UNIVERSITAS INDONESIA

FMIPA

Department of Physics
Faculty of Mathematics and Natural Sciences
Universitas Indonesia

CURRICULUM

for Doctoral Programme in Materials Science

2024 EDITION

CURRICULUM DOCUMENT
STUDY PROGRAM
DOCTOR OF MATERIALS SCIENCE

UNIVERSITAS INDONESIA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES

DEPOK 2024

STUDY PROGRAM IDENTITY*)

Study Program Specifications

1	Institution Name	Universitas Indonesia
2	Name of Study Program	PhD in Materials Science
3	Educational level	Doctor (Dr.)
4	Study Program Address	Department of Physics, FMIPA UI . Building F Campus UI , Depok, 16424. Tel. 021-7872609-19, 7270160. Fax. 021-7863441. Postgraduate Building , Department of Physics FMIPA UI
5	Accreditation Status and Accreditation Body, for example BAN-PT, LAM	LAMSAMA
6	Title/ Title Graduate of	Doctor
7	Vision of Study Program	To become an excellent organizer of the Tridharma of higher education in the field of materials science, which produces Doctors of Materials Science who are able to play a role at the national and global levels in advancing science, technology, and sustainable development.
8	Study Program Mission	• Organizing Doctoral education in Materials Science that is able to produce graduates who are capable of being future leaders who are professional, intelligent, moral, have social sensitivity and excel in competing globally. • Actively participate in the development of material science research to support national development and resilience and play a role at the Southeast Asian level.
9	Programme Learning Outcome (PLO)	• Able to construct an integrated relationship between structure, properties, processing, and performance of material systems. • Able to identify and analyze problems in the field of materials science and able to formulate scientifically responsible solutions, taking into account ethics, the environment and socio-economics.

		● Able to design and implement experimental research methods and mathematical modeling that are ethically academically responsible, analyze data critically and systematically and draw conclusions. ● Able to create and design new materials, processing methods and material analysis techniques and material product innovations by paying attention to humanities values that are beneficial for the development of materials science, industry and society in general. ● Able to apply material science concepts in solving complex industrial material application problems through a multidisciplinary approach that takes into account safety, social and ethical aspects.
10	Duration of study and number of study loads (credits)	6 semesters and minimum 88 credits
11	Curriculum structure, learning strategies, assessment methods, etc.**)	
12	Proposal Status ***) a. New b. Redesign	Redesign

**) Study program identity must be filled in completely*
***)only written in which chapter and page*
****)select one*

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FOREWORD

In the name of Allah, the Most Gracious and Most Merciful,

Praise and gratitude we offer to the presence of Allah SWT, for all the abundance of His grace and guidance that always bestows blessings. Within the framework of scientific tasks and scientific development at the highest level, the curriculum manuscript of the Postgraduate Materials Science Doctoral Program at the Universitas Indonesia is present as a manifestation of an intellectual journey full of dedication.

This curriculum is not just a series of courses, but rather a deep scientific plan, reflecting the spirit of excellence and innovation in the field of Materials Science. Postgraduate studies are expected to produce intellectual cadres who not only have high academic abilities but are also able to respond to and face the complex dynamics of material science that continue to develop.

The development of the Doctoral Program curriculum also always pays attention to and follows every regulatory evolution, from the implementation of the Indonesian National Qualification Framework to the provisions in the Higher Education System Law and the National Higher Education Standards. By following these standards, it is hoped that Materials Science doctors will be able to become agents of significant change at the national and international levels.

We would like to express our thanks to all parties who have participated in initiating and completing the curriculum manuscript for the Materials Science Doctoral Program. May Allah SWT always provide His guidance and blessings on every step of our scientific journey. Amen .

head of the study program

(Dr. Budhy Kurniawan., M.Si)

LIST OF CONTENTS

CHAPTER 1
INTRODUCTION

1.1 Preparation Process Document Curriculum

The Doctoral Program in Materials Science (DPMS) is held in two semesters per academic year, where one period generally includes 16 weeks of educational activities. The current curriculum of DPMS is built using the *Research - Based approach. Education* (RBE), which is a program based on research and Research Courses. The desired competencies are determined by considering internal and external inputs.

This curriculum is designed to produce professionals or experts in academic/research, industry, and other multinational companies. Graduates from this pathway can quickly learn and adapt to the industrial work environment and solve problems in their work areas by applying material science and scientific thinking. The courses are designed to ensure that students achieve the desired competencies, which are categorized as compulsory courses and research-related courses for the lecture-research pathway and research courses for the research pathway. For the lecture-research pathway, during semesters 1 and 2, students take compulsory and elective courses on the basic concepts of material science and its applications to conduct research in semesters 3 to 6.

Compulsory courses in semester 1 (Advanced Structural Materials, Advanced Material Properties and Performance, Advanced Material Thermodynamics and Kinetics, and Advanced Material Characterization and Analysis) are provided to enhance students' basic knowledge of materials science. In semester 3, students can attend international forums and publish their articles in proceedings indexed by Scopus. Students can also publish their papers in national journals with a Sinta rating of at least 2. Articles can be produced as part of their research or in collaboration with lecturers. In semesters 4 to 6, students conduct complete research methodology starting from literature review, proposal, experiment, to dissertation writing.
The 2024 curriculum is designed with reference to Permendikbud no. 53 of 2023 concerning National Standards for Higher Education which is further explained in the UI Chancellor Regulation no. 013/SK/R/UI/2020 concerning the Academic Education Curriculum for Undergraduate Programs, master's Programs, and Doctoral Programs at the Universitas Indonesia. The 2024 curriculum is designed to be flexible, meaning it can be changed according to the PDCA (plan*, do, check, act*) evaluation process.
The curriculum is prepared in a top-down manner, namely from the formulation of graduate profiles which are then passed down to courses. The process of formulating an output-based curriculum is carried out by involving stakeholders including lecturers, students, education staff, alumni, graduate users, benchmarking with university partners, the Indonesian Physics Association (PSI) organization, and internal reviewers.

The process of updating the 2024 curriculum by the Doctoral study program in materials science is carried out through the following stages:

1. Formation of Curriculum Team
2. Formulation Profile Graduate of
3. Formulation Achievements Learning Graduate of
4. Curriculum structure preparation and course determination
5. Compilation of elective courses
6. Mapping of graduate learning outcomes to courses
7. Course syllabus review
8. Internal Review
9. Making a learning design book (BRP)

10. Socialization of the 2024 curriculum with stakeholders
11. External review

1.1.1 Evaluation Curriculum or Tracer Study

A. Evaluation Results Implementation Curriculum

Evaluation of the work achievements of the implementation of the curriculum that has been running can be seen from the analysis of the success or failure of the achievement of the performance indicators that apply in FMIPA UI. The results that have been obtained indicate that the curriculum that has been implemented has been running well. Student input has been achieved well even though many have postponed their studies because they have not received scholarships. Promotion steps through various channels have also been carried out so that the interest of prospective students has increased. The number of foreign students studying in the Doctoral Program in Materials Science (PSDIB) needs to be increased. In the field of education, the PSDIB Curriculum is currently designed to produce a profile of graduates with global quality according to the network that follows the KKNI level 9 competency standards that are in accordance with SNPT. PSDIB produces graduates with an average GPA of 3.8. The output achievements in the field of research by DTPS and students are also good. This can be seen from the number of research grants received by DTPS so that more and more students are involved in research. The research conducted has also been disseminated and published in the form of participation in seminars and publication of scientific articles at the national and international levels (a total of 46 articles). The amount of research conducted along with research outputs in the form of proceedings and scientific articles has also increased, plus an increase in the number of citations in the scientific articles produced. In addition, it is also necessary to transform the shift of scientific publications of students and staff to reputable international journals so that contributions to the global community can be better, which can be seen from the number of citations of lecturers and students.

Meanwhile, in the field of community service (PkM), the number of community services needs to be increased so that the contribution of study programs will increase. DPMS strongly encourages lecturers and students to obtain patents or Intellectual Property Rights (IPR) whose benefits can be felt by the community. Over the past 3 years, DPMS has produced 17 simple patents, one Appropriate Technology and one Activity applied in the community.

B. The Basics of Change

The analysis of the need for curriculum changes for the Doctoral Program in Materials Science (DPMS), Universitas Indonesia is based on the rapid evolution in the industrial world and technological developments, especially in the context of the Industrial Revolution 4.0. In facing these challenges, curriculum changes are essential to ensure that graduates not only understand industry changes, but also have skills and knowledge that are relevant to the needs of the ever-evolving job market.
The updated curriculum needs to specifically address the integration of artificial intelligence, robotics, nanotechnology, and other key elements of the Industrial Revolution 4.0. Focus on practical applications, research, and development is important so that graduates are able to compete globally. The uniqueness of DPMS in exploring materials based on local Indonesian

wisdom also needs to be strengthened, ensuring that students not only have global insight, but also a deep understanding of the application of materials science in a local context.

In addition, curriculum changes can take advantage of opportunities to increase collaboration with industry. Integration of industrial case studies, research collaborations, or internship programs can provide students with practical experience and enrich the curriculum with actual industry perspectives. Strengthening UI's position as a Leading University is an important foundation, by utilizing advantages such as a green campus, a competitive graduate reputation, and support for research and development in the field of materials science. The importance of utilizing educational technology also needs to be considered. The integration of e-learning, simulation, and the latest technology can improve the efficiency and effectiveness of learning, better preparing students for increasingly complex industry demands. By considering these factors, curriculum changes are expected to not only maintain the relevance of PSDIB UI but also strengthen UI's position as a center of excellence in responding to dynamic changes in the world of industry and materials science.

C. Formulation of Change

Table 1.1 Formulation of Changes

No.	Running Curriculum	New Curriculum
1	Set the time division (minutes) per 1 credit, such as ● 50 minutes face to face per week, ● structured assignment 60 minutes per week, and 60 minutes of independent activity per week	Study load of 1 (one) credit unit is equivalent to: ● 45 (fourty five) hours per semester, and ● held in 16 (sixteen) weeks
2	The doctoral program study load is at least 42 (forty-two) credits	The study load for a doctoral program is at least 88 (eighty-eight) credits
3	The Doctoral Program is scheduled for 6 (six) semesters and can be completed in a minimum of 4 (four) semesters, or a maximum of 10 (ten) semesters.	The student's study period is set to not exceed 2 (two) times the curriculum period

1.2 Foundation Design and Development Curriculum

A. Foundation Philosophical

Curriculum development requires a philosophical foundation as a guide to thinking. In the realm of ontology, curriculum development is not only an integral part of the essence of education, but also a support and tool to achieve educational goals. The goals of national education are derived from the values of Pancasila, the 1945 Constitution of the Republic of Indonesia, the Unitary State of the Republic of Indonesia, and Bhinneka Tunggal Ika, which are adjusted to the dynamics of the development of the times. The curriculum that is developed needs to be able to facilitate the development of students' potential so that they become individuals who are faithful, pious, have noble character, are healthy, knowledgeable, capable, creative, independent, and democratic and responsible citizens. The learning process is encouraged to form a strong national character, so that students can become an integral part of Indonesian society that has an identity, is intellectually intelligent, and actively contributes to creating a world that is orderly, just, safe, and peaceful. Learning also needs to integrate local values to support the preservation and development of culture while providing a positive direction for change.

Epistemologically, curriculum development aims to give meaning to the essence of knowledge, including sources of knowledge, methods of seeking knowledge, validity of knowledge, and limitations of knowledge. The curriculum is directed to equip students with a foundation for scientific thinking, both through deductive and inductive reasoning. The development of this curriculum aims to produce graduates who are responsive, competent, and able to answer the challenges of the future of the Indonesian nation amidst the dynamics of the international community. Students are expected to have initiative, a proactive mindset, and attitudes and actions that contribute to self-development and national development.

In terms of axiology, curriculum development needs to integrate the core values that have been agreed upon at the Universitas Indonesia. These values include honesty, justice, trustworthiness, dignity, responsibility and accountability, togetherness, openness, academic freedom, and compliance with the rules. Philosophical studies of the curriculum can provide answers to key questions, such as how to formulate educational objectives, educational materials that should be presented, appropriate learning methods, and the roles of educators and students. The development of the curriculum for the Doctoral Program in Materials Science (DPMS) is based on four philosophical foundations, namely realism, idealism, pragmatism, and reconstructionism.

Realism emphasizes physical or material reality as the basis for learning, with the aim of equipping students with measurable skills. Idealism defines truth as something subjective, which focuses on the holistic development of student character. Pragmatism sees truth as a physical reality that is always changing, and education as an integral part of life itself. Reconstructionism, meanwhile, states that truth is temporary, and the curriculum must create students as agents of change who are critical of existing practices. The development of the DPMS curriculum in an eclectic and incorporative manner combines the four philosophical foundations, creating a comprehensive and relevant approach to support the formation of quality and competitive students in various life contexts.

The philosophical basis of curriculum development is oriented towards four main objectives in education. First, to develop the ability of the field of expertise, the philosophical basis used is Realism, with a competency-based education approach (Competency-*based*

Education) that uses the behavioristic method. The learning approach applied includes skills training and habituation, where lecturers act as instructors and facilitators.

Second, to develop the power of thought, feeling, and morals, the philosophy used is Idealism. The educational approach applied is the development of generic abilities with a humanistic and cognitive psychological approach. The learning approach used includes the Socratesian method, metacognitive, and value clarification.

Third, to develop problem-solving skills, the philosophy used is Pragmatism. The educational approach applied is Production-Based Training with a cognitive psychological approach and experimental learning. The learning methods used are *Learning by doing,* project methods, and contextual learning.

Fourth, to develop critical thinking skills, the philosophy used is Reconstructionism. The educational approach applied is social reconstruction and human preparation as agents of change, with critical education as its psychological approach. The learning approaches used include project methods, *social thematic,* and social problem solving.

From the overall philosophy, it can be concluded that the development of the DPMS curriculum is designed to produce graduates who not only have strong skills in their respective fields, but also have character, are able to solve problems, and think critically.

B. Foundation Sociological

The sociological basis in the development of the PDMS curriculum is carried out by placing assumptions derived from sociology as a starting point in development. Students come from society, receive education within the scope of society, and are directed to be able to plunge into community life. Therefore, community life and culture with all its characteristics are the basis and starting point in implementing education.

Education is a process of preparing students to become the expected society, a process of socialization, as well as a process of enculturation or acculturation. Education is expected to be able to produce humans who are not foreign to society, become humans who are of higher quality, understand, and are able to build their society. The objectives, content, and process of education must be adjusted to the conditions, characteristics, and developments of society. The curriculum must be able to facilitate students to be able to work together, interact, adapt to life in society and be able to increase their dignity and status as cultured beings.

The learning process needs to adapt to the dynamics of society and the development of science and technology. Changes that occur at the local, regional, and global levels are challenges in the development of education. The increasingly complex demands for change need to be anticipated by developing a curriculum in accordance with the demands of these changes. The curriculum needs to be developed to prepare students to be able to answer the challenges and demands of society. The curriculum needs to formulate strategies so that learning can anticipate the development of society and is relevant to current issues, so that learning or the education process becomes more meaningful.

C. Psychological Basis.

Education is always related to human behavior. In its process, education creates interaction between students and the environment, both physical and social. Through education, it is expected that there will be changes in student behavior towards maturity, both physically, mentally, emotionally, morally, intellectually, and socially. The curriculum as a means to achieve educational goals is expected to be a means to develop and optimize student potential and instill new insights and competencies to enter the future.

The development of the DPMS curriculum is based on assumptions derived from psychology which include studies on what and how students develop (developmental psychology) and how students learn (learning psychology). Based on this study, the implementation of learning is carried out in accordance with the characteristics of students, both adjustments in terms of the abilities that must be achieved, the materials or materials that must be delivered, the delivery or learning process, and adjustments in terms of learning evaluation.

Postgraduate students are adults. They have unique learning characteristics that are different from children. Therefore, understanding the learning characteristics of adults is needed to be able to choose appropriate and effective learning strategies. Adult learning (Andragogy) is carried out by stimulating students to be able to carry out the process of searching and discovering the knowledge they need in life.

D. Historical Basis

In adapting curriculum of the Doctoral Study Program in Materials Science (DPMS) Universitas Indonesia, the steps change is driven by change significant in industry, especially along development technology in the era of revolution Industry 4.0. Speed acceleration change this, which includes integration technology like intelligence artificial, robotics, blockchain, nanotechnology, computers quantum, biotechnology, internet of things, 3D printing, and unmanned vehicles, requires a rapid and planned response in the field of materials science.

Universitas Indonesia (UI), as a Leading University, has advantages that are the main foundation to answer this challenge. With its status as the oldest university in Indonesia, its strategic location in the capital city, alumni who occupy key positions in government, a 320-hectare green campus, and a reputation for competitive graduates, UI has a solid foundation to lead change in higher education.

UI's achievements in global rankings, such as the QS GER (Graduate Employability Ranking) and QS WUR (World University Ranking), show that UI graduates, including those from the Faculty of Mathematics and Natural Sciences (FMIPA) UI, have high competitiveness. FMIPA UI, with the Doctoral Study Program in Materials Science as one of its leading scientific fields, has been identified as a major supporter of the Industrial Revolution 4.0. The results of the 2023 future of jobs survey by the World Economic Forum show that the field of work in materials science is one of the fields with the greatest growth. Furthermore, the uniqueness of DPSM which explores materials based on local Indonesian wisdom is an added value that is consistently supported by UI. This support is reflected in the procurement of sophisticated laboratory equipment such as XRD, XRF, Raman spectrometer, NMR, and other facilities at the Indonesian Laboratory for Research on Materials and Catalysts (ILRC). Through this curriculum change, UI aims to ensure that PSDIB remains relevant, produces high-quality graduates, and can meet the demands of the

ever-growing industry, while strengthening its position as a leading higher education institution in responding to global and local dynamics.

E. Legal Basis (KPT, 2020)

1. Constitution Republic of Indonesia Number 14 of 2005 concerning Teachers and Lecturers (State Gazette of the Republic of Indonesia 2005 Number 157, Supplement State Gazette of the Republic of Indonesia Number 4586);
2. Constitution Republic of Indonesia Number 12 of 2012 concerning Higher Education (State Gazette of the Republic of Indonesia 2012 Number 158, Supplement State Gazette of the Republic of Indonesia Number 5336);
3. Regulation President Republic of Indonesia Number 8 of 2012, concerning Framework Indonesian National Qualification (KKNI);
4. Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 73 of 2013, concerning the Implementation of KKNI in the Field of Higher Education.
5. Regulation of the Minister of Education, Culture, Research and Technology of the Republic of Indonesia Number 6 of 2022, concerning Diplomas, Competency Certificates, Professional Certificates, Degrees, and Equivalence of Diplomas from Universities in Other Countries,
6. Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 53 of 2003 concerning Quality Assurance of Higher Education
7. Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 7 of 2020, concerning the Establishment, Amendment, Dissolution of PTN, and the Establishment, Amendment, Revocation of PTS Permits.
8. Regulation of the Minister of Education and Culture Number 22 of 2020, concerning the Strategic Plan of the Ministry of Education and Culture.
9. Guidebook for Preparing KPT in the Industrial Era 4.0 to Support Independent Learning Independent Campus, Directorate General of Belmawa, Dikti- Kemendikbud, 2020,
10. Independent Learning Guidebook – Independent Campus, Directorate General of Belmawa, Higher Education – Ministry of Education and Culture, 2020,
11. Regulation Rector of the Universitas Indonesia Number 1 of 2024, concerning Implementation of Undergraduate Programs,
12. Regulation Rector of the Universitas Indonesia Number 2 of 2024, concerning Implementation of Master's Program,
13. Regulation Rector of the Universitas Indonesia Number 3 of 2024, concerning Implementation of Doctoral Programs.

CHAPTER 2
VISION, MISSION, GOALS, STRATEGY AND *UNIVERSITY VALUES*

2.1. Vision

To become an excellent organizer of the Tridharma of higher education in the field of materials science, which produces Doctors of Materials Science who are able to play a role at the national and global levels in advancing science, technology, and sustainable development.

2.2. Mission

- Organizing Doctoral education in Materials Science that produces graduates with the ability to be future leaders who are professional, intelligent, moral, have social sensitivity and are globally competitive.
- Playing an active role in the development of material science research to support national development and resilience and playing a role at the Southeast Asian level.

2.3. Objectives

- To produce doctors of materials science who can critically evaluate the latest developments in materials science and technology.
- To produce doctors of materials science who can identify and analyze problems in the field of materials science and are able to formulate scientifically responsible solutions through a multidisciplinary approach and are beneficial to humanity.
- Producing doctors of materials science who can manage, lead and develop experimental research methods and/or material modeling that pay attention to ethics, safety, environmental and socio-economic aspects.
- To produce doctors of materials science who can produce innovative and original research work in the form of materials engineering, processing methods and/or new materials analysis techniques that are recognized by the national and international materials science community.

2.4. Strategy

Universitas Indonesia has established a 20-year RPJP divided into 4 stages to provide direction and serve as a reference for all UI residents in realizing their vision, mission, and goals through the implementation of the Tridharma of Higher Education that excels. FMIPA UI including the Doctoral Study Program in Materials Science (PSDIB) UI uses the same stages to realize its vision, mission, and goals. The stages and strategic targets are as follows:

The preparation of the UI strategy map is carried out using the Balanced Scorecards approach consisting of four perspectives, namely Stakeholders, Internal Business Processes, Learning and Growth, and Finance. These four perspectives are the basis for ensuring that all programs and efforts carried out by UI are in line with its vision, mission, and goals. The strategic targets of FMIPA UI are compiled based on the cascading strategic targets that Universitas Indonesia wants to achieve and are agreed upon in a performance contract between the Dean and the Chancellor. The preparation of the FMIPA UI Annual Work Plan (RKT) has been formulated and determined by the university through an annual performance contract agreement by considering the UI 2020-2024 strategy map in Figure 2.1.

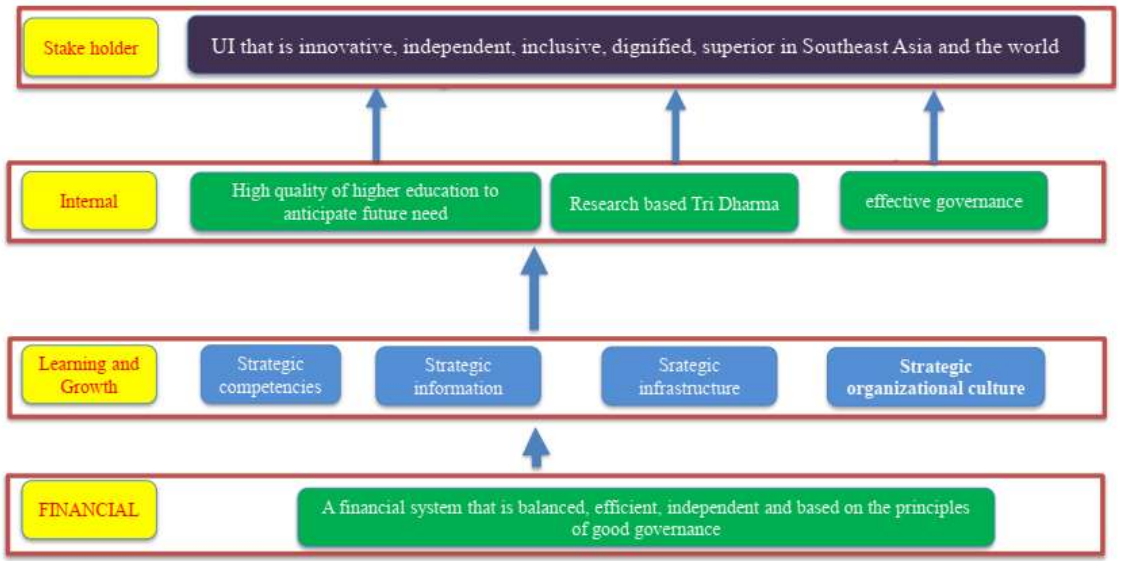

Figure 2.1 UI Strategy Map 2020-2024

The 2022 FMIPA UI RKT consists of 16 strategic targets (SS) with 72 activity indicators (IK) which have been equipped with target weights, indicator weights, formulas, units, Figure 2.2 below:

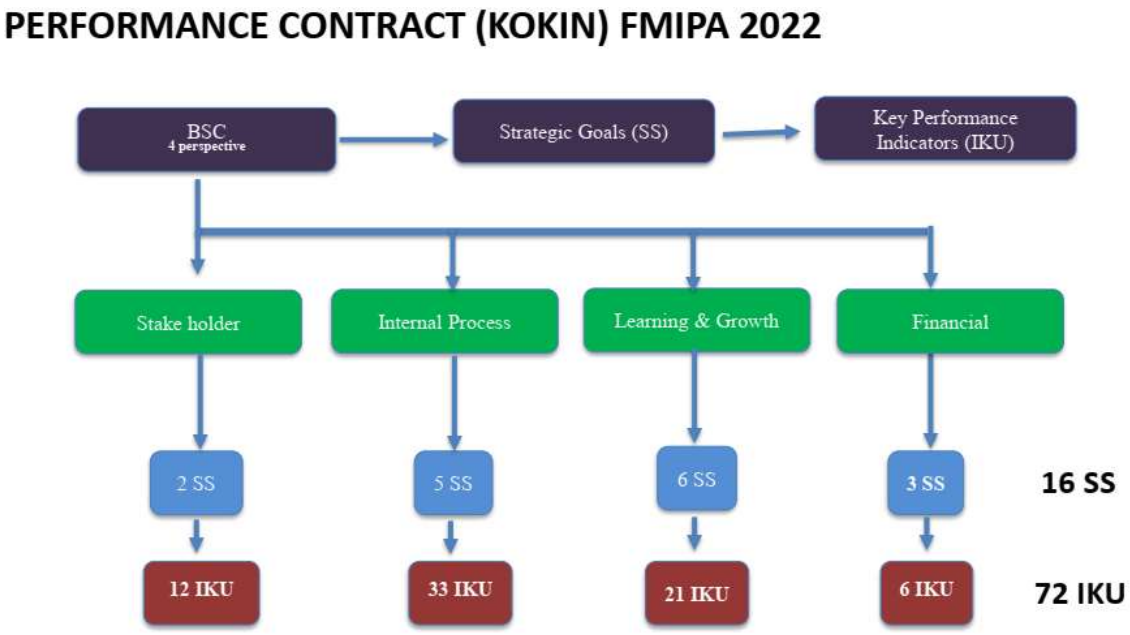

Figure 2.2 FMIPA UI Performance Contract Matrix (Kokin) 2022

2.5. University Value

In accordance with its universal function as a home and barn of knowledge, role model, and moral strength for society, the University of Indonesia (UI) has basic values that must be upheld by its academic community.

"All UI citizens can apply basic values in their daily behavior at UI, so that there are no more differences in perception that arise at various levels at UI, all are UI citizens who have cultural values in their behavior," said UI Vice Chancellor for Human Resources and Cooperation, Prof. Dr. Ir. Dedi Priadi, DEA, in his remarks at the UI values socialization event entitled "9 Values Into Action" held at the Convention Hall, UI Depok Campus, Tuesday, April 9, 2019.

These values must later be practiced by all UI citizens. This is done to realize UI's vision. The following are the basic values: Honesty. Straightforward nature, sincere, speaking and acting correctly, not lying, not cheating, not corrupt, not cheating, which in its implementation is accompanied by an upright attitude, wise and based on nobility. Honesty also covers all academic and non-academic activities. Just and Fair. Providing equal opportunities and treatment fairly and non-discriminatory for every citizen in carrying out their respective duties, including in developing academic activities and other activities, not based on considerations of racial, ethnic, religious, gender, marital status, age, disability, and sexual orientation. Trustworthiness. Behaving and being trustworthy and trustworthy in carrying out mandates and in carrying out every activity or obligation. Dignity and/or Respect. Treating everyone with respect, humanity, obedience to moral norms, propriety, and appropriateness in any situation. Accountability. Responsible in carrying out the duties of his position and functional duties and avoiding conflicts of interest that can harm the interests of Ul or the interests of other UI residents. Togetherness. Upholding tolerance and a spirit of togetherness in pursuing and carrying out the duties and responsibilities assigned to each UI resident in his work environment. Transparency. Openness of conscience and openness of attitude to be willing to listen and seriously consider the opinions of others; academic openness to critically accept all information and academic findings of other parties; and willing to open/share all knowledge information owned to parties who have the right to know/are interested, except those that are confidential. Academic Freedom and Scientific Autonomy. Upholding academic freedom, namely the obligation to maintain and advance science, upholding the freedom of the academic pulpit, namely the freedom to express thoughts and opinions within the Ul environment and in other academic forums. Compliance with applicable laws and regulations (Compliance to Laws). Carrying out all activities within the UI environment by complying with all applicable regulations.

Universitas Indonesia (UI) as a home and barn of knowledge has basic values that must be upheld by all its academic community. These values are the moral and ethical foundation in implementing the Tri Dharma of Higher Education which includes education, research, and community service. The following is the relationship between the nine pillars of UI and the Tri Dharma of Higher Education:

1. **Honesty**
    - **Education** : Teaching and implementing the values of honesty in the learning process, such as encouraging academic integrity and rejecting all forms of plagiarism and academic cheating.
    - **Research** : Ensuring that research is conducted honestly, without data manipulation, and that research results are published with transparency.
    - **Community Service** : Carrying out community service programs with an honest attitude, providing correct and accurate information to the community.
2. **Justice (*Just and Fair*)**

- **Education** : Creating a fair and inclusive learning environment, providing equal opportunities to all students without discrimination.
- **Research** : Providing equitable access to research opportunities and resources, and ensuring fairness in research collaboration.
- **Community Service** : Providing fair and equal services to all levels of society regardless of background.

3. **Trustworthiness**
   - **Education** : Instilling the value of trust in students, so that they can be trusted in every academic and non-academic responsibility.
   - **Research** : Conducting research with high trust, ensuring that every research result is reliable and beneficial to the community.
   - **Community Service** : Building a relationship of mutual trust with the community through consistent and reliable community service activities.
4. **Dignity and / *or* Respect**
   - **Education** : Respecting every individual in the campus environment, teaching the importance of mutual respect in daily interactions.
   - **Research** : Treat research subjects and colleagues with respect, maintaining research ethics.
   - **Community Service** : Providing services that respect the dignity of every individual in society.
5. **Not quite enough Accountability**
   - **Education** : Encourage student For responsible answer on Study they , as well as lecturers and staff For responsible answer in teaching and administration .
   - **Research** : Responsible for accuracy and transparency in research, as well as honest management of research funds.
   - **Community Service** : Implementing community service programs with full responsibility, avoiding conflicts of interest.
6. **Togetherness**
   - **Education** : Creating a collaborative learning environment, encouraging cooperation among students, faculty, and staff.
   - **Research** : Encourage teamwork in research, both interdisciplinary and cross-institutional.
   - **Community Service** : Involving various elements of society in community service activities, building togetherness and solidarity.
7. **Transparency**
   - **Education** : Prioritize openness in the teaching and learning process, including transparency in assessment and academic policies.
   - **Research** : Ensuring transparency in research methodology and results, as well as in the use of research funds.
   - **Community Service** : Providing clear and open information regarding community service programs, and opening up space for constructive dialogue.
8. **Freedom academic and autonomy Academic Freedom *and Scientific* Autonomy**
   - **Education** : Guaranteeing academic freedom for lecturers and students in exploring and conveying knowledge.
   - **Research** : Ensuring freedom in choosing research topics and communicating research results without pressure.
   - **Community Service** : Respecting academic freedom in carrying out science-based community service programs.
9. **Compliance with regulations applicable laws (Compliance *to Laws*)**
   - **Education** : Ensure that all academic and administrative activities are carried out in accordance with applicable laws and regulations.

- **Research** : Comply with all regulations relating to research, including research ethics and protection of research subjects.
- **Community Service** : Carrying out service programs by complying with all applicable legal and ethical regulations.

By implementing these nine basic values in daily life, the entire UI academic community contributes to realizing UI's vision as an excellent institution with high integrity in implementing the Tri Dharma of Higher Education.

CHAPTER 3
PROFILE AND LEARNING ACHIEVEMENTS OF GRADUATES

3.1. Description Profile Graduate of

Doctoral graduates of Materials Science who are able to develop material science and technology that is beneficial to humanity through independent research work that is innovative, original and recognized by the international materials science community.

3.2. Formulation Programme Learning Outcome (PLO)

Table 3.1 Formulation of PLO Study Program

No.	DESCRIPTION
PLO 1	Able to construct an integrated relationship between structure, properties, processing, and performance of material systems. (K)
PLO 2	Able to identify and analyze problem field materials science and capable compile solution responsible solution answer in a way scientific , with notice ethics , environment and social economy . (K)
PLO 3	Able to design and implement experimental research methods and mathematical modeling that are ethically academically responsible, analyze data critically and systematically and draw conclusions.(S)
PLO 4	Able to create and design new materials, processing methods and material analysis techniques and material product innovations by paying attention to humanities values that are beneficial for the development of materials science, industry and society in general.(S)
PLO 5	Able to apply draft material science in breakdown problem application complex materials industry through approach multidisciplinary that pays attention to aspect safety , social and ethics (C)

The five PLOs are then further described in 5 (five) sub PLOs which are depicted in one column in Figure 2. Each sub-PLO has criteria according to Bloom's taxonomy, namely the affective domain (A), psychomotor domain (B) and cognitive domain (C) which are tiered from level 1 to 5 and 6 as follows:

1. Able to connect the relationship between structure, properties, processing, and performance of material systems (C6).→ PLO 1
2. Able to evaluate problem general and specific in the field materials science (C6). →PLO 2
3. Able to carry out various fabrication techniques and material characterization or material modeling (B5).→ PLO 3
4. Able to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods (C6).→ PLO4
5. Able to provide recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics (C6). →PLO 5

Achievements learning graduate of notice
a. vision and mission of the university.
b. Indonesian national qualification framework.
c. development of science and technology;
d. work competency needs from the world of work;
e. scientific domain of the study program;

f. main competencies of study program graduates; and
g. curriculum of similar study programs.

3.3. Alignment of Learning Achievements to KKNI Levels

[Write the qualification level quoted from KKNI according to the study program level]

Table 3.2 Mapping of PLO with KKNI

No.	Description of KKNI	PLO Formula
1	Able to develop knowledge, technology, and/ or art inside field his knowledge or practice professionalism through research, until produce work innovative and proven.	PLO 4 : Able to create and design new materials or processing methods and material analysis techniques or material product innovations by paying attention to humanities values that are beneficial for the development of materials science, industry and society in general.
2	Able to solve problem knowledge knowledge , technology , and/ or art inside field his knowledge through inter or inter approach multidisciplinary .	PLO 2: Able to identify and analyze problems in the field of materials science and able to formulate scientifically responsible solutions, taking into account ethics, the environment and socio-economics. PLO 5: Able to apply the concept of materials science in solving complex industrial material application problems through a multidisciplinary approach that takes into account safety, social and ethical aspects.
3	Able to manage research and development that is beneficial to society and science, and able to gain national and international recognition.	PLO 1 : Able to construct an integrated relationship between structure, properties, processing, and performance of material systems. PLO 3: Able to design and implement ethically responsible experimental research methods and mathematical modeling, analyze data critically and systematically, and draw conclusions.

Experience Matrix Study

- Determination Indicator Achievement each Achievements Learning Graduate (PLO)
- Determination of Measurement Method Achievements Learning Graduate (PLO) – Form Assessment
- Determination of Learning Activities, Study Materials, and Courses

Table 3.3 Matrix Table 2
Doctoral Program in Materials Science

No	PLO	Sub PLO	Activity	Material Study/Scope of Material	Media & Technology	Subject	Indicator	Assessment
	A	B	C	D	E	F	G	H
1	Able to construct an integrated relationship between structure, properties, processing, and performance of material systems.	Able to connect the relationship between structure, properties, processing, and performance of material systems (C6).	• Studying • Study independent	• The breadth and depth of materials science research topics • mastery material knowledge ingredients • systematics scientific • attitude scientific	Computer , LCD, internet	Literature Review 1 Literature Review 2 Advanced Material Structure Advanced Material Properties and Performance Advanced Thermodynamics and Kinetics of Materials Characterization , and Advanced Materials Analysis	Able to conduct systematic literature reviews to prepare research proposals. Able to present the results of literature studies with a good scientific attitude. Able to make paper scientific	Presentation and Scientific Paper
2	Able to identify and analyze problems in the field of materials science and able to formulate scientifically responsible solutions, taking into account ethics, the environment and socio-economics.	Able to evaluate problem general and specific in the field materials science (C6).	• Studying • Study independent	• The breadth and depth of materials science research topics • mastery material knowledge ingredients • systematics scientific • attitude scientific • ethics • balance environment • social	Computer , LCD, internet	Literature Review 1 Literature Review 2 Advanced Material Structure Advanced Material Properties and Performance Advanced Thermodynamics and Kinetics of Materials Characterization , and Advanced Materials Analysis	Able to make a clear , effective and fulfilling research proposal rules scientific . Able to explain and argue the feasibility of the proposed research.	Presentation Research proposal Paper Report analysis problem

No	PLO	Sub PLO	Activity	Material Study/Scope of Material	Media & Technology	Subject	Indicator	Assessment
	A	B	C	D	E	F	G	H
				economy		Publication Scientific (R) Draft Publication International (R) Publication International (R) Integration of Science and Mathematics Publication Scientific Draft Publication International Publication International Research Proposal Research Result Exam 1 Research Result Exam 2 Dissertation Exam 1 Dissertation Exam 2 Promotion Doctor		
3	Able to design and implement experimental research methods and mathematical modeling that are ethically academically responsible, analyze data critically and systematically and draw conclusions.	Able to carry out various fabrication techniques and material characterization or material modeling (B5).	• Studying • Study independent • Study • Work laboratory	• methodology and study literature • methodology research • modeling mathematics • ethics	Computer , LCD, internet, laboratory	Publication Scientific (R) Draft Publication International (R) Publication International (R) Publication Scientific Draft Publication International Publication International Research Result Exam 1 Research Result Exam 2	Able to display and analyze research data effectively. Able to have scientific discussions: interpretation analysis, argumentative logic and consistency of thought. Able to continue research to achieve the final research goal.	Presentation Research Report Dissertation Mathematical modeling

No	PLO	Sub PLO	Activity	Material Study/Scope of Material	Media & Technology	Subject	Indicator	Assessment
	A	B	C	D	E	F	G	H
						Dissertation Exam 1 Dissertation Exam 2 Promotion Doctor		
4	Able to create and design new materials, processing methods and material analysis techniques and material product innovations by paying attention to humanities values that are beneficial for the development of materials science, industry and society in general.	Able to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods (C6).	• Studying • Study independent • Study • Work laboratory	• Material design techniques • Material analysis techniques • Humanities • Material innovation	Computer , LCD, internet	Publication Scientific (R) Draft Publication International (R) Publication International (R) Integration of Science and Mathematics Publication Scientific Draft Publication International Publication International Research Proposal Research Result Exam 1 Research Result Exam 2 Dissertation Exam 1 Dissertation Exam 2 Promotion Doctor	Able to produce scientific work that is worthy of being published in conference proceedings, accredited journals or international journals.	Problem solving analysis report Material design concept Material model Presentation
5	Able to apply material science concepts in solving complex industrial material application problems through a multidisciplinary approach that takes into account safety, social and ethical aspects.	Able to provide recommendations for collaborative design solutions to sustainable development problems by involving various fields within the scope of science and mathematics (C6).	• Studying • Study independent • Literature review	• Properties and structure of atoms and crystals chemical bonds • basics of crystallography impurity materials dislocations • disabled	Computer , LCD, internet, board write	Literature Review 1 Literature Review 2 Advanced Material Structure Advanced Material Properties and Performance Advanced Thermodynamics	Able to connect the relationship between structure, properties, processing, and performance of material systems (C6) Able to select, organize and critically evaluate	Presentation, Exam Implementation of Research Collaboration Research collaboration

No	PLO	Sub PLO	Activity	Material Study/Scope of Material	Media & Technology	Subject	Indicator	Assessment
	A	B	C	D	E	F	G	H
				surface • types failure of material • structure metal ceramics • polymer • composite • K3L • Ethics		and Kinetics of Materials Characterization , and Advanced Materials Analysis Publication Scientific (R) Draft Publication International (R) Publication International (R) Integration of Science and Mathematics Publication Scientific Draft Publication International Publication International Research Proposal Research Result Exam 1 Research Result Exam 2 Dissertation Exam 1 Dissertation Exam 2 Promotion Doctor	the latest scientific information sources (C5)	

Explanation :

A. PLO taken from Table 3.1. Formulation of PLO Study Program

B. Containing description from PLO

C. Describe learning process activities

D. Contains material or study materials provided to achieve PLO
E. The media and technology used in the learning process are in accordance with PLO
F. Courses covered in Table D
G. Related assessment indicators that are in accordance with PLO
H. Appropriate assessment with PLO

3.5. Relationship between Courses and Programme Learning Outcomes (PLO)

Table 3.4 Relationship between Courses and PLO

SUBJECT	Credits	PROGRAMME LEARNING OUTCOMES (PLO)				
		1	2	3	4	5
Semester 1						
Advanced Material Structure	3	√	√			
Advanced Material Properties and Performance	3	√	√			
Integration of Science and Mathematics	4	√	√			√
Scientific Literacy	2	√	√			√
Philosophy of Science	2		√			
Semester 2						
Advanced Materials Characterization and Analysis	3	√	√	√		
Advanced Thermodynamics and Kinetics of Materials	3	√	√			
Research Proposal	8	√	√	√	√	
Semester 3						
Scientific Publication	6					
Research Results Exam-1	8	√	√	√	√	√
Semester 4						
Research Results Exam-2	10	√	√	√	√	√
International Publication-1	6					
Semester 5						
International Publication-2	6	√	√	√	√	√
Dissertation Examination-1	8	√	√	√	√	√
Semester 6						
Dissertation Examination-2	12	√	√	√	√	√
Doctor Promotion	4	√	√	√	√	√
Research Path						
Semester 1						
Literature Review-1	5	√	√			
Literature Review-2	5	√	√			
Semester 2						
Research Proposal	8	√	√	√	√	
Semester 3						
Scientific Publication (R)	8	√	√	√	√	√
Research Result Exam-1	10	√	√	√	√	√
Semester 4						

Research Result Exam-2	10	√	√	√	√	√
International Publication-1 (R)	8	√	√	√	√	√
Semester 5						
Publication International-2 (R)	10	√	√	√	√	√
Dissertation Exam-1	8	√	√	√	√	√
Semester 6						
Dissertation Exam-2	12	√	√	√	√	√
Doctor Promotion	4	√	√	√	√	√
SUBJECT	**Credits**	**PROGRAMME LEARNING OUTCOMES (PLO)**				
		1	**2**	**3**	**4**	**5**
Semester 1						
Advanced Material Structure	3	√	√			
Advanced Material Properties and Performance	3	√	√			
Integrated Science and Mathematics	4	√	√			√
Scientific Literacy	2	√	√			√
Philosophy of Science	2		√			
Semester 2						
Advanced Materials Characterization and Analysis	3	√	√	√		
Advanced Thermodynamics and Kinetics of Materials	3	√	√			
Research Proposal	8	√	√	√	√	
Semester 3						
Scientific Publication	6					
Research Results Exam-1	8	√	√	√	√	√
Semester 4						
Research Results Exam-2	10	√	√	√	√	√
International Publication-1	6					
Semester 5						
International Publication-2	6	√	√	√	√	√
Dissertation Exam-1	8	√	√	√	√	√
Semester 6						
Dissertation Exam-2	12	√	√	√	√	√
Doctor Promotion	4	√	√	√	√	√
Research Path						
Semester 1						
Literature Review-1	5	√	√			
Literature Review-2	5	√	√			
Semester 2						
Research Proposal	8	√	√	√	√	
Semester 3						
Scientific Publication (R)	8	√	√	√	√	√

Research Result Exam-1	10	√	√	√	√	√
Semester 4						
Research Result Exam-2	10	√	√	√	√	√
International Publication-1 (R)	8	√	√	√	√	√
Semester 5						
Publication International-2 (R)	10	√	√	√	√	√
Dissertation Exam-1	8	√	√	√	√	√
Semester 6						
Dissertation Exam-2	12	√	√	√	√	√
Doctor Promotion	4	√	√	√	√	√

Notes : 1. To determine the check mark (√) selected are the courses with the highest level in supporting the achievement of PLO.

3.6. Course Flowchart For PLO Achievements

The flow and continuity between one course and another need to be shown in the Course Flowchart. For evaluation needs at the curriculum level, when mapping learning outcomes to courses, it can be determined which courses are only given prior knowledge, only given learning experiences, and courses that are given learning experiences and monitored for assessment achievements at the curriculum level.

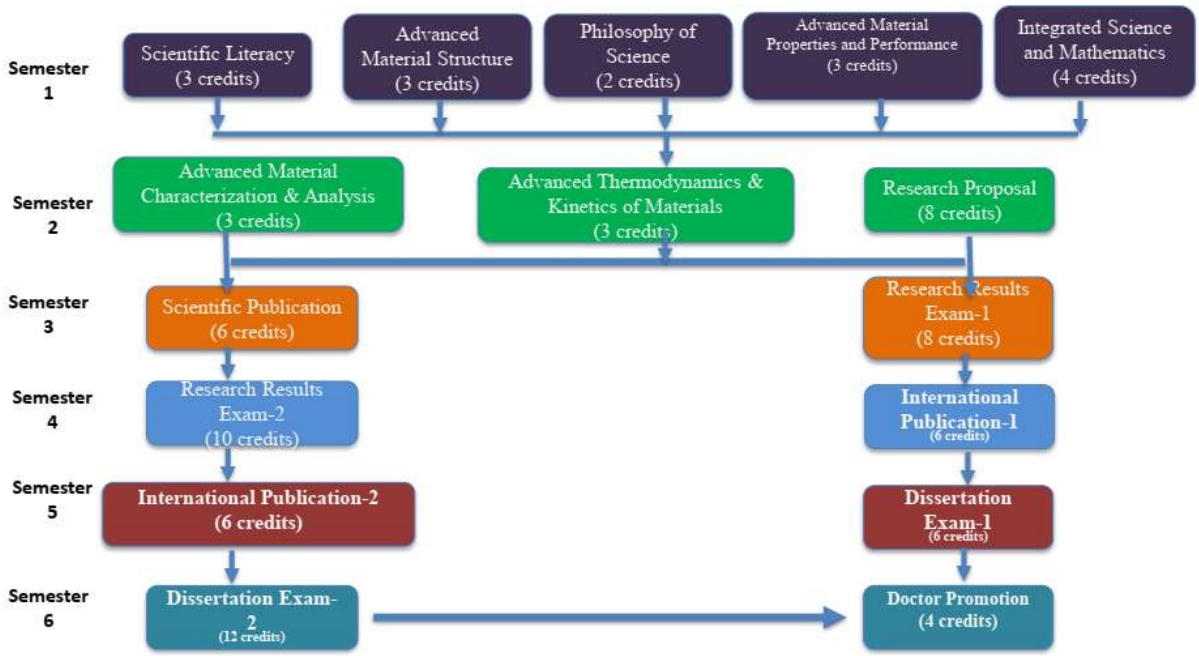

Figure 3.1 Research Course Path

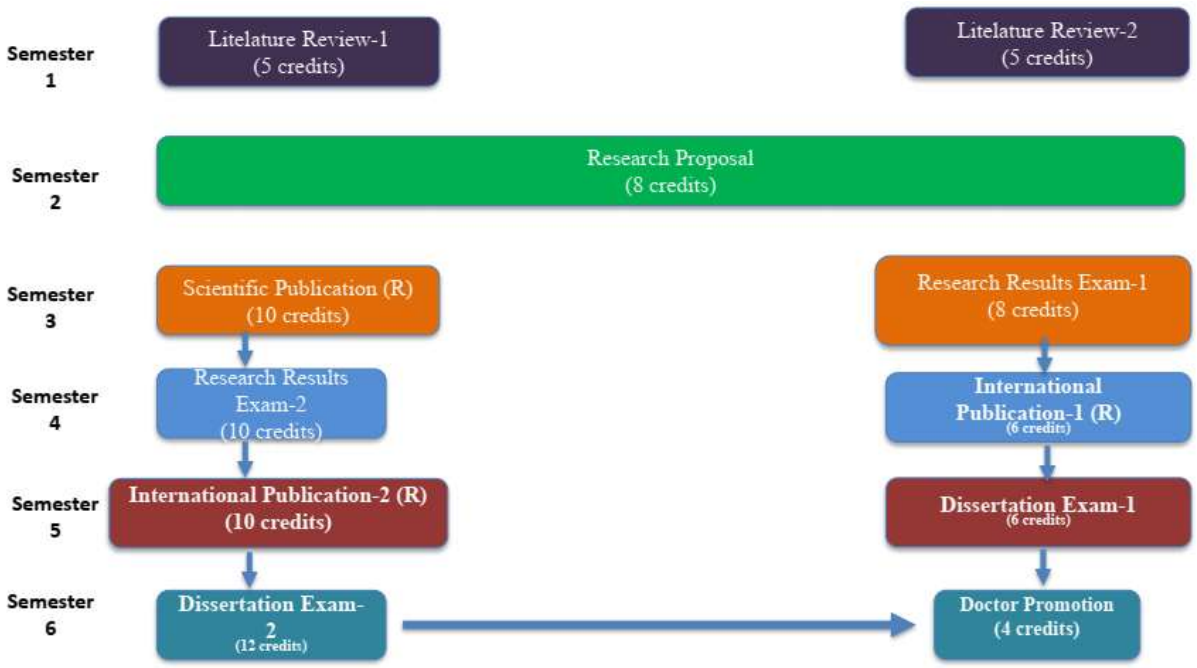

Figure 3.2 Research Path

3.7. Determination of PLO Achievement Indicators

Table 3.5 PLO Description and Achievement Indicators in Courses and Contribution Weight

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
College Path Research						
1	Able to construct an integrated relationship between structure, properties, processing, and performance of material systems.	Able to connect the relationship between structure, properties, processing, and performance of material systems (C6)	1	Literacy Scientific	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			1	Advanced Material Structure	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			1	Advanced Material Properties and Performance	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			2	Advanced Thermodynamics and Kinetics of Materials	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			2	Advanced Materials Characterization and Analysis	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			3	Publication Scientific	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			4	Draft Publication International	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
			5	Dissertation Exam 1	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			5	Publication International	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			6	Dissertation Exam 2	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
			6	Promotion Doctor	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	10%
2	Able to identify and analyze problem field materials science and capable compile solution responsible solution answer in a way scientific , with notice ethics , environment and social economy .	Able to evaluate problem general and specific in the field materials science (C6)	1	Literacy Scientific	Ability For evaluate problem general and specific in the field materials science	7%
			1	Advanced Material Structure	Ability For evaluate problem general and specific in the field materials science	7%
			1	Advanced Material Properties and Performance	Ability For evaluate problem general and specific in the field materials science	7%
			1	Integration of Science and Mathematics	Ability For evaluate problem general and specific in the field materials science	7%
			2	Advanced Thermodynamics and Kinetics of Materials	Ability For evaluate problem general and specific in the field materials science	7%
			2	Advanced Materials Characterization and Analysis	Ability For evaluate problem general and specific in the field materials science	7%
			2	Research Proposal	Ability For evaluate problem general and specific in the field materials science	7%
			3	Publication Scientific	Ability For evaluate problem general and specific in the field materials science	7%
			3	Research Result Exam 1	Ability For evaluate problem general and specific in the field materials science	7%
			4	Research Result Exam 2	Ability For evaluate problem general and specific in the field materials science	7%
			5	Dissertation Exam 1	Ability For evaluate problem general and specific in the field materials science	8%
			5	Publication International	Ability For evaluate problem general and specific in the field materials science	7%
			6	Dissertation Exam 2	Ability For evaluate problem general and specific in the field materials science	8%
			6	Promotion Doctor	Ability For evaluate problem general and specific in the field materials science	7%
3	Able to design and implement experimental research	Able to carry out various fabrication and	1	Literacy Scientific	Ability to perform various fabrication techniques and material characterization or material modeling	12%

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
	methods and mathematical modeling that are ethically academically responsible, analyze data critically and systematically and draw conclusions.	material characterization techniques or material modeling (B5)	1	Integration of Science and Mathematics	Ability to perform various fabrication techniques and material characterization or material modeling	12%
			1	Philosophy of Science	Ability to perform various fabrication techniques and material characterization or material modeling	12%
			2	Research Proposal	Ability to perform various fabrication techniques and material characterization or material modeling	13%
			3	Publication Scientific	Ability to perform various fabrication techniques and material characterization or material modeling	13%
			4	Research Result Exam 2	Ability to perform various fabrication techniques and material characterization or material modeling	13%
			4	Draft Publication International	Ability to perform various fabrication techniques and material characterization or material modeling	12%
			5	Publication International	Ability to perform various fabrication techniques and material characterization or material modeling	13%
4	Able to create and design new materials, processing methods and material analysis techniques and material product innovations by paying attention to humanities values that are beneficial for the development of materials science, industry and society in general.	Able to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods (C6)	1	Literacy Scientific	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations with correct scientific methods.	16%
			1	Integration of Science and Mathematics	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods.	16%
			2	Research Proposal	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations with correct scientific methods.	17%
			3	Research Result Exam 1	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations with correct scientific methods.	17%
			4	Draft Publication International	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods.	16%
			5	Publication International	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations with correct scientific methods.	18%
5	Able to apply draft material science in breakdown problem application complex materials industry through approach	Able to provide recommendation design settlement problem development	1	Literacy Scientific	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
	multidisciplinary that pays attention to aspect safety , social and ethics	sustainable in a way collaborative with involving various field in scope of science and mathematics (C6)	1	Advanced Material Structure	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
			1	Advanced Material Properties and Performance	The ability to provide recommendations for collaborative design solutions to sustainable development problems by involving various fields within the scope of science and mathematics.	6%
			1	Integration of Science and Mathematics	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
			1	Philosophy of Science	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
			2	Advanced Thermodynamics and Kinetics of Materials	The ability to provide recommendations for collaborative design solutions to sustainable development problems by involving various fields within the scope of science and mathematics.	6%
			2	Advanced Materials Characterization and Analysis	The ability to provide recommendations for collaborative design solutions to sustainable development problems by involving various fields within the scope of science and mathematics.	6%
			2	Research Proposal	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
			3	Publication Scientific	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
			3	Research Result Exam 1	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
			4	Research Result Exam 2	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
			4	Draft Publication International	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	7%

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
			5	Dissertation Exam 1	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	7%
			5	Publication International	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	7%
			6	Dissertation Exam 2	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	7%
			6	Promotion Doctor	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	6%
Research Path						
1	Able to construct an integrated relationship between structure, properties, processing, and performance of material systems.	Able to connect the relationship between structure, properties, processing, and performance of material systems (C6)	1	Literature Review 1	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	12%
			1	Literature Review 2	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	12%
			2	Research Proposal	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	12%
			3	Publication Scientific (R)	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	12%
			4	Draft Publication International (R)	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	13%
			5	Publication International (R)	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	13%
			5	Dissertation Exam 1	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	13%
			6	Dissertation Exam 2	The ability to synthesize relationships between the structure, properties, processing, and performance of material systems.	13%
2	Able to identify and analyze problem field materials science and capable compile solution responsible solution answer in a	Able to evaluate problem general and specific in the	1	Literature Review 1	Ability For evaluate problem general and specific in the field materials science	9%
			1	Literature Review 2	Ability For evaluate problem general and specific in the field materials science	9%

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
	way scientific , with notice ethics , environment and social economy .	field materials science (C6)	2	Research Proposal	Ability For evaluate problem general and specific in the field materials science	9%
			3	Publication Scientific (R)	Ability For evaluate problem general and specific in the field materials science	9%
			3	Research Result Exam 1	Ability For evaluate problem general and specific in the field materials science	9%
			4	Research Result Exam 2	Ability For evaluate problem general and specific in the field materials science	9%
			5	Publication International (R)	Ability For evaluate problem general and specific in the field materials science	9%
			6	Dissertation Exam 2	Ability For evaluate problem general and specific in the field materials science	10%
			6	Promotion Doctor	Ability For evaluate problem general and specific in the field materials science	9%
3	Able to design and implement experimental research methods and mathematical modeling that are ethically academically responsible, analyze data critically and systematically and draw conclusions.	Able to carry out various fabrication and material characterization techniques or material modeling (B5)	1	Literature Review 1	Ability to perform various fabrication techniques and material characterization or material modeling	14%
			1	Literature Review 2	Ability to perform various fabrication techniques and material characterization or material modeling	14%
			2	Research Proposal	Ability to perform various fabrication techniques and material characterization or material modeling	15%
			4	Research Result Exam 2	Ability to perform various fabrication techniques and material characterization or material modeling	15%
			5	Draft Publication International (R)	Ability to perform various fabrication techniques and material characterization or material modeling	14%
			5	Publication International (R)	Ability to perform various fabrication techniques and material characterization or material modeling	14%
			6	Promotion Doctor	Ability to perform various fabrication techniques and material characterization or material modeling	14%
4	Able to create and design new materials, processing methods and material analysis techniques and material product innovations by	Able to create and design new materials, processing methods, material	4	Draft Publication International (R)	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods.	33%

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
	paying attention to humanities values that are beneficial for the development of materials science, industry and society in general.	analysis techniques or material product innovations using correct scientific methods (C6)	5	Publication International (R)	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods.	34%
			5	Dissertation Exam 1	The ability to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods.	33%
5	Able to apply draft material science in breakdown problem application complex materials industry through approach multidisciplinary that pays attention to aspect safety , social and ethics	Able to provide recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics (C6)	1	Literature Review 1	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			1	Literature Review 2	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			2	Research Proposal	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			3	Publication Scientific (R)	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			3	Research Result Exam 1	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			4	Research Result Exam 2	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			4	Draft Publication International (R)	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%

No	Programme Learning Outcome (PLO)	Sub-PLO	Semester	Course Name	PLO Indicators in Courses	Weight
			5	Publication International (R)	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			5	Dissertation Exam 1	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%
			6	Dissertation Exam 2	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	10%
			6	Promotion Doctor	Ability For give recommendation design settlement problem development sustainable in a way collaborative with involving various field in scope of science and mathematics	9%

3.8. Alignment PLO and Course Learning Outcome (CLO) Achievements

For convenience of implementation of the Curriculum, the PLO achievement indicators that have been determined above can directly become Course Learning Outcomes (CLO), this Matrix is to ensure alignment between PLO and CLO. By using indicators as CLO.

Table 3.6 Explanation of PLO into CLO Derived from PLO Achievement Indicators

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
Research Course Path					
1	Able to construct an integrated relationship between structure, properties, processing, and performance of material systems.	Able to connect the relationship between structure, properties, processing, and performanc e of material systems (C6)	1	Literacy Scientific	CLO 2: Able to act independently intellectually, tolerantly, and free from dogmatic entanglements
			1	Advanced Material Structure	CLO 1: Able to conduct an integrated study of advanced crystal structures
					CLO 2: Able to examine advanced metal structures
					CLO 3: Able to examine advanced ceramic structures
					CLO 4: Able to examine advanced polymer structures
					CLO 5: Able to examine advanced composite structures
			1	Advanced Material Properties and Performance	CLO 1: Able to identify and examine advanced mechanical properties
					CLO 2: Able to identify and examine advanced electrical and optical properties
					CLO 3: Able to identify and examine advanced magnetic and thermal properties
					CLO 4: Able to identify and examine metal corrosion and advanced material degradation.
			2	Thermodynamics and Kinetics of Advanced Materials	CLO 1: Able to apply advanced thermodynamic principles in the solidification process (liquid-solid phase transformation) and reconstruct phase diagrams.

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
					CLO 2: Able to apply advanced thermodynamic principles in analyzing phase diagrams
					CLO 3: Able to construct advanced Time Temperature Transformation (TTT) and Continuous Cooling Transformation (CCT) diagrams as well as advanced material interphase equilibrium.
					CLO 4: Able to apply electrochemical principles to oxidation and degradation events of materials
			2	Advanced Materials Characterization and Analysis	CLO 1: Able to analyze the results of X-Ray & Neutron Diffraction characterization and various types of microscopes responsibly.
					CLO 2: Able to analyze the results of FTIR and Raman spectroscopy characterization, as well as the results of mechanical property testing according to standards.
					CLO 3: Able to analyze the results of magnetic and thermal property tests
					CLO 4: Able to analyze the results of electrical and optical properties tests
			3	Publication Scientific	CLO 1 : Able to do deepening or expansion science knowledge ingredients with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
					CLO 2: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific writing form
					CLO 3: Able to communicate ideas, results thoughts , and arguments scientific through scientific media to public academic and community wide
			4	Draft Publication International	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 2: Able to do deepening or expansion science ingredients with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
			5	Dissertation Exam 1	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete the target according to with set time
					CLO 5: Able to present work and research results systematically using good sentence structure and language.
			5	Publication International	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 2 : Able to do deepening or expansion Materials Science or knowledge ingredients applied with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
			6		CLO 1: Able to conclude results study with careful related with discussion results research

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
				Dissertation Exam 2	and answer problems and goals study in a way clear
					CLO 2: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
			6	Promotion Doctor	CLO 2: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
2	Able to identify and analyze problem field materials science and capable compile solution responsible solution answer in a way scientific , with notice ethics , environment and social economy .	Able to evaluate problem general and specific in the field materials science (C6)	1	Literacy Scientific	CLO 3: Able to apply ethics in science
					CLO 4: Able to select, organize and critically evaluate the latest scientific information sources.
					CLO 5: Able to apply positivist and phenomenological thinking
			1	Advanced Material Structure	CLO 1: Able to conduct an integrated study of advanced crystal structures
					CLO 2: Able to examine advanced metal structures
					CLO 3: Able to examine advanced ceramic structures
					CLO 4: Able to examine advanced polymer structures
					CLO 5: Able to examine advanced composite structures
			1	Advanced Material Properties and Performance	CLO 1: Able to identify and examine advanced mechanical properties
					CLO 2: Able to identify and examine advanced electrical and optical properties
					CLO 3: Able to identify and examine advanced magnetic and thermal properties
					CLO 4: Able to identify and examine metal corrosion and advanced material degradation.
			1	Integration of Science and Mathematics	CLO 1: Able to develop logical, critical, systematic and creative thinking in studying sustainable development problems according to the field of materials science competence.
					CLO 2: Able to compile recommendations on scientific issues and sustainable development based on comprehensive study results involving various fields within the scope of mathematics and science.
					CLO 3: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession.
			2	Advanced Thermodynamics and Kinetics of Materials	CLO 1: Able to apply advanced thermodynamic principles in the solidification process (liquid-solid phase transformation) and reconstruct phase diagrams.
					CLO 2: Able to apply advanced thermodynamic principles in analyzing phase diagrams
					CLO 3: Able to construct advanced Time Temperature Transformation (TTT) and Continuous Cooling Transformation (CCT) diagrams as well as advanced material interphase equilibrium.
					CLO 4: Able to apply electrochemical principles to oxidation and degradation events of materials
			2		CLO 1: Able to analyze the results of X-Ray & Neutron Diffraction characterization and various types of microscopes responsibly.

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
				Advanced Materials Characterization and Analysis	CLO 2: Able to analyze the results of FTIR and Raman spectroscopy characterization, as well as the results of mechanical property testing according to standards.
					CLO 3: Able to analyze the results of magnetic and thermal property tests
					CLO 4: Able to analyze the results of electrical and optical properties tests
			2	Research Proposal	CLO 1: Able to evaluate various literature latest related with Topic research and critique For find potential development and renewal knowledge knowledge in One field knowledge ingredients
			3	Publication Scientific	CLO 3: Able to communicate ideas, results thoughts , and arguments scientific through scientific media to public academic and community wide
			3	Research Result Exam 1	CLO 2: Able to apply scientific methodology in conducting research by considering guidelines, ethics, safety and environmental impact.
			4	Research Result Exam 2	CLO 2: Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
			5	Dissertation Exam 1	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete the target according to with set time
					CLO 5: Able to present work and research results systematically using good sentence structure and language.
			5	Publication International	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 2 : Able to do deepening or expansion science knowledge ingredients or knowledge ingredients applied with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
			6	Dissertation Exam 2	CLO 2: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
			6	Promotion Doctor	CLO 2: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
3	Able to design and implement experimental research methods and mathematical modeling that are ethically academically responsible, analyze data critically and systematically and draw conclusions.	Able to carry out various fabrication and material characterization techniques or material modeling (B5)	1	Literacy Scientific	CLO 1: Able to explain the structure of science philosophically
					CLO 2: Able to act independently intellectually, tolerantly, and free from dogmatic entanglements
					CLO 3: Able to apply ethics in science
					CLO 5: Able to apply positivist and phenomenological thinking
					CLO 6: Able to apply correct research methodology with strong academic integrity
			1		CLO 2: Able to compose recommendation problem science and development sustainable based on results comprehensive study with

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
				Integration of Science and Mathematics	involving various field in scope mathematics and science
					CLO 3: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession.
			1	Philosophy of Science	CLO 1: Able to develop logical, critical, systematic and creative thinking based on the concept of the philosophy of science.
					CLO 2: Able to recognize philosophy as a basis for understanding science comprehensively and thoroughly.
					CLO 3: Able to link science and culture as an inseparable part of the philosophy of science.
					CLO 4: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession.
			2	Research Proposal	CLO 2: Able to organize ideas and concepts new in research proposal form in accordance with problem science and topics to be covered completed in a way responsible answer based on ethics academic
					CLO 3: Able to design distribution load and time Work with Good For Work independent and in team
					CLO 4: Able to compile a proposal book in accordance with the systematics and writing techniques determined by the guidelines applicable at the university.
					CLO 5: Able to present research plan proposals systematically using good sentence structure and language.
			3	Publication Scientific	CLO 3: Able to communicate ideas, results thoughts , and arguments scientific through scientific media to public academic and community wide
			4	Research Result Exam 2	CLO 2: Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 3: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
			4	Draft Publication International	CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form
			5	Publication International	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 2 : Able to do deepening or expansion science knowledge ingredients or knowledge ingredients applied with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
4	Able to create and design new materials, processing methods and material analysis techniques and material product innovations by paying attention to humanities values	Able to create and design new materials, processing methods, material analysis techniques or material	1	Literacy Scientific	CLO 6: Able to apply correct research methodology with strong academic integrity
			1	Integration of Science and Mathematics	CLO 3: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession.
			2	Research Proposal	CLO 2: Able to organize ideas and concepts new in research proposal form in accordance with

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
	that are beneficial for the development of materials science, industry and society in general.	product innovations using correct scientific methods (C6)			problem science and topics to be covered completed in a way responsible answer based on ethics academic
					CLO 3: Able to design distribution load and time Work with Good For Work independent and in team
					CLO 4: Able to compile a proposal book in accordance with the systematics and writing techniques determined by the guidelines applicable at the university.
					CLO 5: Able to present research plan proposals systematically using good sentence structure and language.
			3	Research Result Exam 1	CLO 2: Able to apply scientific methodology in conducting research by considering guidelines, ethics, safety and environmental impact.
			4	Draft Publication International	CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form
			5	Publication International	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 2 : Able to do deepening or expansion science knowledge ingredients or knowledge ingredients applied with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
5	Able to apply draft material science in breakdown problem application complex materials industry through approach multidisciplinary that pays attention to aspect safety , social and ethics	Able to provide recommend ation design settlement problem developmen t sustainable in a way collaborativ e with involving various field in scope of science and mathematic s (C6)	1	Literacy Scientific	CLO 3: Able to apply ethics in science
			1	Advanced Material Structure	CLO 1: Able to conduct an integrated study of advanced crystal structures
					CLO 2: Able to examine advanced metal structures
					CLO 3: Able to examine advanced ceramic structures
					CLO 4: Able to examine advanced polymer structures
					CLO 5: Able to examine advanced composite structures
			1	Advanced Material Properties and Performance	CLO 1: Able to identify and examine advanced mechanical properties
					CLO 2: Able to identify and examine advanced electrical and optical properties
					CLO 3: Able to identify and examine advanced magnetic and thermal properties
					CLO 4: Able to identify and examine metal corrosion and advanced material degradation.
			1	Integration of Science and Mathematics	CLO 3: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession.
			1	Philosophy of Science	CLO 4: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession.
			2	Advanced Thermodynamics and Kinetics of Materials	CLO 1: Able to apply advanced thermodynamic principles in the solidification process (liquid-solid phase transformation) and reconstruct phase diagrams.
					CLO 2: Able to apply advanced thermodynamic principles in analyzing phase diagrams
					CLO 3: Able to construct advanced Time Temperature Transformation (TTT) and

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
					Continuous Cooling Transformation (CCT) diagrams as well as advanced material interphase equilibrium.
					CLO 4: Able to apply electrochemical principles to oxidation and degradation events of materials
			2	Advanced Materials Characterization and Analysis	CLO 1: Able to analyze the results of X-Ray & Neutron Diffraction characterization and various types of microscopes responsibly.
					CLO 2: Able to analyze the results of FTIR and Raman spectroscopy characterization, as well as the results of mechanical property testing according to standards.
					CLO 3: Able to analyze the results of magnetic and thermal property tests
					CLO 4: Able to analyze the results of electrical and optical properties tests
			2	Research Proposal	CLO 1: Able to evaluate various current literature related to research topics and criticize them to find potential for development and
					CLO 5: Able to present research plan proposals systematically using good sentence structure and language.
			3	Publication Scientific	CLO 1 : Able to do deepening or expansion science knowledge ingredients with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
					CLO 2: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific writing form
					CLO 3: Able to communicate ideas, results thoughts , and arguments scientific through scientific media to public academic and community wide
			3	Research Result Exam 1	CLO 1: Able to implement principle sustainability in apply method scientific and problem solving strategies problems in the field professional whatever
					CLO 3: Able to implement and update knowledge knowledge Ingredients and Applications through study For contribute to the resolution problems in industry and society
					CLO 4: Able to work together with colleagues in completing a research and development project.
					CLO 5: Able to decide on the objectives, strategies and tasks of each member of the research team to achieve research targets.
			4	Research Result Exam 2	CLO 1: Able to internalize the spirit of independence, struggle, and entrepreneurship based on academic values, norms, and ethics.
					CLO 4: Able to communicate effectively in research and development projects
					CLO 5: Able to monitor and evaluate the objectives, strategies and tasks of each member of the research team in carrying out research periodically.
			4	Draft Publication International	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 2: Able to do deepening or expansion science ingredients with produce a model, a method or development original, accurate , tested

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
					, and innovative theories that are useful For industry and society
					CLO 3: Able to convey data information , observations , or results calculation in detail using supporting images , tables and graphs results study
					CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form
			5	Dissertation Exam 1	CLO 2: Able to implement and update knowledge knowledge Ingredients and Applications through study For contribute to the resolution problems in industry and society
					CLO 3: Able to manage network Work with colleague , peer within institutions and communities study more in the field of materials science wide
					CLO 5: Able to present work and research results systematically using good sentence structure and language.
			5	Publication International	CLO 3: Able to convey data information , observations , or results calculation in detail using supporting images , tables and graphs results study
					CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form
			6	Dissertation Exam 2	CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear
					CLO 3: Able to be accountable for the results of research and development project work.
					CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete the target according to with set time
					CLO 5: Able to compose book dissertation in a way systematic in accordance with technique writing as determined by the guidelines in force at the university
					CLO 6 Able to argue in presenting work and research results clearly, straightforwardly, precisely, and well/politely based on data evidence.
			6	Promotion Doctor	CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear
					CLO 3: Able to communicate ideas, results thoughts , and arguments scientific through scientific media to public academic and community wide
					CLO 4: Able to argue in presenting work and research results clearly, straightforwardly, precisely, and well/politely based on data evidence.
Research Path					
1	Able to construct an integrated relationship between structure, properties, processing, and	Able to connect the relationship between structure, properties,	1	Literature Review 1	CLO 1: Able to develop logical, critical, systematic and creative thinking in the field of science and technology in accordance with the field of competency in materials science.
					CLO 2: Able to explore new scientific problems that are relevant to aspects of materials science

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
	performance of material systems.	processing, and performanc e of material systems (C6)			knowledge and its applications in a comprehensive and comprehensive manner.
					CLO 3: Able to examine laws, theories, or formulas of materials science and their relevant applications to solve new scientific problems in a comprehensive and scientific manner.
			1	Literature Review 2	CLO 1: Able to analyze all aspect problems faced with based on conceptual knowledge relevant materials and applications
					CLO 2: Able to analyze comparative data, observations, or calculation results using a theoretical, conceptual approach or related calculation method.
					CLO 3: Able to implement sustainability principles in applying scientific methods and problem-solving strategies in any professional field.
			2	Research Proposal	CLO 1: Able to evaluate various literature latest related with Topic research and critique For find potential development and renewal knowledge knowledge in One field knowledge ingredients
					CLO 2: Able to compile new ideas and concepts in the form of research proposals in accordance with scientific problems and topics that will be resolved responsibly based on academic ethics.
			3	Publication Scientific (R)	CLO 1 : Able to do deepening or expansion Materials Science with produce a model, a method or development original, accurate , tested , and innovative theories that are useful
			4	Draft Publication International (R)	CLO 2: Able to do deepening or expansion science knowledge ingredients with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
			5	Publication International (R)	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 2: Able to do deepening or expansion science knowledge ingredients or knowledge ingredients applied with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
			5	Dissertation Exam 1	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
			6	Dissertation Exam 2	CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear
2	Able to identify and analyze problem field materials science and capable compile solution responsible solution answer in a way scientific , with notice ethics , environment and social economy .	Able to evaluate problem general and specific in the field materials science (C6)	1	Literature Review 1	CLO 2: Able to explore problem science new relevant with aspect knowledge knowledge Ingredients and Applications in a way comprehensive and thorough
			1	Literature Review 2	CLO 2: Able to analyze comparative data, observations, or calculation results using a theoretical, conceptual approach or related calculation method.
			2	Research Proposal	CLO 1: Able to evaluate various literature latest related with Topic research and critique For find potential development and renewal knowledge knowledge in One field knowledge ingredients
			3	Publication Scientific (R)	CLO 1 : Able to do deepening or expansion Materials Science with produce a model, a method or development original, accurate , tested

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
					, and innovative theories that are useful For industry and society
			3	Research Result Exam 1	CLO 1: Able to implement principle sustainability in apply method scientific and problem solving strategies problems in the field professional whatever
			4	Research Result Exam 2	CLO 2: Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 3: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
			5	Publication International (R)	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
			6	Dissertation Exam 2	CLO 2: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
			6	Promotion Doctor	CLO 3: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
3	Able to design and implement experimental research methods and mathematical modeling that are ethically academically responsible, analyze data critically and systematically and draw conclusions.	Able to carry out various fabrication and material characterization techniques or material modeling (B5)	1	Literature Review 1	CLO 4: Able to apply methods and tools to help solve materials science problems in the form of analytical, numerical or experimental approaches in applying knowledge of materials science and its applications.
			1	Literature Review 2	CLO 4: Able to express literature latest relevant with problem science or Topic study with sourced from journal international reputable in sufficient amount
			2	Research Proposal	CLO 2: Able to compile new ideas and concepts in the form of research proposals in accordance with scientific problems and topics that will be resolved responsibly based on academic ethics.
			4	Research Result Exam 2	CLO 2: Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
					CLO 3: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
			5	Draft Publication International (R)	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
			5	Publication International (R)	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
			6	Promotion Doctor	CLO 3: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
4	Able to create and design new materials, processing methods and material analysis techniques and material product innovations by paying attention to humanities values that are beneficial for the development of materials science, industry and society in general.	Able to create and design new materials, processing methods, material analysis techniques or material product innovations using correct scientific methods (C6)	4	Draft Publication International (R)	CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related
			5	Publication International (R)	CLO 2: Able to do deepening or expansion science knowledge ingredients or knowledge ingredients applied with produce a model, a method or development the theory that
			5	Dissertation Exam 1	CLO 2: Able to implement and update knowledge of materials science and its applications through research to contribute to solving problems in industry and society.
5	Able to apply draft material science in breakdown problem application complex materials industry through approach multidisciplinary that pays attention to aspect safety , social and ethics	Able to provide recommend ation design settlement problem developmen t sustainable in a way collaborativ e with involving various field in scope of science and mathematic s (C6)	1	Literature Review 1	CLO 5: Able to utilize information technology in the context of carrying out work by using one of the computer-based applications.
					CLO 6: Able to compile recommendations on scientific issues and sustainable development based on comprehensive study results involving various fields within the scope of mathematics and science.
					CLO 7: Able to adapt to the latest scientific developments by continually learning new things that are relevant to any job or profession.
			1	Literature Review 2	CLO 6: Able to evaluate various literature latest related with Topic research and critique For find potential development and renewal knowledge knowledge in One field knowledge ingredients
					CLO 7: Able to present the results of literature studies systematically using good sentence structure and language.
			2	Research Proposal	CLO 3: Able to design distribution load and time Work with Good For Work independent and in team
					CLO 4: Able to compile a proposal book in accordance with the systematics and writing techniques determined by the guidelines applicable at the university.
					CLO 5: Able to present research plan proposals systematically using good sentence structure and language.

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
			3	Publication Scientific (R)	CLO 2: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific writing form
					CLO 3: Able to communicate ideas, results thoughts , and arguments scientific through scientific media to public academic and community wide
			3	Research Result Exam 1	CLO 2: Able to apply scientific methodology in conducting research by considering guidelines, ethics, safety and environmental impact.
					CLO 3: Able to implement and update knowledge of materials science and its applications through research to contribute to solving problems in industry and society.
					CLO 4: Able to work together with colleagues in completing a research and development project.
					CLO 5: Able to decide on the objectives, strategies and tasks of each member of the research team to achieve research targets.
			4	Research Result Exam 2	CLO 1: Able to internalize the spirit of independence, struggle, and entrepreneurship based on academic values, norms, and ethics.
					CLO 4: Able to communicate effectively in research and development projects
					CLO 5: Able to monitor and evaluate the objectives, strategies and tasks of each member of the research team in carrying out research periodically.
					CLO 6: Able to convey information on data, observations or calculation results in detail using images, tables and graphs that support research results.
			4	Draft Publication International (R)	CLO 2: Able to do deepening or expansion science knowledge ingredients with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society
					CLO 3: Able to convey information on data, observations or calculation results in detail using images, tables and graphs that support research results.
					CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form
			5	Publication International (R)	CLO 3: Able to convey information on data, observations or calculation results in detail using images, tables and graphs that support research results.
					CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form
			5	Dissertation Exam 1	CLO 3: Able to manage network Work with colleague , peer within institutions and communities study more in the field of materials science wide
					CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete the target according to with set time
					CLO 5: Able to present work and research results systematically using good sentence structure and language.
			6		CLO 3: Able to be accountable results work project research and development

No	Programme Learning Outcome (PLO)	Sub PLO	Semester	Course Name	Course Learning Outcomes (CLO)
					CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete the target according to with set time
				Dissertation Exam 2	CLO 5: Able to compose book dissertation in a way systematic in accordance with technique writing as determined by the guidelines in force at the university
					CLO 6: Able to argue in presenting work and research results clearly, straightforwardly, precisely, and well/politely based on data evidence.
			6		CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear
				Promotion Doctor	CLO 3: Able to solve problem science new and development sustainable through inter- or inter-approach multidisciplinary characterized with produced insight , method , knowledge and technology comprehensive valuable
					CLO 4: Able to argue in presenting work and research results clearly, straightforwardly, precisely, and well/politely based on data evidence.

Table 3.7 Matrix between PLO and CLO

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
Research Course Path					
Scientific Literacy					
CLO 1: Able to explain the structure of science philosophically			X		
CLO 2: Able to act independently intellectually, tolerantly, and free from dogmatic entanglements	X		X		
CLO 3: Able to apply ethics in science		X	X		X
CLO 4: Able to select, organize and critically evaluate the late scientific information sources.		X			
CLO 5: Able to apply positivist and phenomenological thinkin		X	X		
CLO 6: Able to apply correct research methodology with stror academic integrity			X	X	
Advanced Material Structure					
CLO 1: Able to conduct an integrated study of advanced crystal structures	X	X			X
CLO 2: Able to examine advanced metal structures	X	X			X
CLO 3: Able to examine advanced ceramic structures	X	X			X
CLO 4: Able to examine advanced polymer structures	X	X			X
CLO 5: Able to examine advanced composite structures	X	X			X
Advanced Material Properties and Performance					

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO 1: Able to identify and examine advanced mechanical properties	X	X			X
CLO 2: Able to identify and examine advanced electrical ar optical properties	X	X			X
CLO 3: Able to identify and examine advanced magnetic ar thermal properties	X	X			X
CLO 4: Able to identify and examine metal corrosion and advanced material degradation.	X	X			X
Integration of Science and Mathematics					
CLO 1: Able to develop logical, critical, systematic and creative thinking in studying sustainable development problems according to the field of materials science competence.		X			
CLO 2: Able to compose recommendation problem scien and development sustainable based on results comprehensive study with involving various field in sco mathematics and science		X	X		
CLO 3: Able to adapt to the latest scientific developments b continually learning new things that are relevant to any job profession.		X	X	X	X
Philosophy of Science					
CLO 1: Able to develop logical, critical, systematic and creative thinking based on the concept of the philosophy of science.			X		
CLO 2: Able to recognize philosophy as a basis for understanding science comprehensively and thoroughly			X		
CLO 3: Able to relate science and culture as the part that is not inseparable with philosophy knowledge			X		
CLO 4: Able to adapt to the latest scientific developments b continually learning new things that are relevant to any jol or profession.			X		X
Advanced Thermodynamics and Kinetics of Materials					
CLO 1: Able to apply advanced thermodynamic principles the solidification process (liquid-solid phase transformation and reconstruct phase diagrams.	X	X			X
CLO 2: Able to apply advanced thermodynamic principles analyzing phase diagrams	X	X			X
CLO 3: Able to construct Time Temperature Transformatio (TTT) and Continuous Cooling Transformation (CCT) diagrams as well as balance between advanced material pha	X	X			X
CLO 4: Able to apply electrochemical principles to oxidatic and degradation events of materials	X	X			X
Advanced Materials Characterization and Analysis					
CLO 1: Able to analyze the results of X-Ray & Neutron Diffraction characterization and various types of microscop responsibly.	X	X			X
CLO 2: Able to analyze the results of FTIR and Raman spectroscopy characterization, as well as the results of mechanical property testing according to standards.	X	X			X
CLO 3: Able to analyze the results of magnetic and thermal property tests	X	X			X
CLO 4: Able to analyze the results of electrical and optical properties tests	X	X			X

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
Research Proposal					
CLO 1: Able to evaluate various literature latest related wit Topic research and critique For find potential development and renewal knowledge knowledge in One field knowledge ingredients		X			X
CLO 2: Able to organize ideas and concepts new in researc proposal form in accordance with problem science and topics to be covered completed in a way responsible answe based on ethics academic			X	X	
CLO 3: Able to design distribution load and time Work wit Good For Work independent and in team			X	X	
CLO 4: Able to compile a proposal book in accordance wit the systematics and writing techniques determined by the guidelines applicable at the university.			X	X	
CLO 5: Able to present research plan proposals systematica using good sentence structure and language.			X	X	X
Publication Scientific					
CLO 1 : Able to do deepening or expansion science knowledge ingredients with produce a model, a method or development original, accurate , tested , and innovative theories that are useful For industry and society	X				X
CLO 2: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific writing form	X				X
CLO 3: Able to communicate ideas, results thoughts , an arguments scientific through scientific media to public academic and community wide	X	X	X		X
Research Result Exam 1					
CLO 1: Able to implement principle sustainability in apply method scientific and problem solving strategies problems the field professional whatever					X
CLO 2: Able to apply scientific methodology in conducting research by considering guidelines, ethics, safety and environmental impact.		X		X	
CLO 3: Able to implement and update knowledge knowled Ingredients and Applications through study For contribute t the resolution problems in industry and society					X
CLO 4: Able to work together with colleagues in completin research and development project.					X
CLO 5: Able to decide goals , strategies and tasks every member team study For achieve research targets					X
Research Result Exam 2					
CLO 1: Able to internalize the spirit of independence, struggle, and entrepreneurship based on academic values, norms, and ethics.					X
CLO 2: Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related		X	X		
CLO 3: Able to solve problem science new and developme sustainable through inter- or inter- approach multidisciplina characterized with produced insight , method , knowledge a technology comprehensive valuable			X		

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO 4: Able to communicate effectively in research and development projects					X
CLO 5: Able to monitor and evaluate the objectives, strateg and tasks of each member of the research team in carrying research periodically.					X
Draft Publication International					
CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related	X				X
CLO 2: Able to do deepening or expansion science ingredients with produce a model, a method or developmen original, accurate , tested , and innovative theories that are useful For industry and society	X				X
CLO 3: Able to convey data information , observations , or results calculation in detail using supporting images , tables and graphs results study					X
CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form			X	X	X
Dissertation Exam 1					
CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related	X	X			
CLO 2: Able to implement and update knowledge knowled Ingredients and Applications through study For contribute t the resolution problems in industry and society					X
CLO 3: Able to manage network Work with colleague , peer within institutions and communities study more in field of materials science wide					X
CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete target according to with set time	X	X			
CLO 5: Able to present work and research results systematically using good sentence structure and language.	X	X			X
Publication International					
CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related	X	X	X	X	
CLO 2 : Able to do deepening or expansion science knowledge ingredients or knowledge ingredients applie with produce a model, a method or development original, accurate , tested , and innovative theories that are useful Fo industry and society	X	X	X	X	
CLO 3: Able to convey information data, observation , or results calculation in detail using supporting images , tables and graphs results study					X
CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form					X
Dissertation Exam 2					
CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear	X				X

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO 2: Able to solve problem science new and developmer sustainable through inter- or inter- approach multidisciplina characterized with produced insight , method , knowledge a technology comprehensive valuable	X	X			
CLO 3 : Able to be accountable for the results of research a development project work					X
CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete target according to with set time					X
CLO 5: Able to compose book dissertation in a way systematic in accordance with technique writing as determined by the guidelines in force at the university					X
CLO 6 Able to argue in presenting work and research result clearly, straightforwardly, precisely, and well/politely based on data evidence.					X
Promotion Doctor					
CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear					X
CLO 2: Able to solve problem science new and developmer sustainable through inter- or inter- approach multidisciplina characterized with produced insight , method , knowledge a technology comprehensive valuable	X	X			
CLO 3: Able to communicate ideas, results thoughts , and arguments scientific through scientific media to public academic and community wide					X
CLO 4: Able to argue in presenting work and research resu clearly, straightforwardly, precisely, and well/politely based on data evidence.					X
Research Path					
Literature Review 1					
CLO 1: Able to develop logical, critical, systematic and creative thinking in the field of science and technology in accordance with the field of competency in materials scienc	X				
CLO 2: Able to explore problem science new relevant with aspect knowledge knowledge Ingredients and Applications a way comprehensive and thorough	X	X			
CLO 3: Able to examine law , theory , or scientific formula relevant materials and applications For solve problem scien new in a way comprehensive and scientific	X				
CLO 4: Able to apply methods and tools to help solve materials science problems in the form of analytical, numerical or experimental approaches in applying knowled of materials science and its applications.			X		
CLO 5: Able to utilize information technology in the contex of carrying out work by using one of the computer-based applications.					X
CLO 6: Able to compose recommendation problem scien and development sustainable based on results comprehensive study with involving various field in sc mathematics and science					X
CLO 7: Able to adapt to the latest scientific developments b continually learning new things that are relevant to any job profession.					X

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
Literature Review 2					
CLO 1: Able to analyze all aspect problems faced with based on conceptual knowledge relevant materials and applications	X				
CLO 2: Able to analyze comparative data, observations, or calculation results using a theoretical, conceptual approach related calculation method.	X	X			
CLO 3: Able to implement principle sustainability in apply method scientific and problem solving strategies problems the field professional whatever	X				
CLO 4: Able to express literature latest relevant with proble science or Topic study with sourced from journal internatio reputable in sufficient amount			X		
CLO 5: Able to analyze trends and developments in a resea topic through expert discussions, current literature and othe relevant reading sources.					
CLO 6: Able to evaluate various current literature related to research topics and criticize them to find potential for developing and updating scientific knowledge in the field o materials science.					X
CLO 7: Able to present the results of literature studies systematically using good sentence structure and language.					X
Research Proposal					
CLO 1: Able to evaluate various literature latest related wit Topic research and critique For find potential development and renewal knowledge knowledge in One field knowledge ingredients	X	X			
CLO 2: Able to compile new ideas and concepts in the forn of research proposals in accordance with scientific problem and topics that will be resolved responsibly based on academic ethics.	X		X		
CLO 3: Able to design distribution load and time Work wit Good For Work independent and in team					X
CLO 4: Able to compile a proposal book in accordance wit the systematics and writing techniques determined by the guidelines applicable at the university.					X
CLO 5: Able to present research plan proposals systematica using good sentence structure and language.					X
Publication Scientific (R)					
CLO 1 : Able to do deepening or expansion Materials Scier with produce a model, a method or development original, accurate , tested , and innovative theories that are useful for industry and society	X	X			
CLO 2: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific writing form					X
CLO 3: Able to communicate ideas, results thoughts , an arguments scientific through scientific media to public academic and community wide					X
Research Result Exam 1					
CLO 1: Able to implement principle sustainability in apply method scientific and problem solving strategies problems the field professional whatever		X			

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO 2: Able to apply scientific methodology in conducting research by considering guidelines, ethics, safety and environmental impact.					X
CLO 3: Able to implement and update knowledge knowled Ingredients and Applications through study For contribute t the resolution problems in industry and society					X
CLO 4: Able to work together with colleagues in completin research and development project.					X
CLO 5: Able to decide goals , strategies and tasks every member team study For achieve research targets					X
Research Result Exam 2					
CLO 1: Able to internalize the spirit of independence, struggle, and entrepreneurship based on academic values, norms, and ethics.					X
CLO 2: Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related		X	X		
CLO 3: Able to solve problem science new and developmer sustainable through inter- or inter- approach multidisciplina characterized with produced insight , method , knowledge a technology comprehensive valuable		X	X		
CLO 4: Able to communicate effectively in research and development projects					X
CLO 5: Able to monitor and evaluate the objectives, strateg and tasks of each member of the research team in carrying research periodically.					X
CLO 6: Able to convey data information , observations , or results calculation in detail using supporting images , tables and graphs results study					X
Draft Publication International (R)					
CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related			X	X	
CLO 2: Able to do deepening or expansion science knowle ingredients with produce a model, a method or developmen original, accurate , tested , and innovative theories that are useful For industry and society	X				X
CLO 3: Able to convey information on data, observations o calculation results in detail using images, tables and graphs that support research results.					X
CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form					X
Publication International (R)					
CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related	X	X	X		
CLO 2: Able to do deepening or expansion science knowle ingredients or knowledge ingredients applied with produce model, a method or development original, accurate , tested and innovative theories that are useful For industry and society	X			X	

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO 3: Able to convey information on data, observations o calculation results in detail using images, tables and graphs that support research results.					X
CLO 4: Able to explain contribution on insight and knowledge valuable in a way precise and comprehensive in scientific paper draft form					X
Dissertation Exam 1					
CLO 1 : Able to do data analysis , observation , results calculation or simulation obtained through study with supported by theory related	X				
CLO 2: Able to implement and update knowledge of materi science and its applications through research to contribute t solving problems in industry and society.				X	
CLO 3: Able to manage network Work with colleague , pee within institutions and communities study more in the field materials science wide					X
CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete target according to with set time					X
CLO 5: Able to present work and research results systematically using good sentence structure and language.					X
Dissertation Exam 2					
CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear	X				
CLO 2: Able to solve problem science new and developmer sustainable through inter- or inter- approach multidisciplina characterized with produced insight , method , knowledge a technology comprehensive valuable		X			
CLO 3: Able to be accountable results work project resea and development					X
CLO 4: Able to complete problems and obstacles technical every member team in implementation study For complete target according to with set time					X
CLO 5: Able to compose book dissertation in a way systematic in accordance with technique writing as determined by the guidelines in force at the university					X
CLO 6: Able to argue in presenting work and research resu clearly, straightforwardly, precisely, and well/politely base on data evidence.					X
Promotion Doctor					
CLO 1: Able to conclude results study with careful related with discussion results research and answer problems and goals study in a way clear					X
CLO 2: Able to solve problem science new and developmer sustainable through inter- or inter- approach multidisciplina characterized with produced insight , method , knowledge a technology comprehensive valuable					
CLO 3: Able to solve problem science new and developmer sustainable through inter- or inter- approach multidisciplina characterized with produced insight , method , knowledge a technology comprehensive valuable		X	X		X

PLO / CLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO 4: Able to argue in presenting work and research resu clearly, straightforwardly, precisely, and well/politely base on data evidence.					X

CHAPTER 4
STUDY PROGRAM CURRICULUM

4.1. Curriculum Structure and Distribution of Courses Each Semester

Table 4.1 Structure Study Program Curriculum Doctor of Materials Science

No	Code	Subject	Courses (EN)	Credits	Semester	Status
1	SCMS901001	Literature Review 1	Literature Review 1	5	1	Research Path
2	SCMS901002	Literature Review 2	Literature Review 2	5	1	Research Path
3	SCMS901003	Scientific Publication (R)	Scientific Publications (R)	8	3	Research Path
4	SCMS901004	International Publication-1 (R)	International Publication-1 (R)	8	4	Research Path
5	SCMS901005	International Publication-2 (R)	International Publication-2 (R)	10	5	Research Path
6	SCST900001	Integrated Science and Mathematics	Integrated Science and Mathematics	4	1	Research Course Path
7	SCST900002	Philosophy of Science	Philosophy of Science	2	1	Research Course Path
8	SCMS901006	Scientific Literacy	Scientific Literacy	2	1	Research Course Path
9	SCMS902001	Advanced Material Structure	Advanced Materials Structure	3	1	Research Course Path
10	SCMS902002	Advanced Material Properties and Performance	Advanced Properties and Performance Materials	3	1	Research Course Path
11	SCMS902003	Advanced Thermodynamics and Kinetics of Materials	Advanced Thermodynamic and Kinetic Materials	3	2	Research Course Path
12	SCMS902004	Advanced Materials Characterization and Analysis	Advanced Materials Characterization and Analysis	4	1	Research Course Path
13	SCMS902005	Scientific Publication	Scientific Publication	6	3	Research Course Path
14	SCMS902006	International Publication-1	International Publication-1	8	4	Research Course Path
15	SCMS902007	International Publication-2	International Publication-2	10	6	Research Course Path
16	SCMS900001	Research Proposal	Research Proposal	8	2	Research Path & Research Course Path
17	SCMS900002	Research Result Exam-1	Research Result Exam-1	8	3	Research Path & Research Course Path
18	SCMS900003	Research Result Exam 2	Research Result Exam-2	10	4	Research Path &

						Research Course Path
19	SCMS900004	Dissertation Exam-1	Dissertation Exam-1	10	5	Research Path & Research Course Path
18	SCMS900005	Dissertation Exam-2	Dissertation Exam-2	12	6	Research Path & Research Course Path
19	SCMS900006	Doctor Promotion	Doctor Promotion	4	6	Research Path & Research Course Path

DISTRIBUTION OF MATERIALS SCIENCE DOCTORAL COURSES 2024 RESEARCH PATH

SEMESTER 1			SEMESTER 2			SEMESTER 3		
Code	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**
SCMS901001	Literature Review 1	5	SCMS900001	Research Proposal	8	SCMS901003	Scientific Publication (R)	8
SCMS901002	Literature Review 2	5				SCMS900002	Research Result Exam 1	10
Faculty Requirement		**0**	**Faculty Requirement**		**0**	**Faculty Requirement**		**0**
Mandatory Study Program		**10**	**Mandatory Study Program**		**8**	**Mandatory Study Program**		**18**
Choice		**0**	**Choice**		**0**	**Choice**		**0**
Total Credits Semester 1		**10**	**Total Credits Semester 2**		**8**	**Total Credits Semester 3**		**18**

SEMESTER 4			SEMESTER 5			SEMESTER 6		
Code	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**
SCMS900003	Research Result Exam-2	10	SCMS901005	Publication International-2 (R)	10	SCMS900005	Dissertation Exam-2	12
SCMS901004	International Publication-1 (R)	8	SCMS900004	Dissertation Exam-1	8	SCMS900006	Doctor Promotion	4
Faculty Requirement		**0**	**Faculty Requirement**		**0**	**Faculty Requirement**		**0**
Mandatory Study Program		**18**	**Mandatory Study Program**		**18**	**Mandatory Study Program**		**16**
Choice		**0**	**Choice**		**0**	**Choice**		**0**
Total Credits Semester 4		**18**	**Total Credits Semester 5**		**18**	**Total Credits Semester 6**		**16**

DISTRIBUTION OF MATERIALS SCIENCE DOCTORAL COURSES 2024 RESEARCH COURSE PATH

SEMESTER 1			SEMESTER 2			SEMESTER 3		
Code	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**
SCMS902008	Scientific Literacy	2	SCMS902003	Advanced Thermodynamics and Kinetics of Materials	3	SCMS902005	Scientific Publication	6
SCMS902001	Advanced Material Structure	3	SCMS902004	Advanced Materials Characterization and Analysis	3	SCMS900002	Research Result Exam 1	8

SCMS902002	Advanced Material Properties and Performance	3	SCMS900001	Research Proposal	8			
SCSC900001	Integrated Science and Mathematics	4						
SCSC900002	Philosophy of Science	2						
Faculty Requirement		**6**	**Faculty Requirement**		**0**	**Faculty Requirement**		**0**
Mandatory Study Program		**8**	**Mandatory Study Program**		**14**	**Mandatory Study Program**		**14**
Choice		**0**	**Choice**		**0**	**Choice**		**0**
Total Credits Semester 1		**14**	**Total Credits Semester 2**		**14**	**Total Credits Semester 3**		**14**

SEMESTER 4			**SEMESTER 5**			**SEMESTER 6**		
Code	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**	**Code**	**SUBJECT**	**SKS**
SCMS900003	Research Result Exam-2	10	SCMS900004	Dissertation Exam-1	8	SCMS900005	Dissertation Exam-2	12
SCMS902006	International Publication-1	6	SCMS902007	International Publication-2	6	SCMS900006	Doctor Promotion	4
Faculty Requirement		**0**	**Faculty Requirement**		**0**	**Faculty Requirement**		**0**
Mandatory Study Program		**16**	**Mandatory Study Program**		**14**	**Mandatory Study Program**		**16**
Choice		**0**	**Choice**		**0**	**Choice**		**0**
Total Credits Semester 4		**16**	**Total Credits Semester 5**		**14**	**Total Credits Semester 6**		**16**

4.2. Curriculum Content (Course Description)

RESEARCH PATH:

Curriculum Content (Course Description)

Literature Review 1

1.	Course Name	Literature Review 1
2.	Course Code	SCMS901001
3.	Study Load	5 credits
4.	Semester	1
5.	Prerequisite	-
6.	CLO	1. Able to develop logical, critical, systematic and creative thinking in the field of science and technology in accordance with the field of competency in materials science. 2. Able to explore new scientific problems that are relevant to aspects of materials science knowledge and its applications in a comprehensive and comprehensive manner. 3. Able to examine laws, theories, or formulas of materials science and their relevant applications to solve new scientific problems comprehensively and scientifically. 4. Able to apply methods and tools to help solve materials science problems in the form of analytical, numerical or experimental approaches in applying knowledge of materials science and its applications.

		5. Able to utilize information technology in the context of carrying out work by using one of the computer-based applications 6. Able to compile recommendations on scientific issues and sustainable development based on comprehensive study results involving various fields within the scope of mathematics and science. 7. Able to adapt to the latest scientific developments by constantly learning new things that are relevant to any job or profession.
7.	Course Description	Literature Review 1 is a course that contains research preparation in the form of strengthening basic scientific concepts that support research. Students are required to search for, read and analyze the basic theories, concepts of materials science related to research and other supporting research materials, then present the concepts and theories of materials science and have scientific discussions periodically. The main topics of this course are adjusted to the needs of the research theme and other supporting sciences.
8.	Soft Skills Attributes	▪ Think critically, creatively and innovatively ▪ Access, analyze, synthesize information
9.	Form of Learning	Independent Activities
10.	Learning methods	▪ Literature review (literature review) ▪ Summarizing
11.	Learning Outcome Assessment	▪ Independent Assignment ▪ Discussion Activity ▪ Presentation
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ Bryan Greetham (2021), How To Write Your Literature Review, Red Globe Press/Macmillan Education ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Literature Review 2

1.	Course Name	Literature Review 2
2.	Course Code	SCMS901002
3.	Study Load	5 credits
4.	Semester	1
5.	Prerequisite	-
6.	CLO	1. Able to analyze all aspects of the problems faced based on the concept of materials science and its relevant applications. 2. Able to analyze comparative data, observations, or calculation results using theoretical, conceptual approaches or related calculation methods. 3. Able to implement sustainability principles in applying scientific methods and problem-solving strategies in any professional field. 4. Able to present the latest literature that is relevant to scientific problems or research topics by sourcing it from reputable international journals in sufficient quantities.

		5. Able to analyze trends and developments in a research topic through expert discussions, current literature and other relevant reading sources. 6. Able to evaluate various current literature related to research topics and criticize them to find potential for developing and updating scientific knowledge in a field of materials science. 7. Able to present the results of literature studies systematically using good sentence structure and language.
7.	Course Description	Literature Review 2 is a course that contains presentation and discussion activities on research topics as initial preparation before conducting research. Students are required to search for, read and analyze reputable journal scientific publications, prepare a literature review plan starting from determining the title, problem, background, method in conducting the study and the results of the literature review. Students are asked to review at least 50 reputable scientific journals related to a particular research topic, criticize, explain current research and get research opportunities. Students present the results of the literature review and have scientific discussions periodically. The main topics of this course include the breadth and depth of research topics, mastery of material and scientific systematics. Scientific attitude in analyzing certain research topics with good scientific systematics.
8.	Soft Skills Attributes	▪ Think critically, creatively and innovatively ▪ Access, analyze, synthesize information
9.	Form of Learning	Independent Activities
10.	Learning methods	▪ Literature review (literature review) ▪ Summarizing
11.	Learning Outcome Assessment	▪ Independent Assignment ▪ Discussion Activity ▪ Presentation
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ Bryan Greetham (2021), How To Write Your Literature Review, Red Globe Press/Macmillan Education ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Research Proposal

1.	Course Name	Research Proposal
2.	Course Code	SCMS900001
3.	Study Load	8 credits
4.	Semester	2
5.	Prerequisite	-
6.	CLO	1. Able to evaluate various current literature related to research topics and criticize them to find potential for developing and updating scientific knowledge in a field of materials science.

		2. Able to compile new ideas and concepts in the form of research proposals in accordance with scientific problems and topics that will be resolved responsibly based on academic ethics. 3. Able to design the distribution of workload and time well for working independently and in a team 4. Able to compile a proposal book in accordance with the systematics and writing techniques determined by the guidelines applicable at the university. 5. Able to present research plan proposals systematically using good sentence structure and language.
7.	Course Description	The Research Proposal course prepares students in planning and writing research proposals. This course prepares important steps in preparing a quality research plan, starting from formulating research questions, developing a theoretical framework, designing a research methodology, to planning data analysis. This course involves discussions, writing assignments, and possibly small projects that allow students to apply the concepts learned in practical situations. The goal is for students to have strong competencies in designing and writing good research proposals, which can be the basis for conducting further research during the education process.
8.	Soft Skills Attributes	▪ Think critically, creatively and innovatively ▪ Access, analyze, synthesize information
9.	Form of Learning	Independent Activities
10.	Learning methods	▪ Literature review (literature review) ▪ Summarizing ▪ Analyze, develop and write
11.	Learning Outcome Assessment	▪ Material Quality ▪ Writing Quality ▪ Presentation Skills
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ UI Chancellor's Decree No. 2143 of 2017 concerning Technical Guidelines for Writing Final Assignments for Universitas Indonesia Students. ▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017. ▪ C. George Thomas (2021), Research Methodology And Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Jay D. Gatrell, Gregory D. Bierly, Ryan R. Jensen, Rajiv R. Thakur (2020), Research Design and Proposal Writing in Spatial Science, Springer ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Scientific Publication (R)

1.	Course Name	Scientific Publication (R)
2.	Course Code	SCMS901003
3.	Study Load	10 credits
4.	Semester	3
5.	Prerequisite	-
6.	CLO	1. Able to deepen or expand the knowledge of materials science by producing an original, accurate, tested and innovative model, method or theory development that is useful for industry and society. 2. Able to present contributions of valuable insights and knowledge appropriately and comprehensively in the form of scientific writing. 3. Able to communicate ideas, thoughts and scientific arguments through scientific media to the academic community and the wider community.
7.	Course Description	The Scientific Publication course prepares students to understand, evaluate, and produce quality scientific publications. This course guides students in choosing the type of publication, writing an abstract, introduction, methods, results, discussion, and bibliography, choosing an appropriate journal or conference for publication, knowing the principles of ethics in scientific publication, including copying and other academic fraud. In addition, students are also guided to learn about how to evaluate the quality of scientific publications, both in terms of content and the reputation of the journal or conference. This course involves discussions, writing assignments, and analysis and criticism of existing scientific publications. The goal is to equip students with the skills and knowledge needed to succeed in the scientific publication process, both as writers and critical readers to success in publishing their own research results.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	▪ Publication Output Achievements
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers

		▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

International Publication-1 (R)

1.	Course Name	International Publication-1 (R)
2.	Course Code	SCMS901004
3.	Study Load	8 credits
4.	Semester	4
5.	Prerequisite	-
6.	CLO	1. Able to analyze data, observations, calculation results or simulations obtained through research supported by related theories 2. Able to deepen or expand the scientific knowledge of materials science by producing an original, accurate, tested and innovative model, method or theory development that is useful for industry and society. 3. Able to convey data information, observations, or calculation results in detail using images, tables and graphs that support research results. 4. Able to present contributions of valuable insights and knowledge accurately and comprehensively in the form of scientific paper drafts.
7.	Course Description	The Scientific Publication course prepares students to understand, evaluate, and produce quality scientific publications. This course guides students in choosing the type of publication, writing an abstract, introduction, methods, results, discussion, and bibliography, choosing an appropriate journal for publication, knowing the principles of ethics in scientific publication, including copying and other academic fraud. In addition, students are also guided to learn about how to evaluate the quality of scientific publications, both in terms of content and the reputation of the journal or conference. This course involves discussions, writing assignments, and analysis and criticism of existing scientific publications. The goal is to equip students with the skills and knowledge needed to succeed in the scientific publication process, both as writers and critical readers to success in preparing a draft of a scientific journal that is the result of their own research.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Publication Output Achievements
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers

		▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

International Publication-2 (R)

1.	Course Name	International Publication-2 (R)
2.	Course Code	SCMS901005
3.	Study Load	10 credits
4.	Semester	5
5.	Prerequisite	-
6.	CLO	1. Able to conclude research results carefully related to the discussion of research results and answer research problems and objectives clearly 2. Able to solve new scientific problems and sustainable development through an inter- or multidisciplinary approach characterized by the production of comprehensive valuable insights, methods, knowledge and technology. 3. Able to present contributions of valuable insights and knowledge appropriately and comprehensively in the form of scientific writing. 4. Able to produce scientific papers that can be published in international and/or national publications 5. Able to communicate ideas, thoughts and scientific arguments through scientific media to the academic community and the wider community.
7.	Course Description	The Scientific Publication course prepares students to understand, evaluate, and produce quality scientific publications. This course guides students in choosing the type of publication, writing an abstract, introduction, methods, results, discussion, and bibliography, choosing an appropriate journal or conference for publication, knowing the principles of ethics in scientific publication, including copying and other academic fraud. In addition, students are also guided to learn about how to evaluate the quality of scientific publications, both in terms of content and the reputation of the journal or conference. This course involves discussions, writing assignments, and analysis and criticism of existing scientific publications. The goal is to equip students with the skills and knowledge needed to succeed in the scientific publication process, both as writers and critical readers to success in publishing their own research results in quality scientific journals.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Publication Output Achievements
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	

16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Integrated Science and Mathematics

1.	Course Name	Integrated Science and Mathematics
2.	Course Code	SCST900001
3.	Study Load	4 credits
4.	Semester	1
5.	Prerequisite	-
6.	CLO	1. Able to develop logical, critical, systematic and creative thinking in studying sustainable development problems according to the field of materials science competence. 2. Able to compile recommendations on scientific issues and sustainable development based on comprehensive study results involving various fields within the scope of mathematics and science. 3. Able to adapt to the latest scientific developments by constantly learning new things that are relevant to any job or profession.
7.	Course Description	This course combines various disciplines of science and mathematics to provide a comprehensive understanding of solving a scientific problem. The course is a cross-border study that cannot be limited to one academic discipline. The focus is on explaining how to use mathematical and scientific principles to understand, analyze, and explain various scientific problems in a multi-disciplinary manner. This course aims to help students develop analytical, problem-solving, and critical thinking skills needed to address challenges in modern science. It also helps them understand the close relationship between mathematics and science, and the relevance of mathematics in understanding and research in various fields of science.
8.	Soft Skills Attributes	▪ Think critically, creatively and innovatively ▪ Access, analyze, synthesize information
9.	Form of Learning	Studying
10.	Learning methods	Classical Method
11.	Learning Outcome Assessment	Formative: Class Discussion, Independent & Group Assignments Somative: UTS (Progress Report), UAS (Final Report)
12.	Competence	Hard skills : 40% Soft skills : 60%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ Scientific journal articles ▪ Textbooks and monographs related to specific topics

Philosophy of Science

1.	Course Name	Philosophy of Science
2.	Course Code	SCST900002
3.	Study Load	2 credits
4.	Semester	1
5.	Prerequisite	-
6.	CLO	1. Able to develop logical, critical, systematic and creative thinking based on the concept of the philosophy of science. 2. Able to recognize philosophy as a basis for understanding science comprehensively and thoroughly 3. Able to link science and culture as an inseparable part of the philosophy of science 4. Able to adapt to the latest scientific developments by constantly learning new things that are relevant to any job or profession.
7.	Course Description	Philosophy of Science courses address fundamental concepts and questions about the nature, limits, and methodology of science. It is the study of the origins, development, and nature of human knowledge, and the ways in which we understand the world around us. It examines the history of philosophical thought about the nature of science, including concepts such as reality, truth, justification, reasoning, the scientific method, and the relationship between science and other beliefs such as religion or philosophy. The focus of the course may include analysis of classical and modern philosophical theories and their application to contemporary issues in science and society. In addition, the course often encourages students to think critically, evaluate arguments, and develop a deeper understanding of the nature and limits of human knowledge.
8.	Soft Skills Attributes	▪ Think critically, creatively and innovatively ▪ Access, analyze, synthesize information
9.	Form of Learning	Studying
10.	Learning methods	Student Centered Learning Research Based Learning
11.	Learning Outcome Assessment	Formative: Class Discussion, Independent & Group Assignments Somative: UTS (Progress Report), UAS (Final Report)
12.	Competence	Hard skills : 60% Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ Kuhn, T.S., Sautoy, D.M., & Hacking, I. (2020). The structure of Scientific Revolutions. Folio Society Ltd. ▪ Poincaré, H., Smith, A.E., Stump, D.J., & Frappier, M. (2022). Science and hypothesis. Bloomsbury Academic. ▪ Popper, K. R. (2014). The logic of Scientific Discovery. Martino Publishing.

Scientific Literacy

1.	Course Name	Scientific Literacy
2.	Course Code	SCMS902008
3.	Study Load	2 credits
4.	Semester	1

5.	Prerequisite	-
6.	CLO	1. Able to explain the structure of science philosophically (C2) 2. Able to act independently intellectually, tolerantly, and free from dogmatic entanglements (A5) 3. Able to apply ethics in science (C3) 4. Able to select, organize and critically evaluate the latest scientific information sources (C5) 5. Able to apply positivist and phenomenological thinking (C3) 6. Able to apply correct research methodology with strong academic integrity (C3)
7.	Course Description	The Scientific Literacy course is a compulsory course given to first-semester students taking the Research Course path. First-semester students are expected to be able to critically evaluate the latest developments in material science and technology, then be able to identify and analyze problems in the field of material science and be able to formulate scientifically responsible solutions through a multidisciplinary approach and be beneficial to humanity. The scope of this course includes written, numerical, and digital literacy related to the understanding of science, methodology, observation, and theory. Lecture delivered with flipped classroom and cooperative learning methods . Lectures are presented online via EMAS and delivered in Indonesian.
8.	Soft Skills Attributes	▪ Think critically, creatively and innovatively ▪ Access, analyze, synthesize information
9.	Form of Learning	Studying
10.	Learning methods	Student Centered Learning Research Based Learning
11.	Learning Outcome Assessment	Formative: Class Discussion, Independent & Group Assignments Somative: UTS (Progress Report), UAS (Final Report)
12.	Competence	Hard skills : 60% Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ Scientific journal articles ▪ Textbooks and monographs related to specific topics

Scientific Publication

1.	Course Name	Scientific Publication
2.	Course Code	SCMS902005
3.	Study Load	6 credits
4.	Semester	3
5.	Prerequisite	-
6.	CLO	1. Able to deepen or expand the scientific knowledge of materials science by producing an original, accurate, tested and innovative model, method or theory development that is useful for industry and society. 2. Able to present contributions of valuable insights and knowledge appropriately and comprehensively in the form of scientific writing. 3. Able to communicate ideas, thoughts and scientific arguments through scientific media to the academic community and the wider community.

7.	Course Description	The Scientific Publication course prepares students to understand, evaluate, and produce quality scientific publications. This course guides students in choosing the type of publication, writing an abstract, introduction, methods, results, discussion, and bibliography, choosing an appropriate journal or conference for publication, knowing the principles of ethics in scientific publication, including copying and other academic fraud. In addition, students are also guided to learn about how to evaluate the quality of scientific publications, both in terms of content and the reputation of the journal or conference. This course involves discussions, writing assignments, and analysis and criticism of existing scientific publications. The goal is to equip students with the skills and knowledge needed to succeed in the scientific publication process, both as writers and critical readers to success in publishing their own research results.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ Sources related digital libraries C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

International Publication-1

1.	Course Name	International Publication-1
2.	Course Code	SCMS902006
3.	Study Load	6 credits
4.	Semester	4
5.	Prerequisite	-
6.	CLO	1. Able to analyze data, observations, calculation results or simulations obtained through research supported by related theories 2. Able to deepen or expand scientific knowledge of materials by producing original, accurate, tested and innovative models, methods or theoretical developments that are useful for industry and society.

		3. Able to convey data information, observations, or calculation results in detail using images, tables and graphs that support research results. 4. Able to present contributions of valuable insights and knowledge accurately and comprehensively in the form of scientific paper drafts.
7.	Course Description	The Scientific Publication course prepares students to understand, evaluate, and produce quality scientific publications. This course guides students in choosing the type of publication, writing an abstract, introduction, methods, results, discussion, and bibliography, choosing an appropriate journal or conference for publication, knowing the principles of ethics in scientific publication, including copying and other academic fraud. In addition, students are also guided to learn about how to evaluate the quality of scientific publications, both in terms of content and the reputation of the journal or conference. This course involves discussions, writing assignments, and analysis and criticism of existing scientific publications. The goal is to equip students with the skills and knowledge needed to succeed in the scientific publication process, both as writers and critical readers to success in preparing a draft of a scientific journal that is the result of their own research.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

International Publication-2

1.	Course Name	International Publication-2
2.	Course Code	SCMS902007
3.	Study Load	6 credits
4.	Semester	6
5.	Prerequisite	-

6.	CLO	1. Able to analyze data, observations, calculation results or simulations obtained through research supported by related theories 2. Able to deepen or expand the scientific knowledge of materials science or applied materials science by producing an original, accurate, tested and innovative model, method or theory development that is useful for industry and society. 3. Able to convey data information, observations, or calculation results in detail using images, tables and graphs that support research results. 4. Able to present contributions of valuable insights and knowledge accurately and comprehensively in the form of scientific paper drafts.
7.	Course Description	The International Publication course prepares students to understand, evaluate, and produce quality scientific publications. This course guides students in choosing the type of publication, writing an abstract, introduction, methods, results, discussion, and bibliography, choosing an appropriate journal or conference for publication, knowing the principles of ethics in scientific publication, including copying and other academic fraud. In addition, students are also guided to learn about how to evaluate the quality of scientific publications, both in terms of content and the reputation of the journal or conference. This course involves discussions, writing assignments, and analysis and criticism of existing scientific publications. The goal is to equip students with the skills and knowledge needed to succeed in the scientific publication process, both as writers and critical readers to success in publishing their own research results in quality scientific journals.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Research Result Exam 1

1.	Course Name	Research Result Exam 1

2.	Course Code	SCMS900002
3.	Study Load	8 credits
4.	Semester	3
5.	Prerequisite	-
6.	CLO	1. Able to implement sustainability principles in applying scientific methods and problem-solving strategies in any professional field. 2. Able to apply scientific methodology in conducting research by considering guidelines, ethics, safety, and environmental impact. 3. Able to implement and update knowledge of materials science and its applications through research to contribute to solving problems in industry and society. 4. Able to work with colleagues in completing a research and development project 5. Able to decide the goals, strategies, and tasks of each member of the research team to achieve research targets.
7.	Course Description	The Research Results Examination 1 course aims to determine and evaluate students' ability to present research findings clearly and cohesively, obtain constructive feedback, and practice communicating effectively. This course guides students in constructing a logical and orderly presentation structure, including the use of images, tables, and graphs to support data presentation. This course also encourages the development of strong oral communication skills, including the ability to speak clearly, explain complex concepts, and answer questions confidently. Student success is based on clear criteria for evaluating presentations and students' knowledge of their own research, as well as providing useful feedback for further development.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers

		▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Research Result Exam 2

1.	Course Name	Research Result Exam 2
2.	Course Code	SCMS900003
3.	Study Load	10 credits
4.	Semester	4
5.	Prerequisite	-
6.	CLO	1. Able to internalize the spirit of independence, struggle, and entrepreneurship based on academic values, norms, and ethics. 2. Able to analyze data, observations, calculation results or simulations obtained through research supported by related theories 3. Able to solve new scientific problems and sustainable development through an inter- or multidisciplinary approach characterized by the production of comprehensive valuable insights, methods, knowledge and technology. 4. Able to communicate effectively in research and development projects 5. Able to monitor and evaluate the objectives, strategies and tasks of each member of the research team in carrying out research periodically. 6. Able to convey data information, observations, or calculation results in detail using images, tables and graphs that support research results.
7.	Course Description	The Research Results Examination 2 course aims to determine and evaluate students' ability to present research findings clearly and cohesively, obtain constructive feedback, and practice communicating effectively. This course guides students in constructing a logical and orderly presentation structure, including the use of images, tables, and graphs to support data presentation. This course also encourages the development of strong oral communication skills, including the ability to speak clearly, explain complex concepts, and answer questions confidently. Student success is based on clear criteria for evaluating presentations and students' knowledge of their own research, as well as providing useful feedback for further development.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion Work Report Presentation
10.	Learning methods	▪ Problem Based Learning Project Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009.

		▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Dissertation Exam 1

1.	Course Name	Dissertation Exam 1
2.	Course Code	SCMS900004
3.	Study Load	8 credits
4.	Semester	5
5.	Prerequisite	-
6.	CLO	1. Able to analyze data, observations, calculation results or simulations obtained through research supported by related theories 2. Able to implement and update knowledge of materials science and its applications through research to contribute to solving problems in industry and society. 3. Able to manage networks with colleagues, peers within institutions and the wider Materials Science research community. 4. Able to resolve technical problems and constraints for each team member in conducting research to complete targets according to the specified time. 5. Able to present work and research results systematically using good sentence structure and language.
7.	Course Description	Dissertation Examination 1 is the final stage in the doctoral program where students are examined on their dissertation, which is the student's original contribution to knowledge in the field of materials science and its applications. This course evaluates the student's ability to design, conduct, and present original and substantial scientific research. This course also provides guidance on the proper structure of a dissertation, including the required chapters such as introduction, literature review, research methodology, results, analysis, and conclusion. The course introduces the dissertation defense process, where students will present their research results to a panel of examiners and answer questions and provide clarification on the material presented. This course has clear evaluation criteria to assess the quality of the dissertation and the student's performance during the defense, as well as provide constructive feedback for further development.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	Research Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%

13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Dissertation Exam 2

1.	Course Name	Dissertation Exam 2
2.	Course Code	SCMS900005
3.	Study Load	12 credits
4.	Semester	6
5.	Prerequisite	-
6.	CLO	1. Able to conclude research results carefully related to the discussion of research results and answer research problems and objectives clearly 2. Able to solve new scientific problems and sustainable development through an inter- or multidisciplinary approach characterized by the production of comprehensive valuable insights, methods, knowledge and technology. 3. Able to be accountable for the results of research and development project work 4. Able to resolve technical problems and constraints for each team member in conducting research to complete targets according to the specified time. 5. Able to compile a dissertation book systematically in accordance with the writing techniques determined by the guidelines applicable at the university. 6. Able to argue in presenting work and research results clearly, straightforwardly, precisely, and well/politely based on data evidence.
7.	Course Description	Dissertation Defense 2 is the final stage in the doctoral program where students are examined on their dissertation, which is the student's original contribution to knowledge in the field of materials science and its applications. This course evaluates the student's ability to design, conduct, and present original and substantial scientific research. This course also provides guidance on the proper structure of a dissertation, including the required chapters such as introduction, literature review, research methodology, results, analysis, and conclusion. The course introduces the dissertation defense process, where students will present their research results to a panel of examiners and answer questions and provide clarification on the material presented. This course has clear evaluation criteria to assess the quality of the dissertation and the student's performance during the defense, as well as provide constructive feedback for further development. The defense examination of this course is conducted privately in front of the promoter team and the examiner team.
8.	Soft Skills Attributes	▪ Critical and Creative

		▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	Research Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ UI Chancellor Decree No. 2143 of 2017 concerning Technical Guidelines for Writing Final Assignments for Universitas Indonesia Students ▪ *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. ▪ Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 ▪ C. George Thomas (2021), Research Methodology and Scientific Writing, Springer ▪ Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers ▪ Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Doctor Promotion

1.	Course Name	Doctor Promotion
2.	Course Code	SCMS900006
3.	Study Load	4 credits
4.	Semester	6
5.	Prerequisite	-
6.	CLO	1. Able to conclude research results carefully related to the discussion of research results and answer research problems and objectives clearly 2. Able to solve new scientific problems and sustainable development through an inter- or multidisciplinary approach characterized by the production of comprehensive valuable insights, methods, knowledge and technology. 3. Able to communicate ideas, thoughts and scientific arguments through scientific media to the academic community and the wider community. 4. Able to argue in presenting work and research results clearly, straightforwardly, precisely, and well/politely based on data evidence.
7.	Course Description	This Doctoral Promotion course is the final stage of the doctoral program where students complete their research and prepare their dissertation to be defended in front of a panel of examiners in public. This course develops strong oral presentation skills, both in preparing presentation materials and in presenting them confidently and clearly. The Doctoral Promotion

		Defense is conducted to complete and defend their dissertation, and obtain a doctoral degree.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Independent Activities ▪ Discussion ▪ Work Report Presentation
10.	Learning methods	Research Based Learning
11.	Learning Outcome Assessment	Open Session Exam
12.	Competence	▪ Hard skills : 60% ▪ Soft skills : 40%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	[1] UI Chancellor Decree No. 2143 of 2017 concerning Technical Guidelines for Writing Final Assignments for Universitas Indonesia Students [2] *On Being a Scientist: A Guide to Responsible Conduct in Research* , Third Edition, National Academy of Sciences, USA, 2009. [3] Guidelines for Scientific Publication, Lukman, Suminar Setiadi Ahmadi, Wasmen Manalu, Deden Sumirat Hidayat, Ministry of Research, Technology, and Higher Education Directorate General of Research and Development Strengthening, 2017 [4] C. George Thomas (2021), Research Methodology and Scientific Writing, Springer [5] Gábor L Lövei (2021), Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, Open Book Publishers [6] Robert E. Berger (2014), A Scientific Approach to Writing for Engineers and Scientists, Wiley-IEEE Press

Advanced Material Structure

1.	Course Name	Advanced Material Structure
2.	Course Code	SCMS902001
3.	Study Load	3 credits
4.	Semester	1
5.	Prerequisite	-
6.	CLO	• Able to conduct an integrated study of advanced crystal structures • Able to examine advanced metal structures • Able to study advanced Ceramic structures • Able to study advanced polymer structures • Able to examine advanced composite structures
7.	Course Description	The Advanced Material Structure course is a compulsory course given to first semester students. After taking the Advanced Material Structure course, students are able to develop the basics of crystallography and relate them to various developments and current developments regarding advanced metal structures, advanced ceramics, advanced polymers and advanced composites appropriately. Lectures are delivered using the Interactive Lecture method, Flipped classroom, Cooperative *Learning* and case studies. Lectures are presented online through EMAS and delivered in Indonesian.

8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Face to face lectures
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Independent Assignments, Quizzes, Mid-Term Exams, Final Exams
12.	Competence	▪ Hard skills : 80% ▪ Soft skills : 20%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ William D. Callister. Jr., Materials Science and Engineering, an Introduction, John Wiley and Sons, 7th edition, 2007 ▪ Charles Kittel, *Introduction to State Physics* , John Wiley & Sons, Inc. ▪ Van Vlack, *Materials Science for Engineers* , Addison Wesley JF Nye, *Physical Properties of Crystals* , Oxford at the Clarendon Press ▪ Alan Cottrell, *An Introduction to Metallurgy* , Edward Arnold Ltd, second edition, 1975

Advanced Material Properties and Performance

1.	Course Name	Advanced Material Properties and Performance
2.	Course Code	SCMS902002
3.	Study Load	3 credits
4.	Semester	1
5.	Prerequisite	-
6.	CLO	• Able to identify and examine advanced mechanical properties (C6) • Able to identify and examine advanced electrical and optical properties (C6) • Able to identify and examine advanced magnetic and thermal properties (C6) • Able to identify and examine metal corrosion and advanced material degradation (C6)
7.	Course Description	Advanced Material Properties and Performance course is a compulsory course given to first semester students. Students are expected to be able to examine in an integrated manner the latest developments and developments in the structure, properties, processing, and performance of material systems. Lectures are delivered using the Flipped classroom and

		Cooperative Learning methods . Lectures are presented online through EMAS and delivered in Indonesian.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Face to face lectures
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Independent Assignments, Quizzes, Mid-Term Exams, Final Exams
12.	Competence	▪ Hard skills : 80% ▪ Soft skills : 20%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ William D. Callister. Jr., *Materials Science and Engineering, an Introduction* , John Wiley and Sons, 7th & 8th edition , 2007 ▪ Fulay , Pradeep P.; Lee, Jung-Kun, *Electronic, magnetic, and optical materials,* Taylor & Francis, CRC, 2017 ▪ R J. Naumann, Introduction to Physics and Chemistry of Materials, Taylor & Francis, CRC, 2008

Advanced Thermodynamics and Kinetics of Materials

1.	Course Name	Advanced Thermodynamics and Kinetics of Materials
2.	Course Code	SCMS902004
3.	Study Load	3 credits
4.	Semester	2
5.	Prerequisite	-
6.	CLO	• Able to apply advanced thermodynamic principles in the solidification process (liquid-solid phase transformation) and reconstruct phase diagrams (C 6) • Able to apply advanced thermodynamic principles in analyzing phase diagrams (C6, A6) • *Time Temperature Transformation* (TTT) and *Continuous Cooling Transformation (CCT)* diagrams as well as advanced material interphase equilibrium (C6) • Able to apply electrochemical principles to oxidation and degradation events of materials (C6)
7.	Course Description	The Advanced Thermodynamics and Kinetics of Materials course is intended to be a comprehensive reference for Doctoral students of materials science in solving material problems (C3), evaluating them (C4), making design analysis and theoretical and experimental designs (C6) from the aspects of thermodynamics and kinetics of phase

		transformations. The discussion of the material includes the explanation and application of statistical and classical thermodynamic principles to materials, including enthalpy, entropy, free energy, and others. The use of thermodynamic laws on the relationship of material properties includes chemical potential, heat capacity, compressibility, magnetism, and others. In this course, the relationship of multiphase equilibrium in solutions (liquid and solid) is demonstrated, constructing, interpreting and using phase diagrams, explaining phase changes, introducing statistical aspects in thermodynamics in relation to macroscopic equilibrium phenomena, crystal defect formation, and electrochemical equilibrium. This course also discusses aspects of phase transformation kinetics such as changes in system free energy, nucleation and transformation rates, free energy diagrams, phase diagrams, transformation diagrams (TTT and CCT diagrams) and diffusion kinetics and shows the role of aspects of phase transformation and its kinetics in material problems when subjected to thermal treatment. After completing the learning from the Advanced Thermodynamics and Kinetics of Materials course, students are able to apply the principles of material thermodynamics in planning material research and evaluate the material response to thermal treatment received by the material with the latest developments.
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Face to face lectures
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Independent Assignments, Quizzes, Mid-Term Exams, Final Exams
12.	Competence	▪ Hard skills : 80% ▪ Soft skills : 20%
13.	Lecturer	
14.	PJMK	
15.	Member	
16.	Mandatory References	▪ David V. Ragone, Thermodynamics of Materials, Volumes I & II, John Wiley & Sons, 1995. ▪ David R. Gaskell, Introduction to Thermodynamics of Materials, Fourth Edition, New York, London: Taylor & Francis 2003. ▪ Gaskel, *Introduction to Metallurgical Thermodynamics* , 3rd ed., London: Taylor & Francis, 1995 ▪ DA Porter and KE Easterling, *Phase Transformations in Metals and Alloys* , Van Nostrand Reinhold, New York, 1981 ▪ DeHoff, Thermodynamics in Materials Science, 2nd Ed , London: Taylor&Francis, 2006.

Advanced Materials Characterization and Analysis

1.	Course Name	Advanced Materials Characterization and Analysis
2.	Course Code	SCMS902004
3.	Study Load	3 credits
4.	Semester	2
5.	Prerequisite	-
6.	CLO	• Able to analyze the results of X-Ray & Neutron Diffraction characterization and various types of microscopes responsibly (C6 A6) • Able to analyze the results of FTIR and Raman spectroscopy characterization, as well as the results of mechanical property testing according to standards (C6, A6) • magnetic and thermal properties tests (C6, C6, A6) according to standards • Able to analyze the results of electrical and optical properties tests (C6, C6, A6) according to standards
7.	Course Description	Material Characterization & Analysis course is a compulsory course given to 2nd semester students. Students are expected to be able to analyze deeply and be able to scientifically justify various types of advanced characterization. Scope of the course Advanced Material Characterization & Analysis is characterization with Advanced X-Ray & Neutron Diffraction Techniques, with various types of microscopes, FTIR and Raman spectroscopy, testing of mechanical properties, magnetic properties, thermal properties , electrical properties and optical properties. Lecture delivered with method *Flipped classroom, Cooperative Learning* **,** case study and *Focus Group Discussion* . Lectures are presented online via EMAS and delivered in Indonesian .
8.	Soft Skills Attributes	▪ Critical and Creative ▪ Communication ▪ Commitment ▪ Independence
9.	Form of Learning	▪ Face to face lectures
10.	Learning methods	▪ Problem Based Learning ▪ Project Based Learning
11.	Learning Outcome Assessment	Independent Assignments, Quizzes, Mid-Term Exams, Final Exams
12.	Competence	▪ Hard skills : 80% ▪ Soft skills : 20%
13.	Lecturer	
14.	PJMK	
15.	Member	

16.	Mandatory References	**Must:** William D. Callister. Jr., *Materials Science and Engineering, an Introduction* , John Wiley and Sons, 7th edition , 2007 Charles-Kittel , *Introduction to Solid State Physics* , John Wiley and Sons, 8th -Edition , 2005 **Addition :** CN Banwell and EM Mc Cash, *Fundamentals of Molecular Spectroscopy* , McGraw Hill Company, 3rd edition, 1983, FTIR chapter 3 and Raman chapter 4. BDCullity and CD Graham, *Introduction to Magnetic Materials* , John Wiley and Sons, 2 nd -Edition, 2009 Yves Jannot and Alain Degiovanni , *Thermal Properties Measurement of Materials* , John Wiley and Sons, 1 st - Edition, 2018 Dieter K. Schroder, *Semiconductor material and device characterization* , John Wiley & Sons, 2006. Jai Singh, *Optical properties of materials and their applications* , John Wiley & Sons, 2020.

CHAPTER 5
LEARNING STRATEGY AND EVALUATION

This chapter is generally related to the learning strategies and evaluation of the Doctoral Program in Materials Science. This chapter includes discussions related to learning methods, learning media, and learning assessments.

5.1. Learning methods

Learning methods are the methods used by lecturers to implement learning plans. Learning methods are adjusted to the learning achievement points of each course. The following are the learning methods applied in the Doctoral Program in Materials Science.

5.1.1. Conventional Method

In this method, lectures tend to run one way with explanations of concepts, principles and facts related to Materials Science and its Applications. Lecturers deliver lecture materials; students follow the lectures. at the end of the lecture method will be closed with a question-and-answer session to get feedback from students. Then in it is carried out learning evaluation in the form of lecture assignments, Mid-Semester Exams (UTS) and also Final Semester Exams (UAS).

5.1.2. Problem-Based Learning Method

Here, the emphasis is on the students' activeness in finding learning resources and independence in learning. The method used is to form small groups (4-5 people) which are given one scenario to be discussed and analyzed. From the results of the analysis, learning objectives emerge, and each student searches/learns independently about the topic. In the next meeting, students discuss to exchange ideas about the learning outcomes of each student. Each group makes a report and presents the results of their learning. The assessment is carried out comprehensively including activeness, discussion and presentation skills, suitability of the material to the learning targets carried out by group members and facilitators.

5.1.3. Project-Based Learning Method

In this learning model, students are taught to become a consultant team that will complete a project. Each group (3-5 people) works together to complete a planning report for one semester guided by an assistant. This learning model is applied to courses of expertise related to clean water planning, wastewater, drainage, garbage, plumbing and AMDAL.

5.1.4. Practical Method

For certain courses, laboratory practice is needed. During one semester, students learn to use tools or perform certain methods in the laboratory or field. The results of the laboratory experiments are presented in the form of reports. At the end of the laboratory experiment period, the practical exam is concluded.

5.1.5. Expert Lecture

Expert lectures are conducted by inviting speakers from various sectors, including industry, professionals, academics and government. The purpose of expert lectures is to enrich students' insights, especially practical aspects, and provide an overview of the world of work that they will face.

5.1.6. Studying Field

Studying field done with facilitate student For can do observation direct to conditions field so that can support understanding student to material presented in class . Lecture model field This used formally in form eye studying Work Practice or done as part from the learning process eye studying other

5.2. Learning Media

Learning media are tools or means used in the educational process to help convey information and facilitate student learning. Learning media can be in various forms, be it physical objects, such as books, props, or models, or digital media, such as videos, animations, multimedia presentations, or interactive applications.

5.2.1. Books and Printed Materials

The first learning media is books and printed materials. Textbooks, reference books, journals, Worksheets, and other printed materials are classic and still widely used learning media. They provide structured and flexibly accessible information.

5.2.2. Audiovisual Media

The second learning media is audiovisual media. This includes audio, video, and multimedia. Audio media such as voice recordings, podcasts, or audio lectures can be used to convey information verbally. Video media can be in the form of visual presentations, demonstration recordings, educational films, or animations. Multimedia media includes a combination of audio, video, text, images, and interactivity, such as multimedia presentations or educational applications.

5.2.3. Image Media

The third learning media is image media. This includes images, photos, diagrams, graphs, and illustrations. Image media can help explain concepts, visualize information, or clarify relationships between complex concepts.

5.2.4. Interactive Media

The fourth Learning Media is interactive media. This includes educational applications, simulations, educational games, and learning software. Interactive media allows students to be actively involved in the learning process and gain first-hand experience in exploring concepts.

5.2.5. Online Media and E-learning

The sixth learning media is online media and e-learning. This includes online learning platforms, online learning videos, online courses, discussion forums, and digital learning resources. Online media allows access to flexible learning materials and collaboration with students and teachers virtually.

5.3. Assessment Learning

Assessment is an effort to obtain data/information from the learning process and results to determine how well students, classes/courses, or study programs perform compared to certain learning objectives/criteria/achievements. After the assessment results are obtained, the assessment process is carried out. Grading is the process of attaching attributes or dimensions or quantities (in the form of numbers/letters) to the assessment results by comparing them to a certain standard instrument. The results of the assessment in the form of attributes/dimensions/quantities are used as evaluation materials. Evaluation is the process of giving status or decisions or classifications to assessment and assessment results. Assessment is the process of collecting and processing information to determine the learning needs, development and achievement of student learning outcomes. Types of assessments according to their function include: assessment as a learning process (assessment as Learning), assessment for the learning process (assessment for Learning), and assessment at the end of the learning process (assessment of learning). So far, the implementation of assessments tends to focus on summative assessments which are used as references for filling out learning outcome reports. The assessment results have not been used as feedback for improving learning. In the new paradigm of learning, educators are expected to focus more on formative assessments than summative and use the results of formative assessments for continuous improvement of the learning process. Table 5.1 and Table 5.2 show the mapping and evaluation methods for achieving PLO for the Research Path and

the Lecture-Research Path. There are several types of learning assessments conducted in the Doctoral Study Program in Materials Science, FMIPA UI, as follows :

1. Formative:
   a. Supervision Observation
   b. Research Discussion
   c. Independent Assignment
   d. Group Assignment
2. Summative :
   a. Mid and Final Exams
   b. Final Project Presentation
   c. Paper Assessment
   d. Assessment of the Trial Examination

5.4. Assessment CLO and PLO achievement

Table 5.1 Mapping and Evaluation Methods for PLO Achievement for the Lecture-Research Path

PLO	Subject	Learning methods	Types of Assessment	
1	Research methodology Literature Review Scientific Writing Integration of Science and Mathematics Philosophy of Science	Student Centered Learning	Formative Summative	- Class Discussion - Independent & Group Assignments - Final Project Presentation - Mid-term & Final Exams
2	Research methodology Literature Review Scientific Writing	Student Centered Learning	Formative Summative	- Class Discussion - Independent & Group Assignments - Final Project Presentation - Mid-term & Final Exams
3	Literature Review Scientific Writing Advanced Material Structure Advanced Material Properties and Performance Integration of Science and Mathematics	Student Centered Learning	Formative Summative	- Class Discussion - Independent & Group Assignments - Final Project Presentation - Mid-term & Final Exams
4	Research methodology Literature Review Integration of Science and Mathematics Philosophy of Science	Student Centered Learning	Formative Summative	- Class Discussion - Independent & Group Assignments - Final Project Presentation - Mid-term & Final Exams
5	Literature Review Proposal	Research Based Learning	Formative Summative	- Guidance Observation - Class Discussion - Independent & Group Assignments - Paper - Trial Examination - Mid-term & Final Exams
6	Proposal Research Results Exam	Research Based Learning	Formative	- Guidance Observation - Research Discussion

	Publication International Dissertation Examination Promotion Doctor		Summative	- Paper - Trial Examination
7	Research Results Exam International Publication Dissertation Examination Promotion Doctor	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination
8	Proposal Research Results Exam Dissertation Examination Promotion Doctor	Research Based Learning	Formative Summative	- Guidance Observation - Research Discussion - Paper - Trial Examination
9	Proposal Research Results Exam Publication International Dissertation Examination Promotion Doctor	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination
10	Proposal Research Results Exam Publication International Dissertation Examination Promotion Doctor	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination
11	Proposal Research Results Exam Dissertation Examination Promotion Doctor	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination

Table 5.2 Mapping and Evaluation Methods for PLO Achievement of Research Paths

PLO	Subject	Learning methods	Types of Assessment	
1	Literature Review 1	Research Based Learning	Formative Summative	- Guidance Observation - Research Discussion - Paper - Trial Examination
2	Literature Review 1	Research Based Learning	Formative Summative	- Guidance Observation - Research Discussion - Paper - Trial Examination
3	Literature Review (1 and 2)	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination
4	Literature Review 1 & 2 Research Results Exam 1 & 2	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination
5	Literature Review 2 Research Proposal	Research Based Learning	Formative	- Observation Guidance - Research Discussion

			Summative	- Paper - Trial Examination
6	Research Proposal Research Results Exam 1 & 2 International Publication-1 (R) Dissertation Exam 1 & 2 International Publication (R)	Research Based Learning	Formative Summative	- Guidance Observation - Research Discussion - Paper - Trial Examination
7	Research Results Exam 1 & 2 Scientific Publication (R) International Publication-1 (R) Dissertation Exam 1 & 2 International Publication-2 (R)	Research Based Learning	Formative Summative	- Guidance Observation - Research Discussion - Paper - Trial Examination
8	Research Proposal Research Results Exam 1 & 2 Dissertation Exam 1 & 2	Research Based Learning	Formative Summative	- Guidance Observation - Research Discussion - Paper - Trial Examination
9	Research Results Exam 1 & 2 Dissertation Exam 1 & 2	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination
10	Research Proposal Scientific Publication (R) Research Result Exam 2 International Publication-1 (R) International Publication-2 (R) Dissertation Exam 2	Research Based Learning	Formative Summative	- Guidance Observation - Research Discussion - Paper - Trial Examination
11	Research Proposal Literature Review 2 Scientific Publication (R) Dissertation Exam 1 & 2 International Publication-1 (R)	Research Based Learning	Formative Summative	- Guidance Observation - Discussion - Paper - Trial Examination

Table 5.3 Assessment Reference

Letter	Range of Number Values	Quality Value
A	85-100	4.00
A-	80-<85	3.70
B+	75-<80	3.30
B	70-<75	3.00
B-	65-<70	2.70
C+	60-<65	2.30
C	55-<60	2.00
D	40-<55	1.00
E	0-<40	0.00

CHAPTER 6
CURRICULUM MANAGEMENT AND IMPLEMENTATION

This chapter is generally related to the curriculum implementation plan and Internal Quality Assurance System (SPMI) tools.
Describe the design of the learning process which includes: 1) planning, 2) implementation and 3) assessment and 4) curriculum evaluation.

6.1. Planning

The Material Science study program of FMIPA UI (DPMS) is designed where the selection of learning objectives is the main basis for achieving academic excellence and development

The learning objectives at DPMS are written again here as follows:
1. To carry out the Tridharma of Higher Education activities to produce material science graduates who have high intellectuality, intelligence, noble character, and the ability to compete globally.
2. Develop an academic atmosphere and research culture for the advancement of science to produce innovation and solutions in the field of material science and contribute to sustainable development.
3. Contribute and play an active role in the development of material science and its innovation.
The learning objectives that have been set include 4 important aspects consisting of: mastery of basic concepts of material science, experimental skills, data analysis, and scientific communication skills. These objectives are designed to ensure that our graduates have a strong foundation in the field of material science and can face challenges in various industrial sectors and the development of material science according to their time.
To achieve the learning objectives as described earlier, the PSDIB curriculum structure has included core courses that reflect the content for providing a solid foundation and pay attention to meeting industry needs and current research trends. PSDIB accommodates a wide range of expertise options and integrates interdisciplinary understanding so that students can develop diverse skills according to their interests and career goals. Thus, our curriculum structure reflects the diversity and dynamics of materials science. This curriculum structure can be seen in Figure 1 for the lecture track and Figure 2 for the lecture-research track.

As seen in Figures 1 and 2, the implementation of education with a predetermined curriculum requires a duration of time for PSDIB to be held in two academic semesters each year, where one semester usually includes 16 weeks of educational activities. The curriculum is built using both the Outcome-Based Education (OBE) approach and the Research Based Education approach. This curriculum is designed to produce professionals or experts in academics/research, industry, and other multinational companies. Graduates from this pathway can learn and adapt quickly in the industrial work environment and solve problems in their work areas by applying material science and scientific thinking. The modules are designed to ensure that students achieve the desired competencies, which are categorized as mandatory and elective modules, especially for course-based programs. During semesters 1 and 2, students take mandatory and elective modules on basic concepts of material science and its applications, while in semesters 3 and 4, they focus on research.

The literature review course has several main objectives, including developing literacy skills, the ability to read and understand scientific literature. Training skills in identifying, evaluating, and synthesizing information from various literature sources. This literature review also teaches students to understand the conceptual or theoretical framework in a field of research. Through the literature review, it is also intended to help students be able to recognize how to

prepare a good research plan later by being able to identify gaps in information that are still not available.

This literature review course is so important in the research path, DPMS gives a weight of 10 credits which are divided into two stages of literature review I and literature review II. This is because the learning outcomes that are set also include training in formulating research problems, recognizing various research methods with all their advantages and disadvantages that have been used based on information in the literature. This is all intended so that students gradually could understand current issues in the field of material research. It cannot be forgotten that in the end this literature review trains students to be able to think independently and write their thoughts and interpretations freely in the form of literature review works.

The teaching method that we consider to be the right method is based on an interactive approach, applied research, and practical experience. For the lecture-research path, DPMS implements interactive lecture activities in class, seminars, and laboratory work to provide theoretical understanding and practical skills to students. Collaboration with industry and joint research allow students to engage in real projects, deepen their experience in the field, and prepare them to answer the challenges of the world of work. As for the research track, DPMS leads its students to be involved in various scientific activities such as being a speaker at various national and international conferences, participating in various information and experience enrichment activities provided by various speakers. Students are also encouraged to participate in various mentoring activities (coaching) for writing scientific papers for publication purposes. Other character development is also obtained by students through soft skill improvement activities such as improving presentation and oral communication skills. With a combination of clearly defined learning objectives, an adaptive and up-to-date curriculum structure, and innovative teaching methods, our DPMS is guaranteed to provide high-quality education that is relevant to industry needs and empowers students to achieve their full potential in the field of materials science.

6.2. Implementation

As explained earlier, the learning achievement path approach can be done in two different ways: 1. Research path and 2. Research Course path. The research path may only be taken by candidates who have the minimum ability to carry out research, marked by having written a scientific publication. Students who take this path undergo a series of sharpening the quality of understanding of Materials Science through a comprehensive literature review. Students must also have the ability to design a research activity plan on in-depth material investigations. Skills improvement training in carrying out investigative stages is carried out together with experienced supervisors, including evaluation of progress in achieving investigation objectives. This is important because the measure of success is marked, among others, by the production of a scientific work in the form of publications in reputable international proceedings and journals as an international recognition that our students have standard qualifications.

In implementing the curriculum in the classroom at PDMS for the **lecture-research path** approach, the learning process is designed to provide students with in-depth experience, including theoretical understanding and practical application in the real world. Several key aspects that include the implementation of learning activities, selection of evaluation methods, and support for lecturers and students are as follows:

Implementation of Learning Activities:
Structured Learning Design: The curriculum is designed with structured thinking, ensuring that each learning session has a clear objective (**CLO**) and is integrated with previous learning.

Active Learning Methods: Implementation of active learning methods in class, such as group discussions, case studies, and research projects, to increase student engagement and promote deep understanding.

Advanced Laboratory Work: Providing complete laboratory facilities and computing devices to enable students to apply theoretical concepts in material investigation activities and data analysis.

Lecturer-Student Collaboration: Facilitating close collaboration between lecturers and students, creating a learning environment that supports academic and professional growth.

Every learning activity always refers to the Teaching Design Book or BRP which is a reference for students and lecturers. This is intended so that the implementation of the curriculum is in accordance with the established design. Appendix .... contains BRP for each course

While the implementation of the curriculum on the research track aims primarily to produce graduates who have deep mastery of material science through a research approach. Through a research-focused curriculum, students are given the opportunity to immerse themselves in and apply materials science concepts in a real-world research environment. The program provides a strong foundation in the principles of materials science and guides students through a series of research activities aimed at developing their in-depth understanding. By incorporating research elements into the curriculum, the track creates a learning environment that encourages students to actively explore scientific questions relevant to the field of materials science. The program also emphasizes collaboration between students and research supervisors, creating opportunities for direct transfer of knowledge and practical skills. Thus, implementing the curriculum in this way reflects the program's commitment to engaging students in an active research process, preparing them to become competent and innovative researchers and materials scientists.

6.3. Assessment

Curriculum Implementation Assessment is an evaluation process used to evaluate the extent to which the curriculum that has been designed and prepared is implemented effectively in the classroom or study program. Curriculum Implementation Assessment plays an important role in ensuring that the curriculum that has been designed and prepared can be implemented well in the classroom, so as to achieve the desired learning objectives. Continuous evaluation of curriculum implementation allows for the identification of areas that need improvement and the development of appropriate improvement strategies. This assessment evaluates how the learning material that has been planned in the curriculum is delivered to students by the instructor. Factors assessed include clarity of delivery, use of appropriate learning methods, and the ability of the instructor to facilitate student understanding. This assessment includes an evaluation of learning activities carried out by students as part of the implementation of the curriculum. In addition, assessments are also carried out on research activities, both in laboratories at FMIPA, University of Indonesia and at domestic and foreign partner institutions. This includes whether the activities are in accordance with learning objectives, are able to improve student understanding, and promote active participation.

6.4. Evaluation

DPMS continues to try to improve the quality of learning through the implementation of a carefully designed curriculum. Evaluation of curriculum implementation is believed to be a critical step in understanding the impact of learning practices on student development.

The objectives of the evaluation are to:

1. **Assess the Achievement of Curriculum Objectives**: In this case, PSDIB must be able to measure the extent to which students achieve the learning objectives set by the curriculum.
2. **Identify Challenges and Opportunities**: PSDIB must also be able to detect obstacles and opportunities in the implementation of the curriculum, both from the perspective of lecturers and from the perspective of students.
3. **Assess the Relevance of Learning Materials**: PSDIB must be able to ensure that learning materials remain relevant to the latest developments in the field of Materials Science.
4. **Improve Teaching Methods**: Assess the effectiveness of teaching methods and find ways to improve them according to student needs.

Several evaluation methods can be applied through:

1. **Survey**: Using surveys to obtain direct feedback from students regarding their understanding of the material, teaching methods, and their learning needs. This evaluation tool is already included in EDOM.
2. **Student Performance Analysis**: Analyze the results of exams, projects, and assignments to measure the achievement of curriculum objectives quantitatively.
3. **Interviews with Lecturers**: Conducting interviews with lecturers to gain their perspectives on the challenges faced and improvements that can be made.
4. **Classroom Observations**: Conducting direct observations of the learning process to evaluate lecturer-student interactions and the effectiveness of teaching methods. Some courses are conducted online. In this case, classroom observations can be conducted through evaluation of teaching activity recordings.

Basically, the implementation of evaluations can be carried out during the implementation of the curriculum through half-semester surveys, periodic evaluation meetings, and review of exam results for direct improvement. The implementation of evaluations is also carried out after the completion of curriculum implementation activities with the results of end-of-semester surveys, student performance analysis, and final evaluations from lecturers to create an overall report.

The implementation of curriculum evaluations is considered useful for the purpose of continuous improvement of the adaptive curriculum at PSDIB. This continuous improvement includes:

1. Continuous improvement: Providing a foundation for continuous improvement in curriculum design and teaching methods.
2. Suitability to Industry Needs: Ensuring that graduates have skills and knowledge that are in line with industry demands.
3. Improving the Learning Experience: Improving students' learning experiences by responding to their needs.

By involving students, lecturers, and other stakeholders, evaluation of curriculum implementation in the Materials Science study program becomes an effective tool to maintain the quality and relevance of education.