CURRICULUM BOOK

INDEPENDENT LEARNING BASED ON INDEPENDENT CAMPUS (MBKM)

BACHELOR PROGRAM (S1)
PHYSICS STUDY PROGRAM FMIPA UNTAN

BY

PHYSICS STUDY PROGRAM LECTURER TEAM

PHYSICS DEPARTMENT
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNIVERSITY OF TANJUNGPURA
DECEMBER, 2020

HALAMAN PENGESAHAN

BUKU KURIKULUM

Berbasis MERDEKA BELAJAR KAMPUS MERDEKA (MBKM)

PROGRAM SARJANA (S1)
PROGRAM STUDI FISIKA FMIPA UNTAN

Edisi	:	Pertama
Tanggal	:	11 Desember 2020
Dikaji Ulang oleh	:	Program Studi Fisika
Disetujui oleh	:	Senat FMIPA Untan

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Pada Tanggal : 11 Desember 2020

Disahkan oleh,	Disusun oleh,
Ketua Senat FMIPA Untan	Ketua Program Studi Fisika
H. Afghani Jayuska, S.Si., M.Si.	Dr. Azrul Azwar, S.Si. M.Si.
NIP. 197107072000121001	NIP. 198107302005011001

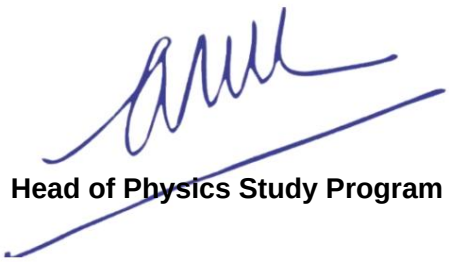
FOREWORD

Praise and gratitude we offer to the presence of Allah SWT, for the abundance of His blessings and gifts so that the preparation of the Independent Learning-Based Curriculum, Independent Campus (MBKM) of the Physics Study Program, FMIPA Untan can be completed properly. This Curriculum Book was compiled after going through a long process and receiving valuable input from various parties in order to improve the curriculum.

The curriculum book was compiled by the Physics Study Program Lecturer Team, FMIPA Untan after receiving input from Alumni and Study Program *Stakeholders .* This book contains the Vision and Mission of the Physics Study Program, Department Profile, Field of Expertise and Curriculum based on Independent Learning Independent Campus (MBKM) of the Physics Study Program.

On this occasion, we would like to express our gratitude and high appreciation to the MBKM-based Curriculum Development Team of the Physics Study Program for all their efforts so far. Gratitude is also expressed to Alumni, *Stakeholders,* MKU Untan, Deans and all Faculty leaders as well as Lecturers and Education staff of FMIPA Untan. This report is expected to be a guideline in implementing learning in the Physics Study Program, FMIPA Untan.

Pontianak, December 2020



Head of Physics Study Program

INDEPENDENT CAMPUS INDEPENDENT LEARNING BASED CURRICULUM (MBKM)
PHYSICS STUDY PROGRAM

PHYSICS DEPARTMENT FAMILY OF MIPA TANJUNGPURA UNIVERSITY

"The **scientist** does **not study nature** because it **is**
useful; he **studies** it because he delights in it, and he delights in it because it **is** beautiful.
If **nature were not** beautiful, it **would not** be worth knowing,
and if **nature were not** worth knowing, life **would not** be worth living.
(Henri Poincaré)

Physics comes from the Greek ***ÿÿÿÿÿÿÿ*** *(physikós)* meaning "natural" and ***ÿÿÿÿÿ*** *(physis)* meaning "nature". In modern terminology, Physics is a scientific discipline *that* studies matter and energy and the interactions between the two. It is a basic science *that* aims to reveal the various regularities that exist in the universe and formulate them into a law *(the laws of nature)* so that humans can understand how nature "works". To achieve this goal, Physics is developed by applying the scientific method *which* begins with in-depth observation of nature and the surrounding environment, designing and conducting a series of experiments to obtain supporting data, then formulating the results into a formal mathematical language so that it becomes a theory that must then be verified again with various observations and experiments. This makes Physics not a static scientific discipline but one that continues to grow and develop along with the development of human civilization.

Apart from being a basic science, Physics has become *a mother science.*
(mother science) which gave birth to various other fields of science, such as Geophysics which is the application of the laws and various methods of Physics in Earth Science *(Geoscience),* Astrophysics which is the application of Physics in Astronomy (Astronomy), Biophysics which is the application of Physics in biological systems (living things) and so on. In fact, currently Physics has been utilized in the field of Economics which gave birth to the field of Econophysics. This further strengthens the position of Physics as a dynamic and ever-evolving science. Furthermore, Physics is also the foundation of various technological advances that exist today. The principles of Physics have become the basis for the development of a number of medical and health technologies such as CT Scan, USG, MRI, X-rays, cancer treatment and others.

Electronics and communication technology also grew very rapidly after scientists succeeded in utilizing the laws of physics in engineering semiconductor materials which are the heart of various electronic components.
Methods in physics are also very useful for exploring natural resources.

natural resources and environmental conservation. In addition to the examples mentioned above, there are many more benefits and applications of Physics for human life, so it is very reasonable to say that Physics is one of the springs for the advancement of science and technology.

Furthermore, Physics also has a role in preparing superior human resources (HR) which are expected to transform various advances in science and technology for national and regional development. Physics trains humans to think at a high level critically, systematically, creatively and innovatively, as well as to be honest, careful, disciplined and never give up. Physics also hones the value of human feeling which is based on their admiration for the order of the universe so that humans are able to appreciate the surrounding nature and submit to their Creator.

From the description above, it can be understood that the existence of the Physics Study Program, Faculty of Mathematics and Natural Sciences (FMIPA) Tanjungpura University (Untan) is important in efforts to support the progress of the nation, especially for the Province of West Kalimantan and is expected to contribute to the welfare of humanity in general. With this basis and after going through a long process and in-depth study, the Physics Study Program (Prodi) FMIPA Untan was established. Officially, the implementation of learning in the Physics Study Program is based on the Letter of the Director General of Higher Education, Ministry of National Education Number 3494 / D / T / 2001, then extended by the Letter of the Director General of Higher Education, Ministry of National Education Number 2320 / D / T / 2004, then extended again based on the Letter of the Director General of Higher Education, Ministry of National Education Number 1131 / D / T / 2008, and currently learning activities in the Physics Study Program are based on the Letter of the Rector of Tanjungpura University to the Director General of Higher Education Number 11185 / D / T / KN / 2012.

In its development, the Physics Study Program has made various efforts to continuously improve quality. This can be seen from the track record of its accreditation assessment since its inception until now which continues to show improvement. Currently, the Physics Study Program's accreditation is ranked B based on the Decree of the National Accreditation Board for Higher Education Number 1083/SK/BAN-PT/Akred/S/IV/2018, which is valid until April 17, 2023. Nevertheless, the Physics Study Program will continue to improve so that a culture of quality is present in all its activities.

One of these efforts is to conduct a curriculum review to make it relevant to the needs of the times. The results of this curriculum review are then outlined in a guidebook so that it can become *a guideline* for students, lecturers and all related parties. In the curriculum guidebook published in 2021, an integration has been carried out between the core curriculum of the Physics study program based on direction from professional organizations, suggestions and input from various stakeholders and the Independent Learning Campus paradigm.

Merdeka (MBKM) which has been initiated by the Ministry of Education, Culture, Research and Technology, with the hope that this curriculum can be one of the tools that can encourage the improvement of the quality of graduates and realize *the link and match* between the world of campus and the world of work. Of course, this effort requires continuity and sustainability, therefore reviews and evaluations will continue to be carried out periodically so that the implementation of this curriculum can run well so as to support the achievement of the institution's vision and mission.

1. VISION AND MISSION

a. Vision

To become a leading institution in the transformation, development and dissemination of physics and its applications based on tropical environment with globally competitive output. **b. Mission**

1. Organizing Higher Education activities in an integrated manner to produce quality outputs that are adaptive to developments in science and technology while still upholding the nation's identity.
2. Carrying out targeted, sustainable and environmentally aware research activities with an orientation towards developing the local potential of West Kalimantan.
3. Carrying out community service activities that have an impact on improving quality environment and community welfare.
4. Building constructive partnerships with various stakeholders interest.

2. GRADUATE PROFILE

Graduate profile is a role that can be done by students after completing their education and graduating from the Physics Study Program, FMIPA Untan. Based on the results of *the tracer study* on alumni and *market signals* from graduate users, it can be mapped that **graduates from the Physics Study Program, FMIPA Untan can play a role in the following fields:**

a. **Research and Engineering,** as a researcher, research assistant, engineer, assistant engineer, *surveyor,* data processor, research laboratory administrator, or other roles related to research and engineering activities. This role can be carried out in various research institutions, be it government research institutions such as LAPAN, LIPI, BMKG, BATAN, Universities and so on, or private research institutions, or in the *Research and Development* section in the business world and industry (DUDI).

b. **Education and Teaching,** as a Physics teacher in various educational institutions, educational laboratory administrator, or as a developer of supporting media for teaching and learning science, such as a writer of textbooks, *content*

multimedia *creator , science communicator* and various other related professions.

c. **Community Empowerment,** as a driving agent involved in the community development process such as village facilitators, public relations (PR), development communicators or social-community organization activists, as well as other activities related to improving community welfare.

d. **Entrepreneurship,** as an independent entrepreneur, whether related to directly or indirectly by utilizing the science of physics.

As a note, the realization of these roles greatly requires various additional competencies and *skills* that can be obtained independently by students outside the Physics Study Program. In addition, supporting documents are also required (such as competency certificates, accompanying diploma certificates, and other related documents) in accordance with applicable administrative provisions. This certainly requires active participation from all parties, be it students, lecturers, institutions or stakeholders.

3. FIELD OF STUDY (FIELD OF INTEREST)

Currently, the Physics Study Program of FMIPA Untan does not strictly limit the field of study, this aims to provide freedom for students and lecturers in exploring and developing various existing potentials. In general, the fields of study developed include aspects:

a. **Theoretical through mathematical formulation, modeling, computing and simulation.** In this aspect, specifically the areas of study developed are theoretical studies on the structure of stars and the dynamics of galaxies and the universe, modeling and computing optical, electronic, and thermodynamic properties of materials, as well as simulation and computing of various other physical systems such as: biological systems (living things), fluid systems (rivers, seas and air), and also solid earth systems and the environment. b. **Experimental through the development of measurement instruments and the design and implementation of experiments.** In this aspect, specifically the areas of study developed are automation of measurement systems, as well as experimental studies of characterization and functionalization of material properties.

c. **Applied and interdisciplinary studies by applying the principles of Physics in various fields of science and technology,** especially in the fields of medical imaging, utilization of earth data, photocatalyst and luminescence technology, engineering of optical, electronic and mechanical properties of materials, as well as the application of various principles of Physics in characterization methods for biological systems.

4. CURRICULUM

a. Learning Outcomes

The competencies (skills) of students in the Physics Study Program, FMIPA, Tanjungpura University are developed through Learning Achievements by grouping them into four categories, which can be seen in the following table:

PHYSICS STUDY PROGRAM LEARNING ACHIEVEMENTS	
ASPECTS OF ATTITUDES AND VALUES (SI)	
SI 1 Fear of God Almighty and able to show a religious attitude;	
SI 2	Uphold humanitarian values in carrying out duties based on religion, morals and ethics;
SI 3 Internalizing academic values, norms, and ethics;	
SI 4	Acting as a proud citizen who loves his country, has nationalism and a sense of responsibility towards the country and nation;
SI 5	Respect the diversity of cultures, views, religions and beliefs, as well as the original opinions or findings of others;
SI 6	Contribute to improving the quality of life in society, the nation and the state, and the progress of civilization based on Pancasila;
SI 7	Working together and having social sensitivity and concern for society and the environment;
SI 8 Obey the law and be disciplined in social and national life;	
SI 9 Internalizing the spirit of independence, struggle, and entrepreneurship;	
SI 10	Demonstrate a responsible attitude towards work in his/her field of expertise independently.
ASPECTS OF KNOWLEDGE MASTERY (PP)	
PP 1 Master the theoretical concepts and basic principles of classical and quantum physics;	
PP 2	Master the principles and applications of mathematical physics, computational physics and instrumentation;
PP 3	Mastering knowledge about technology based on physics and its applications.
SPECIAL SKILLS ASPECT (KK)	
KK 1	Able to formulate physical symptoms and problems through analysis based on the results of observations and experiments;
KK 2	Able to produce mathematical models or physical models that are in accordance with the hypothesis or predicted impact of the phenomenon that is the subject of discussion;
KK 3	Able to analyze various alternative solutions to physical problems and draw conclusions for appropriate decision making;
KK 4 Able to predict the potential application of physical behavior in technology;	
KK 5	Able to disseminate the results of studies on problems and physical behavior of simple phenomena in the form of reports or working papers according to standard scientific principles.
GENERAL SKILLS ASPECT (KU)	

KU 1	Applying logical, critical, systematic and innovative thinking in the context of developing or implementing science and/or technology in accordance with their field of expertise;
KU 2	Reviewing the implications of the development or implementation of science, technology or art in accordance with his/her expertise based on scientific principles, procedures and ethics to produce solutions, ideas, designs or art criticism and compiling a scientific description of the results of his/her study in the form of a thesis or final assignment report;
KU 3	Making appropriate decisions in the context of solving problems in his/her field of expertise, based on the results of analysis of information and data;
KU 4	Managing learning independently;
KU 5	Develop and maintain working networks with mentors, colleagues, peers both inside and outside the institution.

b. Curriculum Structure

Courses in the Physics Study Program are divided into compulsory courses, elective courses, and MBKM mode courses. In order to graduate, students must take a minimum of 144 credits. Compulsory courses total 86 credits (including PKM/KKM and Final Project). Students who program regular lectures, the elective courses taken are a minimum of 58 credits. Students who program MBKM mode for 2 semesters can get **a maximum of 40 credits** and can take the remaining credits as elective courses inside or outside the study program.

Each course has a special code. Here is an explanation of the course code:

1. The first two letters, namely MP, indicate the identity of the field of science (Prodi Courses). The third letter, namely F, is the identity of the Prodi, namely Physics.
2. The first number after the third letter indicates the year code for the course (on a 4-year scale).
3. The second number indicates the course type code.
   a. Number 1 indicates a compulsory course
   b. Number 2 indicates elective courses
   c. Number 3 indicates elective courses or MBKM recognition. 4. The third number in compulsory and elective courses indicates the field code.

interest in Physics Study Program

   a. The number 0 indicates general or recognition courses.
   b. Number 1 indicates the basic physics course.
   c. Number 2 indicates theoretical courses
   d. Number 3 indicates a course in the field of computing
   e. Number 4 indicates the course in the field of experiments and materials
   f. Number 5 indicates applied and interdisciplinary courses.

(note: in student exchange mode, the course code is adjusted to the course code taken at the relevant university or study program)

5. The last number shows the sequence number of the course in each year and semester (odd or even) of the course procurement.

For example, the Mechanics course with code MPF–2113

- MPF shows Physics Study Program Courses
- The number 2 indicates that the course is available in the 2nd year.
- The number 1 indicates that the course is a compulsory course.
- Number 1 indicates basic physics courses
- The number 3 indicates the 3rd course in the odd semester.

The following is the distribution of compulsory courses, elective courses, and MBKM mode courses in each semester.

1. Compulsory Courses

SEMESTER 1					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
1	MKWU-4	2	Indonesian	English	
2	MPF-1111	3	Physics IA	Physics IA	
3	MPF-1113	2	IB Physics	Physics IB	
4	MPF-1115	2	Physics Practical I	Experimental Physics I	
5	MKWU-3	2	Citizenship	Civic Education	
6	MPF-1103	2	Basic Chemistry	Basic Chemistry I	
7	MPF-1101	3	Mathematics I	Mathematics I	
8	MPF-1131	2	Algorithm and Programming	Algorithm and Programming	
9	MPF-1117	2	Measurements and Data Analysis	Measurements and Data Analysis	
		20			

SEMESTER 2					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
1	MKWU-1	3	Religious education	Religious Education	
2	MPF-1112	3	Physics IIA	Physics II	
3	MPF-1114	2	Physics IIB	Physics IIB	
4	MPF-1116	2	Physics Lab II	Experimental Physics II	
5	MKWU-2	2	Pancasila	Pancasila	
6	MPF-1102	3	Mathematics II	Mathematics II	
7	UMG-1106	2	English	English	
8	MPF-1132	3	Computational Physics	Computational Physics	
		20			

SEMESTER 3					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
1	MPF-2111	3	Mathematical Physics I	Mathematical Physics I	
2	MPF-2113	4	Mechanics	Mechanics	
3	MPF-2151	3	Basic Electronics	Basic Electronics	
4	MPF-2115	3	Thermodynamics	Thermodynamics	
5	MPF-2117	4	Electric Magnet	Electricity and magnetism	
6	MPF-2119	3	Modern Physics	Modern Physics	
		20			

SEMESTER 4					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
1	MPF-2142	3	Solid State Physics	Physics of Solid State	
2	MPF-2112	3	Mathematical Physics II	Mathematical Physics II	
3	MPF-2122	4	Quantum Physics	Quantum Physics	
4	MPF-2144	2	Experimental Physics	Experimental Physics I	
5	MPF-2114	3	Core Physics	Introduction to Nuclear Physics	
6	MPF-2116	3	Wave	Waves	
7	MPF-2118	3	Statistical Physics	Statistical Physics	
		21			
SEMESTER 5					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
		20	MBKM Options/Modes		
SEMESTER 6					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
		20	MBKM Options/Modes		
SEMESTER 7					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
		20	MBKM Options/Modes		
SEMESTER 8					

NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
1	UMG-4101	2	KKM/PKM	Community Service	
2	MPF-4102	3	Thesis	Undergraduate Thesis	

2. Elective Courses

ODD SEMESTER					
NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
1	MPF-3221	3	Astrophysics	Astrophysics	
2	MPF-3223	3	Mathematical Physics III	Mathematical Physics III	
3	MPF-3231	3	Simulation in physics	Physics Based Simulation	
4	MPF-4221	3	Relativistic Astrophysics and Cosmology	Relativistic Astrophysics and Cosmology	
5	MPF-3225	2	Special Functions and The application	Special Functions and their applications	
6	MPF-3227	2	Vector and Tensor Analysis	Vector and Tensor Analysis	
7	MPF-3233	4	Introduction to Dynamic Simulation Molecular	Introduction to Molecular Dynamics Simulation	
8	MPF-4231	2	Artificial intelligence	Artificial Intelligence	
9	MPF-4233	2	Introduction to Algorithms and Computation in Mechanics Statistics	Statistical Mechanics Algorithms and Computations	
10	MPF-3255	3	Microcontroller Applications	Microcontroller Applications	
11	MPF-3257	3	Digital electronics	Digital Electronics	
12	MPF-4257	3	Advanced electronics	Advanced Electronics	
13	MPF-3251	3	Environmental Physics	Environmental Physics	
14	MPF-3253	3	Biophysics	Biophysics	
15	MPF-4253	3	Radiation Detection Methods	Radiation Detection Methods	
16	MPF-4251	2	Environmental Conservation	Nature Conservation	
17	MPF-3241	3	Introduction to Quantitative Analysis Microstructure	Quantitative Analysis of Microstructure of Materials	
18	MPF-4245	3	Advanced Solid State Physics	Physics of Solid State II	
19	MPF-3245	3	Spectroscopy	Spectroscopy	
20	MPF-4241	2	Physics of Composite Materials	Composite Material Physics	
21	MPF-4243	2	Material Physics Lab Composite	Composite Experiments Material Physics	
22	MPF-3243	3	Physics of Materials	Material Physics	
23	MPF-3211	3	Metrology	Metrology	
24	MPF-3301	2	Ethics of Scientific Research 1	Scientific Research Ethics	
25	MPF-3303	3	Scientific Writing Techniques 1	Scientific Writing Techniques	

26	MPF-3305	3	Literature Study 1	Literature Review	
27	MPF-3307	3	Research Methodology 1	Research Methodology	
28	MPF-4301	3	Independent Work Monitored 1	Supervised Project	
29	MPF-4303	3	Seminar 1	Seminar	
30	MPF-4305	3	Physics Communication Media 1	Communications in Media for Physics	

EVEN SEMESTER					
NO	**CODE**	**WEIGHT SKS**	**COURSE NAME (Indonesia)**	**COURSE NAME (English)**	**PRE CONDITION**
1	MPF-3224	2	Dynamics of the Galaxy	Galactic Dynamics	
2	MPF-4222	2	Computational Astrophysics	Computational Astrophysics	
3	MPF-3226	3	Theory of Relativity	Theory of Relativity	
4	MPF-4224	3	Nanophotonics	Nanophotonics	
5	MPF-3228	3	Electromagnetics	Electromagnetics	
6	MPF-3232	2	Signal Processing	Signal Processing	
7	MPF-4232	2	Inversion Method	Inversion Method	
8	MPF-3234	2	Molecular Simulation	Molecular Simulation	
9	MPF-3256	3	Instrumentation	Instrumentation	
10	MPF-3258	3	Electrical Circuit Analysis	Analysis of Electric Circuits	
11	MPF-4258	3	Remote Sensing	Remote Sensing	
12	MPF-3254	2	Energy	Energy	
13	MPF-4256	3	Introduction to Reactor Physics	Introduction to Reactor Physics	
14	MPF-3252	2	Radiation Protection	Radiation Protection	
15	MPF-4252	3	Medical Instrumentation	Medical Physics	
16	MPF-4254	2	Radiography Physics	Physics of Radiography	
17	MPF-4242	3	Material Characteristics	Material Characteristics	
18	MPF-3244	3	Atomic and Molecular Physics	Physics of Atoms and Molecules	
19	MPF-3242	3	Introduction to crystallography	Introduction to crystallography	
20	MPF-3248	3	Material Fabrication Methods	Material Fabrication Method	
21	MPF-4246	3	Introduction to Science and Technology Nano	Introduction to Nanoscience and Technology	
22	MPF-3246	3	Material Characterization Methods	Material Characterization Method	
23	MPF-4248	3	Introduction to Polymer Physics	Introduction to Polymers Physics	
24	MPF-3222	2	History of Physics	The History of Physics	
25	MPF-3302	2	Ethics of Scientific Research 2	Scientific Research Ethics	
26	MPF-3304	3	Scientific Writing Techniques 2	Scientific Writing Techniques	

27	MPF-3306	3	Literature Study 2	Literature Review	
28	MPF-3308	3	Research Methodology 2	Research Methodology	
29	MPF-4302	3	Independent Work Monitored 2	Supervised Project	
30	MPF-4304	3	Seminar 2	Seminar	
31	MPF-4306	3	Physics Communication Media 2	Communications in Media for Physics	

3. MBKM Fashion Recognition Course

NO	CODE	WEIGHT SKS	COURSE NAME (Indonesia)	COURSE NAME (English)	PRE CONDITION
ODD SEMESTER					
MODE: RESEARCH, INTERNSHIP, ENTREPRENEURSHIP, HUMANITARIAN PROJECTS, BUILDING PROJECTS VILLAGES, INDEPENDENT PROJECTS, AND TEACHING ASSISTANCE,					
1	MPF-3301	2	Ethics of Scientific Research 1	Scientific Research Ethics 1	
2	MPF-3303	3	Scientific Writing Techniques 1	Scientific Writing Techniques 1	
3	MPF-3305	3	Literature Study 1	Literature Review 1	
4	MPF-3307	3	Research Methodology 1	Research Methodology 1	
5	MPF-4301	3	Independent Work Monitored 1	Supervised Project 1	
6	MPF-4303	3	Seminar 1	Seminar 1	
7	MPF-4305	3	Physics Communication Media 1	Communications in Media for Physics 1	
MODE : STUDENT EXCHANGE (CROSS UNIVERSITY)					
		20	*In accordance with the courses taken at the destination university*		
EVEN SEMESTER					
NO	**CODE**	**WEIGHT SKS**	**COURSE NAME (Indonesia)**	**COURSE NAME (English)**	**PRE CONDITION**
MODE: RESEARCH, INTERNSHIP, ENTREPRENEURSHIP, HUMANITARIAN PROJECTS, BUILDING PROJECTS VILLAGES, INDEPENDENT PROJECTS, AND TEACHING ASSISTANCE,					
1	MPF-3302	2	Scientific Research Ethics 2	Scientific Research Ethics 2	
2	MPF-3304	3	Scientific Writing Techniques 2	Scientific Writing Techniques 2	
3	MPF-3306	3	Literature Study 2	Literature Review 2	
4	MPF-3308	3	Research Methodology 2	Research Methodology 2	
5	MPF-4302	3	Independent Work Monitored 2	Supervised Project 2	
6	MPF-4304	3	Seminar 2	Seminar 2	
7	MPF-4306	3	Physics Communication Media 2	Communications in Medias for Physics 2	
MODE : STUDENT EXCHANGE (CROSS UNIVERSITY)					
		20	*In accordance with the courses taken at the destination university*		

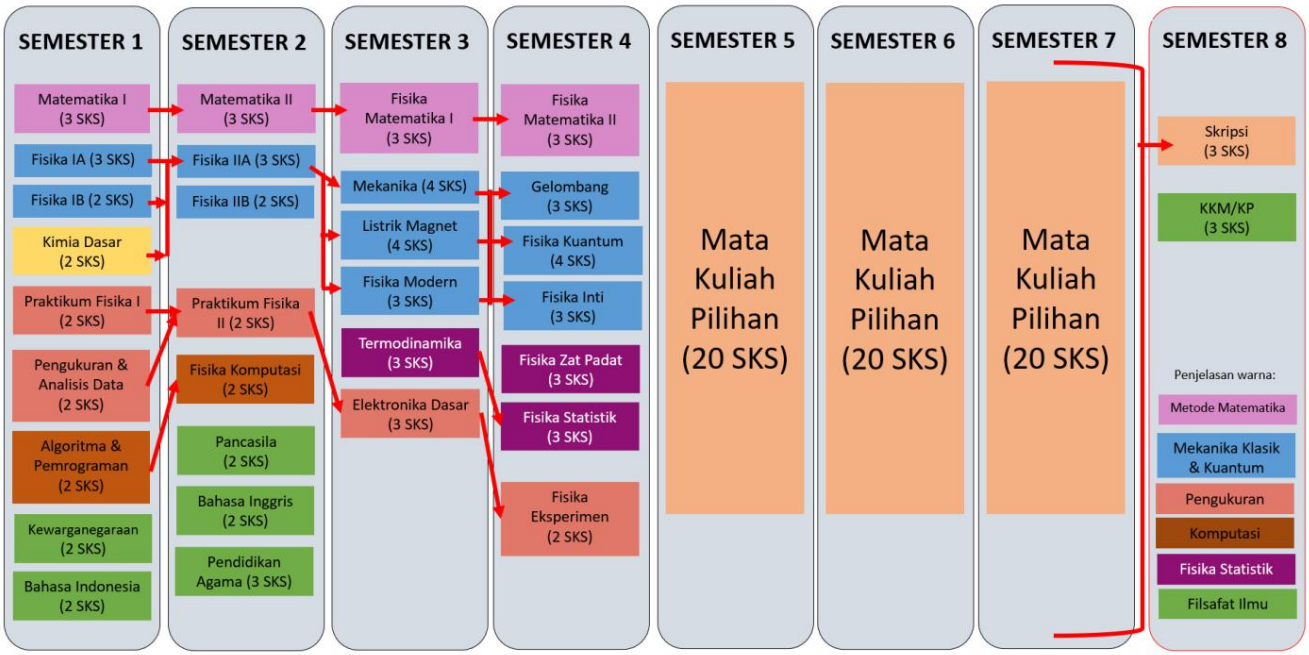
c. Curriculum Matrix & Map Curriculum

Matrix

SEMESTER	KODE MATAKULIAH	NAMA MATAKULIAH	BOBOT SKS	CAPAIAN PEMBELAJARAN																						
				SI 1	SI 2	SI 3	SI 4	SI 5	SI 6	SI 7	SI 8	SI 9	SI 10	PP 1	PP 2	PP 3	KK 1	KK 2	KK 3	KK 4	KK 5	KU 1	KU 2	KU 3	KU 4	KU 5
SEMESTER I	MKWU-4	Bahasa Indonesia	2		√	√	√	√					√								√	√			√	√
	MPF-1111	Fisika IA	3			√							√	√			√			√		√			√	
	MPF-1113	Fisika IB	2			√							√	√			√			√		√			√	
	MPF-1115	Praktikum Fisika Dasar I	2			√				√			√	√			√			√	√	√		√	√	
	MKWU-3	Kewarganegaraan	2	√	√	√	√	√	√	√	√	√	√									√			√	√
	MPF-1103	Kimia Dasar	2			√							√							√		√			√	√
	MPF-1101	Matematika I	3			√							√		√			√				√		√	√	
	MPF-1131	Algoritma Pemrograman	2			√							√		√			√	√			√			√	
	MPF-1117	Pengukuran dan Analisis Data	2			√							√		√			√	√		√	√	√	√	√	
SEMESTER II	MKWU-1	Pendidikan Agama	3	√	√	√	√	√	√	√	√	√	√									√			√	√
	MPF-1112	Fisika IIA	3			√							√	√			√			√		√			√	
	MPF-1114	Fisika IIB	2			√							√	√			√			√		√			√	
	MPF-1116	Praktikum Fisika Dasar II	2			√				√			√	√			√			√	√	√		√	√	
	MKWU-2	Pancasila	2	√	√	√	√	√	√	√	√	√	√									√			√	√
	MPF-1102	Matematika II	3			√							√		√			√				√		√	√	
	UMG-1106	Bahasa Inggris	2		√	√	√	√					√								√	√			√	√
	MPF-1132	Fisika Komputasi	3			√							√		√			√	√	√		√		√	√	
SEMESTER III	MPF-2111	Fisika Matematika I	3			√							√		√			√				√		√	√	
	MPF-2113	Mekanika	4			√							√	√			√			√		√			√	
	MPF-2151	Elektronika Dasar	3			√							√	√	√		√			√		√			√	
	MPF-2115	Termodinamika	3			√							√	√			√			√		√			√	
	MPF-2117	Listrik Magnet	4			√							√	√			√			√		√			√	
	MPF-2119	Fisika Modern	3			√							√	√			√			√		√			√	
SEMESTER IV	MPF-2142	Fisika Zat Padat	3			√							√	√			√			√		√			√	
	MPF-2112	Fisika Matematika II	3			√							√		√							√		√	√	
	MPF-2122	Fisika Kuantum	4			√							√	√			√			√		√			√	
	MPF-2144	Fisika Eksperimen	2			√				√			√	√	√		√		√	√		√		√	√	
	MPF-2114	Fisika Inti	3			√							√	√			√			√		√			√	
	MPF-2116	Gelombang	3			√							√	√			√			√		√			√	
	MPF-2118	Fisika Statistik	3			√							√	√			√			√		√			√	
V		Pilihan / Moda MBKM	20																							
VI		Pilihan / Moda MBKM	20																							
VII		Pilihan / Moda MBKM	20																							
VIII	UMG-4101	KKM/PKM	2	√	√	√	√	√	√	√	√	√	√			√			√	√	√	√	√	√	√	√
	MPF-4102	Tugas Akhir	3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
		Mata Kuliah Pilihan																								
SEMESTER GANJIL	MPF-3221	Astrofisika	3			√							√	√			√			√		√			√	
	MPF-3223	Fisika Matematik III	3			√							√		√			√				√		√	√	
	MPF-3231	Simulasi dalam fisika	3			√							√	√	√	√		√	√	√		√			√	
	MPF-4221	Astrofisika Relativistik dan Kosmol	3			√							√	√			√			√		√			√	
	MPF-3225	Fungsi Khusus dan Aplikasinya	2			√							√		√			√				√		√	√	
	MPF-3227	Analisis Vektor dan Tensor	2			√							√		√			√				√		√	√	
	MPF-3233	Pengantar Simulasi Dinamika Molekuler	4			√							√	√	√	√		√	√	√		√		√	√	
	MPF-4231	Kecerdasan Buatan	2			√							√		√	√		√	√	√		√		√	√	
	MPF-4233	Pengantar Algoritma dan Komputas	2			√							√		√	√		√		√		√		√	√	
	MPF-3255	Aplikasi Mikrokontroler	3			√							√		√	√			√	√		√		√	√	
	MPF-3257	Elektronika digital	3			√							√		√	√			√	√		√		√	√	
	MPF-4257	Elektronika lanjut	3			√							√		√	√			√	√		√		√	√	
	MPF-3251	Fisika Lingkungan	3			√				√			√	√		√	√		√	√		√			√	
	MPF-3253	Biofisika	3			√							√	√			√			√		√			√	
	MPF-4253	Metode Deteksi Radiasi	3			√							√	√	√	√			√	√		√		√	√	
	MPF-4251	Konservasi Lingkungan	2			√				√			√	√		√			√	√		√		√	√	
	MPF-4255	Fisika Bencana	2																							
	MPF-3241	Pengantar Analisis Kuantitatif Mikrostruktur	3			√							√	√	√	√			√	√		√		√	√	
	MPF-4245	Fisika Zat Padat Lanjut	3			√							√	√		√	√			√		√			√	
	MPF-3245	Spektroskopi	3			√							√	√						√		√		√	√	

	MPF-4241	Fisika Material Komposit	2			√							√	√		√	√		√	√		√			√		
	MPF-4243	Praktikum Fisika Material Komposit	2			√							√	√		√			√	√		√		√	√		
	MPF-3243	Fisika Material	3			√							√	√		√	√			√		√			√		
	MPF-3211	Metrologi	2			√							√	√	√	√			√	√		√		√	√		
	MPF-3301	Etika Penelitian Ilmiah 1	2		√	√		√					√								√	√			√		
	MPF-3303	Teknik Penulisan Ilmiah 1	3			√		√					√						√		√	√			√		
	MPF-3305	Studi Literatur 1	3			√		√					√						√	√	√	√	√	√	√		
	MPF-3307	Metodologi Penelitian 1	3			√		√		√			√						√	√	√	√	√		√		
	MPF-4301	Kerja Mandiri Terpantau 1	3		√	√			√			√	√						√	√	√	√	√	√	√		
	MPF-4303	Seminar 1	3			√		√	√				√								√	√	√		√	√	
	MPF-4305	Media Komunikasi Fisika 1	3			√	√	√	√	√	√	√	√								√	√	√		√	√	
	MPF-3224	Dinamika Galaksi	2			√							√	√			√			√		√			√		
	MPF-4222	Komputasi Astrofisika	2			√							√	√	√	√		√	√	√		√		√	√		
	MPF-3226	Teori Relativitas	3			√							√	√			√			√		√			√		
	MPF-4224	Nanofotonik	3			√							√	√		√	√			√		√			√		
	MPF-3228	Elektromagnetika	3			√							√	√			√			√		√			√		
	MPF-3232	Pemrosesan Sinyal	2			√							√		√	√				√		√		√	√		
	MPF-4232	Metode Inversi	2			√							√		√	√			√	√		√		√	√		
	MPF-3234	Simulasi Molekular	2			√							√	√	√	√		√	√	√		√		√	√		
	MPF-3256	Instrumentasi	3			√							√	√	√	√			√	√		√		√	√		
	MPF-3258	Analisis Rangkaian Listrik	3			√							√	√					√	√		√		√	√		
	MPF-4258	Penginderaan Jauh	3			√							√		√	√			√	√		√		√	√		
	MPF-3254	Energi	2			√							√	√		√	√		√	√		√		√	√		
	MPF-4256	Pengantar Fisika Reaktor	3			√							√	√	√	√				√		√			√		
	MPF-3252	Proteksi Radiasi	2			√							√	√		√				√		√		√	√		
	MPF-4252	Instrumentasi Medis	3			√							√	√	√	√				√		√		√	√		
	MPF-4254	Fisika Radiografi	2			√							√	√			√			√		√			√		
	MPF-4242	Karakteristik Material	3			√							√	√	√	√				√		√		√	√		
	MPF-3244	Fisika Atom dan Molekul	3			√							√	√			√			√		√			√		
SEMESTER GENAP	MPF-3242	Pengantar kristalografi	3			√							√	√			√			√		√			√		
	MPF-3248	Metode Fabrikasi Material	3			√							√	√	√	√			√	√		√		√	√		
	MPF-4246	Pengantar Ilmu dan Teknologi Nano	3			√							√	√		√			√	√		√			√		
	MPF-3246	Metode Karakterisasi Material	3			√							√	√	√	√			√	√		√		√	√		
	MPF-4248	Pengantar Fisika Polimer	3			√							√	√			√			√		√			√		
	MPF-3222	Sejarah Fisika	2		√	√		√		√			√	√					√	√		√		√	√		
	MPF-3302	Etika Penelitian Ilmiah 2	2		√	√		√					√								√	√			√		
	MPF-3304	Teknik Penulisan Ilmiah 2	3			√		√					√								√	√			√		
	MPF-3306	Studi Literatur 2	3			√		√					√						√	√	√	√	√	√	√		
	MPF-3308	Metodologi Penelitian 2	3			√		√		√			√						√	√	√	√	√		√		
	MPF-4302	Kerja Mandiri Terpantau 2	3			√			√			√	√						√	√	√	√	√	√	√		
	MPF-4304	Seminar 2	3			√		√	√				√								√	√	√		√	√	
	MPF-4306	Media Komunikasi Fisika 2	3			√	√	√	√	√	√	√	√								√	√	√		√	√	
		Mata Kuliah MBKM																									
	MODA : RISET, MAGANG, KEWIRAUSAHAAN, PROYEK KEMANUSIAAN, PROYEK MEMBANGUN DESA, PROYEK INDEPENDEN, DAN ASISTENSI MENGAJAR,																										
	MPF-3301	Etika Penelitian Ilmiah 1	2		√	√		√					√								√	√			√		
	MPF-3303	Teknik Penulisan Ilmiah 1	3			√		√					√								√	√			√		
	MPF-3305	Studi Literatur 1	3			√		√					√						√	√	√	√	√	√	√		
	MPF-3307	Metodologi Penelitian 1	3			√		√		√			√						√	√	√	√	√		√		
	MPF-4301	Kerja Mandiri Terpantau 1	3			√			√				√						√	√	√	√	√	√	√		
	MPF-4303	Seminar 1	3			√		√	√				√								√	√	√		√	√	
SEMESTER GANJIL	MPF-4305	Media Komunikasi Fisika 1	3			√	√	√	√	√	√	√	√								√	√	√		√	√	
	MODA : PERTUKARAN PELAJAR (LINTAS UNIVERSITAS)																										
		Sesuai dengan mata kuliah yang dia	20																								
	MODA : RISET, MAGANG, KEWIRAUSAHAAN, PROYEK KEMANUSIAAN, PROYEK MEMBANGUN DESA, PROYEK INDEPENDEN, DAN ASISTENSI MENGAJAR,																										
	MPF-3301	Etika Penelitian Ilmiah 1	2		√	√		√					√								√	√			√		
	MPF-3303	Teknik Penulisan Ilmiah 1	3			√		√					√								√	√			√		
	MPF-3305	Studi Literatur 1	3			√		√					√						√	√	√	√	√	√	√		
GENAP	MPF-3307	Metodologi Penelitian 1	3			√		√		√			√						√	√	√	√	√		√		
SEMESTER	MPF-4301	Kerja Mandiri Terpantau 1	3			√			√				√						√	√	√	√	√	√	√		
	MPF-4303	Seminar 1	3			√		√	√				√								√	√	√		√	√	
	MPF-4305	Media Komunikasi Fisika 1	3			√	√	√	√	√	√	√	√								√	√	√		√	√	
	MODA : PERTUKARAN PELAJAR (LINTAS UNIVERSITAS)																										
		Sesuai dengan mata kuliah yang dia	20																								

Curriculum Map of Undergraduate Physics Program



d. Course Syllabus

1. Compulsory Courses

SEMESTER I

MKWU-4 INDONESIAN LANGUAGE (2 CREDITS)	
PREREQUISITE	
MATERIAL	Academic Texts in *Macro Genre;* Exploring the World of Literature; Designing Research Proposals and Activity Proposals; Reporting Research Results and Activity Results; Scientific Articles.
LIBRARY	1. Ministry of Research and Technology, 2016, Indonesian Language Education Module for Higher Education High, Director General of Belmawa, Ministry of Research and Technology, Jakarta 2. Awaluddin, 2017, Introduction to Indonesian for Universities, Deepublish Publisher, Yogyakarta 3. DA Lindayani, et al. 2017. Indonesian as a General Basic Course. Gramedia, Jakarta

MPF-1111 PHYSICS IA (3 CREDITS)	
PREREQUISITE	
MATERIAL	Measurement (introduction to physical quantities, mass standards, length standards, time standards, and significant figures); Kinematics in 1 dimension (uniform linear motion and uniformly accelerated motion); Kinematics in 2 dimensions (projectile motion, uniform circular motion) and 3 dimensions; Dynamics (Newton's laws and their application to translational motion); Kinetic energy and work (kinetic energy work theorem, work by force with one general variable); Potential energy and conservation of energy (relationship between work and potential energy, conservative and nonconservative forces, work done on a system by external forces, concept and application of the law of conservation of energy); Linear momentum, impulse, and collisions (impulse-momentum theorem, conservation of momentum, collisions, concept of center of mass).

	mass); Rotation of rigid bodies (Angular velocity and acceleration, rotation with constant angular acceleration, relationship between linear kinematics and angular kinematics, energy in rotational motion, parallel axis theorem, calculation of moment of inertia); Dynamics of rotational motion (torque and angular acceleration of rigid bodies, rotation of rigid bodies, work and power in rotational motion, angular momentum and its conservation law).
LIBRARY	1. Fundamentals of Physics, 10th Edition, 2013. Authors: David Halliday, Robert Resnick, Jearl Walker. 2. University Physics with Modern Physics, 14th Edition, 2016. Author: Hugh D. Young, Roger A. Freedman. 3. Physics for Scientists and Engineers, 6th Edition, 2008. Author: Paul A. Tipler, Gene Mosca.

MPF-1113 PHYSICS 1B (2 credits)	
PREREQUISITE	
MATERIAL	Fluids, Temperature, Heat and the First Law of Thermodynamics, Kinetic Theory of Gases, Entropy and The Second Law of Thermodynamics, Heat Engines, Equilibrium and Elasticity, Gravity
LIBRARY	1. Fundamentals of Physics, 10th Edition, 2013. Author: David Halliday, Robert Resnick, Jearl Walker. 2. University Physics with Modern Physics, 14th Edition, 2016. Author: Hugh D. Young, Roger A. Freedman. 3. Physics for Scientists and Engineers, 6th Edition, 2008. Author: Paul A. Tipler, Gene Mosca.

MPF-1115 BASIC PHYSICS PRACTICE I (2 CREDITS)	
PREREQUISITE	
MATERIAL	Basics of measurement, Mathematical Swing Experiment, Force on an Inclined Plane, Determination of Moment of Inertia on an Inclined Plane, Coefficient of Restitution, Moment of Inertia on a Solid Cylinder, Coefficient of Viscosity of Liquids, Hydrostatic Pressure, Archimedes' Law, Moment of Force, Torricelli's Principle
LIBRARY	1. Team, 2020, Basic Physics Practical Dictate I, Physics Department, Faculty of Mathematics and Natural Sciences, UNTAN. 2. Jerry D. Wilson, Cecilia A. Hernndez-Hall, 2014, Physics Laboratory Experiments, Brooks Cole 3. Fundamentals of Physics, 10th Edition, 2013. Author: David Halliday, Robert Resnick, Jearl Walker. 4. Hugh D. Young, Roger A. Freedman, 2016, University Physics with Modern Physics, 14th Edition 5. Physics for Scientists and Engineers, 6th Edition, 2008. Author: Paul A. Tipler, Gene Mosca.

MKWU-3 CITIZENSHIP (2 CREDITS)	
PREREQUISITE	
MATERIAL	Civic Education is taught in universities; how the Essence and Urgency of National Identity as one of the Determinants of National Development and Character; how National Urgency as One of the Parameters of National Unity and Unity; constitutional values and norms of statutory provisions under the Constitution; harmony of obligations and rights of the state and citizens in a democracy that is based on people's sovereignty and deliberation for consensus; the nature, instrumentation and Practice of Indonesian Democracy Based on Pancasila and the 1945 Constitution of the Republic of Indonesia; historical dynamics of constitutional, socio-political, cultural and contemporary contexts of law enforcement that are just.; historical dynamics and urgency of the archipelago insight as a collective conception and view

	Indonesian nationality in the context of world relations; the urgency and challenges of national resilience and national defense for Indonesia in building a collective national commitment; citizen project for citizenship education courses
LIBRARY	1. Kemenristekdikti. 2016. Civic Education Module for Higher Education High, Director General of Belmawa, Ministry of Research, Technology and Higher Education, Jakarta 2. Budimansyah, D (Ed). 2006. Moral Values Education in the Dimension of Citizenship Education. Bandung: PKN FPIPS UPI Laboratory. 3. Pasha, MK. 2008. Civic Education. Yogyakarta. Independent Image of Karsa. 4. Sunarso, et al. 2006. Citizenship Education. Yogyakarta: UNY Press.

MPF-1103 BASIC CHEMISTRY (2 CREDITS)	
PREREQUISITE	
MATERIAL	Introduction; Atoms, Molecules and Ions; Stoichiometry; Reactions in Aqueous Solution; Gas; Energy Relationship in Chemical Reactions; Atomic Electron Structure; Periodic Table; Chemical Bonding I: Covalent Bonding; Chemical Bonding II: Molecular Geometry and Hybridization Atomic Orbitals
LIBRARY	1. Chang, R., 2003, General Chemistry: The essential Concepts, 3th ed., McGraw-Hill Companies 2. Petrucci, RH, 1985, General Chemistry: Principles & Modern Applications), 4th ed., Collier Macmillan, Inc.

MPF-1101 MATHEMATICS I (3 CREDITS)	
PREREQUISITE	
MATERIAL	Vectors (Scalar and vector quantities, vector representation, vector components (unit vectors, plane vectors, and space vectors), vector operations [addition or subtraction between vectors (graphical methods and analytical methods), scalar multiplication of vectors, multiplication between vectors *(dot product* and *cross product)];* Functions and graphs (including discussion of transcendental functions); Function limits; Differentials and their applications; Integrals; Ordinary differential equations (ODE) [The initial part of OED is its classification, regarding the equation of solving/determining the solution of differential equations, first-order linear differential equations only in the separation/separation of *(Separable equation)];* Trigonometry. differential And equations
LIBRARY	1. Stroud, KA and Dexter J. Booth, 2003, Engineering Mathematics, Fifth Edition, Volume 1, Jakarta, Erlangga. 2. Stroud, KA and Dexter J. Booth, 2003, Engineering Mathematics, Fifth Edition, Volume 2, Jakarta, Erlangga. 3. Varberg, D., Purcell, E.J., Rigdon, and Steven E., 2010, Calculus, Ninth Edition, Volume 1, Jakarta, Erlangga. 4. Varberg, D., Purcell, EJ, Rigdon, and Steven E., Susila, IN, (Editors) 2011, Calculus, Ninth Edition, Volume 2, Jakarta, Erlangga. 5. Boaz, Mary. L., 2006, Mathematical Methods in the Physical Sciences, 3rd ed., John Wiley.

MPF-1131 Algorithms and Programming (2 credits)	
PREREQUISITE	

MATERIAL	Definition of Algorithm, Examples of Algorithms, Meaning of Programming, Classification of Programming Languages, Introduction to Python Language, Data Types, Arithmetic Operations, Boolean Operations, Variables and Constants, Flow of Program (if, for, while), functions and procedures, vectors (list, tuple, dict), Matrix (numpy), I/O, Plotting (matplotlib).
LIBRARY	1. Lutz, M., 2013, Learning Python, 5th ed, O'Reilly Media, Sebastopol. 2. Kulikov, A. and Pevzner, P., 2018, Learning Algorithms Through Programming and Puzzle Solving, Active Learning Technologies, San Diego. 3. Linge, S. and Langtangen, H.P., 2016, Programming for Computations – Python, Springer Open, Heidelberg.

MPF-1117 DATA MEASUREMENT AND ANALYSIS (2 CREDITS)	
PREREQUISITE	
MATERIAL	Basic concepts of measurement; Measuring instruments; Measurement; Measurement uncertainty; Data collection and processing; Results of experimental data analysis; Application of data processing applications and data presentation.
LIBRARY	1. Morris, AS, Langari, R., 2020, Measurement and Instrumentation: Theory and Applications, ed. 3, Academic Press. 2. Holman, JP, 2012, Experimental methods for engineers ed 8, Mc. Graw Hill, New York 3. Bevington, P., Robinsonm DK, "Data Reduction and Error Analysis for Physical Sciences". Ed. 3., McGraw-Hill, 2003.

SEMESTER II

MKWU-1 RELIGIOUS EDUCATION (3 CREDITS)	
PREREQUISITE	
MATERIAL	**1. Islam religion** PAI is taught in universities. Godly humans. Religion guarantees happiness. Integrating faith, Islam and Ihsan in forming perfect humans. Building a Qur'anic personality. Grounding Islam in Indonesia. Islam builds unity in diversity. Islam faces the challenges of modernization. Contribution of Islam in the development of world civilization. The role and function of campus mosques in the development of Islamic culture. **2. Protestant Christianity** Religion and Its Function in Human Life. God in Christian Belief. Man According to Christian Teachings. Ethics and Christian Character Formation. The Relationship of Christian Faith with Science, Technology and Art. Creating Interfaith Harmony. God's Creation and Protecting It. How to Socialize Well. **3. Catholic Religion** The Calling of Human Life According to the Scriptures. Human Relations with Oneself, Others, the Environment and God. Religion and Faith in Plurality. Jesus Christ. The Church and Faith in Society. **4. Buddhism** Framework and contents of the Holy Book Tipitaka/ Tripitaka. The Meaning and Purpose of Human Life Derived from the Teachings of the Buddha. The Role of Universal Buddhist Law in Daily Life. The Meaning of the Almighty God in the Teachings of the Buddha. Moral Values and Norms (Sila) as the Foundation and Pattern of Life. Harmony of Science and Art in Life. The Concept of Buddhist Society and Construction

	Attitude of Interfaith Harmony. Dynamics of Buddhist Culture and Politics in the Context of Indonesian Nationality. Bhavana Forming a Clean Mind of a Human with Character. **5. Hinduism** The Purpose and Function of MKWU Hindu Religious Education in Building a Humanistic Personality Base for Students. The Role of the History of the Development of Hinduism in Providing Positive Learning. The Teachings of Brahmavidya (theology) in Building Sraddha and Bhakti (Faith and Piety) of Students. The Role of Vedic Studies in Building Students' Understanding of the Existence of the Vedas as Holy Scriptures and Sources of Law. The Concept of Hindu Humans in Building the Personality of Students who are Leaders, Law-abiding, Healthy, Creative and Adaptive. Hindu Moral Teachings in Building the Morality of Hindu Students. The Role of Religious Arts in Forming an Aesthetic Personality. Building Harmony According to Hindu Teachings. How to Build Awareness as a Social Being According to Hindu Teachings. **6. Confucianism** The Purpose and Function of Confucian Religious Education as a Component of MKWU in Diploma and Undergraduate Programs. The Purpose of Human Life and After Life. The Essence and Urgency of Integration of Faith, Belief, Unity, and Prostration in the Formation of Virtuous Humans. The Confucian Concept of Diversity in Religiousness and Its Contribution to the History of World Civilization. The Essence and Urgency of Confucian Religion and Spiritual Values. Sources and Implementation of Confucian Teachings in the Context of Modernity and Indonesianness. The Concept of Science and Technology, Politics, Socio-Culture, Economy, Environment and Education in the Confucian Perspective. The Role and Function of Confucian Student Activities as a Center for the Development of Confucian Culture.
LIBRARY	**1. Islam religion** a. Al Qur'an Al Karim and CD Al Qur'an: Holy Qur'an b. Al Hadith and Al Hadith CD: *Kutub Al Tis'ah,* Al Bayan Publisher c. Kemenristekdikti. 2016. Islamic Religious Education Module for Higher Education. Jakarta: Directorate General of Belmawa Kemenristekdikti d. Ali, Mukti. No year. Understanding Islam. Jakarta: PT Bulan Bintang e. Faiz, Fakhruddin. 2003. Quranic Hermeneutics between Text, Context and Contextualization. Yogyakarta: Qalam **2. Protestant Christianity** a. Kemenristekdikti. 2016. Christian Religious Education Module for Higher Education. Jakarta: Directorate General of Belmawa Kemenristekdikti b. Ariarajah, Wesley. 1989. The Bible and People of Other Beliefs. Jakarta: BPK Gunung Mulia c. Chandra, Robby I. 206. Education Towards Independent Humans. Bandung: Infomedia Generation d. Fletcher, Verne H. 2007. Behold the Man: An Approach to the Ethics of Basic Christian. Jakarta: BPK Gunung Mulia e. Sitompul, Einar M. 2006 The Church Responds to Change. Jakarta: BPK Gunung Glorious **3. Catholic Religion** a. Kemenristekdikti. 2016. Christian Religious Education Module for Higher Education. Jakarta: Directorate General of Belmawa Kemenristekdikti b. Dahler, Franz and Candra, Julius. 1989. Origin and Purpose of Humans – Theory Evolution That Shook the World, Yogyakarta: Kanisius c. Go Piet, Ocarm.2007. Interfaith Relations and Beliefs. Jakarta: KWI Documentation

	d. Harjawyata, Frans. OCSO (ed.). 1998.Jesus and the Situation of His Times. Yogyakarta: Canisius e. Ismartono, I., SJ 1993. Lectures on Catholic Religion. Jakarta: Torch **4. Buddhism** a. Kemenristekdikti. 2016. Buddhist Religious Education Module for Higher Education. Jakarta: Directorate General of Belmawa Kemenristekdikti b. Ekayana. 1995. Science and Buddha Dharma. Jakarta: Karaniya c. Jinarakkhita, A. 1992. Meditation for Higher Education in Buddhism. Jakarta: Vajra Dharma Nusantara d. Kirthisinghe, BP 1995. Buddhism and Science. (trans.) Jakarta: Aryasuryacandra e. Saccaako. 2005. Divinity in Buddhism. Medan: Dian Dharma **5. Hinduism** a. Kemenristekdikti. 2016. Hindu Religious Education Module for Higher Education High. Jakarta: Director General of Belmawa, Ministry of Research, Technology and Higher Education of the Republic of Indonesia b. Compilation Team. 2012. Hindu Religious Education for Public Universities, Directorate General of Hindu Community Guidance. Ministry of Religion of the Republic of Indonesia c. Awanita, Made. 2003. Hinduism (Orientation Module for Provision of Prospective Civil Servants), Project for Developing Prospective Educational Personnel, Bureau of Personnel, Secretariat General, Ministry of Religious Affairs of the Republic of Indonesia. Jakarta d. Nala, I Gusti Ngurah and IGK Adia Wiratmadja. 1991. Murdha Hinduism. Denpasar: Literature Update e. Sharma. 2007. Why? Hindu Traditions and Ceremonies. Surabaya: Paramita **6. Confucianism** a. Kemenristekdikti. 2016. Confucian Religious Education Module for Higher Education. Jakarta: Directorate General of Belmawa Kemenristekdikti RI b. Linggaraja, Uung Sendana, Gunadi, Hartono Hutomo. 2011. Confucian Religious Education Course Module. Jakarta: Directorate General of Higher Education, Ministry of Research, Technology and Higher Education, Republic of Indonesia c. The Supreme Council of Confucianism in Indonesia (Matakin). 1983. Introduction to Reading Su Si. SAK TH XXVII Number 01. 1983/2534 d. Tockary, RIP. 2006 Introduction to Confucian Religion, Lecture Materials. Bogor: The House of Ru. e. Tjhie, Tjay Ing. 2005. "Let's Chant and Read the Trikata Book." SGSK (Confucian Sacred Bell Series): 28/2005 Siencia Number 2556. Solo: Matakin

MPF-1112 PHYSICS IIA (3 CREDITS)	
PREREQUISITE	
MATERIAL	Charge (types of charge, charge quantization, charge conservation), charge-conducting materials (conductors and insulators); Coulomb's law; Electric field from discrete charge sources (general and dipole charge configurations), electric field from continuous charge sources, charge in an electric field; Gauss's law and its applications for calculating electric fields (spherical, cylindrical, plane symmetry cases); Electric potential, equipotential surfaces, electric potential due to discrete and continuous source charges, calculating electric field from potential, electric potential energy of charged particle systems; Capacitors and capacitance, series-parallel arrangement of capacitors, internal energy of capacitors, capacitors with dielectric materials; Current and resistance, electric circuits; Magnetic field and magnetic force (Lorenz force); crossed fields (electric and magnetic fields perpendicular to each other) in cathode ray tubes, effects Hall; Magnetic force on current-carrying wire, torque on current-carrying loop, dipole moment

	magnetic; Magnetic field caused by current (Biot-Savart law); Ampere's law and its application to calculate magnetic field in straight conductor, solenoid, and toroid; Induction and inductance (Faraday's law, Lenz's law), energy transfer, Eddy current, inductor, RC circuit; Energy in magnetic field.
LIBRARY	1. *Fundamentals of Physics,* 10th Edition, 2013. Authors: David Halliday, Robert Resnick, Jearl Walker. 2. *University Physics with Modern Physics,* 14th Edition, 2016. Author: Hugh D. Young, Roger A. Freedman. 3. *Physics for Scientists and Engineers,* 6th Edition, 2008. Author: Paul A. Tipler, Gene Mosca.

MPF-1114 PHYSICS IIB (2 CREDITS)	
PREREQUISITE	
MATERIAL	Oscillation; Mechanical Waves, Sound; EM Waves; Geometric Optics and Optical Instruments; Interference; Diffraction
LIBRARY	1. Fundamentals of Physics, 10th Edition, 2013. Author: David Halliday, Robert Resnick, Jearl Walker. 2. University Physics with Modern Physics, 14th Edition, 2016. Author: Hugh D. Young, Roger A. Freedman. 3. Physics for Scientists and Engineers, 6th Edition, 2008. Author: Paul A. Tipler, Gene Mosca.

MPF-1116 BASIC PHYSICS PRACTICE II (2 CREDITS)	
PREREQUISITE	
MATERIAL	Resistance measurement experiments, Ohm's Law experiments, Kirchoff's Law, Capacitors, RLC Circuits, Magnets, Light Diffraction, Stationary Waves, Positive Lenses, Organ Pipes, Refraction of Light in Prisms, Oscillations in Springs
LIBRARY	1. Team, 2020, Basic Physics Practical Dictate II, Physics Department, Faculty of Mathematics and Natural Sciences, UNTAN. 2. Jerry D. Wilson, Cecilia A. Hernndez-Hall, 2014, Physics Laboratory Experiments, Brooks Cole 3. Fundamentals of Physics, 10th Edition, 2013. Author: David Halliday, Robert Resnick, Jearl Walker. 4. University Physics with Modern Physics, 14th Edition, 2016. Author: Hugh D. Young, Roger A. Freedman. 5. Physics for Scientists and Engineers, 6th Edition, 2008. Author: Paul A. Tipler, Gene Mosca.

MKWU-2 PANCASILA (2 credits)	
PREREQUISITE	
MATERIAL	Pancasila education is taught in higher education; Pancasila in the study of the flow of Indonesian history; The urgency of Pancasila as the State Philosophy of the Republic of Indonesia; Pancasila as the State Ideology; Pancasila as a Philosophical System; Pancasila as an Ethical System; Pancasila as the Basis for the Values of Scientific Development.
LIBRARY	1. Ministry of Research, Technology and Higher Education. 2016. Pancasila Education Module for Higher Education. Jakarta: Director General of Student Affairs and Student Affairs, Ministry of Research, Technology and Higher Education 2. Ali, As'ad Said. 2009. The Pancasila State, the Path to National Welfare. Jakarta: LP3ES Library 3. Bakry, Noor Ms. 2010. Pancasila Education. Student Library: Yogyakarta

	4. Kaelan, 2013, Pancasila Nation State: Cultural, Historical, Philosophical, Legal and Actualization. Yogyakarta: Paradigma Publisher

MPF-1102 MATHEMATICS II (3 SKS)	
PREREQUISITE	
MATERIAL	Matrix; Vector analysis (The initial part of vector analysis material is about *triple product* and vector differential (gradient, directional derivative, divergence, and curl); Linear algebra; Infinite series and power series; Partial differentials.
LIBRARY	1. Boaz, Mary. L., 2006, Mathematical Methods in the Physical Sciences, 3rd ed., John Wiley. 2. Stroud, KA and Dexter J. Booth, 2003, Engineering Mathematics, Fifth Edition, Volume 1, Jakarta, Erlangga. 3. Stroud, KA and Dexter J. Booth, 2003, Engineering Mathematics, Fifth Edition, Volume 2, Jakarta, Erlangga. 4. Varberg, D., Purcell, E.J., Rigdon, and Steven E., 2010, Calculus, Ninth Edition, Volume 1, Jakarta, Erlangga. 5. Varberg, D., Purcell, EJ, Rigdon, and Steven E., Susila, IN, (Editors) 2011, Calculus, Ninth Edition, Volume 2, Jakarta, Erlangga. 6. Ruwanto, B, 2002, Mathematics for Physics and Engineering, Volume 1, Yogyakarta, National Creative Initiative.

UMG-1106 ENGLISH (2 CREDITS)	
PREREQUISITE	
MATERIAL	The use of English is in accordance with the intermediate and preadvanced levels, the use is emphasized on the ability to understand scientific readings, and the addition of vocabulary and expressions in English as much as possible. Sentence structure (grammar) is given in accordance with the scientific reading. English language skills improvement through reading and pronunciation exercises, improving grammar, enriching vocabulary and understanding idioms and usage. Attention is focused on correcting common mistakes.
LIBRARY	

MPF-1132 Computational Physics (3 credits)	
PREREQUISITE	
MATERIAL	Taylor Series, Error, Floating Point Number, Numerical Derivative, Numerical Integral (Composite Trapezoid, Simpson 1/3, Extrapolation, Roomberg), Root Finding (Bisection Method, Regula Falsi Method, Newton Raphson Method, Secant Method), Ordinary Differential Equations (Euler, Heun, Runge Kutta, Leapfrog), Linear Equation System (Gauss, Jacobi, Gauss-Seidel Elimination), Curve Fitting (Linear, Quadratic, Polynomial, Exponential).
LIBRARY	1. Koonin, S.E., 1986, Computational Physics, The Benjamin/Cummings Publishing Company, California. 2. Hoffman, JD, 2001, Numerical Methods for Engineers and Scientists, Marcell Dekker, Inc., Basel.

	3. Linge, S. and Langtangen, H.P., 2016, Programming for Computations – Python, Springer Open, Heidelberg.

SEMESTER III

MPF-2111 MATHEMATICAL PHYSICS I (3 CREDITS)	
PREREQUISITE	
MATERIAL	Complex numbers; Multiple integrals and integral applications; Vector analysis (Continuing the material in Mathematics 2, namely the concept of fields, line/path integrals, Green's theorem on the plane, Divergence theorem, and Stokes' theorem); Ordinary differential equations (ODE) [Continuing the ODE material in Mathematics 1, namely first-order linear differential equations (general solution of first-order linear differential equations, Bernoulli equations, Exact equations, Homogeneous equations), second-order linear differential equations], and Laplace Transforms.
LIBRARY	1. Boaz, Mary. L., 2006, Mathematical Methods in the Physical Sciences, 3rd ed., John Wiley. 2. Ruwanto, B, 2002, Mathematics for Physics and Engineering, Volume 1, Yogyakarta, National Creative Initiative. 3. Ruwanto, B, 2003, Mathematics for Physics and Engineering, Volume 2, Yogyakarta, National Creative Enterprise

MPF-2113 Mechanics (4 credits)	
PREREQUISITE	
MATERIAL	2D and 3D kinematics (Polar, Cylindrical and Spherical Coordinate Systems). 1D Dynamics (Newton's Second Law, Newton's Third Law, Forces depending on time, velocity and position), Numerical solution of Newton's Dynamics equations (Modified Euler and Leapfrog methods.), 2D and 3D Dynamics, Oscillations (Simple Harmonic, Damped, Forced, Coupled), Introduction to Lagrangian and Hamiltonian Formalisms, Central Forces. Non-inertial reference frames. Rigid body dynamics.
LIBRARY	1. Morin, D., 2007, Introduction to Classical Mechanics: with Problems and Solutions, Cambridge University Press, Cambridge. 2. Gregory, RD, 2006. Classical Mechanics: An Undergraduate Text, Cambridge University Press, Cambridge. 3. Symon, K.R., 1971., Mechanics, 3rd ed., Addison-Wesley Publishing Company, Massachusetts.

MPF-2151 BASIC ELECTRONICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Basic concepts of electric current and voltage, Direct Current (DC), Alternating Current (AC), Semiconductor Materials, PN Diodes, Zener Diodes, PNP-NPN Bipolar Transistors, Transistors as amplifiers, Field Effect Transistors, JFET-MOSFET, Power Amplifiers, Operational Amplifiers (Op Amps), Filters.
LIBRARY	4. Smith, Ralph J. 1995. Circuits, Devices, and Systems. John Wiley & Sons

	5. Brophy JJ 1990, Basics Electronics For Scientists, McGrawHill New York, Fifth Edition 6. Milman and Halkias, 1992, Integrated Electronics, Mc GrawHill, Toronto

MPF-2115 THERMODYNAMICS (3 SKS)	
PREREQUISITE	
MATERIAL	**Scope of Thermodynamics :** thermodynamic systems and their variables (temperature, pressure, volume), zeroth law of thermodynamics and thermodynamic equilibrium, thermodynamic processes. **Equation of state :** ideal gas equation of state, real gas equation of state, partial differentials (expansion coefficient and compression coefficient), critical constant of van der Waals gas, relationship between partial differentials and exact differentials). The first law of thermodynamics; work in thermodynamics, the first law of thermodynamics, internal energy, heat flow, heat capacity, enthalpy and the general form of the first law of thermodynamics. **Consequences of the First Law of Thermodynamics :** energy state equation (variables T and V, variables T and P, variables P and V), Gay-Lussac-Joule experiment and Joule-Thomson exp, Carnot cycle, heat engine and cooling engine. **Entropy & Second Law of Thermodynamics :** 2nd law of thermodynamics, entropy (in reversible and irreversible processes), principle of entropy increase. **Combination of the first and second laws of thermodynamics :** TDS equation 1, TDS equation 2, TDS equation 3, + (pure substances, ideal gases, van der Waals gases, liquids and solids under hydrostatic pressure) and Joule and Joule-Thomson experiments.
LIBRARY	1. FW Sears and GL Salinger, *Thermodynamics: Kinetic Theory and Statistics Thermodynamics,* Addison-Wesley 2. M. Alonso and EJ Finn, *Fundamental University Physics,* vol III, Addison Wesley 3. G. Carrington, *Basic Thermodynamics,* Oxford University Press 4. C. Kittel, *Thermal Physics,* WH Freeman and Co, NY 5. W. Greiner, L. Neise and H. Stocker, *Thermodynamics and Statistical Mechanics,* Springer-Verlag

MPF-2117 MAGNETIC ELECTRICITY (3 CREDITS)	
PREREQUISITE	
MATERIAL	Electric field in vacuum, divergence and curl of electric field, electric potential, electrostatic work and energy, conductors; Electric field in materials, polarization, field of polarized objects, electric displacement, linear dielectric (susceptibility, permeability, and dielectric constant); Electric field in vacuum, Lorenz force, Biot-Savart law, divergence and curl of magnetic field, magnetic potential; Magnetic field in materials, magnetization, field of magnetized materials; Maxwell's equations.
LIBRARY	1. *Introduction to Electrodynamics,* 4h Edition, 2013. Author: David J. Griffiths. 2. *Electricity and Magnetism,* 3rd Edition, 2013. Author: Edward M Purcel, David J. Morin.

MPF-2119 MODERN PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Special relativity, Lorentz transformation, Black body radiation, photoelectric effect, X-rays, Compton effect, pair production, atomic matter, atomic spectra, atomic model, de-Broglie waves, Heisenberg uncertainty, Schrodinger equation, solution of Schrodinger equation, hydrogen atom.

LIBRARY	1. Arthur Beiser, 2003, Concepts of Modern Physics, 6th ed., McGraw-Hill Companies, Inc., New York 2. Kenneth Krane. 2012, Modern physics, 3rd ed., John Wiley & Sons, Inc., Hoboken

SEMESTER IV

MPF-2142 SOLID STATE PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	**Crystal structure :** Periodicity, Cell Volume and Stacking Factor, Seven Crystal System, Plane Index and Interplane Distance, Simple Crystals, Crystal Defects and Crystal Bonding. **Diffraction by Lattices and Reciprocal Lattices:** Diffraction of X-rays by Crystal Lattices (Process of X-ray Production, Principle of X-ray Diffractogram, Bragg Equation), Reciprocal Lattices (Fourier Analysis: Scattered Wave Amplitude, Reciprocal Lattice Vectors, Diffraction Conditions: Laue Condition*). Brillouin Zone*, Structure Factor and Atomic Shape Factor. **Crystal Bonding:** Bonding in Noble Gases, Ionic Crystals, Covalent Crystals, Metallic Bonding, Hydrogen Bonding **Crystal Lattice Vibrations: Phonons:** Dispersive Relations, Monatomic Lattice Vibrations, Diatomic Lattice Vibrations, Quantization of Crystal Lattice Vibrations **Thermal Properties of Crystals:** Lattice Heat Capacity (Einstein Model, Debye Model), Thermal Conductivity
LIBRARY	1. Kittel, C. 2005. Introduction to Solid State Physics. John Wiley & Sons. New York 2. Patterson, JD, Bailey, BC, 2007, Solid-State Physics:Introduction to the Theory, Springer-Verlag Berlin Heidelberg
MPF-2112 MATHEMATICAL PHYSICS II (3 credits)	
PREREQUISITE	
MATERIAL	Fourier series and Fourier transform; Special functions, Series solutions of differential equations (Legendre, Bessel, Hermite, and Leguerre functions)
LIBRARY	1. Boaz, Mary. L., 2006, Mathematical Methods in the Physical Sciences, 3rd ed., John Wiley. 2. Ruwanto, B, 2002, Mathematics for Physics and Engineering, Volume 1, Yogyakarta, National Creative Initiative. 3. Ruwanto, B, 2003, Mathematics for Physics and Engineering, Volume 2, Yogyakarta, National Creative Enterprise

MPF-2122 QUANTUM PHYSICS (4 CREDITS)	
PREREQUISITE	
MATERIAL	The birth of quantum theory (classical physics problems, particle nature of waves and wave nature of particles); Introduction of Schrödinger equation, its solution in wave function form (well-behaved wave function), time-independent Schrödinger equation; statistical interpretation of wave function (probability density and expectation value); Heisenberg uncertainty; time-independent Schrödinger equation for 1-dimensional case (barrier potential case, infinite well, harmonic oscillator); Application of Schrödinger equation for Hydrogen atom (energy levels, probability cloud, quantum numbers, angular momentum).
LIBRARY	1. Quantum Mechanics, an Accessible Introduction, 1st Edition, 2006. Author: Robert Joseph Scherrer. 2. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, 2nd Edition, 1974. Authors: Robert Eisberg, Robert Resnick. 3. Introduction to Quantum Mechanics, 3th Edition, 2018. Author: David Griffiths.

MPF-2144 EXPERIMENTAL PHYSICS (2 CREDITS)	
PREREQUISITE	
MATERIAL	Black Body Radiation Experiment, Millikan Oil Drop Experiment, Thomson e/m Experiment, Spectrophotometry
LIBRARY	1. Beiser, A., 1981. *Concepts of Modern Physics .* Volume 3. Translation: The Houw Liong. Jakarta: Erlangga 2. *Experimental Physics Practical Module* 2, Physics Department, Faculty of Mathematics and Natural Sciences, Unitan

MPF-2114 CORE PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Properties of the nucleus: mass, spokes, spin, magnetic moment, electric moment. Binding energy: liquid drop model, Weizsacker mass formula, mass parabola. Two nucleon system: nuclear force, deuteron structure, scattering theory, np scattering. Radioactivity: radioactivity law, radioactive equilibrium, radioactive series, nuclear stability, alpha decay, beta decay and gamma decay. Nuclear Reactions: Classification of nuclear reactions, Energy of nuclear reactions, cross section of nuclear reactions, Mechanism of nuclear reactions, compound nuclear model, Wigner's Theory, optical model of direct reaction, Fission Reactions, Fusion Reactions, introduction to nuclear reactors. Neutrons, Neutron thermalization, nuclear reactions in the center of mass coordinate system. Nuclear instrumentation, particle detectors (geiger muler, scintillation and semiconductor), particle accelerators (cyclotron, betatron, linac, synchrotron).
LIBRARY	1. Meyerhof, WE, 1967: Elements of Nuclear Physics, Mcgraw-Hill Book Co. 2. Arya, Atam H., 1966: Fundamentals of Nuclear Physics, Allen and Bacon Inc. 3. Kenneth S. Krane., 1987: Introductory Nuclear Physics. John Willey & Son.

MPF-2116 WAVES (3 CREDITS)	
PREREQUISITE	
MATERIAL	Waves as a function of space and time, mechanical and electromagnetic wave equations, plane wave solutions, energy flow and wave power, Superposition and modulation principles, wave packets, dispersivity, Polarization and its applications, physical phenomena and quantities at medium boundaries. Brewster's law total internal reflection, Interference and interferometer. concept of space and time coherence, Diffraction: Kirchoff's Formula 1. Tjia, MO, Waves, Dabara Publishers, 1994. , Fraunhoffer and Fresnel diffraction.
LIBRARY	2. Hecht, E., Optics, 2nd edition, Addison Wesley, 1987 3. Pedrotti, FL, and LS Pedrotti, Introduction to Optics, Prentice Hall, 1993

MPF-2118 STATISTICAL PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	**Statistics:** some basics of probability theory, binomial distribution, Poisson distribution, Gauss distribution, Maxwell's particle velocity distribution, Maxwell-Boltzmann distribution. **Statistical Physics Approach:** Macroscopic and microscopic states, statistical loading of microscopic states, principle of maximum entropy, equilibrium in open and closed systems, microscopic ensembles, partition function, equilibrium of systems in thermostats (reservoirs), canonical ensembles, Maxwell-Boltzmann distribution. **Canonical Ensembles:** Paramagnetic properties of solids, internal energy, Helmholtz free energy, heat capacity and entropy, Einstein's heat capacity theory, density of states, Debye's heat capacity theory. **Grand Canonical Ensembles:** Partition function, classical system criteria, equation of state, entropy, Gibbs free energy, thermodynamic and chemical potentials, real gases, virial expansion, critical points. **Quantum Gases:** partition function, Fermi-Dirac distribution, Bose-Einstein distribution. **Fermi-Dirac statistics:** Classical limit, free electron model, electron specific heat,

	magnetic susceptibility. **Bose-Einstein statistics:** Bose-Einstein distribution, black body radiation spectrum, specific heat theory of crystals.
LIBRARY	1. Poynton, *Introduction to Statistical Physics, Longman-Green,* 1967. 2. Reif, F., 1970 : *Fundamentals of Statistics and Thermal Physics,* McGraw-Hill, 3. Sears, FW; GL Salinger, 1982: *Thermodynamics, Kinetic Theory, and Statistics Thermodynamics,* 3rd edition, Addison-Wesley. 4. Kittel, C., 1958 : Elementary Statistical Physics, John Wiley. 5. Krauth, W., 2006, Statistical Mechanics Algorithms and Computations, Oxford: Oxford University Press. 6. Purwanto, A., 2007, Statistical Physics, Media Style, Yogyakarta 7. Abdullah, M., 2007, Introduction to Statistical Physics for Students, ITB, Bandung 8. Huang, K. (1987). Statistical Mechanics. John Wiley & Sons. 9. Huang, K., 2009, Introduction to Statistical Physics, 2nd ed. Boca Raton, CRC Press

SEMESTERS V, VI, VII, VIII

UMG-4101 KKM/PKM (2 credits)	
PREREQUISITE	
MATERIAL	- Regular (conventional) curriculum: - PKM: Carry out Internship activities in the field/related agencies for 1 month, make an Internship report and present it in the form of an open seminar. - KKM: Implementing and making reports on Student Work Lecture activities - Curriculum with MBKM mode program, KKM/PKM is an integrated part from the mode with the obligation to make an Activity Report.
LIBRARY	

MPF-4102 FINAL PROJECT (3 CREDITS)	
PREREQUISITE	
MATERIAL	- Regular (conventional) curriculum, the Final Assignment is in the form of a literature study for compiling research proposals, conducting research, writing reports, and final research results to be compiled in the form of a thesis book. - Curriculum with MBKM mode program, Final assignment is an integrated part from the mode with the obligation to make an Activity Report.
LIBRARY	

2. Elective Courses

ODD SEMESTER

MPF-3221 Astrophysics (3 credits)	
PREREQUISITE	
MATERIAL	Coordinates of Celestial Bodies, Photometry, Spectroscopy, Telescopes, Mechanics of Celestial Bodies, Planets, Structure of Stars, Sun, Binary Systems, Galaxies and Their Contents, *Formation of Planets,* Brief Review of General Theory of Relativity, Cosmology.
LIBRARY	1. Carroll, BW and Otslie, DA ,2007, An Introduction to Modern Astrophysics, 2nd ed., Pearson Education, Inc. San Francisco. 2. Binney, J., 2016, Astrophysics: A very Short Introduction, Oxford University Press, Oxford. 3. Karttunen, H, et al., 2017, Fundamentals of Astronomy, 6th ed., Springer-Verlag

MPF-3223 Mathematical Physics III (3 credits)	
PREREQUISITE	
MATERIAL	Solution of Differential Equation Series, Partial Differential Equations, Functions of Complex Variables, Integral Transformations.
LIBRARY	1. Boas, ML 2006, Mathematical Methods in the Physical Sciences, 3rd ed., John Wiley and Sons, Inc. New Jersey. 2. Riley, KF et al, 2007, Mathematical Methods for Physics and Engineering, 3rd ed., Cambridge University Press, Cambridge. 3. Hasanuddin, 2019, Lecture Notes for Mathematical Physics III.

MPF-3231 SIMULATION IN PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Tools of trade (plotting, animation, Graphical User Interface, Object Oriented Programming), Particle Simulation in Stationary Potential, N-body Simulation, Simulation of Problems based on Ordinary Differential Equations, Monte Carlo.
LIBRARY	1. Gould, H. et al., 2007, An Introduction to Computer Simulations Method: Application to Physical Systems, 3rd ed., Pearson Education, Inc. San Francisco. 2. Linge, S. and Langtangen, H.P., 2016, Programming for Computations – Python, Springer Open, Heidelberg. 3. Koonin, S.E., 1986, Computational Physics, The Benjamin/Cummings Publishing Company, California.

MPF-4221 RELATIVISTIC ASTROPHYSICS AND COSMOLOGY (3 CREDITS)	
PREREQUISITE	Modern Physics, Theory of Relativity
MATERIAL	Special Theory of Relativity, General Theory of Relativity, Relativistic Quantum Mechanics and Particle Physics, Relativistic Spherical Stars, Stellar Evolution, White Dwarfs, Neutron Stars, Black Holes. Cosmological Principle, Robertson-Walker Metric, Dark Energy and Dynamics of the Universe, Inflation and the Beginning of the Universe, Standard Model of the Universe.
LIBRARY	1. *Relativistic Astrophysics and Cosmology: a Premier,* 2007, Peter Hoyng 2. *An Introduction to Mathematical Cosmology,* 2002, JN Islam

MPF-3225 SPECIAL FUNCTIONS AND THEIR APPLICATIONS (2 CREDITS)	
PREREQUISITE	Mathematical Physics I and II
MATERIAL	Gamma Function, Beta Function, Airy Function, Bessel Function, Legendre Polynomial and Spherical Function, Hermite Polynomial.
LIBRARY	1. *Selected Special Functions for Fundamental Physics,* 2019, Valeria Akhmedova and Emil T Akhmedov 2. Mathematical Physics, 2013, Sadri Hassani

MPF-3227 VECTOR AND TENSORS ANALYSIS (2 CREDITS)	
PREREQUISITE	Mathematical Physics I and II
MATERIAL	**Review of coordinate systems :** Vector Representation and Basis Vectors; Gradient, Divergence and Curl Operators; **Introduction to the concept of Manifolds:** Definition of manifolds, Transformation rules, Covariant and Contravariant Vectors, One Form; **Tensors :** Definition, Operations on Tensors, Some examples of special Tensors.
LIBRARY	1. *A Student's Guide to Vectors and Tensors,* 2011, Daniel A Fleisch

	2. *From Vector to Tensor,* 2005, Juan R Ruiz-Tolosa, et al.

MPF-4223 QUANTUM MECHANICS (3 CREDITS)	
PREREQUISITE	Quantum Physics
MATERIAL	Mathematical apparatus of quantum mechanics, postulates of quantum mechanics, application of operator methods to the case of harmonic oscillators, Angular Momentum, Spin, Identical particles.
LIBRARY	1. *Introduction to Quantum Mechanics,* 3th Edition, 2018. Author: David Griffiths. 2. Quantum Mechanics: Concepts and Applications, 2nd Edition, 2009. Author: Nouredine Zettili.

MPF-4231 ARTIFICIAL INTELLIGENCE (3 CREDITS)	
PREREQUISITE	
MATERIAL	Introduction to AI, Problems and State Spaces, Search and Tracking Techniques, Heuristic Search and Tracking, Knowledge Representation, Expert Systems, Uncertainty, Fuzzy logic, *Case Base Reasoning,* ANN, Genetic Algorithm
LIBRARY	1. Bojadziev, G., & Bojadziev, M. 2007, Fuzzy Logic for Business, Finance, and Management . Singapore: Word Scientific. 2. Kusumadewi, S., & Purnomo, H. (2010). Fuzzy Logic Applications: For Decision Support. Yogyakarta: Graha Ilmu 3. Suyanto, 2007, Artificial intelligence: Searching, Reasoning, Planning, and Learning. Bandung: Informatics.

MPF-3223 Introduction to Molecular Dynamics Simulation (3 credits)	
PREREQUISITE	
MATERIAL	Monte Carlo methods, Hard disks and sphere models, path integrals, dynamic Monte Carlo
LIBRARY	1. Gould, H., and Tobochnik, 2021, Statistical and Thermal Physics: With Computer Applications, Second Edition School Edition, Princeton University Press. 2. Krauth, W., 2006, Statistical Mechanics: Algorithms and Computations (Oxford Master Series in Physics Book 13), OUP Oxford

MPF-3255 MICROCONTROLLER APPLICATIONS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Microcontroller Development, Microcontroller Architecture, Microcontroller Support Software, Microcontroller Programming, I/O Port Programming, Serial Port, Parallel Port, Analog to Digital, Microcontroller Applications in Measurement and Control Systems.
LIBRARY	1. MacKenzie I. Scott, 1995 "The Microcontroller", Prentice Hall, New Jersey 2. Sencer Yeraland and Ashutosh Ahluwalia, Programming and Interfacing the 8051, Addison Wesley Publishing. 3. Intel Corporation, MCS51 - Family of the Single Chip Microcomputers User Manual, Intel 1981 4. Jan Axelson, The Microcontroller Idea Book, Lakeview Research 5. Intel Corporation, 8 Bit Embedded Controller Handbook, Intel 1989 6. www.atmel.com

MPF-3257 DIGITAL ELECTRONICS (3 SKS)	
PREREQUISITE	

MATERIAL	Number System, Arithmetic Operations of Binary Number System, Code System, Logic Gates, Logic Gate Circuits, Boolean Algebra, Karnaugh Map, Flip-Flop, Counter, ADC (Analog to Digital Converter), DAC (Digital to Analog Converter), Register.
LIBRARY	1. H. Ritz, 1992, Digital Techniques, Jakarta, Gramedia 2. Kleitz, W., 1996, Digital Electronics, Prentice Hall, Inc, New Jersey. 3. Milman and Halkias, 1992, Integrated Electronics, Mc GrawHill, Toronto 4. Tokeim, L. R, 1955, Digital Electronics, Jakarta, Erlangga
MPF-4257 Advanced Electronics (3 credits)	
PREREQUISITE	
MATERIAL	Number System, logic gates, boolean algebra, adder circuits, open collector gates and their specifications, flip-flops (RS-FF, D-FF, Master slave-FF, JK-FF), Shift Registers, Counters, Schmitt Triggers, One Shots, ADC, DAC, Decoder, Multiplexers, D Multiplexers, Display.
LIBRARY	

MPF-3251 Environmental Physics (3 credits)	
PREREQUISITE	
MATERIAL	Definition of Environmental Physics, Laws of Physics for environmental applications; Human Environment: Water, air, soil, sound, atmosphere, etc.; Environmental Pollution; Principles of Pollution Control, Land Pollution, Water Pollution, Air Pollution, Noise Pollution. Environmental Physics Projects/Experiments.
LIBRARY	1. E. Boeker and R. Van Grondelle. 1995, “Environmental Physics”, John Wiley & Sons 2. BJ Nebel and RT Wright, 1996, “Environmental Science”, Prentice Hall 3. JTHoughton, 1988, “The Physics of Atmosphere”, Chambridge Univ. Press.

MPF-3253 Biophysics (3 credits)	
PREREQUISITE	-
MATERIAL	Introduction to biophysics; Cells, proteins, and membranes; Application of the principles of physics to the human body including various aspects of mechanical, thermal, transport, electrical, magnetic, optical, acoustic, atomic, and nuclear; Biophysical techniques: atomic and molecular structure, size and shape of macromolecules, introduction to fluorescence spectroscopy techniques (fluorophore, adsorption and emission) and microscopy techniques (electron microscopy, light microscopy, x-ray fluorescence microscopy,) for biophysics.
LIBRARY	1. Cotterill, R., 2003, Biophysics: An Introduction, John Wiley & Sons 2. Rubin, AB, 2014, Fundamentals of Biophysics, Wiley 3. Nelson, PC, 2004, Biological Physics: Energy, Information, Life., Chiliagon Science.

MPF-4253 Radiation Detection Methods (3 credits)	
PREREQUISITE	
MATERIAL	Introduction to radiation measurement, errors and statistics in nuclear radiation measurement, an overview of atomic and nuclear structure, radioactive particles, radiation-matter interactions, particle-matter interactions. Working principles of gas-filled detectors, scintillation detectors, semiconductor detectors, and film detectors.
LIBRARY	1. Susetyo, Wisnu, 1988, Gamma Spectroscopy, Gadjah Mada University Press, Yogyakarta 2. Tsoulfanidis, Nicholas, 1983, Measurement and Detection of Radiation, McGraw-Hill, New York.

MPF-4251 Environmental Conservation (2 credits)	
PREREQUISITE	

MATERIAL	Introduction to Environmental Conservation: Definition of conservation, scope, history. Environmental management; Conservation of natural resources: Green economy, green energy. Environmental Conservation Project.
LIBRARY	1. Asdak Chay, 2004, Hydrology and Watershed Management, Gadjah Mada University Press, Yogyakarta 2. 2. Munir, Moch., 2006, Environmental Geology, Bayumedia Publishing, Malang 3. 3. Bayong T., 2004, Climatology, ITB Publisher, Bandung 4. 4. BJ Nebel and RT Wright, 1996, “Environmental Science”, Prentice Hall

MPF-3241 Introduction to Quantitative Analysis of Microstructures (3 credits)	
PREREQUISITE	-
MATERIAL	Basic Stereology Concepts: isotropy-anisotropy, homogeneity-inhomogeneity, sampling and sectioning; Accuracy Optimization: sample size and counting time, resolution and detection errors, sample thickness correction, edge correction, measurement precision; Introduction to microstructure image analysis methods with automation (Fiji or ImageJ or Matlab)
LIBRARY	1. Kurzydlowski, K.J., Ralph, B., The Quantitative Description of the Microstructure of Materials, CRC Press, 1995 2. Wojnar, L., Image Analysis: Applications in Materials Engineering, CRC Press, 1999 3. Brandon, D., Kaplan, W.D., Microstructural Characterization of Materials, 2nd Ed, Wiley 2008

MPF-4245 ADVANCED SOLID STATE PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Free Electron Model, Semiconductors, Fermi Level and Energy Representation, Quantization of Charge Carriers: Plasmons, Polaritons, Polarons and Excitons, Dielectrics and Ferroelectrics, Magnetism, Defects in Solids
LIBRARY	1. Kittel, C., 2005, Introduction to Solid State Physics, 8th edition, John Wiley&Sons, Inc. 2. Patterson, JD, Bailey, BC, 2007, Solid-State Physics:Introduction to the Theory, Springer-Verlag Berlin Heidelberg

MPF-3245 SPECTROSCOPY (3 CREDITS)	
PREREQUISITE	
MATERIAL	**ULTRA VIOLET AND 1 VISIBLE RADIUS SPECTROSCOPY** (Electromagnetic Radiation, Usefulness of UV-VIS Spectroscopy: Quantitative Analysis, Usefulness of UV-VIS Spectroscopy: Qualitative Analysis, Wavelength Prediction According to Woodward-Fieser); **INFRARED SPECTROMETRY** (Variety of Vibrations, Factors Affecting Vibrations, Identification Based on Functional Groups, Organic Compounds Containing Hetero Atoms, How to Analyze Infrared Spectra); **NUCLEAR MAGNETIC RESONANCE** (Position of Nuclear Spin, Nuclear Magnetic Moment, Energy Absorption, Absorption Mechanism (Resonance), Chemical Shift and Protection, Nuclear Magnetic Resonance Spectrometer, Steps on How to Interpret NMR Spectra; **MASS SPECTROMETRY** (Molecular Ions, Fragmentation, Fragmentation associated with functional groups).
LIBRARY	1. Sastrohamidjojo H, 2019, Basics of Spectroscopy, Gadjah Mada University Press, Yogyakarta.

	2. Pavia, DL, Lampman, GM, Kriz, GS, 2001, Introduction to Spectroscopy, Third Edition, Thomson Learning Inc., Washington 3. Griffiths, P.R. Günter Gauglitz and David S. Moore (Eds.): Handbook of spectroscopy, 4 volume set, 2nd ed.. *Anal Bioanal Chem* **406,** 7415–7416 (2014).

MPF-4241 PHYSICS OF COMPOSITE MATERIALS (2 CREDITS)	
PREREQUISITE	
MATERIAL	Definition of composite materials; Matrix and filler materials; Composites: unidirectional, isotropic, lamina and ply structures, Micromechanical analysis of composite materials; Fabrication of composite materials; Microstructure, defects, cracks and tears; Applications of composite materials; Introduction to nano composite materials. Practical: Analysis of physical properties of composite forming materials; Fabrication of composite boards; Testing of physical, thermal, and mechanical properties of composite boards.
LIBRARY	1. Nielsen, LF, Composite materials, Springer-Verlag Berlin Heilderberg, 2005. 2. Sulistijono, Mechanics of Composite Materials, Surabaya: ITS Press, 2012. 3. Bhagwan DA, Analysis And Performance Of Fiber Composites, , WILEY, 2015.

MPF-4243 COMPOSITE MATERIAL PHYSICS PRACTICE (2 CREDITS)	
PREREQUISITE	
MATERIAL	Analysis of physical properties of composite forming materials; Composite board fabrication; Testing of physical, thermal, and mechanical properties of composite boards.
LIBRARY	1. Nielsen, LF, Composite materials, Springer-Verlag Berlin Heilderberg, 2005. 2. Sulistijono, Mechanics of Composite Materials, Surabaya: ITS Press, 2012. 3. Bhagwan DA, Analysis And Performance Of Fiber Composites, , WILEY, 2015.
MPF-3243 PHYSICS OF MATERIALS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Structure of Materials: Gas, Liquid, Crystal, Metal, and Atmosphere; Carbon Iron; Austenine Decomposition; Polymer and Composite Structure; Crystal Lattice; Polymorphy; X-Ray Diffraction; Crystal Defects/Dislocations; Impurities of Materials; Atomic Diffusion; Diffusion Process; Mechanical Properties; Thermal and Electromagnetic; Conductors and Insulators; Semiconductors; Material Testing Methods.
LIBRARY	1. van Vlack, LH, 1995: Materials Science and Technology, Erlangga Publisher. 2. Wyatt, H. 1979,: Metal Ceramics and Polymers Brostow, W. Science of Materials

MPF-3213 METROLOGY (3 CREDITS)	
PREREQUISITE	-
MATERIAL	System of Units and Fundamental Constants, Basics of Statistics in Metrology, Error Analysis and Tolerance, Measurement and Measurement Systems, Instrument Calibration Methods, Dimensional Measurement and Calibration, Mechanical Quantity Measurement and Calibration, Thermodynamic Measurement, Standards and Quality Systems, Introduction to Digital Metrology.
LIBRARY	1. Mekid, Samir. 2022, Metrology and Instrumentation: Practical Application for Engineering and Manufacturing., ASME Press, 2. Willey. Morris, A.S., Langari, R., 2020, Measurement and Instrumentation: Theory and Applications, ed. 3, Academic Press. 3. Holman, JP, 2012, Experimental methods for engineers ed 8, Mc. Graw Hill, New York

MPF-3211 LITERATURE STUDIES (3 SKS)	
PREREQUISITE	-
MATERIAL	Introduction to literature study, purpose of literature study, *literature searching, note-taking* strategies in reading literature, library management *(referencing tools),* critical review practices.
LIBRARY	1. Ridley, Diana. 2012, The Literature Review: A step-by-step guide for students, 2nd Ed., SAGE. 2. Bell, Judith, 2014, Doing Your Research Project: A Guide for First-Time Researchers, 6th Ed., McGraw Hill 3. Scientific articles with topics that suit students' interests

MPF-4212 PHYSICS COMMUNICATION MEDIA (3 CREDITS)	
PREREQUISITE	-
MATERIAL	Introduction to Science Communication, Science communication process, Types of direct and indirect communication, Focus of indirect communication: science journalism, communication of physics science in print and digital media (blogs, social media, digital images and videos, digital audio).
LIBRARY	1. Christensen, LL, 2007. The Hands-On Guide for Science Communicators A Step-by-Step Approach to Public Outreach. Springer. 2. Bauer, MW, Bucchi, M., 2007. Journalism, Science and Society Science Communication between News and Public Relations. Taylor & Francis. 3. Newman, TP, 2020. Theory and Best Practices in Science Communication Training. Routledge Taylor & Francis Group 4. Various communications on science topics in print and digital media

MPF-32 (3 credits)	
PREREQUISITE	-
MATERIAL	
LIBRARY	

EVEN SEMESTER

MPF-3224 GALAXY DYNAMICS (2 SKS)	
PREREQUISITE	
MATERIAL	Galaxies, Potential Theory, Stellar Orbits, Dynamical Friction, Tidal Tides, Dark Matter.
LIBRARY	1. Binney, J. and Tremaine, S. 1987, Galactic Dynamics, Princeton University Press, Princeton. 2. Sparke, L.S. and Gallagher, J.S., 2007, Galaxies in the Universe, 2nd ed., Cambridge University Press, Cambridge. 3. Carroll, BW and Otslie, DA ,2007, An Introduction to Modern Astrophysics, 2nd ed., Pearson Education, Inc. San Francisco.

MPF-4222 COMPUTATIONAL ASTROPHYSICS (2 CREDITS)	
PREREQUISITE	
MATERIAL	N-Body simulation with various techniques: direct N-Body, Tree Barnes-Hut, Fast Multipole Method, Smoothed Particle Hydrodynamics, Adaptive Mesh Refinement.
LIBRARY	1. Dehnen, W. and Read, JI, 2011, N-body simulations of gravitational dynamics, The European Physical Journal Plus, Volume 126.

	2. Aarseth, S., 2010, Gravitational N-Body Simulations. Cambridge University Press, Cambridge 3. Hockney, RW and Eastwood, JW, 1988, Computer Simulation Using Particles, IOP Publishing Ltd., Bristol.

MPF-3226 THEORY OF RELATIVITY (3 CREDITS)	
PREREQUISITE	Modern Physics, Mechanics, Electricity, Magnetism, Vector and Tensor Analysis
MATERIAL	**Special Relativity:** Postulates of special relativity, Kinematic Consequences of the Special Theory of Relativity, Lorentz Transformations, Relativistic Doppler Effect, Relativistic Dynamics, Minkowski Space-time, Lorentz Group, Relativistic Field Theory, Relativistic Hydrodynamics. **General Relativity:** Limitations of special relativity, Equivalence Principle, General Covariance Principle, Einstein's Equations, Classical Tests of the General Theory of Relativity.
LIBRARY	1. *Introduction to Einstein's Theory of Relativity,* 2020, Oyvind Gron 2. *Gravity: an introduction to Einstein's General Relativity,* 2013, James Hartle

MPF-3222 HISTORY OF PHYSICS (2 CREDITS)	
PREREQUISITE	-
MATERIAL	Conceptions and Discoveries in Ancient Greek Era, Physics in the Golden Age of Islam, Renaissance in Europe, The Glory of Classical Physics, Problems in Classical Physics and the Birth of Modern Physics. Recent Developments in Physics.
LIBRARY	1. *The History of Physics: a very short introduction,* 2018, JL Heilborn

MPF-4224 NANOPHOTONICS (3 CREDITS)	
PREREQUISITE	Electromagnetics, Special Functions and Applications
MATERIAL	Maxwell's Equations and Electromagnetic Waves, Equations Schrodinger, Electrons in Periodic Structure, Quantum Confinement Effects, Quantum Dots, Plasmon Resonance, Metal Nanoparticles, Photonic Crystals, interaction of light with nanoscale structures
LIBRARY	1. *Introduction to Nanophotonics,* 2010, Sergey Gaponenko 2. *Nanophotonics:* Manipulating Light with Plasmon, 2017, Hongxing Xu

MPF-3228 ELECTROMAGNETICS (3 SKS)	
PREREQUISITE	Electricity Magnetism, Mathematical Physics I and II
MATERIAL	**Special Techniques for Calculating Potential :** Laplace's Equation, Shadow Method, Variable Separation Method, Multipole Description. **Electromagnetic (EM) Waves** : Maxwell's Equations, EM Waves in Vacuum, EM Waves in Dielectric Medium, Reflection and Transmission of Waves, Waves in Conductive Medium, Absorption and Dispersion of Waves, Dielectric Function of Materials. **EM Wave Scattering :** Scattering by Conductor Cylinders and Spheres, Scattering by Dielectric Cylinders and Spheres. **EM Wave Radiation :** Dipole Radiation, Antenna, Point Charge Radiation.
LIBRARY	1. *Introduction to Electrodynamics,* 4h Edition, 2013. David J. Griffiths 2. *Classical Electromagnetics Theory,* 2nd Edition, 2005. Jack Vanderlinde

MPF-3232 SIGNAL PROCESSING (2 CREDITS)	
PREREQUISITE	
MATERIAL	Linear Discrete Systems, Continuous and Discrete Fourier Transforms, LTIS systems, Z Transform, Digital Filter, Fast Fourier Transform, Digital Filter Design: Filter FIR and IIR Filters

LIBRARY	1. Mitra, SK, 2006, Digital Signal Processing: A Computer-Based Approach (McGraw-Hill Series in Electrical and Computer Engineering) 3rd Edition, McGraw-Hill 2. Openheim, A., and Schafer, R., 2009, Discrete-Time Signal Processing (Prentice-Hall Signal Processing Series) 3rd Edition, Prentice-Hall

MPF-4232 INVERSION METHOD (2 SKS)	
PREREQUISITE	
MATERIAL	Modeling in physics, least squares method, linear inversion, weighted linear inversion, damped linear inversion, non-linear inversion, Gauss-Newton method, gradient method, global approximation, Monte Carlo method, Simulated Annealing method, genetic algorithm, probabilistic representation of inversion problems
LIBRARY	1. Tarantola, A., 1987, Inverse Problem Theory: Methods for Data Fitting and Model Parameter Estimation, Elsevier 2. Chapra, CS, and Canale, RP, 2014, Numerical Methods for Engineers 7th Edition, McGrawHill 3. Gould, H, Tobochnick, J., and Christian, W, 2017, An Introduction to Computer Simulation Methods: Application to Physical Systems 3rd Revised Edition, CreateSpace Independent Publishing Platform.

MPF-3234 MOLECULAR SIMULATION (3 CREDITS)	
PREREQUISITE	
MATERIAL	Introduction to statistical mechanics, Monte Carlo Simulation, Molecular Dynamics Simulation, Monte Carlo Simulation for various ensembles, Molecular Dynamics Simulation on various ensembles.
LIBRARY	1. Frenkel, D., and Smit, B., 2001, Understanding Molecular Simulation 2nd Edition, Academic Press 2. Schneider R., Sharma AR, Rai A. 2008, Introduction to Molecular Dynamics. In: Fehske H., Schneider R., Weiße A. (eds) Computational Many-Particle Physics. Lecture Notes in Physics, vol 739. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-74686-7_1

MPF-3256 INSTRUMENTATION (3 CREDITS)	
PREREQUISITE	
MATERIAL	Instrumentation characteristics, Types of sensors, Signal conditioning, Signal processing, Signal appearance, Temperature and humidity measuring instruments, Pressure measuring instruments, Flow measuring instruments, Distance measuring instruments, etc.
LIBRARY	1. Holman, JP, 1984, Experimental methods for engineers ed Mc. Graw Hill, New York translated by E. Jashfi, 1985, Engineering Measurement Methods 4th edition, Erlangga 2. Eckman DP, 1950, Industrial Instrumentation, John Wiley & Son, Inc., New York 3. Skoog, Holler & Nieman, 1998, Principles of Instrumental Analysis, 5th ed

MPF-4258 REMOTE SENSING (3 CREDITS)	
PREREQUISITE	
MATERIAL	Remote Sensing Concept, Wireless Sensor Network (WSN), Artificial Neural Network, Satellite imagery, Unmanned Aerial Vehicle (UAV), Internet of Things (IoT), Remote sensing application software.
LIBRARY	1. Image Analysis, Classification and Change Detection in Remote Sensing: With Originally published: 2014By Morton J. Canty 2. Physical Principles of Remote SensingOriginally published: 2013By WG Rees

	3. Classification Methods for Remotely Sensed Data, Second Edition Original published: 2009By Paul Mather, Brandt Tso 4. Sutanto, (1999), Remote Sensing, Gadjah Mada University Press.

MPF-3258 Electrical Circuit Analysis (3 credits)	
PREREQUISITE	
MATERIAL	Circuit Concept, Resistive DC Circuits, DC mesh and node analysis, Circuit switching, Sinusoidal circuit analysis, Sinusoidal steady state in frequency perspective, Power and power factor, Multiphase circuits, Frequency response and resonance, Foutirer's method for waveform analysis, Complex frequency, Laplace transform method, State variable analysis, Coupled circuits and transformers.
LIBRARY	1. Joseph A. Edminister. 2004. Electrical Circuits Theory and problems. Erlangga 2. William H. Hayt JR. 2004. Electrical Circuits 1. Erlangga 3. William H. Hayt JR. 2004. Electrical Circuits 2. Erlangga

MPF-3254 Energy (2 credits)	
PREREQUISITE	
MATERIAL	Physics and thermodynamics. Thermal and electrical conversion of solar, chemical and nuclear energy. Thermal, optical and electrical properties of energy conversion materials. Renewable and non-renewable energy. Efficient use of energy, energy economy. Energy problems in Indonesia
LIBRARY	1. Culp Jr., AW, 1979, Principles of Energy Conversion, McGraw Hill 2. Duffle JA and Beckman WA, 1980, solar engineering of thermal processes, John Woley & Son

MPF-4256 Introduction to Reactor Physics (3 credits)	
PREREQUISITE	
MATERIAL	Decay theory, microscopic and macroscopic cross-sections, reactor parts and reactor working principles. Reactor fuel cycle. Neutron formation reaction, neutron reaction, fission reaction. Neutron flux, neutron transport equation, diffusion equation and its solution for various types of reactors and criticality aspects. Reactor kinetics and its solution methods include hourly equation, reactivity, point reactor kinetics, inverse method, approximation method and reactivity-power analysis, feedback.
LIBRARY	1. Lamarsh, JR, 1972, introduction to nuclear reactor theory, Addison-Wiley

MPF-3252 Radiation Protection (3 credits)	
PREREQUISITE	
MATERIAL	Characteristics of the nucleus, theory of alpha-beta-gamma decay, definition of radiation, sources of radiation, interaction of radiation with matter, radiation detectors, radiation activity, effects of radiation on living cells, radiation protection and monitoring systems.
LIBRARY	Martin, Alan and Harbinson, Samuel A., An Introduction to Radiation Protection, John Willey Son, New York

MPF-4252 Medical Instrumentation (3 credits)	
PREREQUISITE	
MATERIAL	Introduction to medical instrumentation including diagnostic aids, MEG, CTScan, Radiology. Utilization of physics in medicine, such as radiotherapy with x-rays and radioactive particles. Simple projects in the form of data analysis from medical instrumentation.
LIBRARY	1. Cameron, JR, Skofronick, JG, Medical Physics, Wiley.

	2. Cameron, JR, Skofronick, JG, Grant, RM, Physics of the Human Body, Medical Physics Publications. 3. Hani, AR, 2010, Health Physics., Nuha Medika

MPF-4254 Radiographic Physics (2 credits)	
PREREQUISITE	
MATERIAL	History of Radiography; Laboratory, Medical, and Industrial. Fundamentals of radiography: atomic physics, nuclear physics, interaction of matter with radiation, quantities and units. Radiodiagnostics, radiotherapy and nuclear medicine.
LIBRARY	1. Yaffe, MJ and Rowlands, JA, 1997, "x-ray detector for digital radiography", Phys. Med. Biol, 42, I-39 2. Campeau, FE, Radiography, Lippincot Williams

MPF-4242 MATERIAL CHARACTERISTICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Mechanical Properties of Materials, Optical Properties of Materials: Photonic Materials, Electrical Properties of Materials, Thermal Properties of Materials, Magnetic Properties of Materials, Degradation of Materials
LIBRARY	1. Callister, WJ, Rethwisch, DG, 2010, Materials Science and Engineering: An Introduction, 8th Edition, John Wiley & Sons, Inc. 2. Askeland, DR, Fulay, PP, 2009, Essentials of Materials Science and Engineering, 2nd Edition, Cengage Learning

MPF-3244 ATOMIC MOLECULAR PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	History of the Development of Atomic Theory, Atomic Spectrum and Transitions, Single-Electron Atoms, Alkali Element Atoms and Multi-Electron Atoms, Atomic Orbits, Molecules and Molecular Orbits, Applications of Atomic-Molecular Theory
LIBRARY	1. Foot, C.J., Atomic Physics, 2005, Oxford University Press Inc., New York 2. Beiser, A., 2003, Concepts of Modern Physics, 6th ed., McGraw-Hill Companies, Inc., 3. Krane, K.S., 2012, Modern physics, 3rd ed., John Wiley & Sons, Inc., Hoboken

MPF-3242 Introduction to Crystallography (3 credits)	
PREREQUISITE	
MATERIAL	Crystal formation, Symmetry in Crystals (Crystal Structure, Crystal Lattices, Unit Cells, Morphology and Angular Relations of Crystals, Point Groups, Space Symmetry Elements, Space Symmetry Groups, Inverse Lattices), X-Ray Diffraction by Crystals, Inorganic Crystals and Minerals, Introduction to Physical Properties of Crystals and Tensor Representation
LIBRARY	1. Giacovazzo, C., et al., Fundamentals of Crystallography, 3rd Ed, Oxford, 2011 2. Borchardt-Ott, W., Crystallography: An Introduction, 3rd Ed., Springer, 2011 3. Liang., D., Fundamentals of X-Ray Crystallography, 2nd Ed, Alpha Science International, 2011. 4. Verma, AR, Crystallography Applied to Solid State Physics, 1991, Wiley

MPF-3248 MATERIAL FABRICATION METHODS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Introduction to Fabrication: Fabrication equipment, material preparation, Material Strengthening mechanism, Heat Treatment. Fabrication Techniques: Activated carbon, adsorbent, polymer, composite board, photocatalyst. Fabrication Projects: Activated carbon, adsorbent, polymer, composite board, photocatalyst.
LIBRARY	1. Callister, WD, 2012, Fundamentals of Materials Science and Engineering: an Integrated Approach, 4th Edition, John Wiley & Sons, New York.

	2. Rosato, DV, 2013, Plastics Engineered Product Design, Elsevier Ltd., 3. Shi, F., 1995, Ceramic Materials – Progress in Modern Ceramics, InTech, Rijeka, Croatia 4. Hoa, SV, 2009, Principles of the Manufacturing of Composite Materials, DEStech Publications, Inc., Pennsylvania, 5. Scientific Articles

MPF-4246 Introduction to Nanoscience and Technology (3 credits)	
PREREQUISITE	
MATERIAL	Size effect on material properties; Synthesis of nanostructured materials; Characterization of nanostructured materials; Quantum dots; Nanowires; Carbon nanotubes; Nanocomposite materials.
LIBRARY	1. Abdullah. M, 2009, Introduction to Nanoscience, Bandung Institute of Technology. Bandung 2. Prasad. N. Paras, Nanophotonics, John Wiley, 2004. 3. Cao. Guazhong, Synthesis, Properties & Applications, Imperial College Press, 2004 4. Hosokawa. M, Nagi. K, Naiko. M, Yokoyama. T, Nanoparticle Technology Hand Book, Elsevier, 2007.

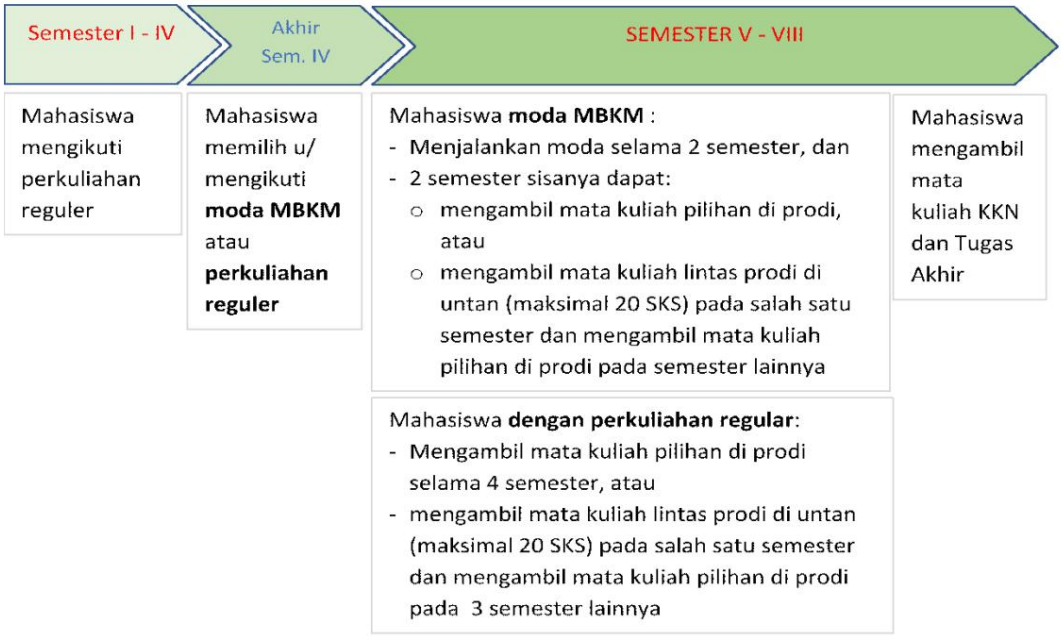
MPF-3246 Material Characterization Methods (3 credits)	
PREREQUISITE	
MATERIAL	Introduction to standardization; Mechanical Characterization; Characterization by diffraction methods (XRD, (enrichment: XRF)), characterization of microscopy methods (SEM, TEM, AFM, SEM-EDX), characterization of Spectroscopic Methods (UV-Visible Spectroscopy, IR, AAS).
LIBRARY	Mikrajuddin Abdullah and Khairurrijal, 2010, Nanomaterial Characterization Theory, Application and Data Processing, CV. Rezeki Putra, Bandung

MPF-4248 INTRODUCTION TO POLYMER PHYSICS (3 CREDITS)	
PREREQUISITE	
MATERIAL	Types of polymers, nomenclature, trade names, types of polymers, cross-linking, polymerization, condensation, addition, step growth, chain growth, stereo polymers. Polymer reactions, polymer properties and structure, temperature relationships, transitions and relaxation. Viscoelasticity model, chemical stress relaxation.
LIBRARY	1. Eisela, U., 1990: Introduction to Polymer Physics, Springer Verlag, NY 2. Aklon, JJ, McKnight, WJ and Shen, M., 1972: Introduction to Polymers Viscoelasticity, John Wiley & Sons, NY 3. Stevens, MP, 1975 : Polymer Chemistry and Introduction, Addison Wesley, NY

e. MBKM Learning Activity Mode

The characteristic of the MBKM Curriculum is that students have the opportunity to develop themselves according to their respective skills and expertise. In the MBKM Curriculum, students can choose one of the modes (from 8 available modes) in Semester V of lectures.

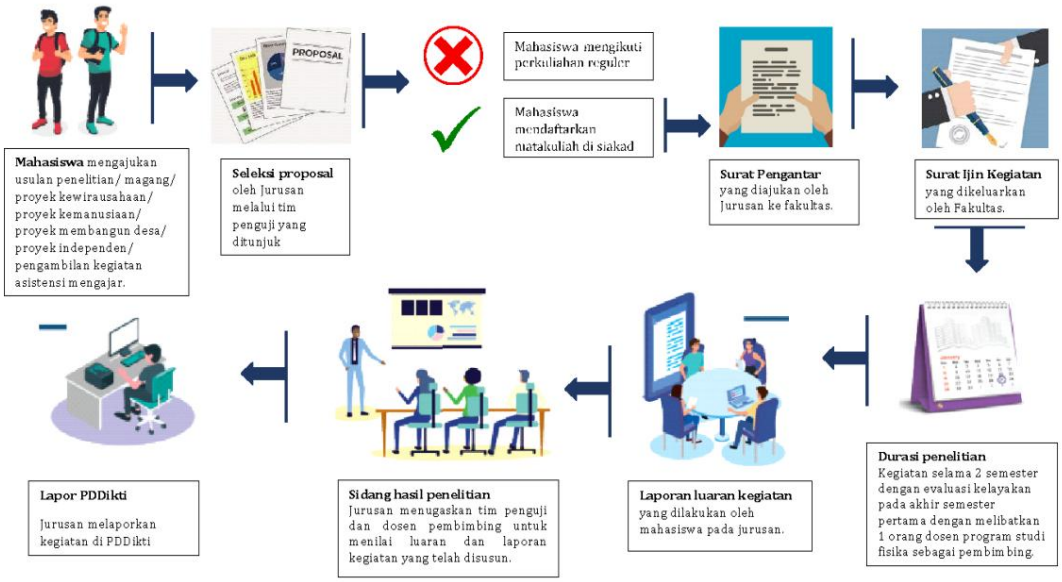
GENERAL PROCEDURES FOR IMPLEMENTING THE MBKM CURRICULUM



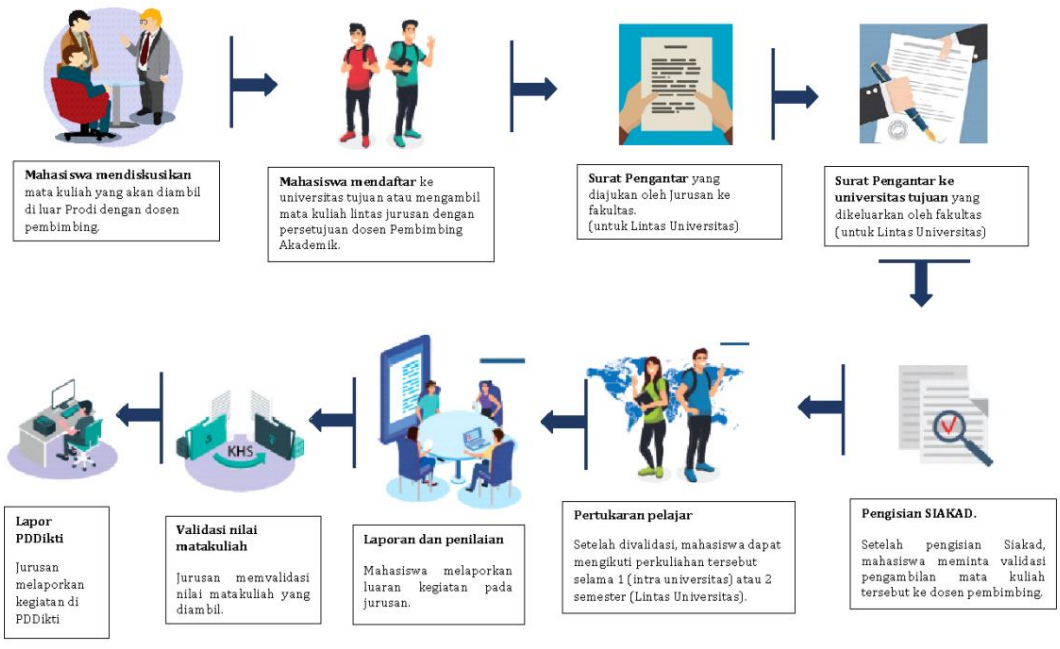
GENERAL PROCEDURES FOR IMPLEMENTING MBKM MODES

The MBKM mode submission procedure is carried out by the proposer (student) in accordance with the procedures in force at FMIPA Untan. The Physics Study Program will conduct a selection of proposals to determine the feasibility of the activities to be carried out.

The following is an infographic of the general procedures for implementing MBKM modes: 1. Research Mode, Internship, Entrepreneurship, Humanitarian Project, Village Development Project, Independent Project, Teaching Assistant



2. Student Exchange Mode



MBKM MODE RECOGNITION MATRIX BASED ON ACTIVITY TYPE

MODE NAME : 1. RESEARCH

EQUIVALENCE : Maximum 40 credits

IMPLEMENTATION : Implemented for 2 semesters consecutively

RESEARCH				
DESCRIPTION	For students who have *a passion* to become researchers, independent learning can be realized in the form of research activities at research institutions/study centers. Through research, students can develop critical thinking, something that is very much needed for various scientific fields at the higher education level. With critical thinking skills, students will be able to explore, understand, and carry out research methods better. For students who have an interest and desire to work in the field of research, the opportunity to intern at a research center laboratory is their dream. In addition, laboratories/research institutions sometimes lack research assistants when working on short-term research projects (1 semester - 1 year).			
EXTERNAL	Articles accepted for publication in Sinta 2 journals or higher			
PERIOD	**INDICATOR CODE**	**COURSE NAME / ACTIVITY DESCRIPTION**	**SKS**	
SEMESTER I MBKM (6 months)	MPF-3301	Ethics of Scientific Research 1	2	anti-plagiarism document
	MPF-3303	Scientific Writing Techniques 1	3	research proposal documents & seminars
	MPF-3305	Literature Study 1	3	literature study document
	MPF-3307	Research Methodology 1	3	research framework document
	MPF-4301	Independent Work Monitored 1	3	preliminary data documents *(preliminary)*
	MPF-4303	Seminar 1	3	pass the progress seminar (Evaluation 1)
	MPF-4305	Physics Communication Media 1	3	Attending a seminar as a speaker
SEMESTER II MBKM (6 months)	MPF-3302	Scientific Research Ethics 2	2	Research data documents
	MPF-3304	Scientific Writing Techniques 2	3	Research data analysis document
	MPF-3306	Literature Study 2	3	Manuscript document
	MPF-3308	Research Methodology 2	3	Passed the final activity seminar (Evaluation 2)
	MPF-4302	Independent Work Monitored 2	3	Submitted manuscript
	MPF-4304	Seminar 2	3	Accepted manuscript
	MPF-4306	Physics Communication Media 2	3	Communication documents of activities in the media
SEMESTER II MBKM	UMG-4101	**KKM/PKM THESIS**	2 3	Collecting the output of MBKM activities as a substitute for KKM/PKM and Assignments
	MPF-4102			End

MODE NAME : 2. INTERNSHIP

EQUIVALENCE : Maximum 40 credits

IMPLEMENTATION : Implemented for 2 semesters consecutively

APPRENTICESHIP				
DESCRIPTION	So far, students have not received enough work experience in the real industry/professional world, so they are less prepared to work. Meanwhile, short-term internships (less than 6 months) are not enough to provide students with industrial experience and competence. Companies that accept interns also stated that very short internships are not beneficial, and even disrupt activities in the industry. The objectives of the internship program include: The 1-2 semester internship program provides students with sufficient experience, direct learning in the workplace (experiential learning). During the internship, students will gain *hard skills* (skills, *complex problem solving, analytical skills,* etc.), as well as *soft skills* (professional/work ethics, communication, cooperation, etc.). Meanwhile, the industry gains talents who, if suitable, can be directly recruited, thus reducing *recruitment* costs and initial *training* / induction. Students who are already familiar with the workplace will be better prepared to enter the workforce. Through this activity, industrial problems will flow to universities so that teaching materials and lecturers' learning as well as research topics in universities will be more relevant.			
EXTERNAL	Internship Certificate/Certificate and articles in scientific journals or community service journals			
PERIOD	**CODE**	**COURSE NAME**	**SKS**	**INDICATORS / DESCRIPTION OF ACTIVITIES**
SEMESTER I **MBKM** **(6 months)**	MPF-3301 MPF-3303 MPF-3305 MPF-3307 MPF-4301 MPF-4303 MPF-4305	Ethics of Scientific Research 1 Scientific Writing Techniques 1 Literature Study 1 Research Methodology 1 Independent Work Monitored 1 Seminar 1 Physics Communication Media 1	2 3 3 3 3 3 3	internship location survey document internship proposal documents & seminars internship location feasibility report detailed activity plan document Internship activity data document term-1 pass the progress seminar (Evaluation 1) convey ideas orally and in writing well
SEMESTER II **MBKM** **(6 months)**	MPF-3302 MPF-3304 MPF-3306 MPF-3308 MPF-4302 MPF-4304 MPF-4306	Scientific Research Ethics 2 Scientific Writing Techniques 2 Literature Study 2 Research Methodology 2 Independent Work Monitored 2 Seminar 2 Physics Communication Media 2	2 3 3 3 3 3 3	Activity implementation questionnaire by colleagues Internship activity data document term-2 Internship activity data analysis Internship activity seminar at the internship location Final Report Document Passed the final activity seminar (Evaluation 2) Communication documents of activities in the media
SEMESTER II **MBKM**	UMG-4101 MPF-4102	**KKM/PKM** **THESIS**	2 3	Collecting the output of MBKM activities as a substitute for KKM/PKM and Assignments End

MODE NAME : 3. ENTREPRENEURSHIP

EQUIVALENCE : Maximum 40 credits

IMPLEMENTATION : Implemented for 2 semesters consecutively

ENTREPRENEURSHIP				
DESCRIPTION	Based on the Global Entrepreneurship Index (GEI) in 2018, Indonesia only had a score of 21% entrepreneurs from various fields of work, or ranked 94 out of 137 countries surveyed. Meanwhile, according to research from the IDN Research Institute in 2019, 69.1% of millennials in Indonesia have an interest in entrepreneurship. Unfortunately, the entrepreneurial potential for the millennial generation has not been managed well so far. The Independent Campus Policy encourages the development of students' entrepreneurial interests with appropriate learning activity programs. The aim of the entrepreneurship program is to provide students who have an interest in entrepreneurship with the opportunity to develop their businesses early and with guidance.			
EXTERNAL	Officially registered business *start-ups* and articles in scientific journals or community service journals			
PERIOD	**CODE**	**COURSE NAME**	**SKS**	**INDICATORS / DESCRIPTION OF ACTIVITIES**
SEMESTER I MBKM (6 months)	MPF-3301 MPF-3303 MPF-3305 MPF-3307 MPF-4301 MPF-4303 MPF-4305	Ethics of Scientific Research 1 Scientific Writing Techniques 1 Literature Study 1 Research Methodology 1 Independent Work Monitored 1 Seminar 1 Physics Communication Media 1	2 3 3 3 3 3 3	Business Plan Document business proposal documents & seminars business marketing plan Audience with consumers/stakeholders Business Plan Evaluation Preparation pass the progress seminar (Evaluation 1) convey ideas orally and in writing well
SEMESTER II MBKM (6 months)	MPF-3302 MPF-3304 MPF-3306 MPF-3308 MPF-4302 MPF-4304 MPF-4306	Scientific Research Ethics 2 Scientific Writing Techniques 2 Literature Study 2 Research Methodology 2 Independent Work Monitored 2 Seminar 2 Physics Communication Media 2	2 3 3 3 3 3 3	Product/start-up license registration Business financial report documents Attending a product exhibition Registering a business with an official institution Final Report Document Passed the final activity seminar (Evaluation 2) Communication documents of activities in the media
SEMESTER II MBKM	UMG-4101 MPF-4102	**KKM/PKM** **THESIS**	2 3	Collecting the output of MBKM activities as a substitute for KKM/PKM and Assignments End

MODE NAME : 4. HUMANITARIAN PROJECT

EQUIVALENCE : Maximum 40 credits

IMPLEMENTATION : Implemented for 2 semesters consecutively

HUMANITARIAN PROJECT				
DESCRIPTION	Indonesia has experienced many natural disasters, such as earthquakes, volcanic eruptions, tsunamis, hydrological disasters, etc. Universities have helped a lot in overcoming disasters through humanitarian programs. The involvement of students has been voluntary and only short-term. In addition, many international institutions (UNESCO, UNICEF, WHO, etc.) have conducted in-depth studies and created pilot development projects in Indonesia and other developing countries. Students with a young spirit, scientific competence, and interests can become "foot soldiers" in humanitarian and other development projects both in Indonesia and abroad. The aim of this program is to train students to have social sensitivity to explore and dive into existing problems and contribute to providing solutions according to their respective interests and expertise.			
EXTERNAL	Publication of project processes and results in the form of videos and writing in online and print media and articles in scientific journals or community service journals.			
PERIOD	**CODE**	**COURSE NAME**	**SKS**	**INDICATOR / ACTIVITY DESCRIPTION**
SEMESTER I **MBKM** **(6 months)**	MPF-3301 MPF-3303 MPF-3305 MPF-3307 MPF-4301 MPF-4303 MPF-4305	Ethics of Scientific Research 1 Scientific Writing Techniques 1 Literature Study 1 Research Methodology 1 Independent Work Monitored 1 Seminar 1 Physics Communication Media 1	2 3 3 3 3 3 3	field survey and observation documents project proposal documents & seminars Humanitarian program design Percentage of program achievement 50% Field report by project colleagues Passed the final seminar (100% Evaluation) Communication documents of activities in the media
SEMESTER II **MBKM** **(6 months)**	MPF-3302 MPF-3304 MPF-3306 MPF-3308 MPF-4302 MPF-4304 MPF-4306	Scientific Research Ethics 2 Scientific Writing Techniques 2 Literature Study 2 Research Methodology 2 Independent Work Monitored 2 Seminar 2 Physics Communication Media 2	2 3 3 3 3 3 3	field survey and observation documents project proposal documents & seminars humanitarian program design Percentage of program achievement 50% Field report by project colleagues Passed the final seminar (100% Evaluation) Communication documents of activities in the media
SEMESTER II **MBKM**	UMG-4101 MPF-4102	**KKM/PKM** **THESIS**	2 3	Collecting the output of MBKM activities as a substitute for KKM/PKM and Assignments End

MODE NAME : 5. VILLAGE DEVELOPMENT PROJECT

EQUIVALENCE : Maximum 40 credits

IMPLEMENTATION : Implemented for 2 semesters consecutively

VILLAGE BUILDING PROJECT				
DESCRIPTION	For students who have high technical interests and abilities, independent learning can be realized in the form of village development project activities. These activities can be in the form of Dikti programs, projects in collaboration with agencies/ companies, or **independent programs.** The target of village development projects is prioritized to be implemented in remote areas/regions with communities that are still classified as pre-prosperous groups. Through village development projects, students can show themselves as productive people by actively helping to realize facilities and infrastructure that are useful for the community. Students with a background in physics are also expected to be able to help pave the way for improving the social welfare of the community by fulfilling social facilities and infrastructure and listening to social needs for improving community welfare to the global world. The objectives of the village development/real work lecture program include: 1) Provide opportunities for students to utilize the knowledge, technology and skills they have, and collaborate with stakeholders 2) Help accelerate development in rural areas			
EXTERNAL	Publication of project processes and results in the form of videos and writing in online media and articles in scientific journals or community service journals.			
PERIOD	**CODE**	**COURSE NAME**	**SKS**	**INDICATORS / DESCRIPTION OF ACTIVITIES**
SEMESTER I **MBKM** **(6 months)**	MPF-3301 MPF-3303 MPF-3305 MPF-3307 MPF-4301 MPF-4303 MPF-4305	Ethics of Scientific Research 1 Scientific Writing Techniques 1 Literature Study 1 Research Methodology 1 Independent Work Monitored 1 Seminar 1 Physics Communication Media 1	2 3 3 3 3 3 3	field survey and observation documents project proposal documents & seminars innovative and appropriate program design for the community, community involvement document in program implementation Percentage of program achievement 50% passed the progress seminar (Evaluation 1) convey ideas orally and in writing well
SEMESTER II **MBKM** **(6 months)**	MPF-3302 MPF-3304 MPF-3306 MPF-3308 MPF-4302 MPF-4304 MPF-4306	Scientific Research Ethics 2 Scientific Writing Techniques 2 Literature Study 2 Research Methodology 2 Independent Work Monitored 2 Seminar 2 Physics Communication Media 2	2 3 3 3 3 3 3	Collaboration plan with stakeholders Conducting activity seminars with village officials and related parties Innovative products resulting from empowerment village community Percentage of program achievement 100% Final Report Document Passed the final activity seminar (Evaluation 2) Communication documents of activities in the media
SEMESTER II **MBKM**	UMG-4101 MPF-4102	**KKM/PKM** **THESIS**	2 3	Collecting the output of MBKM activities as a substitute for KKM/PKM and Assignments End

MODE NAME : 6. INDEPENDENT PROJECT

EQUIVALENCE : Maximum 40 credits

IMPLEMENTATION : Implemented for 2 semesters consecutively

INDEPENDENT PROJECT				
DESCRIPTION	Students who are interested in realizing work that is included in the competition or work that is realized from innovative ideas can take an independent project. This mode is ideally a complement to the relevant courses that have been taken by students but can also be used as a complement to cross-disciplinary topics. Independent project activities are carried out in the form of group work in the same field or across scientific disciplines. Independent projects aim to realize students' ideas in developing innovative products, organizing research and development-based education, and improving students' achievements in national and international events. Independent projects can complement or replace courses that must be taken. The equivalence of independent study activities to courses is calculated based on the contribution and role of students as evidenced in activities under the coordination of the supervisor.			
EXTERNAL	Innovative works that will be included in national and international competitions, applied in society, or submitted to obtain a patent.			
PERIOD	**COURSE NAME CODE**		**SKS**	**INDICATORS / DESCRIPTION OF ACTIVITIES**
SEMESTER I **MBKM** **(6 months)**	MPF-3301 MPF-3303 MPF-3305 MPF-3307 MPF-4301 MPF-4303 MPF-4305	Ethics of Scientific Research 1 Scientific Writing Techniques 1 Literature Study 1 Research Methodology 1 Independent Work Monitored 1 Seminar 1 Physics Communication Media 1	2 3 3 3 3 3 3	anti-plagiarism document project proposal documents & seminars literature study document science and technology utilization plan preliminary data documents *(preliminary)* pass the progress seminar (Evaluation) convey ideas orally and in writing well
SEMESTER II **MBKM** **(6 months)**	MPF-3302 MPF-3304 MPF-3306 MPF-3308 MPF-4302 MPF-4304 MPF-4306	Scientific Research Ethics 2 Scientific Writing Techniques 2 Literature Study 2 Research Methodology 2 Independent Work Monitored 2 Seminar 2 Physics Communication Media 2	2 3 3 3 3 3 3	Independent project data document Draft participation in the competition Successfully participated in the competition Draft activity report Final Report Document Passed the final activity seminar (Evaluation 2) Communication documents of activities in the media
SEMESTER II **MBKM**	UMG-4101 MPF-4102	**KKM/PKM** **THESIS**	2 3	Collecting the output of MBKM activities as a substitute for KKM/PKM and Assignments End

MODE NAME : 7. TEACHING ASSISTANCE

EQUIVALENCE : Maximum 40 credits

IMPLEMENTATION : Implemented for 2 semesters consecutively

TEACHING ASSISTANCE				
DESCRIPTION	Classroom learning or laboratory development			
EXTERNAL	Documented innovative learning media and articles in scientific journals or community service journals			
PERIOD	**CODE**	**COURSE NAME**	**SKS**	**INDICATORS / DESCRIPTION OF ACTIVITIES**
SEMESTER I	MPF-3301	Ethics of Scientific Research 1	2	Documents on the suitability of the activity location
MBKM	MPF-3303	Scientific Writing Techniques 1	3	activity proposal documents & seminars
(6 months)	MPF-3305	Literature Study 1	3	learning media products
	MPF-3307	Research Methodology 1	3	Student ability improvement data (pre-test & post-test) Teacher ability
	MPF-4301	Independent Work Monitored 1	3	improvement data Passed progress seminar
	MPF-4303	Seminar 1	3	(Evaluation)
	MPF-4305	Physics Communication Media 1	3	attend a seminar as a speaker
SEMESTER II	MPF-3302	Scientific Research Ethics 2	2	Collaboration plan with stakeholders
MBKM	MPF-3304	Scientific Writing Techniques 2	3	Innovative teaching material products
(6 months)	MPF-3306	Literature Study 2	3	Improving the quality of learning or laboratory facilities and infrastructure
	MPF-3308	Research Methodology 2	3	Analysis of activity result data
	MPF-4302	Independent Work Monitored 2	3	Final Report Document
	MPF-4304	Seminar 2	3	Passed the final activity seminar (Evaluation 2)
	MPF-4306	Physics Communication Media 2	3	Communication documents of activities in the media
SEMESTER II	UMG-4101	**KKM/PKM**	2	Collecting the output of MBKM activities as a substitute
MBKM	MPF-4102	**THESIS**	3	for KKM/PKM and Assignments End

MODE NAME : 8. STUDENT EXCHANGE

EQUIVALENCE : Maximum 40 credits (CROSS UNIVERSITY), Maximum 20 credits (INTRA UNIVERSITY)

IMPLEMENTATION : Implemented for 2 consecutive semesters (CROSS UNIVERSITY), 1 semester (INTRA UNIVERSITY)

STUDENT EXCHANGE (CROSS UNIVERSITY)				
DESCRIPTION	Currently, student exchanges with full credit transfer have been widely carried out with partner universities abroad, but the credit transfer system carried out between universities in the country itself is still very small in number. Student exchanges are held to form several student attitudes as stated in the Regulation of the Minister of Education and Culture (Permendikbud) Number 3 of 2020, namely respecting cultural diversity, views, religions, and beliefs, as well as the opinions or original findings of others; and working together and having social sensitivity and concern for society and the environment. Student exchange objectives include: 1) Study across campuses (domestic and overseas), live with family on the destination campus, students' insight into Bhineka Tunggal Ika will grow, cross-cultural and cross-ethnic brotherhood will grow stronger. 2) Building student friendships between regions, tribes, cultures and religions, so that increasing the spirit of national unity and unity. 3) Organizing the transfer of knowledge to cover educational disparities between domestic universities and the conditions of higher education in the country and abroad.			
EXTERNAL	Students successfully take cross-university courses with a minimum grade of B for each course.			
PERIOD	**CODE**	**COURSE NAME**	**SKS**	**INDICATOR**
SEMESTER I MBKM (6 months)	*In accordance with the courses taken at the destination university*			*Pass the courses taken with a minimum grade of B*
SEMESTER II MBKM (6 months)	*In accordance with the courses taken at the destination university*			*Pass the courses taken with a minimum grade of B*

5. CURRICULUM TRANSITION RULES

a. General Rules

The MBKM curriculum is applied to students starting from the 2020 intake and is not retroactive, therefore a transition regulation is needed for the old curriculum, namely KKNI to the MBKM Curriculum.

The general rules in the curriculum transition process are as follows:

1. The MBKM curriculum applies in the 2021/2022 academic year and is applied starting from the 2020 intake and thereafter.
2. **Semester I and II courses** taken by students of the 2020 intake will still be recognized as courses that have been completed according to the rules (see section b for more details):

    a. Courses with the same name in the MBKM curriculum will be recognized as compulsory courses.
    b. Courses that have changed credit weight in the MBKM Curriculum will still be recognized. the amount if the student does not repeat the course.
    c. Courses that are no longer in the MBKM curriculum will change status to elective courses
    d. Students who wish to repeat a course: (1) the credit weight of the repeated course will refer to the MBKM curriculum for compulsory physics courses, (2) courses that change status to electives can be taken at the study program that provides them with a credit weight that corresponds to that available in the study program.

    e. The total number of credits passed in the first year remains the same if the student does not repeat the course. subject.

3. MBKM mode is taken in Semester V (starting from the 2022/2023 academic year) with the following procedures: registration as specified in Point 4.d
4. Student participation in a national seminar, international seminar, *summer course,* or *workshop* (minimum one-day *workshop)* as a participant can be converted into a “Literature Study (3 credits)” course, and as a speaker can be converted into a “Physics Communication Media (3 credits)” course.
5. Students of the Class of 2021 who start their studies in the academic year 2021-2022 will use the MBKM Curriculum
6. Students from the 2019 intake and earlier will continue to implement the KKNI Curriculum in full.
7. Students from the 2019 intake and earlier are allowed to repeat only compulsory courses in the KKNI Curriculum (elective courses cannot be repeated).

b. Course Transfer Rules

The course transfers applicable to students of the 2020 intake are listed in the following table:

WEIGHT SKS	COURSE NAME (KKNI CURRICULUM)	WEIGHT SKS	COURSE NAME (MBKM CURRICULUM)	TRANSITIONAL RULES ON MBKM CURRICULUM
Semester I				
4	Physics IA	3	Physics IA	Change in credit weight
3	IB Physics	2	IB Physics	Change in credit weight
2	Contextual Biology	-	-	Change status to elective course
3	Basic Chemistry I	2	Basic Chemistry	Change in credit weight
3	Mathematics I	3	Mathematics I	No changes
2	Introduction to Technology Information	-	-	Change status to elective course
3	Indonesian	2	Indonesian	Change in credit weight
2	Measurement Method	2	Measurement and Data analysis	Conversion and renaming
Semester II				
4	Physics IIA	3	Physics IIA	Change in credit weight
3	Physics IIB	2	Physics IIB	Change in credit weight
3	Basic Chemistry II	-	-	Change status to elective course
3	Mathematics II	3	Mathematics II	No changes
3	Basic Statistics	-	-	Change status to elective course
3	Religious education	3	Religious education	No changes
3	English	2	English	Change in credit weight
Semester III				
3	Education Citizenship	2	Citizenship	Change in credit weight
3	Mathematical Physics I	3	Mathematical Physics I	No changes
3	Mechanics I	4	Mechanics	Change in credit weight
4	Basic Electronics	3	Basic Electronics	Change in credit weight
3	Thermodynamics	3	Thermodynamics	No changes
3	Electromagnetics I	4	Electric Magnet	Change in credit weight
2	Algorithm Programming	2	Algorithm Programming	Move to Semester II
Semester IV				
3	Mathematical Physics II	3	Mathematical Physics II	No changes
3	Mechanics II	-	-	
3	Electromagnetics II	-	-	
3	Modern Physics	3	Modern Physics	Move to Semester III
3	Wave	3	Wave	No changes
4	Computational Physics I	4	Computational Physics I	Move to Semester II
Semester V				

3	Mathematical Physics III	-	-	
3	Quantum Physics I	4	Quantum Physics	Move to Semester IV Change in credit weight
2	Experimental Physics I	2	Experimental Physics	Move to Semester IV
4	Core Physics	3	Core Physics	Move to Semester IV Change in credit weight
3	Statistical Physics	3	Statistical Physics	Move to Semester IV
Semester VI				
3	Quantum Physics II	-	-	
2	Experimental Physics II	-	-	
4	Solid State Physics	3	Solid State Physics	Move to Semester IV Change in credit weight
2	Research methods	-	-	
Semester VII				
2	KKM/PKM	2	KKM/PKM	No changes
2	Independent Work Monitored		-	
6	Thesis	3	Thesis	Change in credit weight
2	Entrepreneurship		-	