	Universitas Negeri Surabaya Faculty of Engineering, Mechanical Engineering Undergraduate Study Program	Document Code

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Metrology	2120102136	Compulsory Study Program Subjects	T=2	P=0	ECTS=3.18	3	April 28, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
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Learning model	**Project Based Learning**	
Program Learning Outcomes (PLO)	**PLO study program that is charged to the course**	
	PLO-5	Work independently and in groups
	PLO-6	Experimentation and data analysis
	PLO-14	Science and engineering knowledge
	Program Objectives (PO)	
	PO - 1	a. Ability to identify specific facts regarding mathematics, science and engineering required for metrology applications, measurement principles, calibration techniques and the use of measuring tools in the manufacturing industry including direct and indirect measuring tools, based on good and correct SOPs
	PO - 2	a. Able to design experimental plans
	PO - 3	a. Able to formulate problems identifying metrology applications, measurement principles, calibration techniques, and the use of measuring tools in the manufacturing industry including direct and indirect measuring tools, based on good and correct SOPs. and analyzing obstacles.
	PO - 4	b. Able to explain the technical use, skills and tools specific to modern engineering practices
	PLO-PO Matrix	

P.O	PLO-5	PLO-6	PLO-14
PO-1			
PO-2			
PO-3			
PO-4			

PO Matrix at the end of each learning stage (Sub-PO)

P.O	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PO-1																
PO-2																
PO-3																
PO-4																

Short Course Description	This course provides students with experience in understanding the concepts, theory and application of metrology, measurement principles, calibration techniques, and the use of measuring instruments in the manufacturing industry including direct and indirect measuring instruments, based on good and correct SOPs. Learning is carried out using demonstration, virtual, discussion and active collaboration methods between students and lecturers both individually and in groups accompanied by assignments to support understanding the lecture material.	
References	**Main :**	

1. [5] Munadi. 1988. Dasar-Dasar Metrologi Industri . Jakarta: Depdikbud: Dirjen Dikti, Proyek Pengembangan LPTK
2. [4] Rochim, Taufiq. 2004. Spesifikasi Metrologi Dan Kontrol Kualitas Geometrik . Bandung : Gramedia
3. [1] Thomas G, Beckwith (2007) Mechanical measurements, Sixth Edition, Pearson Prentice Hall, New Jersey
4. [2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.
5. [3] J.P Holman (2012) Experimental Methods for Engineers, Eigth Edition, McGraw-Hill, New York.

Supporters:	
Supporting lecturer	Iskandar, S.T., M.T. Tri Hartutuk Ningsih, S.T., M.T.

Week-	Final abilities of each learning stage (Sub-PO)	Evaluation		Help Learning, Learning methods, Student Assignments, [Estimated time]		Learning materials [References]	Assessment Weight (%)
		Indicator	Criteria & Form	Offline (*offline*)	Online (*online*)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Know and understand the concept of measurement systems, units of measurement, standards, calibration	Definition of the concept of measurement system, units of quantity, standards, calibration	**Criteria:** Mastery of material, communication skills **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Learning Based on Problems Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** measurement concepts, units of quantity, standards, calibration **References:** *[1] Thomas G, Beckwith (2007) Mechanical measurements, Sixth Edition, Pearson Prentice Hall, New Jersey* **Material:** Concept of measurement systems, units of quantity, standards, calibration **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.*	3%
2	Able to understand the static & dynamic characteristics of measurement instruments (accuracy, precision, sensitivity, linearity, error and frequency response)	Definition of static & dynamic characteristics of measurement instruments (accuracy, precision, sensitivity, linearity, error and frequency response)	**Criteria:** 3 **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Learning Based on Problems Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Static & dynamic characteristics of measurement instruments (accuracy, precision, sensitivity, linearity, error and frequency response) **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.*	0%

3	Able to understand sensor and transducer systems	Understanding sensor and transducer systems	**Criteria:** mastery of material, communication skills **Form of Assessment** : Project Results Assessment / Product Assessment	Model: Problem Based Learning / Learning Based on Problems Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50	Model: Problem Based Learning / Learning Based on Problems Method: Lecture, simulation, discussion, problem solving, question and answer 2x50	**Material:** Sensor and transducer systems **References:** *[3] JP Holman (2012) Experimental Methods for Engineers, Eighth Edition, McGraw-Hill, New York.* **Material:** Sensor and transducer systems **References:** *[2] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	20%
4	Able to know and understand dimensional measurements	Can understand and be skilled at measuring dimensions	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Dimensional measurements **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.*	3%
5	Able to know and understand measurements of displacement, strain, force, torque, speed and acceleration	Can understand the measurement of displacement, strain, force, torque, speed and acceleration.	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Learning Based on Problems Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 x 50	**Material:** Measurement of displacement, strain, force, torque, speed and acceleration. **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.* **Material:** Measurement of displacement, strain, force, torque, speed and acceleration. **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	3%

6	Able to know and understand temperature, fluid flow and pressure measurements.	Understand the concept of measuring temperature, fluid flow and pressure.	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Measurement of temperature, fluid flow and pressure. **References:** *[3] JP Holman (2012) Experimental Methods for Engineers, Eighth Edition, McGraw-Hill, New York.*	3%
7	Able to know and understand the processing and presentation of measurement data.	Understand the concept of processing and presenting measurement data.	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Processing and presenting measurement data **References:** *[3] JP Holman (2012) Experimental Methods for Engineers, Eighth Edition, McGraw-Hill, New York.* **Material:** Processing and presenting measurement data **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	3%
8	Material: Chapter at Meetings 1-7	USS-Sub Summative Exam/UTS Midterm Exam	**Criteria:** USS-Sub Summative Exam/UTS Midterm Exam	USS-Sub Summative Exam/UTS Midterm Exam 2 X 50		**Material:** All material at meetings 1-7 **References:** *[2] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	20%

9	Know and understand the processing and presentation of measurement data.	Understand the processing and presentation of measurement data.	**Criteria:** mastery of material, communication skills **Form of Assessment** : Project Results Assessment / Product Assessment	Model: Problem Based Learning / Learning Based on Problems Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Processing and presenting measurement data. **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.* **Material:** Processing and presenting measurement data **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	20%
10	Know and understand the processing and presentation of measurement data.	Understand the processing and presentation of measurement data.	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Processing and presenting measurement data. **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.* **Material:** Processing and presenting measurement data. **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	20%

11	Know and understand the classification of tools and geometric measurement methods	understand the classification of tools and geometric measurement methods	**Criteria:** According to the Rubric **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Classification of tools and geometric measurement methods **Reference:** *[5] Munadi. 1988. Basics of Industrial Metrology. Jakarta: Depdikbud: Director General of Higher Education, LPTK Development Project* **Material:** Classification of geometric measurement tools and methods **References:** *[1] Thomas G, Beckwith (2007) Mechanical measurements, Sixth Edition, Pearson Prentice Hall, New Jersey*	3%
12	Know and understand linear, angular, flatness measurements	Understand and be skilled at linear, angular, flatness measurements	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Linear measurements, angles, flatness **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia* **Material:** Linear measurements, angles, flatness **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.*	4%

13	Know and understand roundness measurements and shape errors	Know and understand roundness measurements and shape errors	**Criteria:** mastery of the material, skilled in using tools, skilled in communicating **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Learning Based on Problems Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Measurement of roundness and shape errors **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia* **Material:** Measurement of roundness and shape errors **References:** *[3] JP Holman (2012) Experimental Methods for Engineers, Eighth Edition, McGraw-Hill, New York.*	4%
14	Know and understand qualitative control charts	Knowledge and skill in linear, angular, flatness measurements	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50		**Material:** Qualitative control diagrams **References:** *[1] Thomas G, Beckwith (2007) Mechanical measurements, Sixth Edition, Pearson Prentice Hall, New Jersey* **Material:** Qualitative control diagram **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	10%
15	Know and understand quantitative control diagrams	Know and be skilled at making quantitative control charts	**Criteria:** mastery of material, communication skills **Form of Assessment** : Participatory Activities	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 X 50	Model: Problem Based Learning / Problem Based Learning Method: Lecture, simulation, discussion, problem solving, question and answer 2 x 50	**Material:** Quantitative control diagrams **References:** *[2] Richard S. Figliola and Donald E. Beasley (2011) Theory and Design for Mechanical Measurements, Fifth Edition, John Wiley & Sons, New York.* **Material:** Quantitative control diagram **References:** *[4] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia*	4%

16	Material: Chapter at Meetings 9-15	US-Summative Exam/UAS Final Semester Exam	**Criteria:** US-Summative Exam/UAS Final Semester Exam	US-Summative Exam/UAS Final Semester Exam 2 X 50		**Material:** Material at meeting 9-15 **References:** *[2] Rochim, Taufiq. 2004. Metrology Specifications and Geometric Quality Control. Bandung: Gramedia* **Material:** Material at meeting 9-15 **References:** *[3] JP Holman (2012) Experimental Methods for Engineers, Eighth Edition, McGraw-Hill, New York.*	30%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	45%
2.	Project Results Assessment / Product Assessment	55%
		100%

Notes

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** ability in the process and student learning outcomes are specific and measurable statements that identify the ability or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.
8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.