TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

INTRODUCTION TO MATERIAL SCIENCE

by

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UNIVERSITAS INDONESIA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
PHYSICS UNDERGRADUATE STUDY PROGRAM

TEACHING INSTRUCTIONAL DESIGN

Course Name	Introduction to Material Scoence	**Credit(s)**	**Prerequisite course(s)**	**Requisite for course(s)**	**Integration Between Other Courses**
Course Code	SCPH603703	4	Modern Physics, Introduction to Solid State Physics	-	-
Relation to Curriculum	Elective Course				
Semester	6				
Lecturer(s)	Anawati, PhD Ariadne L Juwono, PhD				
Course Description	Introduction Material Science is an elective subject with a focus on Material Physics and is the basis for students to take other Material Physics courses. The material covered in this course contains fundamentals, types of materials, process-properties-material structure relationships, material structures (structure: macro, micro, sub, crystal and atomic electronic structures); atomic bonds in crystals, binding energy; unit cell; allotropy; crystal direction and plane; defects in crystals; materials: metals and alloys, ceramics, polymers, composites, electronic and magnetic materials. The language of instruction used in lectures is Indonesian.				

Graduate Learning Outcome (GLO)	
GLO-1	Apply the concepts of one of the following fields of Physics or Applied Physics:

	a. Nuclear Physics & Theoretical Particles b. Material Physics c. Condensed Matter Physics d. Physical System & Instrumentation e. Medical Physics & Biophysics
GLO-2	Formulating problems and solving Physics and its application, as well as interdisciplinary problems related to science and mathematics clumps critically, creatively, and innovatively.
GLO-3	Apply knowledge of Physics in society and practical life, as well as identify and adapt to new things.
Course Learning Outcome (CLO)	
CLO	After completing this course, students are able to solve simple structured problems related to the structure of metals, ceramics, and polymers and their correlation with the method of formation and the properties of the resulting material. (C4)
Sub-CLO(s)	
Sub-CLO 1	Be able to explain the bonds and atomic structure. (C2)
Sub-CLO 2	Able to explain crystal structure and crystal defects and perform mathematical calculations related to crystal structure. (C3)
Sub-CLO 3	Be able to determine the type of dislocation and the material strengthening mechanism. (C3)
Sub-CLO 4	Be able to correlate structure with material properties. (C4)
Sub-CLO 5	Be able to correlate material formation methods with material properties. (C4)
Study Materials	• Atomic structures and bonds • Crystal structure • Crystal defects • Dislocation and reinforcement mechanisms • Mechanical properties of metals • Structure and properties of ceramics

	• The structure and properties of the polymer • Metal forming process • The process of forming ceramics • The polymer formation process
Reading List	1. W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007. 2. Related articles and journals.

I. Teaching Plan

Week	Sub-CLO	Study Materials [with reference]	Teaching Method [with est. time]	Learning Experiences (*O-E-F)	Sub-CLO Achievement Indicator		Sub-CLO Weight on Course (%)
					General	Specific	
1	Sub-CLO 1 Be able to explain the bonds and atomic structure. (C2)	Atomic structure • Electrons in atoms • Periodic arrangement Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Synchronous, face-to-face lectures on msTeam (40 minutes) Asynchronous, Videos and materials on EMAS (60 minutes)	O (100%): Synchronous Face-to-face lectures via msTeam. Asynchronous Watch videos and read materials on EMAS	After attending lectures (synchronous), reading material and watching videos on EMAS (asynchronous), students can explain the arrangement of electrons in atoms and their correlation with the periodic table arrangement.	Students can explain the system for determining the periodic arrangement.	50%
		Atomic bond • Binding force and energy • Primary atomic bonds • Secondary atomic bonds Reference: W.D. Callister, Jr. Materials Science and	Asynchronous, Videos and materials on EMAS (60 minutes)	O (50%): Asynchronous Watch videos and read materials on EMAS	After attending lectures (synchronous), reading material and watching videos on EMAS	Students can explain the difference between primary atomic bonds and	50%

		Engineering: An Introduction, 7th Ed, John Wiley & Sons	Asynchronous, sub-CLO 1 test in EMAS (40 minutes)	E (40%): Work on achievement test questions for sub-CLO 1 in EMAS F (10%): Answers to the sub-CLO achievement test questions 1	(asynchronous), students can explain the concept of binding force and energy.	secondary atomic bonds.	
2	Able to explain crystal structure and crystal defects and perform mathematical calculations related to crystal structure. (C3)	Crystal structure • Definition • Unit cell • Metal crystal structure • Calculation of density • Point coordinates • Crystal field • Field direction • Linear and plane density • Closed-packed crystal structure Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Focus group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion (FGD) via msTeam F (30%): Group discussion	After reading the material and conducting FGD discussions, students can explain the crystal system and its related parameters.	Students can apply mathematical calculations to determine the direction, plane, and density of the crystal, and the crystal coordinate number.	20%

				(FGD) via msTeam			
	Able to explain crystal structure and crystal defects and perform mathematical calculations related to crystal structure. (C3)	Crystal structure • Definition • Unit cell • Metal crystal structure • Calculation of density • Point coordinates • Crystal field • Field direction • Linear and plane density • Closed-packed crystal structure Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Home group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion (HGD) via msTeam	After reading the material and having a HGD discussion, students can explain the crystal system and its related parameters.	Students can apply mathematical calculations to determine direction, plane, density, and crystal coordinate numbers.	20%
3	Able to explain crystal structure and crystal defects and perform mathematical calculations	Crystal structure • Definition • Unit cell • Metal crystal structure • Calculation of density • Point coordinates • Crystal field • Field direction • Linear and plane density	Presentation and clarification (100 minutes)	E (20%): Synchronous Group presentation via msTeam F (80%): Synchronous	After reading the material and discussing FGD and HGD, students can explain the crystal system and its related parameters.	Mahasiswa dapat menerapkan perhitungan matematis untuk menentukan arah, bidang, dan kerapatan	20%

	related to crystal structure. (C3)	• Closed-packed crystal structure Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007		Clarification via msTeam		kristal, dan bilangan koordinat kristal	
	Able to explain crystal structure and crystal defects and perform mathematical calculations related to crystal structure. (C3)	Crystal defects • Point defects • Linear-dislocation defect • Interfacial defects • Volume or bulk defects • Atomic vibration Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Focus group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion (FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	After reading the material and conducting FGD discussions, students can explain the types and causes of defects in crystals.	Students can explain the phenomenon of point defects, dislocation, interfacial, and volume.	10%
4	Able to explain crystal structure and crystal	Crystal defects • Point defects • Linear-dislocation defect • Interfacial defects • Volume or bulk defects	Asynchronous, reading material in EMAS (2x20 minutes)	O (20%): Asynchronous Reading material on the EMAS	After reading the material and having a HGD discussion, students can	Students can explain the phenomenon of point defects, dislocation,	10%

	defects and perform mathematical calculations related to crystal structure. (C3)	• Atomic vibration Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Synchronous, Home group discussion on msTeam (60 minutes)	E (50%): Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion (HGD) via msTeam	explain the types and causes of defects in crystals.	interfacial, and volume	
	Able to explain crystal structure and crystal defects and perform mathematical calculations related to crystal structure. (C3)	Crystal defects • Point defects • Linear-dislocation defect • Interfacial defects • Volume or bulk defects • Atomic vibration Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Presentation and clarification (100 minutes)	E (20%): Synchronous Group presentation via msTeam F (80%): Synchronous Clarification via msTeam	After reading the material and conducting FGD and HGD discussions, students can explain the types and causes of defects in crystals.	Students can explain the phenomenon of point defects, dislocation, interfacial, and volume	10%
5	Able to explain crystal	Crystal structure Crystal defects	Asynchronous, watch videos on	O (20%): Asynchronous	students are able to solve simple		10%

	structure and crystal defects and perform mathematical calculations related to crystal structure. (C3)	Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	EMAS (2x10 minutes) Asynchronous, reading material in EMAS (2x10 minutes) Sub-CLO 2 test in EMAS (40 minutes)	Watch videos and read materials on EMAS E (60%): Asynchronous Working on achievement problems for sub-CLO 2 in EMAS F (20%): Asynchronous Answers to sub-CLO 2 questions in EMAS	problems related to crystal structure and crystal defects		
	Be able to determine the type of dislocation and the material strengthening mechanism. (C3)	Dislocation and reinforcement mechanism • The concept of dislocation • Dislocation characteristics • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials • Twinning deformation	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Focus group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion	After reading the material and conducting FGD discussions, students can explain the concept of dislocation and its application	Students can explain the phenomenon of dislocation and various deformations for material reinforcement	30%

		• Reinforcement by reducing grain size • Solid-solution strengthening • Strain hardening • Recovery • Recrystallization • Grain growth Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007		(FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	in strengthening the material.		
6	Be able to determine the type of dislocation and the material strengthening mechanism. (C3)	Dislocation and reinforcement mechanism • The concept of dislocation • Dislocation characteristics • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials • Twinning deformation • Reinforcement by reducing grain size • Solid-solution strengthening • Strain hardening • Recovery • Recrystallization • Grain growth	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Home group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion	After reading the material and having a HGD discussion, students can explain the concept of dislocation and its application in strengthening the material.	Students can explain the phenomenon of dislocation and various deformations for material reinforcement.	30%

		Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007		(HGD) via msTeam			
	Be able to determine the type of dislocation and the material strengthening mechanism. (C3)	Dislocation and reinforcement mechanism • The concept of dislocation • Dislocation characteristics • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials • Twinning deformation • Reinforcement by reducing grain size • Solid-solution strengthening • Strain hardening • Recovery • Recrystallization • Grain growth Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Presentation and clarification (60 minutes) Sub-CLO 3 test in EMAS (40 minutes)	E (60%): Synchronous Presentation via msTeam. Asynchronous Sub-CLO 3 achievement test via EMAS F (40%): Synchronous Clarification via msTeam. Asynchronous Answers to sub-CLO 3 achievement test questions via EMAS	After reading the material and conducting FGD and HGD discussions, students can explain the concept of dislocation and its application in strengthening the material.	Students can explain the phenomenon of dislocation and various deformations for material reinforcement.	40%
7	Be able to correlate structure with material	Metal mechanical properties • Stress-strain concept • Stress-strain behavior • Inelasticity	Asynchronous, reading material in EMAS (2x20 minutes)	O (20%): Asynchronous	After reading the material and conducting FGD	Students can explain stress-strain diagrams, the concept of	10%

	properties. (C4)	• The elastic properties of the material • Creepiness • Real stress-strain • Elastic recovery after plastic deformation • Compression, punter and torsional deformations • Violence Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Synchronous, Focus group discussion on msTeam (60 minutes)	Reading material on the EMAS E (50%): Synchronous Group discussion (FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	discussions, students can explain the methods of measuring various metal mechanical properties.	measuring mechanical properties with Tensile, compression, and torsional tests	
	Be able to correlate structure with material properties. (C4)	Metal mechanical properties • Stress-strain concept • Stress-strain behavior • Inelasticity • The elastic properties of the material • Creepiness • Real stress-strain • Elastic recovery after plastic deformation • Compression, punter and torsional deformations • Violence	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Home group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%):	After reading the material and having a HGD discussion, students can explain the methods of measuring various metal mechanical properties.	Students can explain stress-strain diagrams, the concept of measuring mechanical properties with Tensile, compression, and torsional tests.	10%

		Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007		Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion (HGD) via msTeam			
8	Mid Term Exam						
9	Be able to correlate structure with material properties. (C4)	Metal mechanical properties • Stress-strain concept • Stress-strain behavior • Inelasticity • The elastic properties of the material • Creepiness • Real stress-strain • Elastic recovery after plastic deformation • Compression, punter and torsional deformations • Violence	Presentation and clarification (100 minutes)	E (20%): Synchronous Group presentation via msTeam F (80%): Synchronous Clarification via msTeam	After reading the material and conducting FGD and HGD discussions, students can explain the measurement methods of various metal mechanical properties.	Students can explain stress-strain diagrams, the concept of measuring mechanical properties with Tensile, compression, and torsional tests.	10%

		Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007					
	Be able to correlate structure with material properties. (C4)	Structure and properties of ceramics • Ceramic structure • Silicates • Carbon • Ceramic defects • Ion diffusion • Ceramic phase diagram • Mechanical properties of ceramics • Plastic deformation mechanism Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Focus group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion (FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	After reading the material and conducting FGD discussions, students can correlate the structure and properties of ceramics.	Students can explain the structure and defects of ceramic crystals and their consequences on the mechanical properties of ceramics	10%
10	Be able to correlate structure with material properties. (C4)	Structure and properties of ceramics • Ceramic structure • Silicates • Carbon • Ceramic defects	Asynchronous, reading material in EMAS (2x20 minutes)	O (20%): Asynchronous Reading material on the EMAS	After reading the material and having a HGD discussion, students can correlate the	Students can explain the structure and defects of ceramic crystals and their	10%

		• Ion diffusion • Ceramic phase diagram • Mechanical properties of ceramics • Plastic deformation mechanism Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Synchronous, Home group discussion on msTeam (60 minutes)	E (50%): Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion (HGD) via msTeam	structure and properties of ceramics.	consequences on the mechanical properties of ceramics	
	Be able to correlate structure with material properties. (C4)	Structure and properties of ceramics • Ceramic structure • Silicates • Carbon • Ceramic defects • Ion diffusion • Ceramic phase diagram • Mechanical properties of ceramics • Plastic deformation mechanism Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Presentation and clarification (100 minutes)	E (20%): Synchronous Group presentation via msTeam F (80%): Synchronous Clarification via msTeam	After reading the material and conducting FGD and HGD discussions, students can correlate the structure and properties of ceramics.	Students can explain the structure and defects of ceramic crystals and their consequences on the mechanical properties of ceramics	10%

11	Be able to correlate structure with material properties. (C4)	Polymer structure and properties • Hydrocarbon molecules • Polymer molecules • Molecular weight • Molecular shape • Molecular structure • Thermoplastic and thermosetting polymers • Copolymers • Polymer crystallinity • Polymer crystals • Polymer defects • Diffusion in polymers Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Focus group discussion on msTeam (60 minutes)	O (20%): Asynchronous Read material on EMAS E (50%): Synchronous Group discussion (FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	After reading the material and conducting FGD discussions, students can correlate the structure and properties of the polymer.	Students can explain the molecular structure of the polymer and its mathematical calculations	10%
	Be able to correlate structure with material properties. (C4)	Polymer structure and properties • Hydrocarbon molecules • Polymer molecules • Molecular weight • Molecular shape • Molecular structure • Thermoplastic and thermosetting polymers • Copolymers • Polymer crystallinity • Polymer crystals	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Home group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS	After reading the material and having a HGD discussion, students can correlate the structure and properties of the polymer.	Students can explain the molecular structure of the polymer and its mathematical calculations	10%

		• Polymer defects • Diffusion in polymers Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007		E (50%): Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion (HGD) via msTeam			
12	Be able to correlate structure with material properties. (C4)	Polymer structure and properties • Hydrocarbon molecules • Polymer molecules • Molecular weight • Molecular shape • Molecular structure • Thermoplastic and thermosetting polymers • Copolymers • Polymer crystallinity • Polymer crystals • Polymer defects • Diffusion in polymers	Presentation and clarification (100 minutes)	E (20%): Synchronous Group presentation via msTeam F (80%): Synchronous Clarification via msTeam	After reading the material and conducting FGD and HGD discussions, students can correlate the structure and properties of the polymer.	Students can explain the molecular structure of the polymer and its mathematical calculations.	10%

		Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007					
	Be able to correlate structure with material properties. (C4)	Metal mechanical properties Structure and properties of ceramics Polymer structure and properties	Asynchronous, watch videos on EMAS (2x10 minutes) Asynchronous, reading material in EMAS (2x10 minutes) Asynchronous, achievement test sub-CLO 4 in EMAS (40 minutes)	E (60%): Synchronous Presentation via msTeam. Asynchronous Sub-CLO 4 performance test via EMAS F (40%): Synchronous Clarification via msTeam. Asynchronous Answers to sub-CLO 4 achievement test questions via EMAS	after reading the material students can correlate the structure and properties of metals, ceramics, and polymers.	Mahasiswa dapat menyelesaikan soal sederhana terkait sifat mekanik logam, struktur dan sifat mekanik keramik, dan struktur dan sifat polimer.	10%
13	Be able to correlate material formation	Metal and ceramic forming process • Metal type • Metal fabrication	Asynchronous, reading material in EMAS (2x20 minutes)	O (20%): Asynchronous Read material on EMAS	After reading the material and conducting FGD	Students can explain various fabrication methods and	16%

	methods with material properties. (C4)	• Metal heating process • Types of ceramics • Ceramic fabrication and processing Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Synchronous, Focus group discussion on msTeam (60 minutes)	E (50%): Synchronous Group discussion (FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	discussions, students can correlate the process of forming metals and ceramics with the resulting mechanical properties.	metal heating and the resulting properties as well as ceramic fabrication methods and the resulting properties.	
	Be able to correlate material formation methods with material properties. (C4)	Metal and ceramic forming process • Metal type • Metal fabrication • Metal heating process • Types of ceramics • Ceramic fabrication and processing Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Home group discussion on msTeam (60 minutes)	O (20%): Asynchronous Read material on EMAS E (50%): Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion	After reading the material and having a HGD discussion, students can correlate the process of forming metals and ceramics with the resulting mechanical properties.	Students can explain various fabrication methods and metal heating and the resulting properties as well as ceramic fabrication methods and the resulting properties.	16%

				(HGD) via msTeam			
14	Be able to correlate material formation methods with material properties. (C4)	Metal and ceramic forming process • Metal type • Metal fabrication • Metal heating process • Types of ceramics • Ceramic fabrication and processing Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Presentation and clarification (100 minutes)	E (20%): Synchronous Group presentation via msTeam F (80%): Synchronous Clarification via msTeam	After reading the material and conducting FGD and HGD discussions, students can correlate the process of forming metals and ceramics with the resulting mechanical properties.	Students can explain various fabrication methods and metal heating and the resulting properties as well as ceramic fabrication methods and the resulting properties.	16%

	Be able to correlate material formation methods with material properties. (C4)	Polymer formation process • Mechanical properties of polymers • Deformation mechanism for polymer reinforcement • Crystallization, melting and glass transition of polymers • Type of polymer • Polymer synthesis and processing Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Focus group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion (FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	After reading the material and conducting FGD discussions, students can correlate the polymer formation process with the resulting properties.	Students can explain various polymer fabrication methods and the resulting properties.	16%

15	Be able to correlate material formation methods with material properties. (C4)	Polymer formation process • Mechanical properties of polymers • Deformation mechanism for polymer reinforcement • Crystallization, melting and glass transition of polymers • Type of polymer • Polymer synthesis and processing Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007	Asynchronous, reading material in EMAS (2x20 minutes) Synchronous, Home group discussion on msTeam (60 minutes)	O (20%): Asynchronous Reading material on the EMAS E (50%): Synchronous Group discussion (HGD) via msTeam F (30%): Group discussion (HGD) via msTeam	After reading the material and having a HGD discussion, students can correlate the polymer formation process with the resulting properties.	Students can explain various polymer fabrication methods and the resulting properties.	16%
	Be able to correlate material formation methods with material properties. (C4)	Polymer formation process • Mechanical properties of polymers • Deformation mechanism for polymer reinforcement • Crystallization, melting and glass transition of polymers • Type of polymer • Polymer synthesis and processing	Synchronous in ms Team, presentation and classification (60 minutes) Asynchronous, sub-CLO 5 test in EMAS (40 minutes)	E (60%): Synchronous Presentation via msTeam. Asynchronous Sub-CLO 5 performance test via EMAS F (40%):	After reading the material and conducting FGD and HGD discussions, students can correlate the polymer formation process with the	Students can explain various polymer fabrication methods and the resulting properties.	20%

		Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007		Synchronous Clarification via msTeam. Asynchronous Answers to sub-CLO 5 achievement test questions via EMAS	resulting properties.		
16	Final Exam						

II. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
1	Sub-CLO 1 evaluation test	1	Doing questions on EMAS	• Atomic structure • Atomic bonds	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
1	Homework 1	1	Doing question	• Atomic structure • Atomic bonds	Individual assignment at home	1 week	answer sheet at EMAS
2	Focus group discussion	2	Discussion in MsTeams	Crystal structure	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
2	Home group discussion	2	Discussion in MsTeams	Crystal structure	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
3	Presentation	2	Presentation in MsTeams	Crystal structure	Group presentation, synchronous on ms Team	100 minutes	Presentation powerpoint slides
3	Focus group discussion	2	Discussion in MsTeams	Crystal defect	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
4	Home group discussion	2	Discussion in MsTeams	Crystal defect	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results

4	Presentation	2	Presentation in MsTeams	Crystal defect	Group presentation, synchronous on ms Team	100 minutes	Presentation powerpoint slides
4	Sub-CLO 2 evaluation test	2	Doing questions on EMAS	• Crystal structure • Crystal defect	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
4	Homework 2	2	Doing question	• Crystal structure • Crystal defect	Individual assignment at home	1 week	answer sheet at EMAS
5	Focus group discussion	3	Discussion in MsTeams	Dislocation and reinforcement mechanism	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
5	Home group discussion	3	Discussion in MsTeams	Dislocation and reinforcement mechanism	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
6	Presentation	3	Presentation in MsTeams	Dislocation and reinforcement mechanism	Group presentation, synchronous on ms Team	60 minutes	Presentation powerpoint slides
6	Sub-CLO 3 evaluation test	3	Doing questions on EMAS	Dislocation and materials reinforcement mechanism	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
6	Homework 3	3	Doing question	Dislocation and materials reinforcement mechanism	Individual assignment at home	1 week	answer sheet at EMAS

7	Focus group discussion	4	Discussion in MsTeams	Metal mechanical properties	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
7	Home group discussion	4	Discussion in MsTeams	Metal mechanical properties	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
8	Mid Term Exam	1, 2, 3	Work on problems	• Atomic structure • Atomic bonds • Crystal structure • Crystal defects • Dislocation and material strengthening mechanism	Individual assignments in EMAS	100 minutes	answer sheet at EMAS
9	Presentation	4	Presentation in MsTeams	Metal mechanical properties	Group presentation, synchronous on ms Team	100 minutes	Presentation powerpoint slides
9	Focus group discussion	4	Discussion in MsTeams	Structure and properties of ceramics	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
10	Home group discussion	4	Discussion in MsTeams	Structure and properties of ceramics	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
10	Presentation	4	Presentation in MsTeams	Structure and properties of ceramics	Group presentation,	100 minutes	Presentation powerpoint slides

					synchronous on ms Team		
11	Focus group discussion	4	Discussion in MsTeams	Structure and properties of polymer	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
11	Home group discussion	4	Discussion in MsTeams	Structure and properties of polymer	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
12	Presentation	4	Presentation in MsTeams	Structure and properties of polymer	Group presentation, synchronous on ms Team	100 minutes	Presentation powerpoint slides
12	Sub-CLO 4 evaluation test	4	Doing questions on EMAS	• Mechanical properties of metals • Structure and properties of ceramics • structure and properties of the polymer	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
12	Homework 4	4	Doing question	• Mechanical properties of metals • Structure and properties of ceramics • structure and properties of the polymer	Individual assignment at home	1 week	answer sheet at EMAS
13	Focus group discussion	5	Discussion in MsTeams	Metal and ceramic forming process	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results

13	Home group discussion	5	Discussion in MsTeams	Metal and ceramic forming process	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
14	Presentation	5	Presentation in MsTeams	Metal and ceramic forming process	Group presentation, synchronous on ms Team	100 minutes	Presentation powerpoint slides
14	Focus group discussion	5	Discussion in MsTeams	polymer forming process	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
15	Home group discussion	5	Discussion in MsTeams	polymer forming process	Group discussion, synchronous on ms Team	60 minutes	Video recording of discussion results
15	Presentation	5	Presentation in MsTeams	polymer forming process	Group presentation, synchronous on ms Team	60 minutes	Presentation powerpoint slides
15	Sub-CLO 5 evaluation test	5	Doing questions on EMAS	• Metal forming process • The process of forming ceramics • The polymer formation process	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
15	Homework 5	5	Doing question	• Metal forming process • The process of forming ceramics • The polymer formation process	Individual assignment at home	1 week	answer sheet at EMAS
16	Final Exam	4,5	Work on problems	• Metal forming process • The process of forming ceramics • The polymer formation process	Individual assignments in EMAS	100 minutes	answer sheet at EMAS

III. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Discussion activities	2, 3, 4, 5	Discussion rubric	16 times	20%
Presentation	2, 3, 4, 5	Presentation rubric	8 times	10%
Sub-CLO Problem test	1, 2, 3, 4, 5	Multiple choices problem at EMAS	5 times	20%
Homework	1, 2, 3, 4, 5	Essay problems	4 times	10%
Mid term exam	1, 2, 3	Essay problems at EMAS	1 times	20%
Final exam	4, 5	Essay problems at EMAS	1 times	20%
			Total:	100%

IV. Rubric(s)

a. Essay Question Score Criteria (Individual assignment, mid term exam, final exam)

Nilai	Kualitas Jawaban
100	The answer is very precise, all the definitions and main components are complete
76-99	The answer is quite precise, the meaning and the main components are almost complete
51-75	Inaccurate answers, incomplete understanding and main components
26-50	The answer is very inaccurate, the meaning and the main components are very incomplete
<25	Wrong answer

b. Rubrik Nilai Presentasi kelompok

No	Category	4	3	2	1
1	Group member cooperation	Cooperate well with members in the group and become a facilitator for the group	Less cooperation with the group	Very individual. Only work with one person	Does not cooperate well with group members
2	Mastery of the material	Mastering the material well and without text when presenting.	Not mastering the material and without text when presenting.	Not mastering the material and using text when presenting.	Not mastering the material.
3	Delivery of material	The material is easy to understand with good body language.	Partial material can be understood with good body language.	The material is less understandable.	The material cannot be understood.

Presentation score = (total score/12) x 100

c. Rubrik Nilai Diskusi kelompok

No	Category	4	3	2	1
1	Involvement of group members	All members are involved in the discussion	Most of the members were involved in the discussion and a few were not	A few were involved in the discussion and most were not	All members showed no intention and effort to discuss
2	Discussion results	Answer all the questions given correctly	Answering most of the questions correctly and a few incorrectly	Answering a small number of questions given and mostly imprecise	Absolutely not answering the questions given correctly
3	Reference use	Using references appropriately to answer the problems in the discussion material	Most of them use references to answer the problems in the discussion material	A small proportion use references in answering the problems in the discussion material.	Do not use references in answering problems in the discussion material.

Discussion score = (total score/12) x 100

The conversion of the final value (student passing grade) follows the value conversion provisions applicable at the University of Indonesia as follows. Minimum pass criteria is C.

Score	Grade	Equivalent
85 - 100	A	4.00
80 - < 85	A-	3.70
75 - < 80	B+	3.30
70 - < 75	B	3.00
65 - < 70	B-	2.70
60 - < 65	C+	2.30
55 - < 60	C	2.00

40 - < 50	D	1.00
< 40	E	0.00