ACADEMIC GUIDELINES

MECHANICAL ENGINEERING EDUCATION STUDY PROGRAM

"Growing with Character"

UNESA

ASIIN

Faculty of Engineering
Universitas Negeri Surabaya

2020

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Academic Guidelines

Undergraduated Program
In Mechanical Engineering Education

Faculty of Engineering (FT)
Universitas Negeri Surabaya (Unesa)

Institution Vision and Mission

The vision of Unesa is as follows:
“Excellent in Education Strong in Science”
The mission of Unesais as follow:

- Organizing education and learning centered on students by using an active learning approach and optimizing the use of technology
- Conducting research in education, natural sciences, social and cultural sciences, arts, and / or sports, and technological development whose findings are beneficial for the development of science and public welfare
- Disseminating science, technology, arts and culture, and sports, and the results of research through community service-oriented towards empowering and civilizing the community
- Realizing Unesa as a center of education, mainly primary and secondary education and a scientific center based on the noble values of national culture
- Organizing an autonomous, accountable, and transparent tertiary education institution to guarantee and improve quality and improve quality continuously.

The vision of the Faculty of Engineering (FT) is as follows:
“Excellent in Technology and Vocational Education”

The mission of FT is as follow:

- Providing quality education that is relevant to the needs of the global job market and the development of science and technology, which refers to the National Standards of Higher Education.
- Improve the quality of educators and education personnel, the quality of facilities and infrastructure to support continuous improvement in the quality of the learning process.
- Develop research in the field of technology and vocational education based on professionalism to be applied in the context of community service and education.
- Build institutions that are healthy, efficient, effective, productive, transparent, accountable, prosperous, and fair.
- Develop cooperation with related national and international institutions on an ongoing basis.
- Produce educational and non-educational staff who are competent, professional, religious, creative, independent, and have the spirit of leadership and are capable of entrepreneurship.

Program Educational Objectives (PEO)

1. Having the ability to plan, implement, evaluate, and develop curricula for scientific knowledge taught in vocational education that is relevant to the development of the global industry.
2. Having initiatives to adapt, innovate, and think positively to build technology-based networks based on Faith and Taqwa to God.
3. Having technopreneurship capabilities that are relevant to the development of the global industry.
4. Having the ability to perform maintenance, repair, and mechanical engineering that has environmental insight.

Table 1 below shows the objective of the undergraduate program in mechanical engineering education versus the 6th level of national qualification framework

Table 1. The objective of The Undergraduate Program in Mechanical Engineering Education versus the 6th Level of National Qualification Framework

	Capable of applying science, technology, and art within her/his expertise and adaptable to the various situation faced while solving a problem	Mastering in-depth general and specific theoretical concept of individual knowledge and capable of formulating related problem-solving procedure	Capable of takingthe strategic decision based on the information and data analysis and provides direction in choosing various alternative solutions independently and in groups	Responsible for her/his job and can be assigned to take responsibility for the attainment of the organization's performances
Objective 1	S	S	S	S
Objective 2	S	S	S	S
Objective 3	S	M	M	S
Objective 4	S	S	S	S

S-Strong, M-Moderate

Program Learning Outcomes (PLO)

The Undergraduate Program in Mechanical Engineering Education sets the Program Learning Outcomes (PLO) for the graduates as follows:

1. Able to align the curriculum of scientific knowledge in vocational education that is relevant to the demands of global industrial development.
2. Able to plan, implement, and evaluate innovative and effective learning programs in vocational engineering education that are relevant to the development of the global industry.
3. Able to apply applied research for innovation in vocational learning methods, optimization of production process technology and mechanical engineering services that are relevant to the needs of industrial development.
4. Able to think critically, creatively, analytically, synthesis-solutive, have a high work ethic, work together, build networks, and communicate oral-written in vocational engineering field accordance with the development of global industry.
5. Have a positive, honest, disciplined, diligent, aesthetic, efficient-effective, and responsible personality.
6. Able to operate mechanical and digital-based production machines to produce workpieces and maintain and repair motorized vehicles according to standard procedures relevant to the development of the global industry.
7. Able to apply technopreneurship, service advisor, supervisor of the mechanical engineering industry relevant to the development of the global industry.
8. Able to adapt to the development of science-technology, social environment, and continuous learning throughout life.
9. Able to apply concepts and theories of economic-business, ecology, occupational health-safety and environment in designing and carrying out relevant professional work in a sustainable manner.

Table 2 below shows the correlation between the program learning outcomes and the objectives of the program.

Table 2. Correlation between the Objective of the Undergraduate Program in Mechanical Engineering Education and the Program Learning Outcomes

	Objective 1	Objective 2	Objective 3	Objective 4
Outcome 1	S	S	S	M
Outcome 2	S	S	S	M
Outcome 3	S	S	M	S
Outcome 4	S	S	S	S
Outcome 5	S	S	S	S
Outcome 6	M	S	M	S
Outcome 7	M	S	S	S
Outcome 8	M	S	S	S

Outcome 9	M	S	S	S

S-Strong, M-Moderate

PROGRAM STRUCTURE

The Curriculum

The Mechanical Enggineering Education curriculum is a set of plans and arrangements regarding the content, study materials, delivery methods and assessments that are used as guidelines for organizing teaching and learning activities in Mechanical Enggineering Education. Mechanical Enggineering Education curriculum contains educational programs that must be known and implemented by lecturers and students to achieve a graduate competency standard (SKL). The curriculum is packaged in a form that is easily communicated to various interested parties and is accountable and easy to apply. The Mechanical Enggineering Education curriculum is compiled based on the Decree of the Minister of National Education of the Republic of Indonesia Number 232 / U / 2000 concerning Guidelines for the Preparation of Higher Education Curriculum and Assessment of Student Learning Outcomes and National Curriculum for Undergraduate Study Programs (S1 Education and S1 Non-Education) and Kepmendiknas No. 045 / U / 2002 concerning Higher Education Curriculum. The curriculum that applies at Unesa is a competency-based curriculum (KBK).

1. Curriculum Principles

The Unesa curriculum is based on the following basic principles.

a. Oriented towards the goals of national education.

b. There is a balance between theory and practice.

c. Insightful in character and entrepreneurship.

d. Diversification (diversity) programs are prepared by taking into account the needs.

e. The open nature of the program allows continuation or transfer of students from one program to another with certain conditions.

2. Curriculum Organization

The Mechanical Enggineering Education curriculum consists of a national curriculum (core) and a local curriculum (institutional). The national curriculum is a guide to guarantee quality and capability (competency) in accordance with the study program undertaken. The curriculum is unique to a study program, as is the specific educational goals and competencies of graduates of a study program. The curriculum contains four main elements, namely the content (content), learning strategies (teaching-learning strategy), the assessment process (assessment processes), and the evaluation process (evaluation processes). The curriculum organization is organized as follows:

a. Core Curriculum

The Core Curriculum is the main competency to differentiate between one study program and another. Characteristics of graduates' main competencies must be seen from the dimensions of (1) the importance in shaping cultural life and (2) synergistic complementary linkages among various other major competencies. The core curriculum of a study program has the characteristics of (1) as a basis for

achieving graduate competence, (2) is a minimum standard reference for the quality of study programs, (3) applies nationally and internationally, (4) flexible and accommodating to changes very quickly in future, and (5) is a joint agreement between the tertiary educational institutions, the professional community, and graduates. Meanwhile, supporting competencies and other competencies that are specific and appropriate with the main competencies of a study program are determined by the organizer of the study program at Unesa.

b. Institutional Curriculum

Institutional curriculum is a number of materials and lessons consisting of additions from the group of knowledge and core curriculum compiled and pay attention to the circumstances and environmental needs as well as the characteristics of Unesa

COURSE ROADMAP

The whole courses in the program are prepared to support the success of achieving Learning Outcomes. All courses taken by students contribute to the achievement of PLOs. The following table shows the relationship (mapping) between the courses and the PLOs.

Table 3. Mapping of the courses that support the program learning outcomes (PLO)

No.	Code	Courses	SKS	PLO									Semester
				1	2	3	4	5	6	7	8	9	
1	52324204	Engineering of Physics I	2				x						1
2	52524201	Health and Work Safety	2				x	x	x	x		x	1
3	52324206	Engineering of Chemistry	2				x						1
4	52324201	Mathematics I	2				x						1
5	52324220	Basic Drawing	2				x		x				1
6	52324212	Digital Literacy	2			x	x	x					1
7	90120206	Pancasila	2					x					1
8	52324221	Knowledge of Measuring Instruments	2				x						1
9	52324217	Mechanics Technology	2				x						1
10	90420304	Basic Education	3	x									1
11	52324214	Material Science I	2				x				x		1
12	90320202	English	2				x						2
13	52324213	Machine Element I	2				x						2
14	52324205	Engineering of Physics II	2				x						2
15	52324202	Mathematics II	2				x						2
16	52324208	Engineering Mechanics I	2				x						2
17	90120201	Religion Education	2					x			x		2
18	90120207	Citizenship Education	2					x			x		2
19	35324215	Engine Drawing	2				x						2
20	52324211	Thermodynamics I	2				x				x		2
21	90420302	Educational Psychology	2	x									2
22	90210206	Educational Philosophy	3	x									3
23	90210204	Indonesian	2				x						3
24	36324204	Machine Element II	2				x						3
25	90210203	Basic Cultural Science *	2					x			x		3
26	35314201	Automotive Electricity	2								x		3
27	52324219	Engineering Mathematics	2				x						3
28	52324209	Engineering Mechanics II	2				x						3
29	52324201	Fluid Mechanics	3			x	x						3
30	52424303	Learning Plan	3	x									3
31	52424301	Learning Strategy	3	x									3
32	35324210	Gasoline Engine Technology	2			x					x		4
33	36324216	Energy Conversion Engine	2				x				x		4
34	35324304	Automotive Electricity Practicum	2			x	x		x	x			4
35	35324219	Car Air Conditioner Technology	2			x					x		4

No.	Code	Courses	SKS	PLO									Semester
				1	2	3	4	5	6	7	8	9	
36	35324212	Diesel Engine Technology	2			x					x		4
37	35324218	Combustion and Fuel Technology	2			x					x		4
38	35324202	Thermodynamics II	2				x						4
39	52424304	Media Learning and ICT	3		x	x	x						4
40	52324302	Heat Transfer	3			x	x				x		4
41	35324303	Motorcycles & Small Engine Practicum	3			x	x		x	x			4
42	36324201	CAD	2				x						5
43	35324213	Painting Technology	2			x	x				x		5
44	52524202	Educational Management	2	x									5
45	35324205	Car Air Conditioner Practicum	2				x		x	x			5
46	52424302	Analysis of Vocational High School Curriculum	2	x									5
47	52424206	Research Methodology	2			x	x						5
48	52424305	Learning Evaluation	3	x	x	x							5
49	35424302	Gasoline Engine Practicum	3			x	x		x	x			5
50	35324214	Chassis Technology	2							x			5
51	52324210	Statistics	2		x	x	x						6
52	35424306	Diesel Engine Practicum	3			x	x		x	x			6
53	35424307	Body Painting and Repair Practicum	3			x	x		x	x			6
54	52424101	Thesis Proposal	1				x	x					6
55	35324222	Engine Performance Analysis	2			x	x			x			6
56	52324218	Corrosion Engineering	2				x				x	x	6
57	36424308	Chassis Practicum	3			x	x		x	x			6
58	90610303	Community Service (KKN)	3			x	x	x					6
59	90210209	Microteaching	2	x	x		x	x					6
60	35324208	Maintenance Machine Engineering	2							x			6
61	90210210	Teaching and Learning Program (PLP)	4	x	x	x	x	x					7
62	90520204	Internship	2			x	x	x	x	x			7
63	52424501	Thesis	5			x	x	x					7
64	90520203	Entrepreneurship	2				x	x		x		x	8
65		Courses Choice	2										8
Total			148 SKS										

Table 4. Correlation Between the Program Learning Outcomes and Subject-Specific Criteria (SSC) ASIIN

ASIIN SUBJECT SPECIFIC CRITERIA (SSC)		Code	COURSE	Program Learning Outcomes (PLO)									PROFILE						
				1	2	3	4	5	6	7	8	9							
				Knowledge	Specialist Competence		Knowledge	Attitude	Specialist Competence		General Competence		1	2	3	4	5	6	7
1	Have acquired basic knowledge of engineering relevant to technological developments	52324204	Engineering Physics I				M						√	√			√	√	
		52324206	Engineering of Chemistry				M						√	√			√	√	
		52324201	Mathematics I				M						√	√	√	√	√	√	√
		52324220	Basic Drawing				M		M				√	√			√	√	
		90120206	Pancasila education					M					√	√	√	√	√	√	√
		52324221	Knowledge of Measuring Instruments				S						√	√	√	√			
		52324217	Mechanics Technology				M						√	√			√	√	
		90420304	Basic Education	M									√	√					
		52324214	Materials Science I				M				M		√	√			√	√	
		90320202	English				M						√	√	√	√	√	√	√
		52324213	Machine Element I				M						√	√			√	√	
		52324208	Engineering Mechanics I				M						√	√			√	√	
		90120201	Islamic Religious Education					M			M		√	√	√	√	√	√	√
		90120207	Citizenship Education					M			M		√	√	√	√	√	√	√

		35324215	Engine Machine				S						√	√	√	√	√		
		52324211	Thermodynamics I				M				M		√	√			√	√	
		90420302	Educational Psychology	M									√	√					√
		90210206	Education Philosophy	M									√	√					√
		90210204	Indonesian				M						√	√	√	√	√	√	√
		90210203	Basic Culture Science (IBD) *					M			M		√	√	√	√	√	√	√
		52324219	Engineering Mathematics				S						√	√			√	√	
2	Has a good knowledge of the implementation of mechanical engineering and education	52324205	Engineering Physics II				S						√	√			√	√	
		52324202	Engineering Mathematics II				S						√	√			√	√	
		36324204	Engine Element II				S						√	√			√	√	
		35314201	Automotive Electrical								M		√	√			√	√	
		52324209	Mechanical Mechanics II				S						√	√			√	√	
		52324201	Fluid Mechanics			S	S						√	√			√	√	
		52424303	Lesson Plan	S									√	√					√
		52424301	Learning Strategy	S									√	√					√
		35324210	Gasoline Motor Technology				M				M		√	√			√	√	
		36324216	Energy Conversion Engine				H				S		√	√			√	√	
		35324219	Car AC Technology			M					M		√	√			√	√	
		35324212	Diesel Engine Technology			M					M		√	√			√	√	
		35324218	Combustion and Fuel			M					M		√	√			√	√	

			Technology																
		35324202	Thermodynamics II				S						√	√			√	√	
		52424304	Learning Media and ICT		M	M	M						√	√					√
		52324302	Heat Transfer			S	S				S		√	√			√	√	
		36324201	CAD				S						√	√	√		√	√	
		35324213	Painting Techniques			M	M				M		√	√			√	√	
		52524202	Educational Management	M									√	√					√
		35324205	Car AC Practicum				S		S	S			√	√	√		√	√	
		52424302	Vocational School Curriculum Studies	M									√	√					√
		35324214	Chassis Technology							M			√	√	√		√	√	
		52324218	Corrosion Engineering				M				M	M	√	√	√		√	√	
		35324208	Mechanical Maintenance Engineering							M			√	√	√		√	√	
		90520203	Entrepreneurship				M	M		M		M	√	√	√				√
			Courses courses				M												
3	Has acquired methodological competence in mechanical engineering and education, and can solve problems and present their	52324212	Digital literacy			M	M	M					√	√	√	√	√	√	√
		52424206	Research Methodology			S	S						√	√			√	√	
		52424305	Learning Evaluation	S	S	S							√	√					√
		52324210	Statistics		S	S	S						√	√	√	√	√	√	√
		52424101	Thesis Proposal				S	S					√	√	√	√	√	√	√

	results	52424501	Thesis			S	S	S					√	√	√	√	√	√	√
4	Able to do independent practical work in laboratories and the Business World / Industrial World	35324304	Automotive Electrical Practices			S	S		S	S			√	√	√	√	√	√	
		35324303	Motorcycle and Small Motorbike Practicum			S	S		S	S			√	√	√	√	√	√	
		35324205	Car Air Conditioning Practicum				S		S	S			√	√	√	√	√	√	
		35424302	Gasoline Motor Practicum			S	S		S	S			√	√	√	√	√	√	
		35424306	Diesel Motor Practicum			S	S		S	S			√	√	√	√	√	√	
		35424307	Painting and Body Repair Practicum			S	S		S	S			√	√	√	√	√	√	
		35324222	Engine Performance Analysis			S	S		S	S			√	√	√	√	√	√	
		36424308	Chasis Practicum			S	S		S	S			√	√	√	√	√	√	
		90610303	Real Work Lecture (KKN)			S	S	S					√	√	√	√	√	√	√
		90210209	Microteaching	S	S		S	S					√	√					√
		90210210	PLP	S	S	S	S	S					√	√					√
		90520204	Internship			S	S	S	S	S			√	√	√	√	√	√	√
5	Have relevant knowledge about safety and environmental issues as well as those related to the legal basis	52524201	Health and Work Safety				M	M	M	M		M	√	√	√	√	√	√	√

Roadmap PLO 1

Able to align the curriculum of scientific knowledge in vocational education that is relevant to the demands of global industrial development.

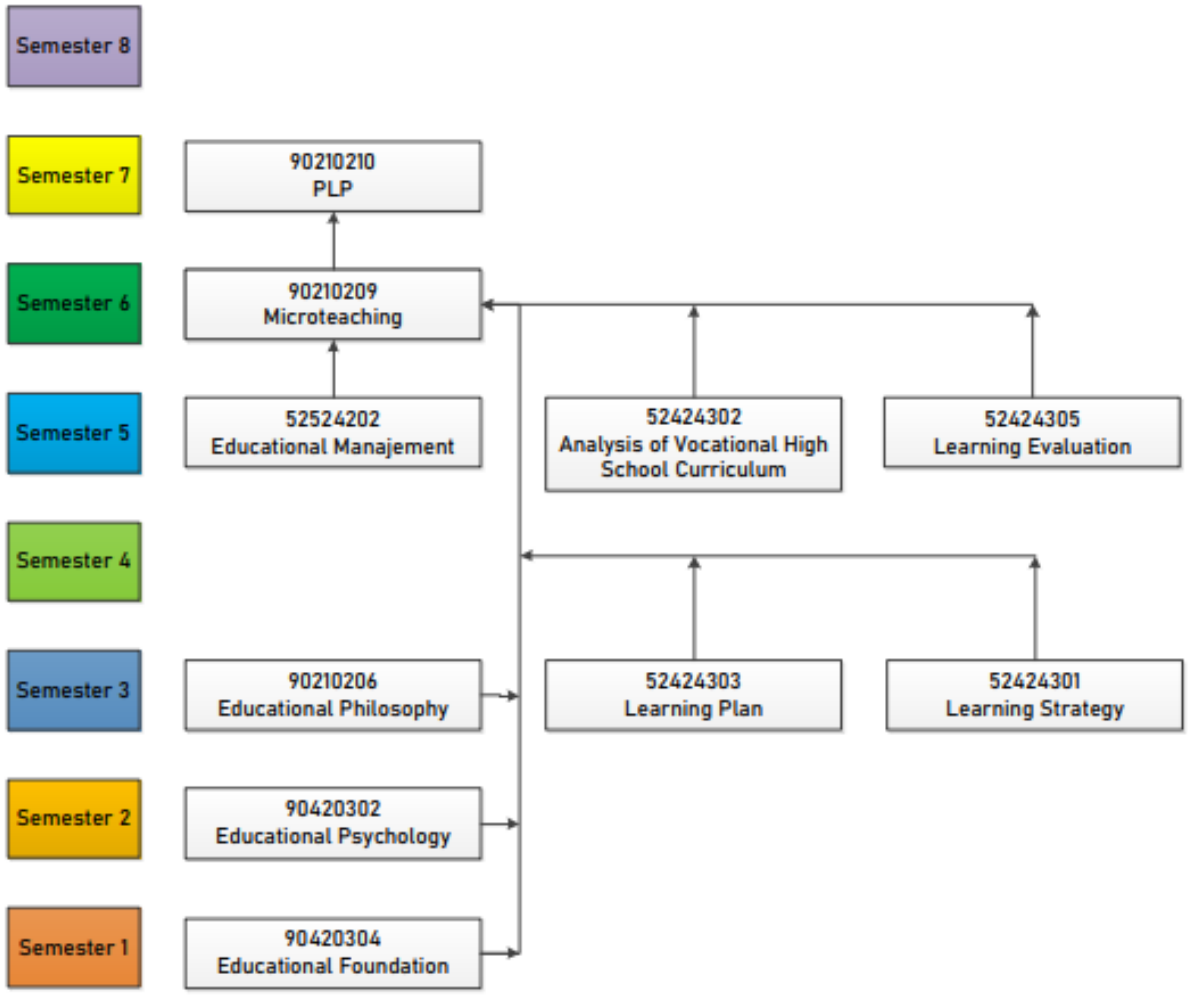

Figure 1. Course Roadmap For Achieving Learning Outcomes 1.

Description of Roadmap PLO 1

Semester 1, student take Basic Education course (3 credit). This course about tough foundation how to behave by learning education. Student be expected can learn every where they are, although they graduate. Its more important student become an educated society. In semester 2, student get Educational Psychology (2 credit). Educational Psychology is a branch of psychology that specializes in understanding teaching and learning in an educational environment. The study of the learning process, cognitive and behavioral point of view, learning individual differences in terms of intelligence, cognitive development, affect, motivation, self-regulation, self-concept, and the role in the learning process. Educational psychology relies on testing and measurement with quantitative methods, to enhance educational activities such as instructional design, class management, and assessment, which aim to facilitate the learning process in various educational settings throughout life. Educational psychology include the study of memory, conceptual processes, and individual differences (through cognitive psychology) in conceptualizing new strategies regarding learning processes in humans. Educational psychology has been built on the theory of operant conditioning, functionalism, structuralism, constructivism, humanistic psychology, Gestalt psychology, and information processing.

In semester 3, students will take 3 courses, namely Educational Philosophy (3 credits), Learning Planning (3 credits) and Learning Strategy (3 credits). Educational philosophy is the science of philosophy that studies the essence of implementation and education. The material learned includes the objectives, background, methods, results, and essence of education. The method used is to critically analyze the structure and educational benefits. Educational philosophy seeks to answer questions about educational policy, human resources, curriculum theory and learning as well as other aspects of education. One thing that is criticized concretely is the relationship between educators and students in learning. Learning planning is an activity to formulate the objectives to be achieved by a learning activity, what methods are used to assess the achievement of these objectives, what material will be delivered, how to convey it, and what tools or media are needed.Learning planning is an activity to formulate the objectives to be achieved by a learning activity, what methods are used to assess the achievement of these objectives, what material will be delivered, how to convey it, and what tools or media are needed. learning strategies are ways that teachers used to deliver learning materials aimed at making it easier for students to understand learning materials.

In semester 5, students take courses in Educational Management (2 credits), Analysis of Vocational High School Curriculum (2 credits), and Learning Evaluation (3 credits). Educational Management is the process of planning, organizing, directing, supervising, and evaluating educational efforts to achieve the stated educational goals. Management is needed with the aim of a planned implementation systematically and can be evaluated correctly, accurately and completely so as to achieve the goals productively, quality, effectively and efficiently. The curriculum is a set of plans and arrangements regarding the objectives, content, and learning materials as well as the methods used to guide the implementation of learning activities to achieve certain educational goals. Analysis of Vocational High School Curriculum is the process of analyzing the applicable curriculum or that has been used in vocational schools to see synchronization or link and match with the needs of students and the industrial. Learning evaluation is a systematic process to determine the decision achievement by student of teaching objectives.

In semester 6, students take Microteaching courses (2 credits). Microteaching is a teaching technique aimed at preparing prospective teachers or instructors for real classroom settings (Brent & Thomson, 1996). Microteaching is also defined as teaching technique used in pre-service teacher or instructor education to train them systematically by allowing them to experiment in learning. Microteaching is one form of educational practice models or teaching training. The teaching context contains many actions, including technical delivery of material, use of methods, use of media, guiding learning, motivating, managing classes, and giving assessments. Therefore, in the framework of mastering basic teaching skills, prospective teachers, instructors or lecturers need to practice partially, meaning that each component of basic teaching skills needs to be mastered separately (isolated).

In semester 7, students will take Teaching and Learning Program or PLP (4 credits). The PLP program is a combination of activities aimed at developing the potential of students as prospective educators and administrators. Placement of students in practical locations is expected to be able to motivate the school community in an effort to develop all its potential. The PLP program includes Pre-PLP observations and PLP implementation in schools. Teaching practice is carried out in Vocational Schools and before conducting teaching practice students make a Learning Implementation Plan (RPP) as a reference in teaching. In the implementation of PLP students have a Field Guidance Teacher in the study program is expected to guide students in teaching practice.

After taking a variety of courses, graduates of the Mechanical Engineering Education Study Program will be able to synchronize their curriculum in the field of education in vocational education that is relevant to the demands of global industry development (PLO 1).

Roadmap PLO 2

Able to plan, implement, and evaluate innovative and effective learning programs in vocational engineering education that are relevant to the development of the global industry.

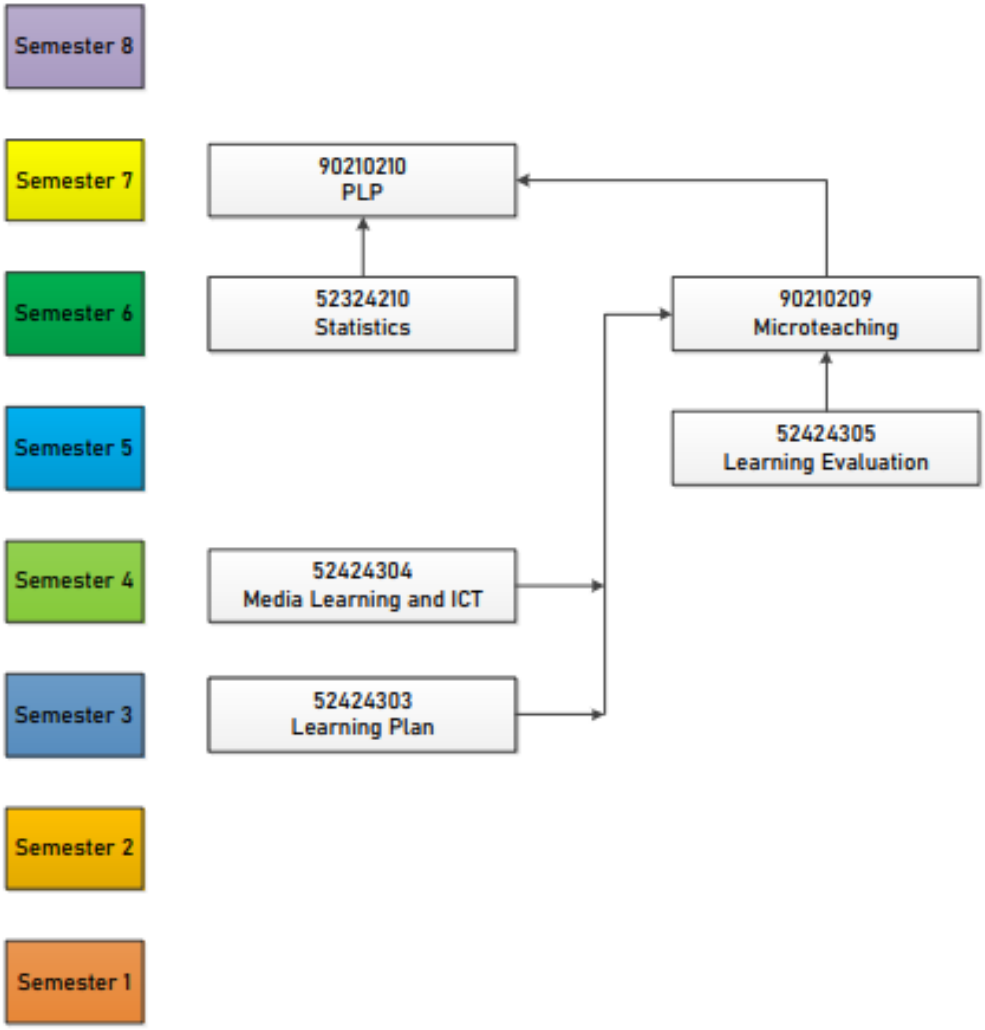

Figure 2. Course Roadmap For Achieving Learning Outcomes 2.

Description of Roadmap PLO 2

In semester 3, students take Learning Plan (3 credits). Learning Plan is an activity formulating the objectives of learning activities, how to assess the achievement of objectives, the material to be delivered, how to deliver, and what media are needed. Learning Plan is an activity projecting the actions to be carried out in a learning (PBM), namely by coordinating (organizing and responding) learning components so that the direction of the activity (objectives), the content of the activity (material), how to deliver activities (methods and techniques), and how to measure it (evaluation) becomes clear and systematic.

In semester 4, students take Media Learning and ICT (3 credits). In today's digital era the term "ICT as a tool" or "ICT (Information and Communication Technology) as a learning medium" is very familiar to educational practitioners. The world of education in the 21st century is indeed synonymous with the use of integrated technology. Learning on campus is no longer centered on lecturers and books as learning resources. For students, the existence of the internet and gadgets has been able to provide various kinds of information that comes from an unlimited source, without limitation of space and time. Learning media are software and hardware devices that function as learning resources and teaching aids. As a tool in the learning process, the learning media are adapted to the characteristics of teaching materials by taking into account the characteristics of students. This course teaches students about making ICT-based hardware and software learning media.

In semester 5, students take Learning Evaluation (3 credits). Teaching evaluation is a systematic process for determining decisions to what extent teaching objectives have been achieved by students. Teaching evaluation is also defined as an assessment or interpretation of students' progress towards the goals that have been set. The purpose of teaching evaluation is to obtain evidence data that measures the level of ability and success of students in achieving teaching goals.

In semester 5, students take Statistics (2 credits) and Microteaching (2 credits). Statistics are a set of methods and rules regarding the collection, analysis, processing, and interpretation of data from numbers that describe data or observations. Students must study statistics because statistics are generally used in various fields, such as education, engineering, economics, business, manufacturing, marketing, etc. With statistics get conclusions and facilitate the decision making process. in education, prospective teachers or instructors must learn micro teaching. Microteaching is one form of educational practice models or teaching training. The teaching context contains many actions, including technical delivery of material, use of methods, use of media, guiding learning, motivating, managing classes, and giving assessments.

In semester 7, students take Teaching and Learning Program or PLP (4 credits). The PLP program is a combination of activities aimed at developing the potential of students as prospective educators and administrators. Placement of students in practical locations is expected to be able to motivate the school community in an effort to develop all potentials. The PLP program includes Pre-PLP observations and PLP implementation in schools. Teaching practice is carried out in Vocational Schools and before conducting teaching practice students make a Learning Implementation Plan (RPP) as a reference in teaching. In the implementation of PLP students also have a Field Guidance Teacher in each study program that guides students in teaching practice.

Roadmap PLO 3

Able to apply applied research for innovation in vocational learning methods, optimization of production process technology and mechanical engineering services that are relevant to the needs of industrial development.

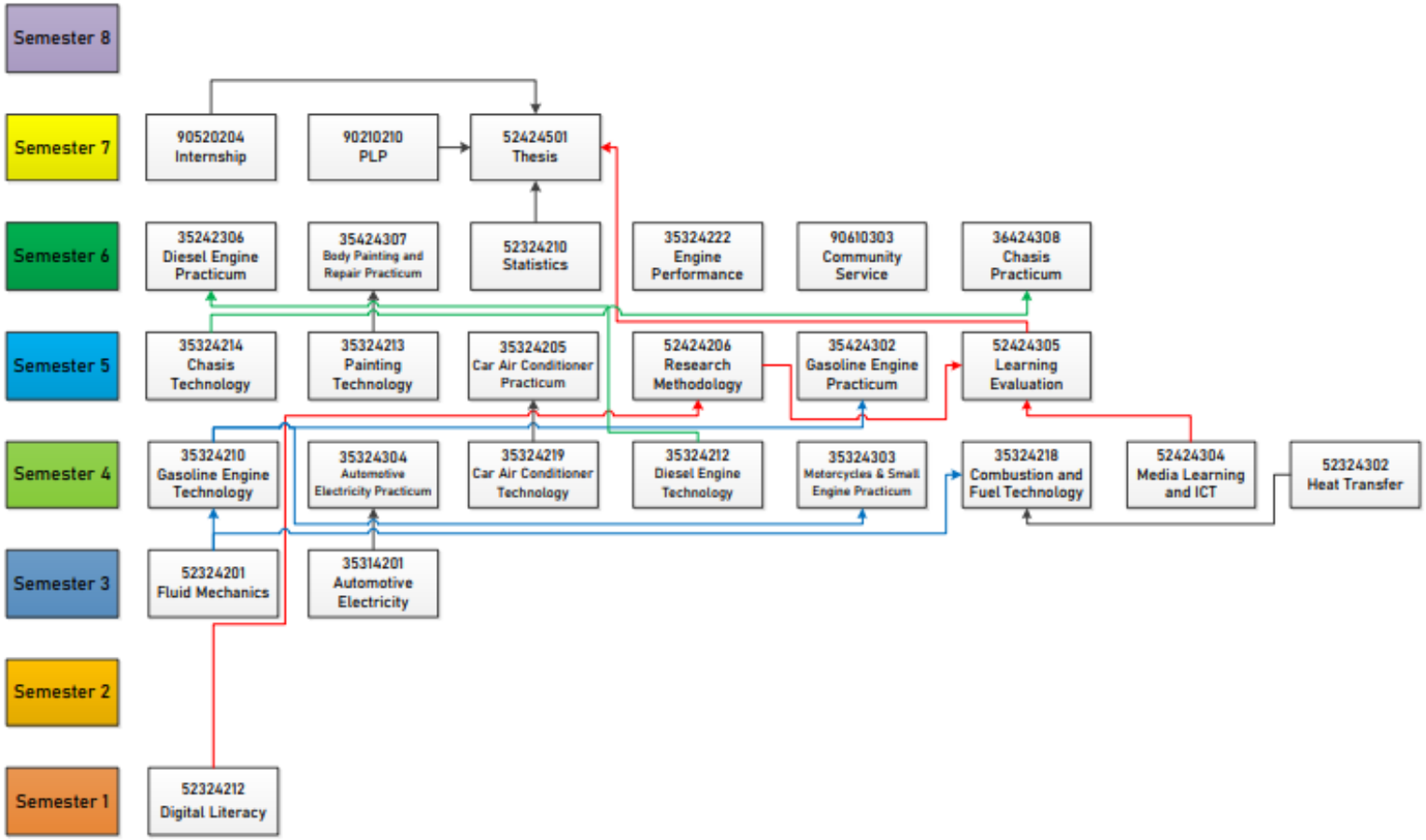

Figure 3. Course Roadmap For Achieving Learning Outcomes 3.

Description of Roadmap PLO 3

In the first semester, students in mechanical engineering education will be taking Digital literacy courses (2 credits), Health and Work Safety (2 credits), and Pancasila education (2 credits). In accordance with 21st century skill demands, where everyone is required to have the capability of ICT Literacy, the student is also taught digital literacy. Digital literacy is a knowledge of the use of digital media, communication tools, or networks in discovering, evaluating, using, making information, and utilizing it healthily, wisely, intelligently, carefully, appropriately, and legally compliant in order to foster communication and interaction in daily life. Digital literacy can improve the ability to use information and communication technology (ICT) to communicate content/information with cognitive and technical as well as emotional social capabilities in the world and the digital environment.

Insemester 3, students will take the course of fluid mechanics (3 credits) and automotive Electricity (2 credits).Fluid mechanics are branches of the science of physics that learn about fluid substances (liquids, gases and plasmas) and styles that work on them. Fluid mechanics can be divided into fluid statics that study the fluid state of silence and fluid kinematics that learn about the moving fluid as well as the fluid dynamics that study the effects of the moving force fluid. This is a branch of the continuum mechanics, a subject that modeled the material without regard to information about the constituent atom of the material so that it is more based on a macroscopic standpoint than a microscopic standpoint. Fluid dynamics is the main field of research with many things that have not been resolved or only partially resolved. Fluid mechanics can become very complicated in mathematics, so the solution uses numerical methods (computer calculations). Computational fluid dynamics is one of the disciplines devoted to solving the problem of fluid mechanics with a numerical approach.The automotive electrical courses teach about electrical systems that support the engine to be lit and the system on the machine still works. Automotive electricity is divided into 3, namely machine electrical system, electrical system body, and electrical system accessories.

In semester 4, students will take a number of courses. Among them are Gasoline Engine technology (2 credits),Automotive Electricity Practicum (3 credits), Car Air Conditioning Technology (2 credits), Diesel Engine Technology (2 credits), Combustion and Fuel Technology(2 credits), Motorcycles & Small Engine Practicum (3 credits), Media Learning and ICT (3 credits), and Heat transfer (3 credits). The course of gasoline engine technology discusses the technology of gasoline motors over time, covering basic concepts and development technologies. Specifically, the discussion includes the development of gasoline motor technologies, the thermodynamic cycles of gasoline motors, the fuel system of gasoline, the ignition system and the burning of gasoline motors, as well as control of gasoline-motor exhaust emissions.The course of automotive electrical practicum discusses the exercises of body electrical material on motor vehicles. Each exercise contains stages of operation. The objective is to evaluate how far the understanding and ability of students regarding the activities of automotive electrical practices.The subject of car air conditioning technology teaches about environmentally friendly car AC technology. A good eco-friendly car AC technology without removing pollution that is not good for the Earth's health and

balance. Car air conditioning in this modern era is the same as the AC that is in the house, the more advanced technology is now also an environmentally friendly version. Comfort in the vehicle is increasingly awake without having to remove pollution that is not good for the health and balance of the Earth. In Indonesia in 2015 already implemented implementation HPMP (HCFC or Hydrochlorofluorokarbon Phase-Out Management Plan). In the regulation it is also written for the removal of HCFC-22 or better known as Freon R22 in the refrigeration sector.The course of Diesel engine technology teaches about the rapid development of diesel motor technology from the use of fuel to performance enhancement related to mechanical technology to improvement power, and fuel consumption to be more friendly with the environment.While the courses of motorcycle and motorcycle practice teach about tune up procedures, overhaul and periodic maintenance on motorcycles and small motors.The courses of combustion and fuel technology teach students about the fuel sense, fuel types, fuel characteristics, and how to make alternative fuels.Heat transfer course is one of the displinals of thermal engineering that learns how to produce heat, use heat, change heat, and exchange heat between physical systems. Heat transfer is classified as thermal conductivity, thermal convection, thermal radiation, and heat transfer through phase changes.

Insemester 5, students will take the course of Car Air Conditioner Practicum (2 credits), Gasoline Engine Practicum (3 credits), Chassis Technology (2 credits), painting technology (2 credits), Car Air Conditioner Practicum (3 credits), Research Methodology (2 credits), andLearning Evaluation (3credits).Course Chassis technology will learn about clutch, transmission, power transfer system, wheels, brake system, frame, and steering system. Courses of painting technology teaches about the technique to coat the surface of the material in order to beautify (decoratif), reinforce (reinforcing), and protect (protective) from corrosion/rust on the body of the motor vehicle.Courses of Car Air Conditioner Practicum teaches about the procedure of repair of compressor damage, evaporator, received drier, expansion valve, and replacement of Freon. While the course of Gasoline Engine Practicum teaches about the tune up and overhaul procedures of gasoline engines both carburetor and technology electronic fuel Injection (EFI).Research Methodologycourses teach students about the process or scientific way to get the data to be used for research purposes. Methodology is also a theoretical analysis of a step or method. After taking this course, students will be smart in conducting applied research according to their field of expertise.Learning Evaluation is a systematic process of determining or making decisions to the extent to which the teaching objectives have been achieved by the student. In addition, the evaluation of the teaching is also defined as an assessment or interpreter on the growth and advancement of learners toward the objectives that have been established. The objective of the teaching evaluation is to obtain proof data that will measure up to the extent of the ability and the understanding of learners to achieve curricular or instructional purposes.

In semester 6, students will take the course of the Diesel Engine Practicum (3 credits), Body Painting and Repair Practicum (3 credits), Chassis Practicum (3 credits), Engine Performance Analysis (2 credits), Statistics (2 credits), and Community Service (3 credits). Courses of Diesel Motor Practicum teaches about the tune up and overhaul procedures of diesel engines both conventional and technologically common-rail systems.Courses in Body Painting and Repair Practicum taught about painting techniques and repair body vehicles, ranging from putty technique, basic paint, color paint and top coat (finishing).Course

statistics teaches about methods and rules regarding the collection, analysis, processing, and interpretation of data from values that describe data or observations. Students should study statistical sciences because they are generally widely used in studies in various fields, such as education, engineering, economics, business, manufacturing, marketing, and others. The final goal of statistics is to get the conclusion and facilitate the decision making process or work step.Courses in Engine Performance Analysis teaches about torque testing procedures, power, fuel consumption, exhaust emissions, and noise levels in motor vehicles.Chassis Practicum courses teach about the procedure of maintenance and replacement of couplings, transmissions, power shifting systems, spooring and balancing wheels, brake systems, chassis, and steering systems.The community Service (CS) course teaches about the form of community dedication activities by students with a cross-scholarly and sectoral approach at certain times and regions in Indonesia. The implementation of CS activities usually lasts between one to two months and is located in a village-level area. The Directorate General of Higher Education in Indonesia has required each college to implement CS as an intrurricular activity that combines high school Tri Dharma: Education, research, and community service.

In semester 7, students will attend Teaching and Learning Program (3 credits), Intrenship (2 credits), and thesis (5 credits). The course of Teaching and Learning Program (TLP) is a combination of activities aimed at developing students ' potential as a candidate for educators and educational personnel. The placement of students in practical locations is expected to motivate the school community to develop all its potential. TLP includes pre-TLP observation and TLP implementation at school. Teaching practice was conducted on VHS and before practising student teaching practice made the Learning Plan for teaching. In the implementation of the TLP students also have field guidance teachers in each study program that hopefully can guide students in teaching practice. Internship courses aim to improve the skills and ability of students to apply the theory gained in the course of implementation to the practice in the field, so that students better understand the field of work that has been practiced. Thesis course is a continuation of thesis proposal course.A thesis proposal is a research plan that contains a concrete and clear picture of the direction, objectives, and end result that will be achieved in thesis research. A research will be done well if it is based on proposals designed in accordance with the rules of research. In undergraduate study program, thesis is directed to applied research in education and non-educational field.

After taking various courses above, graduates of the undergraduate study program will be able to apply applied research to the innovation of vocational learning methods and for the optimization of production process technology and machinery engineering services relevant to the needs of development of small and medium industries.

Roadmap PLO 4

Able to think critically, creatively, analytically, synthesis-solutive, have a high work ethic, work together, build networks, and communicate oral-written in vocational engineering field accordance with the development of global industry.

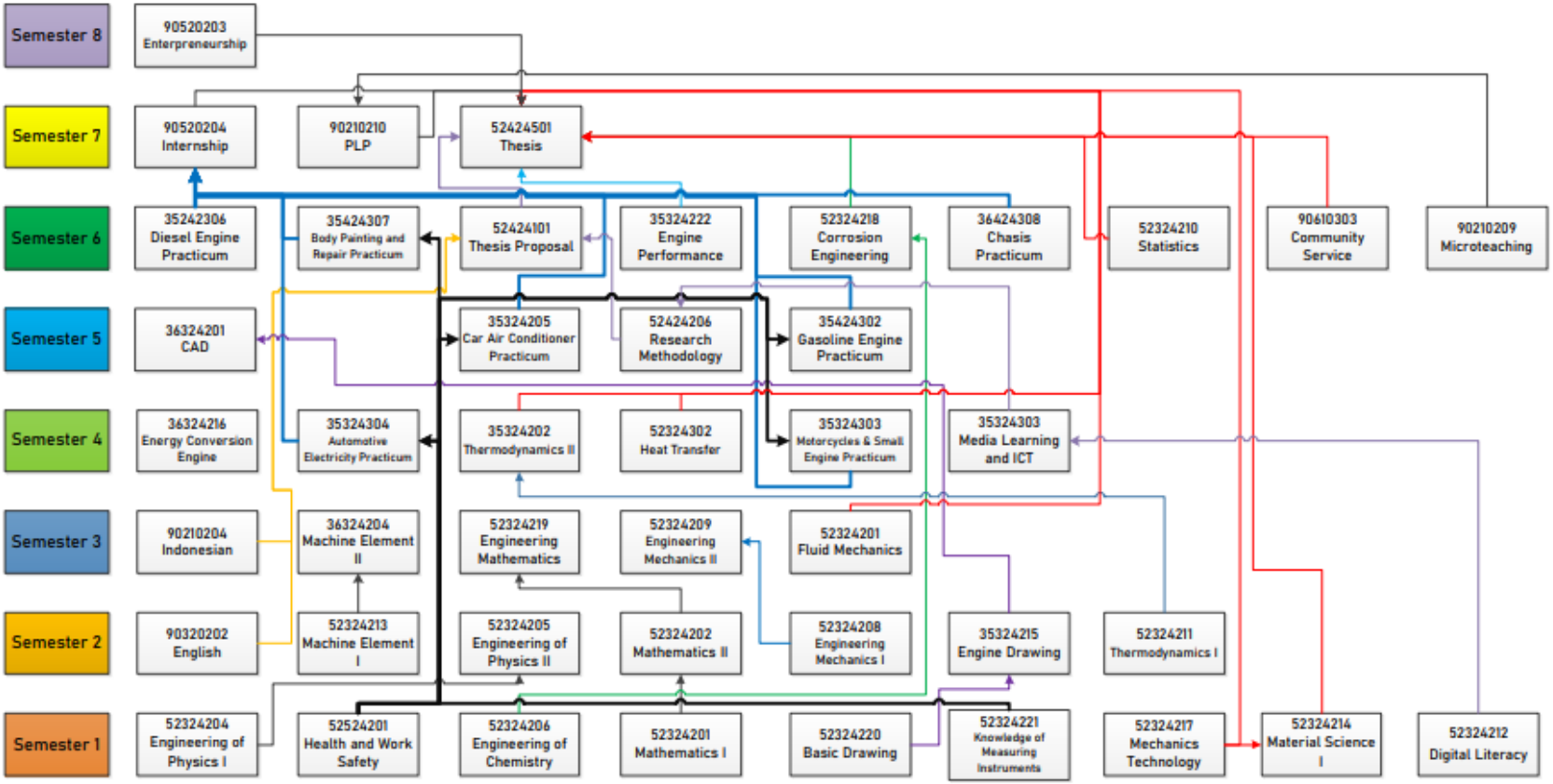

Figure 4. Course Roadmap For Achieving Learning Outcomes 4.

DescriptionRoadmap PLO 4

In the 1st semester, undergraduate study program students will take the course of in Engineering of physics I (2 credits), Health and Work Safety (2 credits), Engineering of Chemistry (2 credits), Mathematics I (2 credits), Basic Drawing (2 credits), Knowledge of Measuring Instruments (2 credits), Mechanics technology (2 credits), Material Science I (2 credits), and Digital literacy (2 credits).Engineering of physics I will teach you about the application of basic science, applied sciences and technology utilization. Bachelor degree in Mechanical Engineering education is expected to have a strong base of mathematics, physics, chemistry and engineering that stands out because of the field of work whose coverage is very wide starting from upstream to downstream industry.Health and Work Safety (HWS) courses learn about the fields related to the health, safety, and welfare of people in an institution or project location. The aim of HWS is to ensure the health and safety of the working environment for workers, coworkers, family workers, consumers, and people around the work environment. HWS is quite important to moral, legality, and financial, so all organizations have a duty to ensure that everyone involved stays in safe conditions at all time. The practices of HWS include prevention, granting of sanctions, compensation, wound healing & care for workers and providing health care & sick leave. HWS is associated with occupational health, safety engineering, Industrial engineering, Chemistry, health physics, organizational & industrial psychology, ergonomics, and occupational health psychology.Engineering of Chemistry teaches about processing raw materials into more useful goods, can be either finished goods or semi-finished goods. Engineering chemistry is applied mainly in the design and maintenance of chemical processes, both in small scale and in large scale such as factories.Courses Mathematics I teaches about complex numbers, systems of linear equations, functions and functions operations, derivatives of functions and applications, and indefinite integrals.Course drawing basic teaches about 6 major core subjects that must be mastered in learning the engineering drawings, namely: the types of lines, projections, perspectives, pieces, the appointment of size, and tolerance.Knowledge of Measuring instruments teaches about the use of analog and digital measuring instruments that are often used in manufacturing and automotive.Mechanics technology teaches about the process of working an object or material especially metal, so that obtained the results in accordance with the requirements required (according to specifications).The course of Material Science I teaches about the relationship between the material structure and material properties or it can be said that the science of materials is an interdisciplinary engineering science that studies the nature of its materials and applications against various fields of science and engineering. This science learns the relationship between the material structure and its nature.Digital literacy is a knowledge of the use of digital media, communication tools, or networks in discovering, evaluating, using, making information, and utilizing it healthily, wisely, intelligently, carefully, appropriately, and legally compliant in order to foster communication and interaction in daily life. Digital literacy can improve the ability to use information and communication technology (ICT) to communicate content/information with cognitive and technical as well as emotional social capabilities in the world and the digital environment.

Insemester 2, students will be studying English, (2 credits), Machine Element I (2 credits), Engineering of PhysicsII (2 credits), Mathematics II (2 credits), Engineering Mechanics I (2 credits), Engine Drawing (2 credits), and thermodynamics I (2 credits).English courses Learn about structure, listening, reading, writing and conversation to

improve student skills in communicating both orally and written English.The course of the machine element I taught the parts of a construction that has its own form and function, such as bolts-nuts, pens, stakes, shafts, couplings, belts, chain-sprockets, gears and the others. Engineering of Physics II learns about the concept of electric fields, capacitors and dielectrics, direct circuit current circuits, magnetic fields, magnetic induction, alternating current electrical circuits, transformers, catholerays, electromagnetic waves, geometry optics, interference and diffraction, polarization and photometry, X-ray problems, atomic model concepts, concepts of quantum physics and theoretical physics precisely and correctly.Mathematics II teaches about the concepts of indefinite integrals, certain integrals, multiple integral (double and triple integrals), polar coordinates and parametric equations, heavy points, moment of inertia and the pressure of liquids, matrices and applications. Engineering Mechanics 1 learns about the behavior of structures, or machines against loads that work on it.. The behavior of such structures is generally lendutan and force (reaction force and internal force).The Engine Drawing Course is a continuation of the subject drawing base. The difference is on drawing the machine more towards its application. Drawing this machine is also very helpful in delivering accurate information. In drawing machines we follow the rules in the International Organization for Standarization (ISO). Among them are the rules regarding paper size, line type, or projection type and tolerance in drawing.The courses of thermodynamics I teach about heat and temperature, as well as their second relationship to energy and motion. The essence of thermodynamic discussion is how the energy in the form of heat can flow from one object to another, the process of the flow of energy, and the consequences attributed to the transfer of energy.

After taking various courses above, graduates of undergraduate study Program will be able to think critically, creatively, analytically, synthesize, solutif, high work ethic, cooperation, network building, and communicate verbal-writing in the field of vocational education of mechanical engineering according to the development of the global industry.

Roadmap PLO 5

Have a positive, honest, disciplined, diligent, aesthetic, efficient-effective, and responsible personality.

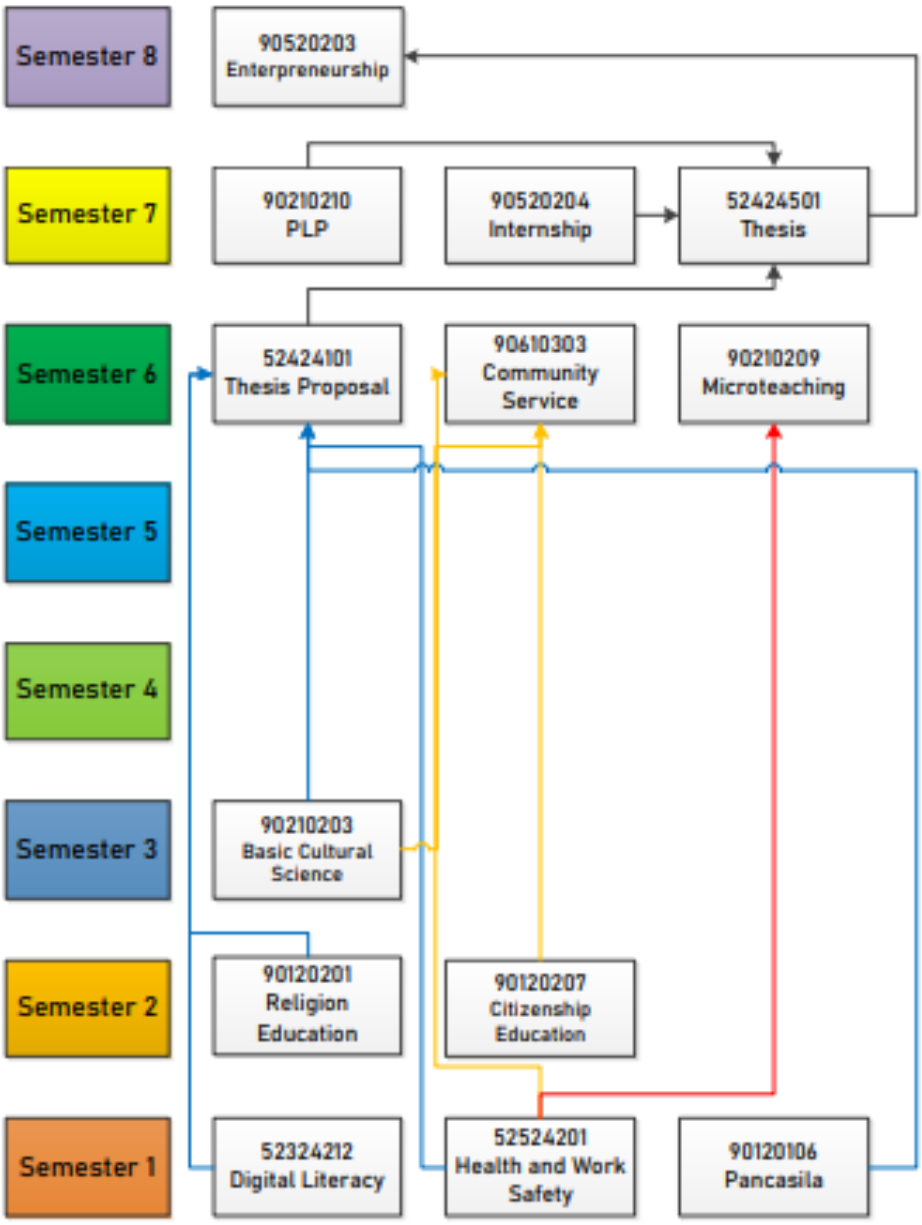

Figure 5. Course Roadmap For Achieving Learning Outcomes 5.

Description of Roadmap PLO 5

In the first semester, students in mechanical engineering education will be taking Digital literacy courses (2 credits), Health and Work Safety (2 credits), and Pancasila education (2 credits). In accordance with 21st century skill demands, where everyone is required to have the capability of ICT Literacy, the student is also taught digital literacy. Digital literacy is a knowledge of the use of digital media, communication tools, or networks in discovering, evaluating, using, making information, and utilizing it healthily, wisely, intelligently, carefully, appropriately, and legally compliant in order to foster communication and interaction in daily life.Digital literacy can improve the ability to use information and communication technology (ICT) to communicate content/information with cognitive and technical as well as emotional social capabilities in the world and the digital environment.Health and Work Safety (HWS) courses learn about the fields related to the health, safety, and welfare of people in an institution or project location. The aim of HWS is to ensure the health and safety of the working environment for workers, coworkers, family workers, consumers, and people around the work environment. HWS is quite important to moral, legality, and financial, so all organizations have a duty to ensure that everyone involved stays in safe conditions at all time. The practices of HWS include prevention, granting of sanctions, compensation, wound healing & care for workers and providing health care & sick leave. HWS is associated with occupational health, safety engineering, Industrial engineering, Chemistry,health physics, organizational & industrial psychology, ergonomics, and occupational health psychology.Pancasila Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have knowledge, personality, and expertise in accordance with their study program. Thus, studentsable to make constructive contributions in society, nation, and state, referring to the values of Pancasila. This means the course of Pancasila is a learning process using student centered learning approach, to develop knowledge, attitude, and skills of students as a candidate for the nation's leaders in building their professional soul in accordance with their study program, and by making the values of Pancasila as a rule of the guide, so that it becomes a good citizen.

Insemester 2, students will take courses in religious education (2 credits) and Citizenship Education (2 credits). Religious education is a primary, intermediate, and high education that prepares learners to be able to play a role that demands mastery of knowledge of religious teachings and/or become a religious expert. Religious education teaches students about obedience to execute orders and avoid prohibitions according to their religion, so that graduates have good and religious character.While the citizenship education course is a science that involves the active participation of students in projects related to social issues, politics, economics, and the global environment. The two main elements of citizenship education are global awareness (the moral and ethical aspects of global issues) and global competencies (skills that enable students to compete in global employment exchanges). Citizenship education is an idea of governments and NGOS to confront the emergence of supranational institutions, area economic blocks, and the development of information and communication technologies. All of these factors drive a more global-oriented and collaborative approach to education.

Insemester 3, students will take the course of Basic Cultural Sciences (2 credits). Courses of basic culture (BCS) is a science that learns the basics and understanding of the concept of development to examine cultural issues. BSC has been developed in Indonesia as

a substitute of Basic Humanities which learns that making one can be more human, more culturally and more refined, while culture is a way or direction in acting and thinking to fulfill the needs of life both temporal and spiritual.

In semester 6, students will take the course of thesis Proposal (1 credits), Community Service (3 credits), and Mecroteaching (2 credits). A thesis Proposal is a research plan that contains a concrete and clear picture of the direction, objectives, and end result that will be achieved in thesis research. A research will be done well if it is based on proposals designed in accordance with the rules of research. In undergraduate study program, thesis is directed to applied research in education and non-educational field.The community Service (CS) course teaches about the form of community dedication activities by students with a cross-scholarly and sectoral approach at certain times and regions in Indonesia. The implementation of CS activities usually lasts between one to two months and is located in a village-level area. The Directorate General of Higher Education in Indonesia has required each college to implement CS as an intrurricular activity that combines high school tri Dharma: Education, research, and community service.Microteaching is a technique aimed at preparing a prospective teacher/instructor to a real classroom arrangement (Brent & Thomson, 1996). Microteaching can be defined as a teaching technique that is primarily used in pre-office education teachers/instructors to systematically train them by allowing them to experiment with the behavior of primary teachers/instructors. Microteaching is one of the forms of educational practice models or teaching training. In a real context, teaching contains many actions, both covering technical material delivery, use of methods, media use, guiding learning, motivating, managing classes, providing assessments and so on. In other words, the act of teaching is very complex. Therefore, in order to mastery the basic teaching skills, prospective teachers/instructors or lecturers need to practice partially, meaning that each component of the basic teaching skills will need to be mastered separately.

Insemester 7, students will attend Teaching and Learning Program (3 credits), Intrenship (2 credits), and thesis (5 credits). The course of Teaching and Learning Program (TLP) is a combination of activities aimed at developing students ' potential as a candidate for educators and educational personnel. The placement of students in practical locations is expected to motivate the school community to develop all its potential. TLP includes pre-TLP observation and TLP implementation at school. Teaching practice was conducted on VHS and before practising student teaching practice made the Learning Plan for teaching. In the implementation of the TLP students also have field guidance teachers in each study program that hopefully can guide students in teaching practice. Internship courses aim to improve the skills and ability of students to apply the theory gained in the course of implementation to the practice in the field, so that students better understand the field of work that has been practiced. Thesis course is a continuation of thesis proposal course.

Insemester 8, students will be attending entrepreneurship courses (2 credits). This course teaches mehasiswa about the process of identifying, developing a product/service, and bringing vision into life. That vision can be an innovative idea, a chance, a better way to run something. The end result of the process is the creation of a new business both products and services are formed at risk conditions or uncertainty.After taking various courses above, graduates of undergraduate study program will have personality traits characterized by positive-minded, honest, disciplined, diligent, aesthetic, effective-efficient, and responsible.

Roadmap PLO 6

Able to operate mechanical and digital-based production machines to produce workpieces and maintain and repair motorized vehicles according to standard procedures relevant to the development of the global industry

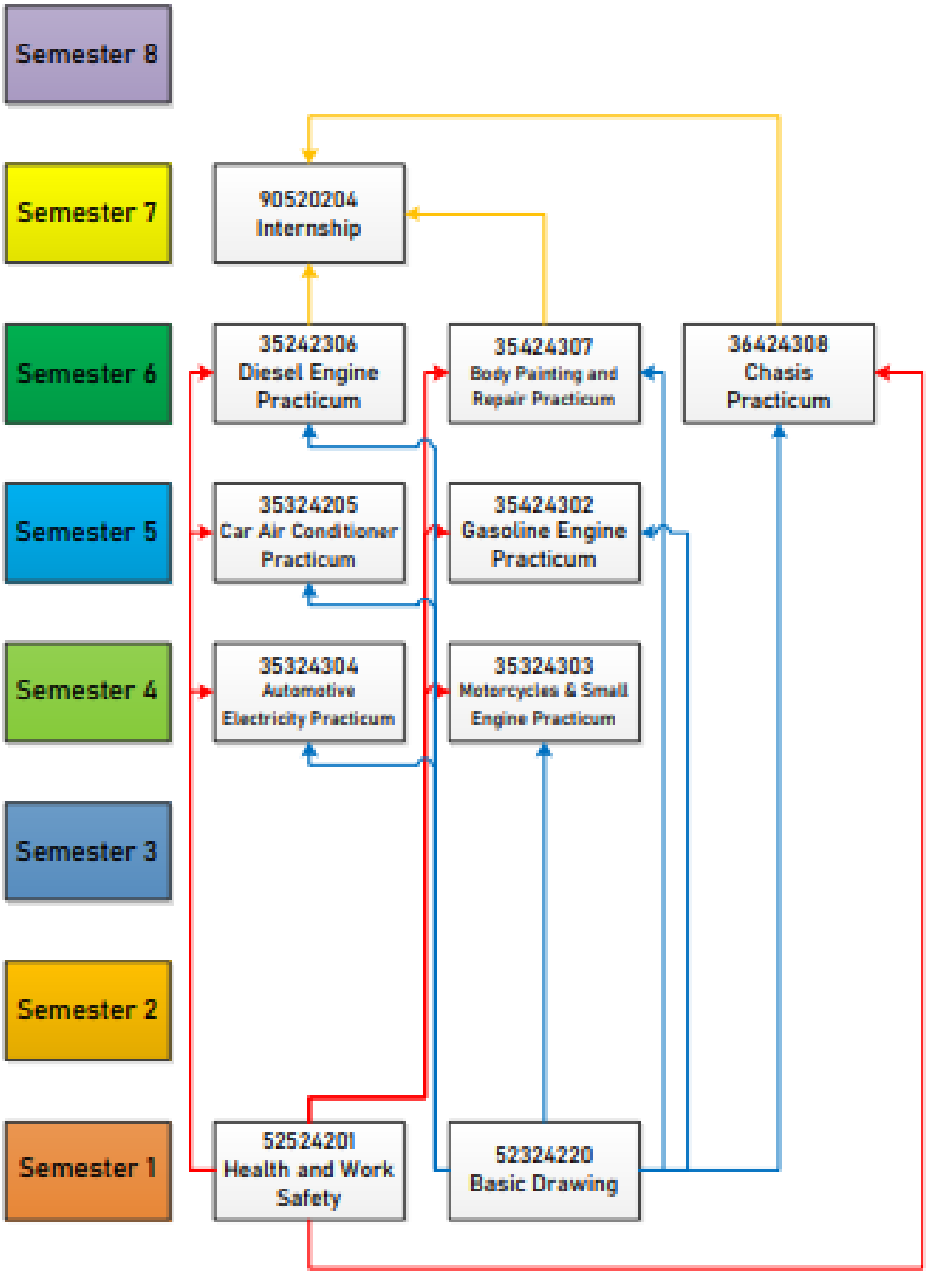

Figure 6. Course Roadmap For Achieving Learning Outcomes 6

Description of Roadmap PLO 6

In the first semester, students in mechanical engineering education will be taking about Health and Work Safety (2 credits), and Basic Drawing (2 credits). Health and Work Safety (HWS) courses learn about the fields related to the health, safety, and welfare of people in an institution or project location. The aim of HWS is to ensure the health and safety of the working environment for workers, coworkers, family workers, consumers, and people around the work environment. HWS is quite important to moral, legality, and financial, so all organizations have a duty to ensure that everyone involved stays in safe conditions at all time. The practices of HWS include prevention, granting of sanctions, compensation, wound healing & care for workers and providing health care & sick leave. HWS is associated with occupational health, safety engineering, Industrial engineering, Chemistry,health physics, organizational & industrial psychology, ergonomics, and occupational health psychology.Course drawing basic teaches about 6 major core subjects that must be mastered in learning the engineering drawings, namely: the types of lines, projections, perspectives, pieces, the appointment of size, and tolerance.

Insemester 4, students will take the courses of Automotive Electricity Practicum (3 credits) and Motorcycles & Small Engine Practicum (3 credits). The automotive electrical courses teach about electrical systems that support the engine to be lit and the system on the machine still works. The course of automotive electrical practicum discusses the exercises of body electrical material on motor vehicles. Each exercise contains stages of operation. The objective is to evaluate how far the understanding and ability of students regarding the activities of automotive electrical practices. While the courses of motorcycle and motorcycle practice teach about tune up procedures, overhaul and periodic maintenance on motorcycles and small motors.

Insemester 5, students will take the course of Car Air Conditioner Practicum (2 credits) and Gasoline Engine Practicum (3 credits). Courses of Car Air Conditioner Practicum teaches about the procedure of repair of compressor damage, evaporator, received drier, expansion valve, and replacement of Freon. While the course of Gasoline Engine Practicum teaches about the tune up and overhaul procedures of gasoline engines both carburetor and technology electronic fuel Injection (EFI).

In semester 6, students will take the course of the Diesel Engine Practicum (3 credits), Body Painting and Repair Practicum (3 credits), and Chassis Practicum (3 credits). Courses in Body Painting and Repair Practicum taught about painting techniques and repair body vehicles, ranging from putty technique, basic paint, color paint and top coat (finishing). Courses of Diesel Motor Practicum teaches about the tune up and overhaul procedures of diesel engines both conventional and technologically common-rail systems. Chassis Practicum courses teach about the procedure of maintenance and replacement of couplings, transmissions, power shifting systems, spooring and balancing wheels, brake systems, chassis, and steering systems.

In semester 7, students will be attending an internship course (2 credits). Internship courses aim to improve the skills and ability of students to apply the theory gained in the course of implementation to the practice in the field, so that students better understand the field of work that has been practiced.

Roadmap PLO 7

Able to apply technopreneurship, service advisor, supervisor of the mechanical engineering industry relevant to the development of the global industry.

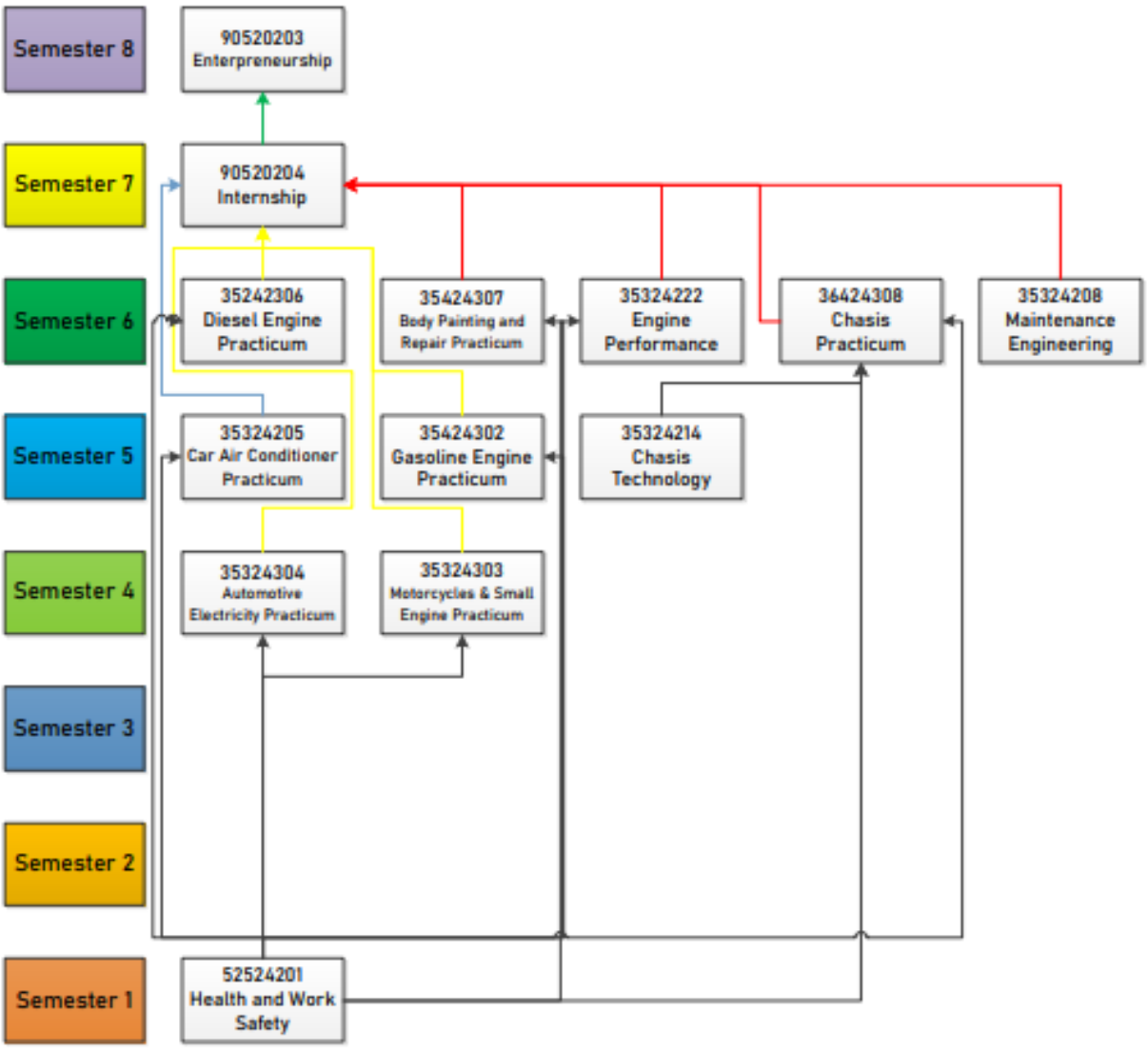

Figure 7. Course Roadmap For Achieving Learning Outcomes 7.

Description of Roadmap PLO 7

In the first semester, students in mechanical engineering education will be taking Digital literacy courses (2 credits), Health and Work Safety (2 credits), and Basic Drawing (2 credits). Health and Work Safety (HWS) courses learn about the fields related to the health, safety, and welfare of people in an institution or project location. The aim of HWS is to ensure the health and safety of the working environment for workers, coworkers, family workers, consumers, and people around the work environment. HWS is quite important to moral, legality, and financial, so all organizations have a duty to ensure that everyone involved stays in safe conditions at all time. The practices of HWS include prevention, granting of sanctions, compensation, wound healing & care for workers and providing health care & sick leave. HWS is associated with occupational health, safety engineering, Industrial engineering, Chemistry, health physics, organizational & industrial psychology, ergonomics, and occupational health psychology.

Insemester 4, students will take the courses of Automotive Electricity Practicum (3 credits) and Motorcycles & Small Engine Practicum (3 credits). The automotive electrical courses teach about electrical systems that support the engine to be lit and the system on the machine still works. The course of automotive electrical practicum discusses the exercises of body electrical material on motor vehicles. Each exercise contains stages of operation. The objective is to evaluate how far the understanding and ability of students regarding the activities of automotive electrical practices.While the courses of motorcycle and motorcycle practice teach about tune up procedures, overhaul and periodic maintenance on motorcycles and small motors.

Insemester 5, students will take the course of Car Air Conditioner Practicum (2 credits), Gasoline Engine Practicum (3 credits) and Chassis Technology. Courses of Car Air Conditioner teaches about the procedure of repair of compressor damage, evaporator, received drier, expansion valve, and replacement of Freon. While the course of Gasoline Engine Practicum teaches about the tune up and overhaul procedures of gasoline engines both carburetor and technology electronic fuel Injection (EFI).Course Chassis technology will learn about clutch, transmission, power transfer system, wheels, brake system, frame, and steering system.

In semester 6, students will take the course of the Diesel Engine Practicum (3 credits), Body Painting and Repair Practicum (3 credits),Chassis Practicum (3 credits), Engine Performance Analysis (2 credits) andMaintenance Machine Engineering (2 sks). Courses in Body Painting and Repair Practicum taught about painting techniques and repair body vehicles, ranging from putty technique, basic paint, color paint and top coat (finishing). Courses of Diesel Motor Practicum teaches about the tune up and overhaul procedures of diesel engines both conventional and technologically common-rail systems. Chassis Practicum courses teach about the procedure of maintenance and replacement of couplings, transmissions, power shifting systems, spooring and balancing wheels, brake systems, chassis, and steering systems.Courses in Engine Performance Analysis teaches about torque testing procedures, power, fuel consumption, exhaust emissions, and noise levels in motor vehicles. Courses in Maintenance Machine Engineering teaches about maintenance techniques, repairs of tools, tools, machinery and equipment as well as all units related to the production process or activities with the use of such infrastructure.

In semester 7, students will be attending an internship course (2 credits). Internship courses aim to improve the skills and ability of students to apply the theory gained in the

course of implementation to the practice in the field, so that students better understand the field of work that has been practiced.

Insemester 8, students will be attending entrepreneurship courses (2 credits). This course teaches mehasiswa about the process of identifying, developing a product/service, and bringing vision into life. That vision can be an innovative idea, a chance, a better way to run something. The end result of the process is the creation of a new business both products and services are formed at risk conditions or uncertainty.After taking various courses above, graduates of undergraduate study program will be able to apply Technopreneurship, Service Advisor, machine engineering industry supervisor relevant to the development of global industry.

Roadmap PLO 8

Able to adapt to the development of science-technology, social environment, and continuous learning throughout life.

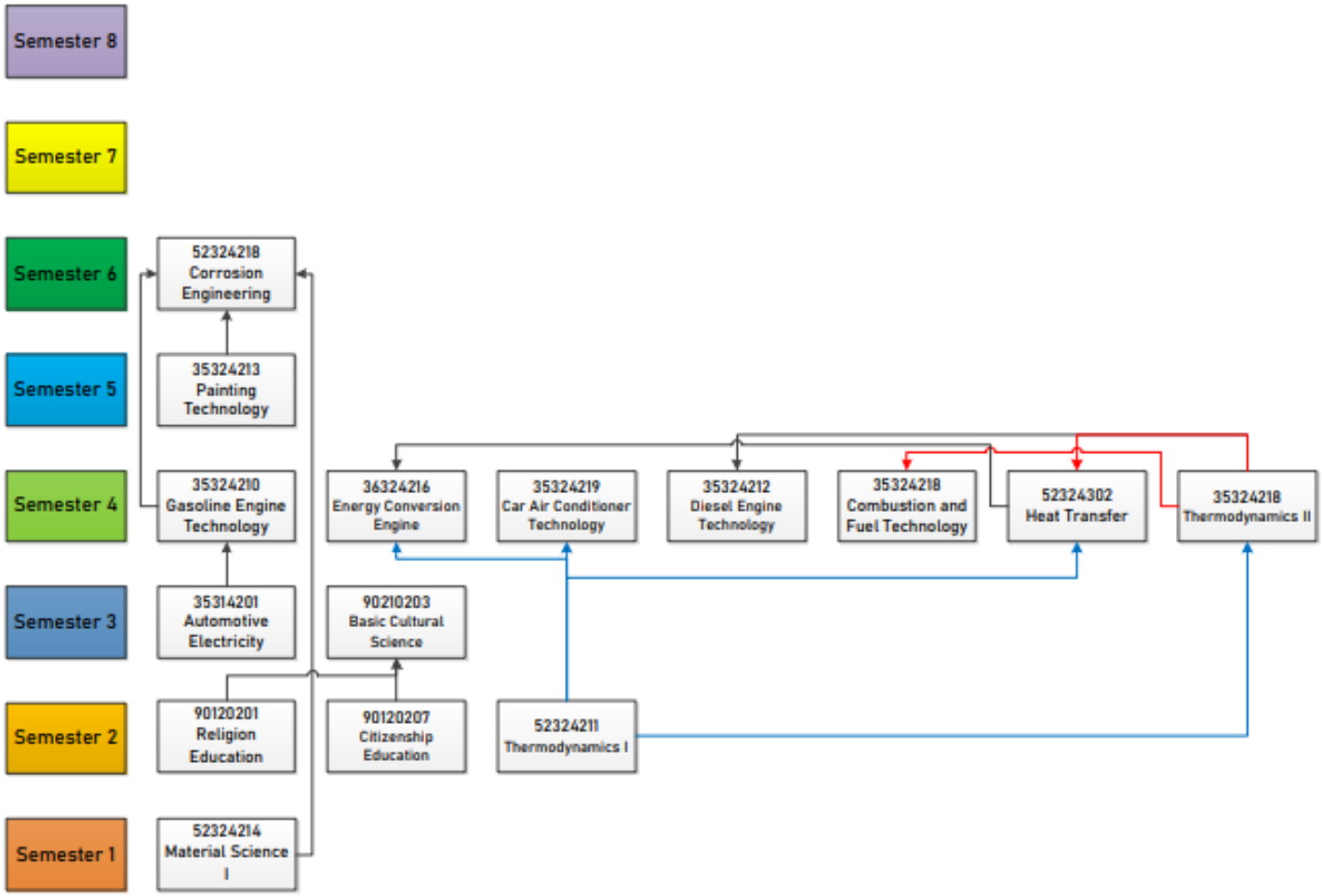

Figure 8. Course Roadmap For Achieving Learning Outcomes

Description of Roadmap PLO 8

In the first semester, students will take the course of Material Science I (2 credits). The course of Material Science I teaches about the relationship between the material structure and material properties or it can be said that the science of materials is an interdisciplinary engineering science that studies the nature of its materials and applications against various fields of science and engineering. This science learns the relationship between the material structure and its nature.

Insemester 2, students will take courses in religious education (2 credits), Citizenship Education (2 credits) and Thermodynamic I (2 credits). Religious education is a primary, intermediate, and high education that prepares learners to be able to play a role that demands mastery of knowledge of religious teachings and/or become a religious expert. Religious education teaches students about obedience to execute orders and avoid prohibitions according to their religion, so that graduates have good and religious character.While the citizenship education course is a science that involves the active participation of students in projects related to social issues, politics, economics, and the global environment. The two main elements of citizenship education are global awareness (the moral and ethical aspects of global issues) and global competencies (skills that enable students to compete in global employment exchanges). Citizenship education is an idea of governments and NGOS to confront the emergence of supranational institutions, area economic blocks, and the development of information and communication technologies. All of these factors drive a more global-oriented and collaborative approach to education.The courses of thermodynamics I teach about heat and temperature, as well as their second relationship to energy and motion. The essence of thermodynamic discussion is how the energy in the form of heat can flow from one object to another, the process of the flow of energy, and the consequences attributed to the transfer of energy.

Insemester 3, students will take the course of Automotive Electricity (2 credits) and Basic Cultural Sciences (2 credits). The automotive electrical courses teach about electrical systems that support the engine to be lit and the system on the machine still works. Automotive electricity is divided into 3, namely engine electrical system, electrical system body, and electrical system accessories. Courses of basic culture (BCS) is a science that learns the basics and understanding of the concept of development to examine cultural issues. BSC has been developed in Indonesia as a substitute of Basic Humanities which learns that making one can be more human, more culturally and more refined, while culture is a way or direction in acting and thinking to fulfill the needs of life both temporal and spiritual.

In semester 4, students will take a number of courses. Among them are Gasoline Engine technology (2 credits), Energy conversion Engine (2 credits), Car Air Conditioning Technology (2 credits), Diesel Engine Technology (2 credits), Combustion and Fuel Technology(2 credits), Heat transfer (3 credits), and Thermodinamika II (2 credits). The course of gasoline engine technology discusses the technology of gasoline motors over time, covering basic concepts and development technologies. Specifically, the discussion includes the development of gasoline motor technologies, the thermodynamic cycles of gasoline motors, the fuel system of gasoline, the ignition system and the burning of gasoline motors, as well as control of gasoline-motor exhaust emissions. The course of energy conversion machinery teaches about a plane that

produces a motion/work or an aircraft that serves to transform an energy into another energy resulting in a business/work utilized for human benefit. The working principle of this machine by using gas pressure resulting from combustion and air that will produce a force that can make the stem of the Thak moving. The movement of the piston will then result in a rotation on the crankshaft. In this lecture, students will learn a variety of energy conversion machines that are commonly found and often utilized in people's lives, such as: piston cylinders, engines, gas turbines, electric motors, compressors, refrigeration (air conditioning), fuel cell, and solar cell. The subject of car air conditioning technology teaches about environmentally friendly car AC technology. A good eco-friendly car AC technology without removing pollution that is not good for the Earth's health and balance. Car air conditioning in this modern era is the same as the AC that is in the house, the more advanced technology is now also an environmentally friendly version. Comfort in the vehicle is increasingly awake without having to remove pollution that is not good for the health and balance of the Earth. In Indonesia in 2015 already implemented implementation HPMP (HCFC or Hydrochlorofluorokarbon Phase-Out Management Plan). In the regulation it is also written for the removal of HCFC-22 or better known as Freon R22 in the refrigeration sector.The course of Diesel engine technology teaches about the rapid development of diesel motor technology from the use of fuel to performance enhancement related to mechanical technology to improvement power, and fuel consumption to be more friendly with the environment.The courses of combustion and fuel technology teach students about the fuel sense, fuel types, fuel characteristics, and how to make alternative fuels. The Heat transfer course is one of the displinals of thermal engineering that learns how to produce heat, use heat, change heat, and exchange heat between physical systems. Heat transfer is classified as thermal conductivity, thermal convection, thermal radiation, and heat transfer through phase changes.The course of Thermodynamics II continues on the thermodynamics I learned about the review of the fundamental concepts of thermodynamics, application of thermodynamic concepts for flow process, power generation from heat and cycle systems Otto, Diesel, and double, thermodynamics solution, phase equilibrium which include: the vapor-liquid equilibrium of low pressure and moderate pressure, liquid-liquid equilibrium, solid-liquid and steam-dense, chemical equilibrium.

In semester 5, students will go to Painting Technology courses (2 credits). Courses of painting techniques teach students about techniques to coat the surface of the material with the aim to beautify (decoratif), strengthen (reinforcing), and protect (protective) from corrosion/rust on the body of the motor vehicle.

In semester 6, students will take the course of Corrosion Engineering (2 credits). Corrosion is the process of degradation/detheorization/destruction of material that occurs due to the surrounding environment. In this lecture students will be taught about the definition, type, process of corrosion, and corrosion control technique.

After taking various courses above, graduates of undergraduate study Program will be able to adapt to the development of technology, social environment, and sustainable learning throughout life.

Roadmap PLO 9

Able to apply concepts and theories of economic-business, ecology, occupational health-safety and environment in designing and carrying out relevant professional work in a sustainable manner.

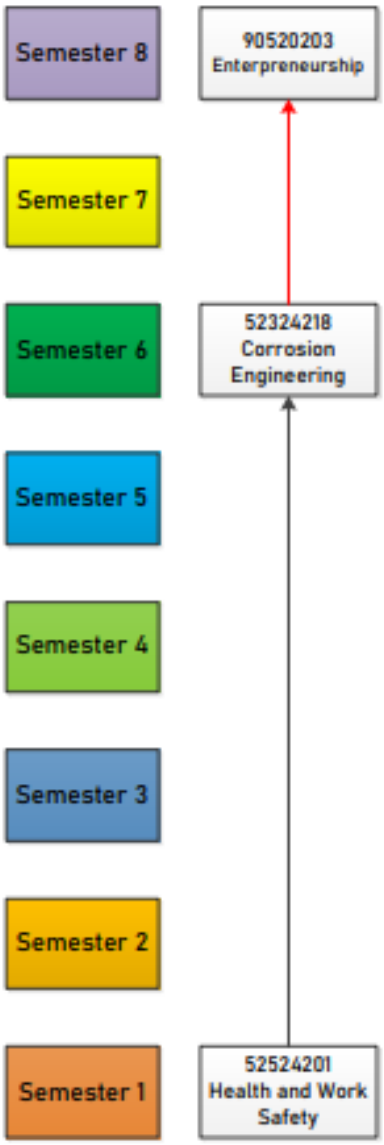

Figure 9. Course Roadmap For Achieving Learning Outcomes 9.

Description of Roadmap PLO 9

In the first semester, students in mechanical engineering education will be taking Digital literacy courses (2 credits), Health and Work Safety (2 credits), and Basic Drawing (2 credits). Health and Work Safety (HWS) courses learn about the fields related to the health, safety, and welfare of people in an institution or project location. The aim of HWS is to ensure the health and safety of the working environment for workers, coworkers, family workers, consumers, and people around the work environment. HWS is quite important to moral, legality, and financial, so all organizations have a duty to ensure that everyone involved stays in safe conditions at all time. The practices of HWS include prevention, granting of sanctions, compensation, wound healing & care for workers and providing health care & sick leave. HWS is associated with occupational health, safety engineering, Industrial engineering, Chemistry, health physics, organizational & industrial psychology, ergonomics, and occupational health psychology.

Insemester, 6 students will take the course of Corrosion Engineering (2 credits). Corrosion is a process of degradation or detheorization/destruction of material that occurs due to the surrounding environment. It can also be said that corrosion is a material destruction without mechanical destruction, the inverse of extractive metallurgy, and electrochemical process in achieving the thermodynamics equilibrium of a system. In this lecture students will be taught about the definition, type, process of corrosion, and corrosion control techniques to carry out the relevant profession work sustainably.

Insemester 8, students will be attending entrepreneurship courses (2 credits). This course teaches mehasiswa about the process of identifying, developing a product/service, and bringing vision into life. That vision can be an innovative idea, a chance, a better way to run something. The end result of the process is the creation of a new business both products and services are formed at risk conditions or uncertainty.

After taking a variety of courses above, graduates of the undergraduate study Program will be able to apply the concepts and theories of economic-business, ecology, occupational health and environment in designing and carrying out sustainable profession-relevant work.

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ENGINE PERFORMANCE TESTING LABORATORY

A	**Obligation**
	1. Students enter the workshop in accordance with the set practice schedule 2. During practice, students are required to wear lab coats and work safety equipment 3. Students borrow tools according to those listed on the tool bon sheet and are responsible for the tools borrowed during use until they are returned to the 4. Each work object and or practice is obliged to fill in the tools and materials and make a temporary report on the practice 5. Students stop the practice 10 minutes before the practice hours end to clean work tools, work desks, and work floors and return the tools and remaining materials used 6. Every practice is completed, students are required to fill out a list of tools and or machines 7. In the event of damage to equipment and or electrical machinery, students must report to laboran and fill the damage book 8. Lost tools, students are obliged to change 9. Students must maintain cleanliness, order, workshop security and tranquility of the atmosphere in the Engine Performance Testing Laboratory 10. The code of conduct for attending the theory lecture, the no. 1-10 quoted system also applies. 11. Official activities in the Laboratory from 07.00-16.00, and if there are additional activities must be laboran permission, known kasub lab and approved Kalab..
B	**Student Ban**
	1. It is forbidden to enter the electrical workshop outside of scheduled lecture hours, unless there is an interest with laboranpermission,known to kasublab, and approved Head of Laboratory 2. Students are prohibited from entering the tool room, materials room, and instructor/laboran/technicianroom, unlessthey have obtained a prior entry permit 3. Smoking/eating and drinking are not allowed inside the workshop 4. During lectures and or practices, students are prohibited from leaving the electrical workshop without the permission of laborans and or lecturers **5.** Before the tool, the workspace is neat,clean and restored as condition before use, students are prohibited from leaving the Engine Performance Testing Laboratory. **6.** Students are prohibited from sleeping in the laboratory, unless there are incidental activities related to research activities and important tasks (urgent race preparation) without laboran permission (if any), known kasublab, kalab, and approved by the head of the Department of Mechanical Engineering
C	**Sanctions**
	1. Students who do not heed thetiped system and laboran instructions, will be dismissed from their activities in the Laboratory 2. Any student who removes the device is required to replace with the same device, no

	later than 1 month after loss 3. Any student who intentionally damages the device, wajib replacesif the tool cannot be used according to its function 4. Any student who is knowingly caught taking tools, materials, and work objects or other things for personal or group gain will be punished with the highest penalty of being expelled from the course.