric materials; processes such as polymer formation are explained starting from polymerization reactions, stepwise polymerization, co-polymerization, polymer modification and polymer biosysnthesis; Characterization of polymers, testing for polymer characterization is given specifically regarding failure tests, fault energy, creep failure and crazing of polymeric materials, polymer fatigue, and the thermal and electrical properties of polymeric materials.

Bibliography:

- F. Rodriguez, Principles of Polymer Systems, Hemisphere Publishing Corporation, Washington, 1982
- FW Billmeyer, Textbook of Polymer Science, John Wiley & Sons, Inc., New York, 1984

3. **Course : Composite Materials**

Code / Credits / Prerequisites: SCMS801109 / 3 Credits / SCMS801101

Objective:

Providing debriefing to participants regarding the understanding of composite materials.

Subjects:

The discussion of composite materials starts from the definition of composite materials, factors that influence the properties of composites, types of composite reinforcing fibers and classifications of composite types. The scope of the discussion includes composite metallic matrices and their process and inter-surface reactions, ceramic-based composites and processing methods, specifically regarding monolithic structure materials, composites with polymer matrix (PMC) types of commercial PMC Characteristics of mechanical properties are also given in particular the method of measuring stress and strain and its relationship, isotropic material, failure criteria, prinicipal stress and strain. The types of laminated composites are also discussed specifically in "off axis loading" in unidirectional composites, constitutive equations for composites. In the discussion of unidirectional and laminated composite strength, laminate and lamina strength was explained because many types of laminated materials were found in Indonesia. The role of composite support fibers is also discussed with the aim of distinguishing stress and strain properties. The size of the fiber is very important for composite reinforcement because it also discusses the critical length of the fiber, the average strength of the fiber, and the orientation of the fiber. The discussion includes fraction mechanisms and strengthening mechanisms, resistance to impact and the effects of the environment and fatigue testing. Non-destructive testing for composite materials is also given such as ultrasonic testing, radiography, and emission testing of acoustic waves.

Bibliography:

- Stuart M Lee, J. Ian Gray, Miltz, Lee M Lee, Reference Book for Composites Technology , CRC Press, 1989

4. **Course: Ceramic Materials**

Code / Credits / Prerequisites: SCMS801110 / 3 Credits / SCMS801101

Objective:

Equip students with ceramics knowledge, how to make and characterize it.

Subjects:

Definition of ceramics, bonding to ceramics, ceramic structures, physical properties, defects in ceramics, conductivity and diffusion, formation, ceramics making, thermal properties, dielectrics, electro-ceramics

Bibliography:

- M. Barsoum, Fundamentals of Ceramics , McGraw-Hill International, 2000
- S. Somiya, F. Aldinger, N. Claussen, RM Spriggs, K. Uchino, K. Koumoto and M. Kaneno, Handbook of Advanced Ceramics Vol I & II, Elsevier Academic Press, 2003

5. **Course: Electronic Materials**

Code / Credits / Prerequisites: SCMS801111 / 3 Credits / SCMS801101

Objective:

Study the material, nature and classification of electronic materials

Subjects:

Solid band theory, state density, Fermi Dirac and Boltzmann statistics, Fermi Energy and effective electron mass, drift currents, diffusion currents, intrinsic and extrinsic Semiconductors, Heterogenous structures, Minority charge recombinations and injections, Schottky Connections and Ohmic Contact, Light interaction with semiconductor materials. Light interaction with semiconductor materials. The basic concept of PN connection, MOSFET, Solar Cell and Light Emitting Diodes

Bibliography:

- Principles of Electronic Materials and Devices, 3rd Edition by SOCoarse
- Electronic Properties of Materials, by Rolf E. Hummel (3ed Edition, Springer, New York, 2000)

- Electronic Materials and Devices , David K.Ferry and Jonathan Bird, Academic Press, San Diego, 2001

6. **Course: Magnetic Materials**

Code / Credits / Prerequisites: SCMS801112 / 3 Credits / SCMS801101

Objective:

Equip students to gain knowledge in the field of modern magnetic materials.

Subjects:

Basic theories of micromagnetics, Para-, Ferro-, Antiferro- and Ferrimagnetics, Magnetic domains and hysteresis curves, Usage.

Bibliography:

- E. P. Wohlfarth, Ferro-Magnetic Materials , North-Holland, 1980
- R. C. O'Handley, Modern Magnetic Materials , John-Wiley & Sons, 2000
- BD Culity, Introduction to Magnetic Materials , Addition Wesley, 1986
- McCaig and AG Clegg, Permanent Magnets in Theory and Practice , Pentech Press, London, 1977

7. **Course: Materials Computation Method**

Code / Credits / Prerequisites: SCMS801113 / 3 Credits / SCMS801101

Objective:

Students are given knowledge about the basics of research methods and procedures for making data analysis. Students are expected to master one programming language that can be used to assist research .Some topics commonly given in numerical analysis (root equations, curve fitting, differentiation, integration, etc.) are discussed with emphasis on the use of materials analysis.

Subjects:

Introduction, Basics of Research Methods; Sampling and Measurement; Design and Analysis Programming One Language Recognition; Roots of Equation; Linear Algebra Equation System; Computing Curve Fitting (Matching); Differentiation and numerical integration; Differential Equation Computing; Partial Differential Equations; Special Topic of Numerical Analysis, Example: application to the determination of materials structure.

Bibliography:

- SC Chapra and RP Canale, Numerical Methods for Engineers, McGraw-Hill International Edition, Third Edition, Singapore, 1998
- WH Press, BP Flannery, SA Teukolsky and WT Vetterrling, Numerical Recipes: The Art of Scientific Computing, Cambridge University Press, London, 1997

8. Courses : Manufacturing Process of Metal and Alloys

Code / Credits / Prerequisites: SCMS801114 / 3 Credits / SCMS801101

Objective:

Students of this lecture are expected to be able to understand the relationship between materials behavior and manufacturing processes, especially the influence of process parameters, so that students can improve their analytical skills to support research on materials for manufacturing applications.

Subjects:

The initial explanation of this course is about materials mechanics, namely the concepts of stress, strain, materials behavior. Then proceed with the terms and understanding of manufacturing processes related to the behavior of technical materials, product samples, materials selection, manufacturing process parameters. Next is the deepening of manufacturing processes with metal materials, namely rolling, forgery, extrusion, wire drawing, casting / casting. Explanation of each process is related to the formation ability of the materials through the parameters of metal manufacturing processes such as the effects of temperature, process speed, lubrication, mold, deformation quantity and printed materials. For the process of manufacturing non-metallic materials deepening in plastic materials only, such as injection molding, extrusion blow molding. Closing is explained about material materials for manufacturing, quality control and examples of process failures and manufacturing products.

Bibliography:

- John Noel Harris, Mechanical Working Of Metal, Theory And Practice , Pergamon International, 1983
- GW Rowe, Element Of Metal Working Theory , Arnold, Paris ,.1979
- Dieter, GE Mechanical Metallurgy , McGraw Hill, 1988
- TS. Alton, H. Gegel, Metal Forming: Fundamentals And Applications , 1995

- GE Dieter, Engineering Design: A Material And Processing Approach , McGraw-Hill, 1991

9. **Course : Thin Layer Materials**

Code / Credits / Prerequisites: SCMS801115 / 3 Credits / SCMS801101

Objective:

Studying physical and chemical concepts in the formation of thin layers, the parameters of materials in thin layers, identifying, evaluating and classifying modern thin layer deposition techniques that have been applied for various purposes.

Subjects:

Thin layer physics techniques and concepts, physics of solids: crystal structures and crystal defects, thermodynamics: free energy, phase diagrams, growth kinetics; Ficks' law, diffusion coefficient, Arrhenius, nucleation and growth, plasma physics, deposition parameters, PVD (Physical Vapor Deposition), Vacuum technique, evaporation and sputtering; n CVD (Chemical Vapor Deposition); Deposition of Plasma / ion beam, Molecular Beam Epitaxi, Pulse Laser Deposition.

Bibliography:

- Milton Ohring, The Materials Science of Thin Films , Academic Press, 1992
- Donald L. Smith, Thin-Film Deposition: Principles and Practice , McGraw-Hill, Inc. , 1995
- John A. Venables, Surface Film and Thin Film Processes , Cambridge University Press, 2003
- Aicha AR Elshabini-Riad and Fred D. Barlow III, Thin Film Technology Handbook , McGraw-Hill, 1998

10. **Course : Nano Materials**

Code / Credits / Prerequisites: SCMS801168 / 3 Credits / SCMS801101

Objective:

Providing extensive and multipisciplinary introduction to physical phenomena, theoretical concepts and materials fabrication techniques on a nanometer scale, studying the application of nanomaterials in various applications.

Subjects:

Introduction of nanomaterials, Nanostructures: structures 0, 1, 2 and 3 dimensions, optical, electronic and magnetic properties of nano publication. Nanomaterials ceramics, metal nanomaterials; plasmon resonance localized surface, semiconductor nanomaterials; quantum dot, quantum well, quantum wire, nanopolymer, nanocomposite, synthesis and characterization of nanomaterials.

Bibliography:

- A Edelstein, RC Cammarat (Ed.), Nano materials: Synthesis, Properties and Applications, Institute of Physics Publishing, 2002
- Poole, Charles P., Introduction to Nanotechnology, John Wiley & Sons, Inc. All right reserved 2003
- Hari Singh Nalwa (Ed)., Nano Structured Materials and Nanotechnology, Academic Press 2002

B. Compulsory Courses of Master by Research Programs

1. **Course : Periodic Seminar**

Code / Credits / Prerequisites: SCMS801120 / 8 Credits / -

Objective:

It is a literature review and presentation activity to look for and explore one of the research topics in preparation for making a research proposal. Students are required to search, read and analyze reputable journal scientific publications, then present the results of the literature review and periodically discuss scientific issues.

Subjects:

Extent and depth of research topics, mastery of materials, scientific systematic, scientific attitude

2. **Course : Research Proposal Defense**

Code / Credits / Prerequisites: SCMS801121 / 4 Credits / -

Objective:

Based on the results of the literature review in Periodic Seminars, students can analyze one of the problems to be solved, formulate formulas and limitations of problems, collect hypotheses, analyze facilities and infrastructure to conduct research which is then written in research proposals and present them to the examiners.

Subjects:

Contents of the Proposal: Background, problem formulation, hypothesis, purpose, update, experimental method. Mastery of proposals: Scientific attitude and dexterity of discussion. Research readiness. Publication potential

3. **Course : Research Result Defense**

Code / Credits / Prerequisites: SCMS801122 / 8 Credits / SCMS801121

Objective:

As a control of the research process carried out, students will present the results of their research, draw conclusions and plan further research.

Subjects:

Framework for thinking, methodology and literature review. Results, sharpness of data analysis, stability draw conclusions. Presentation and mastery of materials. Potential for continuation of research

4. **Course : Scientific Seminar 2**

Code / Credits / Prerequisites: SCMS902201 / 4 Credits / -

Objective:

To disseminate the results of their research, students are required to present their work in an international scientific seminar and to make scientific articles that will be published in indexed national / international proceedings.

Subjects:

Abstract, background problems, research methods, results and discussion, conclusions and suggestions, bibliography.

5. **Course : Scientific Publication**

Code / Credits / Prerequisites: SCMS802120 / 10 Credits / -

Objective:

Based on the results of his research, with the direction of the supervisor, students are required to make scientific publications starting with literature search activities, collecting materials to be conveyed, sketching papers, abstracts, processing and analyzing data by referring to literature, searching for appropriate scientific journals, following the writing format and procedures for submitting to indexed national or international scientific journals.

Subjects:

Abstract, Publication framework, research methods, results and discussion, conclusions and suggestions, bibliography.

6. Course : Thesis Defense

Code / Credits / Prerequisites: SCMS802002 / 8 Credits / Already ≥ 34 credits

Objective:

A research process so that students can write scientific work at the end of the study period of the master's program in Materials Science and present in front of a board of examiners.

Subjects:

Research, writing and final presentation of students under the guidance of one or two counselors.

Bibliography:

- Effionora (ed.), Guidelines for Making Theses and Dissertations at FMIPA UI , UI-Press, 2006

SYLLABUS

DOCTOR IN MATERIALS SCIENCE

A. Compulsory of Doctor by Research & Course Program

1. **Course**: **Philosophy of Science**

Code / Credits / Prerequisites: SCMS901101 / 2 Credits / -

Objective:

Learn about the philosophy of science in general.

Subjects:

Philosophical and scientific relations; scientific method; sense and experience; positivism problem of science; the debate between realism and antirealism; postapositivism, critical theory, and constructivism, as well as theoretical and applied ethical discourse.

2. **Course: Research Methodology**

Code / Credits / Prerequisites: SCMS901102 / 2 Credits / -

Objective:

Equip students to know in practice the procedures of a research.

Subjects:

Basics of research methods; sampling and measurement; design and analysis, reporting procedures.

Bibliography:

William M. Trochim, *Knowledge Base Research Methods* , http://trochim.omni.cornell.edu/kb, 2006

3. **Course: Analytical Method in Materials Characterization**

Code / Credits / Prerequisites: SCMS901103 / 4 Credits / -

Objective:

This course is intended to introduce students to the PS Materials Doctoral Program about the physical principles of measuring instruments and measurement and analysis techniques for the purpose of materials characterization. Activities include face-to-face lectures and lab work. It is expected that the knowledge and experience achieved from the activities can support the research needs of Doctoral students.

Subjects:

Overview of Lecture Analytical Methods and Characterization of Materials; Electronic instrumentation measurement system: detector, signal amplification system, S / N ratio, recording system; Statistical analysis and error of measurement data; Sample preparation and error factors; Instrument system and XRD and XRF measurement techniques; Instrument Systems and Electron Microscope measurement techniques; Instrument systems and thermal measurement techniques: Physical principles of DSC, DTA and TGA, measurement techniques, instrument systems and spectral measurement techniques. Optics, UV VIS, IR and FTIR, AAS; Neutron Diffraction Instrumentation System; Resonant Spin Electron Instrumentation System; Laboratory / research work and research results Seminar

Bibliography:

- C. Suryanarayana and M. Grant Norton, X-ray Diffraction a Practical Approach , Plenum Press, 1998
- HH Willard, LI Merrett Jr., JA Dean and FA Settle Jr., Instrumental Methods of Analysis , Wadsworth Publishing Company, Belmont, 1988
- GW Ewing, Instrumental Methods of Chemical Analysis , McGraw-Hill Int.Edition, 1985

4. **Course**: **Selected Topics**

Code / Credits / Prerequisites: SCMS901104 / 4 Credits / -

Objective:

It is a literature review and presentation activity to look for and explore one of the research topics in preparation for making a research proposal. Students are required to search, read and analyze reputable journal scientific publications, then present the results of the literature review and periodically discuss scientific issues.

Subjects:

Discussion of specific topics of very specific Materials Science that will be used as a basis for making a dissertation. Face-to-face lectures and writing literature studies related to research topics.

5. **Course: Research Proposal Defence**

Code / Credits / Prerequisites: SCMS901105 / 6 Credits / Credits ≥ 12

Objective:

Based on the results of the literature review in Periodic Seminars, students can analyze one of the problems to be solved, formulate formulas and limitations of problems, collect hypotheses, analyze facilities and infrastructure to conduct research which is then written in research proposals and present them to the examiners.

Subjects:

Contents of Proposal: L back, formulation of the problem, hypothesis, purpose, update, experimental method.Mastery of proposals: S scientific discussion and dexterity discussion.Research readiness .Publication potential

6. **Course: Research Result Defence**

Code / Credits / Prerequisites: SCMS902101 / 10 Credits / SCMS901105

Objective:

As a control of the research process carried out, students will present the results of their research, draw conclusions and plan further research.

Subjects:

Framework for thinking, methodology and literature review. Results, sharpness of data analysis, stability draw conclusions. Presentation and mastery of materials. Potential for continuation of research

7. **Course: Scientific Publication**

Code / Credits / Prerequisites: SCMS902102 / 8 Credits / SCMS901105

Objective:

Based on the results of his research, with the direction of the supervisor, students are required to make scientific articles that begin with literature search activities, collect materials to be conveyed, frame articles, abstract, process and analyze data by referring to literature, searching for appropriate scientific journals, following the writing format and procedures for submitting to scientific journals.

Subjects:

Abstracts, article frameworks, research methods, results and discussions, conclusions and suggestions, bibliography.

8. **Course**: **Promotion Defense**

Code / Credits / Prerequisites: SCMS903001 / 8 Credits / Credits ≥ 40

Objective:

The final presentation of research results at the open session of the University of Indonesia's doctoral exam.Doctoral promotion also aims to communicate the results of research in the field of materials science to the general public.

Subjects:

Presentation of research results and question and answer in public.

Elective courses

9. **Course**: **Advanced Ceramics**

Code / Credits / Prerequisites: SCMS901106 / 4 Credits / -

Objective:

Equip students with advanced topics about ceramics

Subjects:

Basic Science of Advanced Ceramic, Functional Ceramics (electro-ceramics and optoelectro-ceramics) and ceramics engineering.

Bibliography:

- R. M. Spriggs, Handbook of Advanced Ceramics: Materials, Applications, Processing and Properties , Academic Press, 2005
- M. Barsoum, Fundamentals of Ceramics , McGraw-Hill International, 2000

- S. Somiya, F. Aldinger, N. Claussen, RM Spriggs, K. Uchino, K. Koumoto and M. Kaneno, Handbook of Advanced Ceramics Vol I & II, Elsevier Academic Press, 2003

10. **Course: Advanced Polymers**

Code / Credits / Prerequisites: SCMS901107 / 4 Credits / -

Objective:

Equip students with advanced topics about polymers

Subjects:

Characterization of polymers, testing for polymer characterization is given specifically regarding failure tests, fault energy, creep failure and crazing of polymeric materials, polymer fatigue, and the thermal and electrical properties of polymeric materials. Use and modification of polymers in industrial fields, polymers and composites, nano-polymers.

Bibliography:

- F. Rodriguez, Principles of Polymer Systems , Hemisphere Publishing Corporation, Washington, 1982
- FW Billmeyer, Textbook of Polymer Science , John Wiley & Sons, Inc., New York, 1984

11. **Course: Science and Technology of Metal / Alloy**

Code / Credits / Prerequisites: SCMS901108 / 4 Credits / -

Objective:

Equip students to recognize methods, processes and applications of metal-based materials and their alloys from the stages of exploration of raw materials to useful products.

Subjects:

Characteristics of mineral resources, metal genes, metal exploration, metal exploitation, and phasing exploitation. Process flow from minerals to pig iron, to become semi-finished products or components. Producing minerals to finished materials, metal beneficiation processes, peletizing, sintering, refining processes in steel such as blast furnace processes (chemical reactions in blast furnaces, blast furnace operations, modern blast furnace techniques), direct reduction processes such as Shaft processes (Midrex, HYL, Purofer), fluidized Bed process Fior / FINMET, Iron Carbide, Circored), Rotary kiln (Krupp-CODIR, SL / RN, DRC, ACCAR / OSIL), Shaf and Hearth processes (Kinglor-Metor, Fastmet, INMETCO), and the Smelting Reduction process (COREX, DIOS, Hismelt, AISI Direct Steel Making, Romelt, Cyclone Converter Furnace). Smelter and Melter (SEAF, EAF), Vacum degassing, BOF, AOD. Cast product and wrought product; Continuous casting, ingot casting. Classification of steel, the principle of metallurgical design of steel products. Hot rolling process type, thermo mechanical treatment process, metal reinforcement techniques used, hot rolled coil types and their use, low alloy steel, high strength low alloy steel (HSLA), Manganese steel, stainless steel. Mechanical Testing and microstructure of steel. Type of cold rolling process, annealing and recrystallization process of various types of cold rolled coil products. Texture and shape measurement methods in steel, enamel steel, electrical steel, SPCC, SPCD, SPCEN and Super SPCEN steel and their applications.

Bibliography:

- AF Taggart, Handbook of Mineral Dressing , John Wiley & Sons Inc., 1967
- B. A. Wills, Mineral Processing Technology , Caborne School of Mines, Conwall, UK, 1992
- ML Begeman, Process Manufacturing , John Wiley & Son, 4th Ed, 1981
- S. Business, Manufacturing Processes for Engineering Materials , Addison Wesley, 2 nd Ed, 1980
- EP DeGarmo, Manufacturing and Process in Manufacturing , McMillan Publishing. 7th Ed.1888
- Ginzburg, Steel-Rolling Technology, Teory and Practice , Marcel Dekker, Inc., 1989
- W. L. Robert, Hot Rolling of Steel , Marcel Dekker, Inc., 1983
- W. L. Robert, Cold Rolling of Steel , Marcel Dekker, Inc., 1978

12. **Course: Electronic and Magnetic Materials**

Code / Credits / Prerequisites: SCMS901109 / 4 Credits / -

Objective:

Equip students with advanced topics in electronic and magnetic materials

Subjects:

Solid state electronics, magnetoelectronics, ferroelectrics, organic electronics, multiferoic, photovoltaics, magnetoresistance, plasmonics, spintronics.

Bibliography:

- Pradeep Fulay, Electronic, Magnetic, and Optical Materials (Advanced Materials and Technologies) , CRC Press, 2010

B. **Compulsory of Doctor by Research Program**

1. **Course**: **Periodic Seminar**

Code / Credits / Prerequisites: SCMS901201 / 8 Credits / -

Objective:

It is a literature review and presentation activity to look for and explore one of the research topics in preparation for making a research proposal. Students are required to search, read and analyze reputable journal scientific publications, then present the results of the literature review and periodically discuss scientific issues.

Subjects:

Extent and depth of research topics, mastery of materials, scientific systematic, scientific attitude

2. **Course**: **Research Proposal Defense**

Code / Credits / Prerequisites: SCMS901202 / 4 Credits / SCMS901201

Objective:

Based on the results of the literature review in Periodic Seminars, students can analyze one of the problems to be solved, formulate formulas and limitations of problems, collect hypotheses, analyze facilities and infrastructure to conduct research which is then written in research proposals and present them to the examiners.

Subjects:

Contents of Proposal: L back, formulation of the problem, hypothesis, purpose, update, experimental method. Mastery of proposals: Scientific discussion and dexterity discussion. Research readiness. potential Publication

3. **Course**: **Research Result Defense**

Code / Credits / Prerequisites: SCMS903201 / 10 Credits / SCMS902201, SCMS902202

Objective:

As a control of the research process carried out, students will present the results of their research, draw conclusions and plan further research.

Subjects:

Framework for thinking, methodology and literature review. Results, sharpness of data analysis, stability draw conclusions. Presentation and mastery of materials. Potential for continuation of research

4. **Course**: **Scientific Publication 1**

Code / Credits / Prerequisites: SCMS902201 / 4 Credits / SCMS901202

Objective:

Based on the results of his research, with the direction of the supervisor, students are required to make scientific publications that begin with literature search activities, collect the materials they wish to convey, frame publications, abstract, process and analyze data by referring to literature, finding appropriate scientific journals, following the writing format and procedures for submitting to reputable national scientific journals.

Subjects:

Abstract, Publication framework, research methods, results and discussion, conclusions and suggestions, bibliography.

5. **Course: Scientific Publication 2**

Code / Credits / Prerequisites: SCMS903202 / 8 Credits / SCMS902201

Objective:

Based on the results of his research, with the direction of the supervisor, students are required to make scientific publications that begin with literature search activities, collect the materials they wish to convey, frame publications, abstract, process and analyze data by referring to literature, finding appropriate scientific journals, following the writing format and the procedure for submitting to reputable international scientific journals.

Subjects:

Abstract, Publication framework, research methods, results and discussion, conclusions and suggestions, bibliography.

6. **Course**: **Scientific Seminar**

Code / Credits / Prerequisites: SCMS902202 / 6 Credits / SCMS901202

Objective:

To disseminate the results of their research, students are required to present their work in a reputable international scientific seminar.

Subjects:

Presentation framework, background, research scope, experimental methods, results and conclusions.

7. **Course**: **Promotion Defense**

Code / Credits / Prerequisites: SCMS903001 / 8 Credits / Already ≥ 40 credits

Objective:

The final presentation of research results at the open session of the University of Indonesia's doctoral exam.Doctoral promotion also aims to communicate the results of research in the field of materials science to the general public.

Subjects:

Presentation of research results and question and answer in public.