

## TEACHING INSTRUCTIONAL DESIGN (BRP) COURSE

INTRODUCTION TO MATERIAL SCIENCE

by

Anawati, PhD

Undergraduate Program in Physics
Faculty of Mathematics and Natural Sciences
Universitas Indonesia
Depok
September 2020



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

	TEACHING INST	RUCTIONAL D	ESIGN						
Course Name	Introduction to Material Scoence	Credit(s)	Prerequisite course(s)	Requisite for course(s)	Integration Between Other Courses				
Course Code	SCPH603703		Modern						
Relation to Curriculum	Elective Course		Physics,						
Semester	6	4	Introduction to	-	-				
Lecturer(s)	Anawati, PhD  Ariadne L Juwono, PhD	Solid State Physics							
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								
<b>Graduate Learning Outcome</b> (	GLO)								
GLO-1	Apply the concepts of one or	f the following fie	elds 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				
Formulating problems and solving Physics and its application, as well as interdisciplinary				
problems related to science and mathematics clumps critically, creatively, and innovatively.				
Apply knowledge of Physics in society and practical life, as well as identify and adapt to new				
things.				
After completing this course, students are able to solve simple structured problems related to t				
structure of metals, ceramics, and polymers and their correlation with the method of formation				
and the properties of the resulting material. (C4)				
Be able to explain the bonds and atomic structure. (C2)				
Able to explain crystal structure and crystal defects and perform mathematical calculations				
related to crystal structure. (C3)				
Be able to determine the type of dislocation and the material strengthening mechanism. (C3)				
Be able to correlate structure with material properties. (C4)				
Be able to correlate material formation methods with material properties. (C4)				
• 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	
	1. W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley &	
Reading List	Sons, Inc., 2007.	
	2. Related articles and journals.	

#### I. Teaching Plan

				Learning		chievement	Sub-CLO
Week	Sub-CLO	Study Materials	Teaching Method	Experiences	Indic	cator	Weight on
		[with reference]	[with est. time]	(*O-E-F)	General	Specific	Course (%)
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	Asynchronous, sub-	E (40%):	(asynchronous),	secondary	
			,	` /	· •		
		Ed, John Wiley & Sons	CLO 1 test in	Work on	students can	atomic bonds.	
			EMAS (40 minutes)	achievement	explain the		
				test questions	concept of		
				for sub-CLO	binding force		
				1 in EMAS	and energy.		
				F (10%):			
				Answers to			
				the sub-CLO			
				achievement			
				test questions			
				test questions			
				1			20%
2		Crystal structure		O (20%):			20%
	Able to	Definition		Asynchronous			
	explain	• Unit cell		Reading		Students can	
	crystal	Metal crystal structure	Asynchronous,	material on	After reading	apply	
	structure and	• Calculation of density	reading material in	the EMAS	the material and	mathematical	
		Point coordinates	_		conducting	calculations to	
	crystal		EMAS (2x20	E (50%):	FGD		
	defects and	• Crystal field	minutes)	Synchronous	discussions,	determine the	
	perform	• Field direction	_	Group	students can	direction, plane,	
	mathematical	• Linear and plane density	Synchronous, Focus	discussion	explain the	and density of	
	calculations	<ul> <li>Closed-packed crystal structure</li> </ul>	group discussion on	(FGD) via	crystal system	the crystal, and	
	related to		msTeam (60	msTeam	and its related	the crystal	
	crystal	Reference: W.D. Callister, Jr.	minutes)	ms ream		coordinate	
	structure.	Materials Science and		E (200/):	parameters.	number.	
	(C3)	Engineering: An Introduction, 7th		F (30%):			
	, ,	Ed, John Wiley & Sons, Inc., 2007		Group			
		, , , , , , , , , , , , , , , , , , , ,		discussion			

	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)	(FGD) via msTeam O (20%): Asynchronous Reading material on the EMAS  E (50%): Synchronous Group discussion (HGD) via msTeam  F (30%): Group discussion (HGD) via	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	Crystal structure  • Definition  • Unit cell  • Metal crystal structure  • Calculation of density  • Point coordinates  • Crystal field  • Field direction	Presentation and clarification (100 minutes)	E (20%): Synchronous Group presentation via msTeam  F (80%):	After reading the material and discussing FGD and HGD, students can explain the crystal system and its related	Mahasiswa dapat menerapkan perhitungan matematis untuk menentukan	20%
	calculations	Linear and plane density		Synchronous	parameters.	arah, bidang, dan kerapatan	

	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	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%
	Able to	Crystal defects	Asynchronous,	O (20%):	After reading	Students can	10%
	explain	• Point defects	reading material in	Asynchronous	the material and	explain the	
4	crystal	• Linear-dislocation defect	EMAS (2x20	Reading	having a HGD	phenomenon of	
	structure and	• Interfacial defects	minutes)	material on	discussion,	point defects,	
	crystal	Volume or bulk defects		the EMAS	students can	dislocation,	

	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%):	explain the types and causes of defects in crystals.	interfacial, and volume	
	A11 /			Group discussion (HGD) via msTeam			10%
	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	
5	Able to explain crystal	Crystal structure Crystal defects	Asynchronous, watch videos on	O (20%): Asynchronous	students are able to solve simple		10%

Crystal defects and perform mathematical calculations related to crystal structure. (C3)   C3   C3   C3   C3   C3   C4   C3   C4   C4	structure and	Reference: W.D. Callister, Jr.	EMAS (2x10	Watch videos	problems		
defects and perform mathematical calculations related to crystal structure.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  C3)  Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007  Asynchronous, reading material in EMAS (2x10 E (60%): minutes)  Asynchronous, Asynchronous Working on achievement EMAS  Asynchronous, Answers to sub-CLO 2 in EMAS  Asynchronous, reading material in EMAS  Asynchronous, reading material in EMAS  F (20%): Asynchronous, reading material in EMAS  England and revistal defects  C3)  Asynchronous, reading material in EMAS  Asynchronous, reading material in EMAS  Synchronous, reading material in EMAS  Asynchronous, reading material in EMAS  Asynchronous  As		· · · · · · · · · · · · · · · · · · ·	,		*		
perform mathematical calculations related to crystal structure.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  C3)  C4 Asynchronous, reading material in EMAS (40 minutes)  Asynchronous, reading material in EMAS  C4 (20)  Minutes)  Asynchronous, reading material in EMAS  Asynchronous, reading material in EMAS  C4 (20)  Minutes)  Asynchronous, reading material in EMAS  C5 (220)  Minutes)  Asynchronous, reading material in EMAS  C6 (20%):  Asynchronous, reading material in EMAS  C7 (20%):  Asynchronous, reading material in EMAS  C7 (20%):  Asynchronous, reading material in EMAS  C8 (220)  Minutes)  Asynchronous Answers to sub-CLO 2 questions in EMAS  C9 (20%):  Asynchronous Answers to sub-CLO 2 questions in EMAS  C9 (20%):  Asynchronous Answers to sub-CLO 2 questions in EMAS  C9 (20%):  Asynchronous Answers to sub-CLO 2 questions in EMAS  C9 (20%):  Asynchronous Answers to sub-CLO 2 questions in EMAS  C9 (20%):  Asynchronous Answers to sub-CLO 2 questions in EMAS  C9 (20%):  C9 (20%):	•		minutes)				
mathematical calculations related to crystal structure.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism achievement problems for sub-CLO 2 questions in EMAS  (C3)  After reading material on the material and streading material in EMAS (2x20 minutes)  E (50%):  Synchronous Answers to sub-CLO 2 questions in EMAS  (C3)  Asynchronous Answers to sub-CLO 2 questions in EMAS  (C3)  After reading the material and streading material on the material and streading material in EMAS (2x20 minutes)  Synchronous, reading material in EMAS (2x20 minutes)  E (50%):  Synchronous After a diagram a		,	Asynchronous		"		
related to crystal structure.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the group of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the group of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the group of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the group of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the group of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the group of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the group of dislocation and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism of dislocation and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism of dislocation and the material in EMAS (2x20 minutes)  Synchronous, Focus group discussion on ms Team (60 minutes)  Synchronous Reading material on the EMAS students can explain the phenomenon of dislocation and group discussion on ms Team (60 minutes)  Twinning deformation of minutes of minutes of material in EMAS (2x20 minutes)  Synchronous Reading material in EMAS (2x20 minutes)  Synchronous Reading material on the material and conducting material on the EMAS students can explain the phenomenon of dislocation and students can explain the phenomenon of dislocation and dislocation	1	Ed, John Whey & Sons, He., 2007	,	LWAS	_		
related to crystal structure.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to destruction and the material strengthening mechanism.  (C3)  Twinning deformation of polycrystalline materials strengthening (C3)  Twinning deformation of polycrystalline materials of the polycrystal in the polycr				E (600/)	defects		
crystal structure. (C3)  Be able to determine the type of dislocation and the material strengthening mechanism. (C3)  Dislocation characteristics  System slip  Sub-CLO 2 test in EMAS  Asynchronous, reading material in EMAS (2x20 minutes)  Synchronous, Focus group discussion on ms Team (60 polycrystalline materials  Sub-CLO 2 test in EMAS  F (20%): Asynchronous, Answers to sub-CLO 2 questions in EMAS  O (20%): Asynchronous, Reading material and conducting material on the EMAS  Students can explain the phenomenon of dislocation and various deformation strengthening mechanism.  (C3)  Working on achievement problems for sub-CLO 2 in EMAS  F (20%): Asynchronous, Reading material in EMAS  Students can explain the phenomenon of dislocation and various deformations for material enconcept of dislocation and various deformations for material reinforcement in EMAS  Sub-CLO 2 in EMAS  F (20%): Asynchronous, Reading material on the EMAS  Students can explain the phenomenon of dislocation and various deformations for material reinforcement in EMAS  Synchronous Reading material on the EMAS  Synchronous, Focus group discussion on ms Team (60)  Synchronous  Synchronous discussions, students can explain the concept of dislocation and various deformations for material reinforcement in EMAS			`	` ′			
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Sub-CLO 2 to EMAS  Asynchronous Answers to sub-CLO 2 questions in EMAS  O (20%): Asynchronous Asynchronous Reading material in EMAS (2x20 minutes)  Synchronous, Focus group discussion on msTeam (60 minutes)  Be able to determine the type of dislocation and the material strengthening mechanism.  System slip  Synchronous, Focus group discussion on msTeam (60 minutes)  Synchronous Reading material on the EMAS  E (50%): Synchronous Group  Students can explain the discussions, students can explain the group discussion on msTeam (60 minutes)  Be able to determine the type of dislocation and the material and conducting phenomenon of discussions, students can explain the group discussion on msTeam (60 minutes)  Be able to determine the type of dislocation and the material and conducting phenomenon of discussions, students can explain the group discussion on msTeam (60 minutes)  Be able to determine the type of dislocation and the material and conducting explain the group discussion on msTeam (60 minutes)  Be able to determine the type of dislocation and the material and conducting explain the group discussion on material on the EMAS discussions, students can explain the group discussion on msTeam (60 minutes)  Be able to determine the type of dislocation and the type of dislocation and the material and conducting explain the group discussion on the EMAS discussion and the material and conducting explain the group discussion on the EMAS discussion and the material and conducting explain the group discussion on the EMAS discussion and the material and conducting explain the group discussion on the EMAS discussion and the material and conducting explain			minutes)	_			
EMAS (40 minutes)  EMAS (40 minutes)  problems for sub-CLO 2 in EMAS  F (20%): Asynchronous Answers to sub-CLO 2 questions in EMAS  Be able to determine the type of dislocation and the material strengthening mechanism  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism  (C3)  EMAS (40 minutes)  F (20%): Asynchronous Asynchronous reading material in EMAS  O (20%): Asynchronous Reading material on the EMAS  System slip Synchronous, reading material on the EMAS Synchronous, Reading material on the EMAS Synchronous the material and conducting FGD minutes)  E (50%): Synchronous Group  Synchronous Group  dislocation and reinforcement  conducting FGD phenomenon of dislocation and various deformations for material reinforcement	· ·						
Be able to determine the type of dislocation and the material strengthening mechanism (CC3).  Sub-CLO 2 in EMAS  F (20%): Asynchronous Answers to sub-CLO 2 questions in EMAS  Asynchronous, reading material in EMAS (2x20 minutes)  Synchronous, reading material on the material and conducting material on the EMAS discussions, students can explain the phenomenon of dislocation and various deformations or msTeam (60 minutes)  Synchronous Group discussion and reinforcement mechanism  Synchronous Reading material on the EMAS discussions, students can explain the concept of dislocation and various deformations for material reinforcement reinforcement							
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  EMAS  F (20%): Asynchronous Answers to sub-CLO 2 questions in EMAS  O (20%): Asynchronous, reading material in EMAS (2x20 minutes)  FMAS (2x20 minutes)  Synchronous, reading material in EMAS (2x20 minutes)  Synchronous, reading material on the EMAS discussions, students can explain the phenomenon of dislocation and various deformation some material properties of minutes)  FEOD minutes (50%): Synchronous Reading material on the EMAS discussions, students can explain the phenomenon of dislocation and various deformations for material reinforcement mechanism.  FOD minutes (50%): Synchronous Group discussion on msTeam (60 minutes)  FOD discussions, students can explain the phenomenon of dislocation and various deformations for material reinforcement	(C3)		EMAS (40 minutes)	-			
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and reinforcement mechanism opolycrystalline materials  (C3)  Be able to determine the type of dislocation and reinforcement mechanism opolycrystalline material on the material strengthening opolycrystalline materials opolycrystalline materials  (C3)  Be able to determine the type of dislocation and reinforcement mechanism opolycrystalline material on the EMAS opolycrystalline material opolycrystal							
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and treinforcement mechanism  • The concept of dislocation echaracteristics • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials  • Twinning deformation  • Asynchronous, reading material in EMAS (2x20 minutes)  • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials  • Twinning deformation  • Twin				EMAS			
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and treinforcement mechanism  • The concept of dislocation end and the material strengthening mechanism.  • Twinning deformation  • Asynchronous, reading material in EMAS (2x20 minutes)  • System slip  • Slip on a single crystal  • Plastic deformation  • Twinning deformation							
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Asynchronous, reading material in EMAS (2x20 minutes)  Asynchronous, reading material in EMAS (2x20 minutes)  Asynchronous, reading material in EMAS (2x20 minutes)  System slip  Synchronous, Focus group discussion on msTeam (60 minutes)  E (50%): Synchronous the material and conducting material on the EMAS discussions, students can explain the deformations  Synchronous Group discussion and reinforcement  Students can explain the conducting material on the EMAS students can explain the deformations  Synchronous Group dislocation and reinforcement				, ,			
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and reinforcement mechanism  • The concept of dislocation eharacteristics • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials • Twinning deformation  • Twinning deformation  • Twinning deformation  • Dislocation and reinforcement mechanism  • The concept of dislocation • Dislocation and reinforcement mechanism  • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials • Twinning deformation				Asynchronous			
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism objects and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism objects and the material in the type of dislocation of polycrystalline materials  Synchronous, reading material in the material in the phenomenon of the EMAS of the material and conducting material on the EMAS of the material and conducting material on the EMAS of the material and discussions, dislocation and objects and the material on the EMAS of the material and conducting material on the EMAS of the material and discussions, dislocation and objects and the material on the EMAS of the material and the material on the EMAS of the material on the EMAS of the material and discussions, and the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the material on the EMAS of the EMAS of the EMAS of the material on the EMAS of t				Answers to			
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism  Asynchronous, reading material in EMAS (2x20 minutes)  EMAS  O (20%): Astre reading the material and Reading conducting explain the material on the EMAS discussions, students can various deformation of msTeam (60 minutes)  EMAS  O (20%): Asynchronous the material and Students can explain the material on the EMAS discussions, students can various deformation msTeam (60 minutes)  EMAS  O (20%): Asynchronous the material and Students can explain the material on the EMAS discussions, students can various deformations  Synchronous concept of for material material on the EMAS discussions, students can explain the deformations  Synchronous concept of dislocation and reinforcement material on the EMAS discussions, students can explain the deformations  Synchronous concept of dislocation and reinforcement material in EMAS (2x20 minutes)				sub-CLO 2			
Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Dislocation and reinforcement mechanism  Dislocation and reinforcement mechanism  Asynchronous, reading material in EMAS (2x20 minutes)  Asynchronous, reading material in EMAS (2x20 minutes)  Asynchronous, reading material in EMAS (2x20 minutes)  Asynchronous, Reading conducting material on the EMAS discussions, students can explain the phenomenon of dislocation and various deformation  Synchronous, Focus group discussion on msTeam (60 minutes)  Asynchronous Reading conducting material and students can explain the phenomenon of dislocation and various deformations  Synchronous Group dislocation and reinforcement				questions in			
Be able to determine the type of dislocation and the material strengthening mechanism.  Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)  Be able to determine the type of dislocation and reinforcement mechanism  Dislocation and reinforcement mechanism.  Asynchronous, reading material in EMAS (2x20 minutes)  Asynchronous, Reading material on the EMAS  Students can explain the phenomenon of dislocation and various group discussion on msTeam (60 minutes)  E (50%):  Synchronous concept of dislocation and reinforcement dislocation and reinforcement mechanism.  Asynchronous, Reading material on the EMAS  Students can explain the phenomenon of dislocation and various group discussion on msTeam (60 minutes)  For material and conducting explain the phenomenon of dislocation and various deformations  Synchronous, reading material in EMAS  Synchronous, reading material on the EMAS  Synchronous of dislocation and various deformations  For material on the EMAS  Students can explain the phenomenon of dislocation and various deformations  For material on the EMAS  Synchronous of dislocation and various deformation dislocation and reinforcement				EMAS			
determine the type of dislocation and the material strengthening mechanism.  (C3)  determine the type of dislocation and the material strength ening mechanism.  (C3)  determine the type of dislocation the type of dislocation and the material strength ening mechanism.  (C3)  determine the type of dislocation the type of dislocation the type of dislocation characteristics the type of dislocation the type of dislocation the type of dislocation the type of dislocation the material and conducting material on the EMAS  Students can explain the phenomenon of dislocation and various group discussion on material the phenomenon of the EMAS  Synchronous, Focus group discussion on msTeam (60 minutes)  Synchronous Group dislocation and reinforcement	Do abla to	Dislocation and minforcement	Agymahmanaya	O (20%):	After reading		30%
the type of dislocation and the material strengthening mechanism.  (C3)  The concept of dislocation dislocation  • The concept of dislocation  • Dislocation characteristics  • Dislocation characteristics  • System slip  • Slip on a single crystal  • Plastic deformation of polycrystalline materials  • Twinning deformation  • The concept of dislocation  • Dislocation characteristics  • System slip  • Slip on a single crystal  • Plastic deformation  • Twinning deformation  • The concept of dislocation  • Dislocation characteristics  • Synchronous, Focus group discussion on msTeam (60  minutes)  • Reading material on the phenomenon of dislocation and various  • Synchronous group discussion on msTeam (60  minutes)  • C3)  • Twinning deformation  • Twinning deformation			· ·	Asynchronous	the material and	Students can	
dislocation and the material strengthening mechanism.  (C3)  Dislocation characteristics  • Dislocation characteristics  • Dislocation characteristics  minutes)  material on the EMAS  Synchronous, Focus group discussion on msTeam (60 minutes)  E (50%): Synchronous  Synchronous  FGD discussions, dislocation and various  explain the concept of dislocation and dislocation and dislocation and dislocation and reinforcement				Reading	conducting	explain the	
and the material strengthening mechanism.  (C3)  • System slip • Slip on a single crystal • Plastic deformation of polycrystalline materials • Twinning deformation  • System slip • Slip on a single crystal • Plastic deformation  Synchronous, Focus group discussion on msTeam (60 minutes)  Twinning deformation  • System slip • Synchronous, Focus group discussion on msTeam (60 minutes)  Synchronous  Group  The EMAS  discussions, students can explain the concept of dislocation and reinforcement	• •	1	`	material on	FGD	phenomenon of	
material strengthening mechanism.  (C3)  *Slip on a single crystal strengthening mechanism.  *Slip on a single crystal students can explain the group discussion on msTeam (60 minutes)  Synchronous, Focus group discussion on msTeam (60 minutes)  Synchronous Group  Students can explain the concept of dislocation and reinforcement			minutes)	the EMAS	discussions,	dislocation and	
strengthening mechanism.  (C3)  • Plastic deformation of polycrystalline materials  • Twinning deformation  • Plastic deformation of polycrystalline materials  • Twinning deformation  • Twinning deformation  minutes)  • Twinning deformation  minutes)  • Plastic deformation of msTeam (60 group discussion on msTeam (60 group discussion on msTeam (60 dislocation and reinforcement		±			students can	various	
strengthening mechanism.  (C3)  • Plastic deformation of polycrystalline materials  • Twinning deformation  • Plastic deformation of polycrystalline materials  • Twinning deformation  group discussion on msTeam (60 Group dislocation and reinforcement		1 6 .	· ·	E (50%):	explain the	deformations	
mechanism. polycrystalline materials ms Team (60 group dislocation and reinforcement minutes)	0 0		• •	` /		for material	
(C3)   • Twinning deformation   minutes)   • Twinning deformation   minutes)		1 0 0	`		1 *		
discussion   its application	(C3)	Twinning deformation	minutes)	discussion	its application		

		<ul> <li>Reinforcement by reducing grain size</li> <li>Solid-solution strengthening</li> <li>Strain hardening</li> <li>Recovery</li> <li>Recrystallization</li> <li>Grain growth</li> <li>Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley &amp; Sons, Inc., 2007</li> <li>Dislocation and reinforcement</li> </ul>		(FGD) via msTeam F (30%): Group discussion (FGD) via msTeam	in strengthening the material.		30%
6	Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)	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	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.	3070

	Be able to determine the type of dislocation and the material strengthening mechanism.  (C3)	Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007 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 Metal mechanical properties	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 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.	10%
7	correlate structure with material	<ul> <li>Stress-strain concept</li> <li>Stress-strain behavior</li> <li>Inelasticity</li> </ul>	reading material in EMAS (2x20 minutes)	O (20%): Asynchronous	the material and conducting FGD	explain stress- strain diagrams, the concept of	. 1070

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

		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%

	Be able to correlate structure with material properties. (C4)	Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007  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%

	<ul> <li>Ion diffusion</li> <li>Ceramic phase diagram</li> <li>Mechanical properties of ceramics</li> <li>Plastic deformation mechanism</li> <li>Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley &amp; Sons, Inc., 2007</li> </ul>	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 structure  • Thermoplastic and thermosetting polymers  • Copolymers  • Polymer crystallinity  • 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%

		<ul> <li>Polymer defects</li> <li>Diffusion in polymers</li> <li>Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley &amp; Sons, Inc., 2007</li> </ul>		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 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%

	Be able to correlate structure with material properties. (C4)	Reference: W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007  Metal mechanical properties Structure and properties of ceramics Polymer structure and properties  Metal and ceramic forming	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  O (20%):	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.	16%
	correlate	process	reading material in	Asynchronous	the material and	explain various	10/0
13	material	-	_	Read material		fabrication	
		• Metal type	EMAS (2x20		conducting		
	formation	Metal fabrication	minutes)	on EMAS	FGD	methods and	

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

m	Be able to correlate material formation aethods 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)	(HGD) via msTeam  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	Students can explain various fabrication methods and metal heating and the resulting properties as well as ceramic fabrication methods and the resulting properties.	16%
		Ed, John Wiley & Sons, Inc., 2007			mechanical properties.	properties.	

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	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.	Synchronous	resulting	
		Materials Science and	Clarification	properties.	
		Engineering: An Introduction, 7th	via msTeam.		
		Ed, John Wiley & Sons, Inc., 2007	Asynchronous		
			Answers to		
			sub-CLO 5		
			achievement		
			test questions		
			via EMAS		
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	<ul><li>Crystal structure</li><li>Crystal defect</li></ul>	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
4	Homework 2	2	Doing question	<ul><li>Crystal structure</li><li>Crystal defect</li></ul>	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	<ul> <li>Atomic structure</li> <li>Atomic bonds</li> <li>Crystal structure</li> <li>Crystal defects</li> <li>Dislocation and material strengthening mechanism</li> </ul>	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	<ul> <li>Mechanical properties of metals</li> <li>Structure and properties of ceramics</li> <li>structure and properties of the polymer</li> </ul>	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
12	Homework 4	4	Doing question	<ul> <li>Mechanical properties of metals</li> <li>Structure and properties of ceramics</li> <li>structure and properties of the polymer</li> </ul>	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	<ul><li> Metal forming process</li><li> The process of forming ceramics</li><li> The polymer formation process</li></ul>	Individual assignments in EMAS	40 minutes	answer sheet at EMAS
15	Homework 5	5	Doing question	<ul><li> Metal forming process</li><li> The process of forming ceramics</li><li> The polymer formation process</li></ul>	Individual assignment at home	1 week	answer sheet at EMAS
16	Final Exam	4,5	Work on problems	<ul><li> Metal forming process</li><li> The process of forming ceramics</li><li> The polymer formation process</li></ul>	Individual assignments in EMAS	100 minutes	answer sheet at EMAS

#### III. Assessment Criteria (Learning Outcome Evaluation)

<b>Evaluation Type</b>	Sub-CLO	Assessment Type	Frequency	<b>Evaluation Weight (%)</b>
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	5 times	20%
		EMAS		
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 =  $(total score/12) \times 100$ 

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 =  $(total score/12) \times 100$ 

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	В	3.00
65 - < 70	B-	2.70
60 - < 65	C+	2.30
55 - < 60	С	2.00

40 - < 50	D	1.00
< 40	E	0.00