TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

MATERIALS PROPERTIES

by

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I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Materials Properties
3.	Course Code	:	SCFI603512
4.	Semester	:	7th
5.	Credit	:	3 credits
6.	Teaching Method(s)	:	Interactive lectures, cooperative learning, individual assignments, and written exams.
7.	Prerequisite course(s)	:	Introduction to Material Science
8.	Requisite for course(s)	:	None
9.	Integration Between Other Courses	:	None
10.	Lecturer(s)	:	Dr. Anawati Dr. Bambang Soegijono Dr. Vivi Fauzia Dr. Dede Djuhana
11.	Course Description	:	The Material Properties course is a compulsory subject given to students who are interested in Material Physics in semester 7. Students are expected to be able to study in an integrated manner the structure, properties, and processing critically to keep up with the latest developments in the science and technology of metallic, ceramics, polymers and composites materials and their proper applications. The scope of this course is to explain fundamentally the mechanical, electrical, optical, magnetic, and thermal properties, as well as metal corrosion and material degradation. Lectures are delivered using the flipped class-room method and cooperative learning. Lectures are presented online via EMAS and delivered in Indonesian.

II. Course Learning Outcome (CLO) and Sub-CLOs

A. CLO

After participating in the Material Properties course, 7th semester students of the physics undergraduate study program with a special interest in materials physics are able to identify and examine material properties as well as metal corrosion and material degradation (C4).

B. Sub-CLOs

1. Be able to identify and examine mechanical properties (C4).
2. Be able to identify and study electrical and optical properties (C4).
3. Be able to identify and study magnetic and thermal properties (C4).
4. Be able to identify and study metal corrosion and material degradation (C4).

II. Teaching Plan

Week	Sub-CLO	Study Materials	Teaching Method	Learning Experiences (*O-E-F)	Sub-CLO Weight on Course (%)	Sub-CLO Achievement Indicator		Ref.
						General	Specific	
1-3	1	Deformation of elastic and plastic, deformation due to tensile forces, compressive forces, shear forces and rotational forces; hardness, toughness, impact, fatigue and creep.	2 x 50 minutes reading reference material 1 x 50 minutes Synchronous, face-to-face virtual meeting 1 x 120 minutes discussion in Focus Group on EMAS 1 x 120 minutes discussion in the Home Group on EMAS 40 minutes creating PowerPoint files in Focus Group 20 minutes of presentation and clarification 60 minutes of exam in 3rd week	30% O (explanation at initial meeting), 50% E (group discussion), 20% F (clarification)	100	Able to describe in depth the mechanical properties of materials.	Make presentation files according to academic standards.	[1] Ch. 6, 7, 8
4	2	Free electron and metal band theory; Drude's classical theory and quantum theory, Matthiessen's Rule, Hall Effect, Wiedemann-Franz Ratio, Conductive polymers, Joule Heating.	50 minutes of synchronous lectures, virtual face-to-face meetings 3 x 50 minutes group assignment	50% O (Synchronous: Face to face at Ms Teams) 50% E	20	Be able to explain the concept of metal conductivity using classical and quantum theory.	1. Able to explain problems that the classical theory of metals cannot explain. 2. Able to explain the	[1] Ch. 18

				(Asynchronous: Doing group assignments on EMAS) 25% F (Asynchronous: Discussion of group assignments on EMAS)			Hall and Wiedemann-Franz Ratio effect and polymer conductivity.	
5	2	Semiconductors; group IV semiconductors, intrinsic and extrinsic semiconductors, semiconductor Fermi energy level, Hall coefficient, semiconductor conductivity, polymer semiconductors.	1 x 50 minutes watching video lectures on EMAS 3 x 50 minutes group assignment calculates the relationship between electron mobility and concentration and temperature on EMAS 1 x 50 minutes group assignment to analyze the Fermi semiconductor energy level curve on EMAS	50% O (Asynchronous: Watch video lectures and read material on EMAS) 30% E (Asynchronous: Doing exercises on EMAS) 20% F (Asynchronous: Answers to workouts on EMAS)	20	Able to explain in depth the electrical properties of various types of semiconductors.	1. Able to explain in depth the concept of the energy band structure of various types of semiconductors. 2. Be able to explain and calculate the relationship between Fermi energy, electron and hole concentration and temperature.	[1] Ch. 18
6	2	Semiconductor Devices; PN diode and Schottky diode applications.	1 x 50 minutes watching video lectures on EMAS 3 x 50 minute assignments to create a WIKI assignment on EMAS	50% O (Asynchronous: Watch video lectures on EMAS) 30% E (Asynchronous: Doing assignments on EMAS)	20	Able to explain in depth the charge transport mechanism in semiconductors.	Be able to explain the mechanism of action of PN diode and Schottky diode.	[1] Ch. 18

				20% F (Asynchronous: Answers to assignments on EMAS)				
7	2	Dielectric and Dielectric Functions; dielectric conductivity, dielectric polarization, dielectric, ferroelectric and piezoelectric functions.	1 x 50 minutes Asynchronous course on EMAS 2 x 50 minutes group assignment to make a dielectric material glossary on EMAS 1 x 50 minutes of synchronous discussion at Ms Teams	40% O (Asynchronous: watch video lectures on EMAS) 50% E (Asynchronous Doing assignments on EMAS) 10% F (Synchronous Responses to assignments on EMAS)	20	Able to explain in depth the electrical properties of dielectric materials.	1. Able to explain the concept of dielectric material polarization. 2. Able to explain and calculate the relationship between capacitance, permittivity, impedance and frequency. 3. Able to explain in general the ferroelectric, piezoelectric and pyroelectric mechanisms.	[1] Ch. 21
8	2	Optical properties of the material; electromagnetic waves, refractive index, refraction, reflectance, transmittance, absorbance, extension, optical properties of conductive materials, semiconductors and dielectrics.	50 minute online lecture on Ms Teams 3 x 50 minutes analyzing the absorbance curve on EMAS	40% O (Asynchronous: face-to-face virtual lectures at Ms Teams) 50% E (Asynchronous: Doing assignments on EMAS)	20	Able to describe in depth the optical properties of materials.	1. Able to explain concepts, refractive index, refraction, reflectance, transmittance, extinction. 2. Able to analyze the optical properties curves of metals, semiconductors and	[1] Ch. 21

				10% F (Asynchronous: Answers to assignments and post-tests on EMAS)			dielectrics	
9	3	Magnetic Material; basic concepts of magnets and magnetic phenomena, magnetic domains and hysteresis curves.	Flipped Learning (Self-learning; Asynchronous structured learning through the EMAS platform and discussion/synchronization via the Ms Teams)	40% O (Asynchronous: Reading material on EMAS) 30% E (Asynchronous: Doing assignments on EMAS) 30% F (Synchronous: Discussion in Ms Teams)	25	Able to explain in general the magnetic phenomenon of the material.	Able to explain the basic principles of magnetism, magnetic domains, and hysteresis curves.	[1] Ch. 20
10	3	Magnetic Material Applications; Magnetic material based technology applications: (1) Magneto-optic effect: Faraday and Kerr Effect, (2) Magnetoresistance: Ordinary and Anisotropic MR, Giant MR and Colossal MR and Superconductors.	Flipped Learning (Self-learning; Asynchronous structured learning through the EMAS platform and discussion/synchronization via the Ms Teams)	40% O (Asynchronous: Reading material on EMAS) 30% E (Asynchronous: Doing assignments on EMAS) 30% F (Synchronous: Discussion in Ms Teams)	25	Able to explain in general the application of magnetic material based technology based on magneto-optics and magnetoresistance (MR).	Able to explain Faraday effect, Kerr effect, and magnetoresistance phenomena (Ordinary and Anisotropy MR, Giant MR and Colossal MR and Superconductor).	[1] Ch. 20

11	3	Thermal Properties of Materials; lattice heat capacity: (1) classical model and (2) Debye model, thermal conductivity, grating thermal conductivity, and thermal expansion.	Flipped Learning (Self-learning; Asynchronous structured learning through the EMAS platform and discussion/synchronization via the Ms Teams)	40% O (Asynchronous: Reading material on EMAS) 30% E (Asynchronous: Doing assignments on EMAS) 30% F (Synchronous: Discussion in Ms Teams)	25	Be able to explain in general the thermal properties of materials related to heat capacity, thermal conduction and thermal expansion.	Be able to describe heat capacity in classical and quantum perspectives (Debye model), thermal conductivity of gas and lattice / phonon models, and classical thermal expansion and energy functions.	[1] Ch. 19
12	3	Application of Material Thermal Properties; transport effect and application of thermal properties such as thermocouple, thermoelectric.	Flipped Learning (Self-learning; Asynchronous structured learning through the EMAS platform and discussion/synchronization via the Ms Teams)	40% O (Asynchronous: Reading material on EMAS) 30% E (Asynchronous: Doing assignments on EMAS) 30% F (Synchronous: Discussion in Ms Teams)	25	Able to explain in general the phenomenon of transport and application of thermal properties to materials.	Be able to explain the transport effect based on Fourier, Fick and Ohm's law. Thermal properties applications such as thermocouples and thermoelectrics.	[1] Ch. 19
13	4	Electrochemical reaction; definition, reaction equilibrium, corrosion principle, cell potential.	Synchronous, virtual face-to-face meeting (40 minutes) Asynchronous, reading material on EMAS (2 x 20 minutes)	100% O (Synchronous Virtual face-to-face lectures on Ms Teams. Asynchronous Watch lecturing	25	After attending lectures (synchronous), reading material and viewing videos on EMAS (asynchronous),	Students can calculate the potential of corrosion electrochemical reaction cells in acidic, alkaline, and neutral environments.	[1] Ch. 17

			Asynchronous, watch the material video on EMAS (2 x 10 minutes)	videos on EMAS).		students can explain the electrochemical reactions of corrosion in various environments.		
14	4	Corrosion thermodynamics; Gibbs free energy, Nernst equation, Pourbaix diagram	Asynchronous, watch a video lecturing on EMAS (2 x 10 minutes) Asynchronous, reading material on EMAS (2 x 20 minutes) Asynchronous, doing Practice problem-1 (40 minutes)	40% O (Asynchronous Watch lecturing videos on EMAS. Read material on EMAS) 40% E (Asynchronous Doing Practice problem-1 on EMAS) 20% F (Asynchronous Answers to Practice problem-1 on EMAS)	25	After reading the material and viewing the video on EMAS (asynchronous), students can analyze the Pourbaix diagram.	Students can construct a Pourbaix diagram for Fe and Al.	[1] Ch. 17
15	4	Corrosion kinetics; definition, cell corrosion, polarization.	Asynchronous, watch a video lecturing on EMAS (2 x 10 minutes) Asynchronous, reading material on EMAS (2 x 20 minutes) Asynchronous, doing Practice problem-2 (40 minutes)	40% O (Asynchronous Watch lecturing videos on EMAS. Read material on EMAS) 40% E (Asynchronous Doing Practice problem-2 on EMAS)	25	After reading the material and watching the video on EMAS (asynchronous), students were able to identify the phenomena of activation and diffusion polarization.	Students can apply mathematical calculations in the phenomena of activation and diffusion polarization.	[1] Ch. 17

				20% F (Asynchronous Answers to Practice questions-2 on EMAS)				
16	4	Degradation of ceramics and polymers; degradation of ceramics, swelling of polymers, breaking of polymer bonds, weathering.	Asynchronous, watch a video lecturing on EMAS (2 x 10 minutes) Asynchronous, reading material on EMAS (2 x 20 minutes) Asynchronous, doing Practice problem-3 (40 minutes)	40% O (Asynchronous Watch lecturing videos on EMAS. Read material on EMAS) 40% E (Asynchronous Doing Practice problem-3 on EMAS) 20% F (Asynchronous Answers to Practice problem-3 on EMAS)	25	After reading the material and watching videos on EMAS (asynchronous), students can identify degradation phenomena in ceramics and polymers.	Students can analyze the types of degradation in ceramics and polymers.	[1] Ch. 17

*) O : Orientation
E : Exercise
F : Feedback

References:

[1] W.D. Callister, Jr. Materials Science and Engineering: An Introduction, 7th Ed, John Wiley & Sons, Inc., 2007
[2] L.H. Van Vlack, Materials Science for Engineers, 6th Ed, Addison-Wesley Pub. Co., Bab 1 – 7, 1975
[3] Donald R. Askeland, The Science and Engineering of Materials, 2nd S.I. Ed, Chapman & Hall, 1990.

III. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Method	Time limit	Outcome
3	Assignment	1	Problem set	Mechanical properties of materials	Individual assignment	1 week	Answer uploaded to EMAS
4	Assignment	2	Problem set	Electrical properties of the material	Group assignment	1 week	Answer uploaded to EMAS
5	Assignment	2	Problem set	Electrical properties of the material	Group assignment	1 week	Answer uploaded to EMAS
6	Assignment	2	Presentation video	Electrical properties of the material	Individual assignment	1 week	Answer uploaded to EMAS
7	Assignment	2	Problem set	Optical properties of the material	Group assignment	1 week	Answer uploaded to EMAS
8	Assignment	2	Presentation video	Optical properties of the material	Individual assignment	1 week	Answer uploaded to EMAS
9	Assignment	3	Problem set	Magnetic properties of the material	Individual assignment	1 week	Answer uploaded to EMAS
10	Assignment	3	Problem set	Magnetic properties of the material	Individual assignment	1 week	Answer uploaded to EMAS
11	Assignment	3	Problem set	Thermal properties of the material	Individual assignment	1 week	Answer uploaded to EMAS
12	Assignment	3	Problem set	Thermal properties of the material	Individual assignment	1 week	Answer uploaded to EMAS
14	Assignment	4	Problem set	Corrosion and degradation of materials	Individual assignment	1 week	Answer uploaded to EMAS
15	Assignment	4	Problem set	Corrosion and degradation of materials	Individual assignment	1 week	Answer uploaded to EMAS
16	Assignment	4	Problem set	Corrosion and degradation of materials	Individual assignment	1 week	Answer uploaded to EMAS

IV. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Assigments	1, 2, 3	Assignments	5	41
Presentations	2		2	17
Discussions	3		4	33
Exams	1		1	9
			Total	**100**

V. Rubric(s)

A. Conversion of the student's final score

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

B. Assessment rubric: assignment report

Criteria	Score	Indicator
Introduction	4	Contains: (1) background for the preparation of the report, (2) problem identification / gap analysis, (3) questions (4) objectives, and (5) citing relevant and current references
	3	Loads the goal and 3 of the other 4 items
	2	Loading objective and 2 of the other 4 items
	1	Does not contain the purpose of preparing the report, there are one or more than 4 other items
	0	Does not contain objectives and 4 other items
Content	4	Structured & cohesive, conducts a comprehensive literature review and performs a complete critical analysis
	3	Structured, conduct a comprehensive literature review and complete critical analysis

	2	Less structured, conducting literature reviews but less comprehensive and carrying out simple critical analysis
	1	Unstructured & cohesive, review of literature is not comprehensive and does not contain critical analysis
Conclusion	4	Related to the implementation of tasks and there are suggestions for feasible improvements to the next assignment
	3	It is related to the implementation of tasks and there are suggestions for improvement of the next assignment but it is not feasible
	2	Regarding the implementation of the task but no suggestions
	1	Not related to the execution of duties and no suggestions
	4	The report is neat and attractive, complete with cover and photo / picture
	3	The report is neat and attractive, with a cover or photo / image
	2	The report includes a cover or photo / image but is not neat or attractive
	1	The report is not neat and unattractive, does not have a cover and photo / image
	4	Easy to understand, correct word choice, and spelling all right
	3	Easy to understand, correct word choice, some misspellings
	2	Less understandable, inaccurate word choice, and some misspellings
	1	It is not easy to understand, the choice of words is not quite right, and there are lots of misspellings