	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
Advanced Materials	2120102145	Compulsory Curriculum Subjects - Institutional	T=2	P=0	ECTS=3.18	5	April 28, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Mochamad Arif Irfa'i, S.Pd., M.T	Mochamad Arif Irfa'i, S.Pd., M.T	Ir. Priyo Heru Adiwibowo, S.T., M.T.

Learning model	**Case Studies**	
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	Students have good morals, ethics and personality when attending lectures.
	PO - 2	Students have knowledge of the definition of ceramic materials, ceramic classification, ceramic bonding, ceramic structure, thermodynamics/kinetics, defects in ceramics, diffusion and electrical conductivity, phase equilibrium, glass structure, powder metallurgy, crystal minerals, product solubility, ceramic testing, equilibrium and species. , ceramic biomaterials.
	PO - 3	Students have skills about ceramic materials, ceramic classification, ceramic bonding, ceramic structure, thermodynamics/kinetics, defects in ceramics, diffusion and electrical conductivity, phase equilibrium, glass structure, powder metallurgy, crystal minerals, product solubility, ceramic testing, equilibrium and species , ceramic biomaterials.
	PO - 4	Students are able to interact and work together in teams, be responsible, think logically and intelligently in solving problems faced professionally in the field of technical ceramics.
	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	Students can explain the definition of ceramic materials, ceramic classification, ceramic bonding, ceramic structure, thermodynamics/kinetics, defects in ceramics, diffusion and electrical conductivity, phase equilibrium, glass structure, powder metallurgy, crystal minerals, product solubility, ceramic testing, equilibrium and species. , ceramic biomaterials.	
References	**Main :**	

1. Barsoum M. W.,1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia
2. Mullin J. W, 2001, Crystallization, Butterworth-Heinemann
3. Bahan-bahandari Internet dan kepustakaan lain
4. Jones R.M.1975 Mechanics of Composite Materials New York: Mc Graw Hill.
5. Kaw Autar K. 2006 Mechanics of Composite materials ed. 2 nd CRC Press.

Supporters:	
Supporting lecturer	Mochamad Arif Irfa'i, S.Pd., 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	Understanding Engineering Ceramic Materials	1. Students can explain the meaning of technical ceramic materials. 2. Students are able to explain the general properties of engineering ceramic materials.	**Form of Assessment** : Participatory Activities, Portfolio Assessment	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. Definition of engineering ceramic materials 2. General properties of engineering ceramic materials **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%
2	Understand the classification of materials that make up technical ceramics	1. Students are able to explain the materials that make up technical ceramics. 2. Students are able to explain the classification of technical ceramic materials	**Criteria:** Criteria: Understanding and Mastery Non-test form: Paper writing and presentation **Form of Assessment** : Participatory Activities, Portfolio Assessment	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. Materials that make up engineering ceramics 2. classification of engineering ceramic materials **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%
3	Understand atomic structure and bonds	1. Students can explain the structure of atoms and bonds. 2. Students can explain the relationship between material properties and bonds	**Criteria:** Criteria: Understanding and Mastery Non-test form: Paper writing and presentation **Form of Assessment** : Participatory Activities, Portfolio Assessment	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Materials:** 1. atomic structure and bonds 2. relationship between material properties and bonds **References:** *Mullin J. W, 2001, Crystallization, Butterworth-Heinemann*	6%

4	Understanding the behavior of ceramic structures	1. Students can explain the structure of ceramics. 2. Students can explain impurities in ceramics	**Criteria:** Criteria: Understanding and Mastery Non-test form: Paper writing and presentation **Form of Assessment** : Participatory Activities, Portfolio Assessment	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. concept of ceramic structure 2. concept of impurities in ceramics **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	7%
5	Understand thermodynamics and reaction kinetics	1. Students can explain the concept of chemical thermodynamics 2. Students can explain reaction kinetics	**Form of Assessment** : Participatory Activities	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. chemical thermodynamics 2. reaction kinetics **References:** *Mullin J. W, 2001, Crystallization, Butterworth-Heinemann*	7%
6	Understanding defects in engineering ceramics	1. Students can explain point defects 2. Students can explain line defects 3. Students can explain surface defects	**Form of Assessment** : Participatory Activities, Portfolio Assessment	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. point defects 2. line defects 3. surface defects **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	7%
7	Mastering the study material from the 1st to the 6th meeting	understand the study material from the 1st meeting to the 6th meeting	**Form of Assessment** : Participatory Activities, Portfolio Assessment	Written exam 2 X 50	Written Exam 2 x 50	**Material:** Meeting materials 3 and 6 **References:** *Mullin J. W, 2001, Crystallization, Butterworth-Heinemann* **Material:** Material from meetings 1,2, 4 and 5. **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	7%
8	Understanding diffusion and electrical properties in ceramics	1. Students can explain the diffusion mechanism. 2. Students can explain the electrical properties of ceramics	**Form of Assessment** : Participatory Activities, Tests	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. diffusion mechanism 2. electrical properties of ceramics **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%

9	Understand the theory of Phase Equilibrium	1. Students can explain the phase rule. 2. Students can explain phase diagrams	**Form of Assessment** : Participatory Activities	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations		6%
10	Understand the structure of glass	1. Students are able to explain glass ceramics. 2. Students can explain and give examples of glass ceramics	**Form of Assessment** : Participatory Activities	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations		**Material:** Glass-Ceramic Technology (2002), W. Höland & G. Beall, The American Ceramic Society, Westerville, OH. **References:**	6%
11	Understanding Ceramic Powder manufacturing (Processing of Powder Ceramics), glass	1. Students can explain the process of making ceramics. 2. Students can explain the process of making glass.	**Form of Assessment** : Participatory Activities	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. Process of making ceramics 2. Process of Making Glass **Library:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%
12	Understand mechanical testing of ceramic materials	1. Students can understand ceramic bending testing. 2. Students can understand fracture toughness testing.	**Form of Assessment** : Participatory Activities	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. ceramic bending testing, 2. fracture toughness testing **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%
13	Understand the theory about ceramics biomaterials (bioceramics)	1. Students can understand the types of bioceramics. 2. Students can understand the mechanical properties of ceramic biomaterials.	**Form of Assessment** : Participatory Activities	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. types of bioceramics 2. mechanical properties of ceramic biomaterials **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%
14	Understand product solubility and common ion effect	1. Students can understand the types of solutions. 2. Students can understand molar solubility	**Form of Assessment** : Participatory Activities, Portfolio Assessment	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. types of solutions, 2. molar solubility **Bibliography:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%

15	Understand solubility and solubility	1. Students can understand the criteria for precipitation of dissolution. 2. Students can understand the effect of pH on solubility	**Criteria:** Criteria: Understanding and Mastery Non-test form: Paper writing and presentation **Form of Assessment** : Participatory Activities, Portfolio Assessment	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	1. Direct and Cooperative Learning Model 2. Discussion and Question and Answer 3. 2 X 50 Presentations	**Material:** 1. precipitation of dissolution criteria, 2. effect of pH on solubility **Reference:** *Barsoum MW, 1966, Fundamentals of Ceramics, Institute of Physics Publishing Bristol and Philadelphia*	6%
16	material for meetings 1 to 15	Criteria: Understanding and Mastery Non-test form: Paper writing and presentation	**Criteria:** Criteria: Understanding and Mastery Non-test form: Paper writing and presentation	Written Exam 2 x 50	Written Exam 2 x 50	**Material:** meeting 3, meeting 5 and meeting 7 materials **Reference:** *Mullin J. W, 2001, Crystallization, Butterworth-Heinemann* **Material:** meeting 1, pert. 2, pert. 4, pert. 6, pert. 8, pert. 9, pert. 10, pert. 11, pert. 12, pert. 13, pert. 14 and pert. 15 **References:** *Mullin J. W, 2001, Crystallization, Butterworth-Heinemann*	6%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	65.5%
2.	Portfolio Assessment	25.5%
3.	Test	3%
		94%

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.