TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

THERMODYNAMICS OF MATERIALS

by

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PREFACE

The Teaching Instructional Design (BRP) in the Thermodynamics of Materials course was prepared to be used as a reference for learning in the Thermodynamics of Materials subject in the FMIPA UI Undergraduate Physics Study Program, which was attended by physics students who were interested in material physics in semester 6 on the condition that the student had taken the Introduction to Materials Science course. In the Thermodynamics of Materials course, students will be taught about the application of thermodynamic physics concepts and evaluate the results of thermal treatment on materials appropriately. It is hoped that this BRP can become a reference in the learning process for both lecturers as teachers and students as course participants so that the material is conveyed properly and perfectly.

Depok, 20 November 2016

Dr. Nurlely, M.Si.

I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Thermodynamics of Materials
3.	Course Code	:	SCFI603513
4.	Semester	:	6th
5.	Credit	:	3 credits
6.	Teaching Method(s)	:	Interactive lectures, question-based learning, self-directed study, discussion, 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. Nurlely, M.Si.
11.	Course Description	:	After completing this lecture, physics students with a special interest in material physics in semester 6 are able to apply (C3) the concepts of thermodynamic physics and evaluate (C4) the results of thermal treatment on materials appropriately in accordance with the applicable laws of physics. The language of instruction used in this course is Indonesian.

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

A. CLO

Students are able to apply (C3) thermodynamic physics concepts and analyze (C4) the results of thermal treatment on materials appropriately. (ELO (s) 3, 5, 6, 8)

B. Sub-CLOs

1. Able to apply (C3) systematic thermodynamic principles in stages from basic principles to application.
2. Be able to correlate (C4) the response of the material with a given thermal effect.
3. Be able to build (C3) phase diagrams.
4. Be able to apply (C3) thermodynamic principles in analyzing phase diagrams.

II. Teaching Plan

Week	Sub-CLO	Study Materials	Teaching Method	Time Required	Learning Experiences (*O-E-F)	Sub-CLO Weight on Course (%)	Sub-CLO Achievement Indicator	References
1	Course Introduction							
2	1	Law of thermodynamics 1: conservation of energy, converting energy into heat and work	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain the concept of thermodynamic law 1	[1]
3	1	Thermodynamic laws 2 & 3: heat and entropy	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain the concept of thermodynamic law 2 & 3	[1]
4	1	Thermodynamic variables and their relationship as well as variations in heat capacity	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain the relationship between thermodynamic variables	[1]
5	2	Thermoelastic and magnetic effects	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	6.25	Be able to understand and explain thermoelastic and magnetic effects on materials	[1]
6	2	Thermodynamic equilibrium of the system and its parameter variations, first and second-order transitions, and chemical equilibrium in thermodynamic parameters	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	6.25	Able to understand and explain the concept of thermodynamic equilibrium and chemical equilibrium of materials and their transitions	[1]
7	1	Statistical thermodynamics:	Interactive	150 minutes	40% O, 30% E, 30% F	6.25	Able to understand and	[1]

		isolated systems, Boltzmann hypothesis, partition function, Maxwell-Boltzmann distribution	lectures, question-based learning, self-directed study, discussion				explain the concept of statistical thermodynamics	
8	**Mid-Term Exam**							
9	2	Thermal equilibrium and the Boltzmann equation and heat flow and entropy	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	6.25	Able to understand and explain the concept of thermal equilibrium and the Boltzmann equation	[1]
10	3	Thermodynamic functions: Enthalpy, Helmholtz free energy, Gibss free energy	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain thermodynamic functions	[1]
11	3	Closed systems, chemical potentials, the Maxwell, and Gibbs-Helmholtz Equations	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain closed system concepts and Maxwell and Gibbs-Helmholtz equations	[1]
12	3	Introduction to phase diagrams	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain phase diagram concepts for various transitions	[1]
13	4	Solid defects	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain the occurrence of defects in solid materials	[1]
14	4	Material surfaces and interfaces	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain the concept of surface and material interface	[1]

15	4	Diffusion and basic reaction kinetics	Interactive lectures, question-based learning, self-directed study, discussion	150 minutes	40% O, 30% E, 30% F	8.33	Able to understand and explain diffusion concepts and basic kinetics of materials	[1]
16	**Final Exam**							

*) O : Orientation
E : Exercise
F : Feedback

References:

[1] D. R. Gaskell, *Thermodynamics Material*, McGraw Hill, 1981.

[2] D. V. Ragone, *Thermodynamics of Materials*, Vol. I, John Wiley & Sons, Inc., 1995.

[3] J. Bevan Ott dan J. Boerio-Goates, *Chemical Thermodynamics*, Elsevier, 2000.

III. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
2-7, 9-15	Individual assignments	1-4	Problem set via EMAS platform	The entire range of material on the relevant week.	40 minutes		Answer sheets uploaded to EMAS
8	Mid-Term Exam	1-2	Problem set	• Law of thermodynamics 1: conservation of energy, converting energy into heat and work • Thermodynamic law 2: entropy and heat • Law of thermodynamics 3: entropy changes in chemical reactions • Thermodynamic variables and their relationship as well as variations in heat capacity • Thermoelastic and magnetic effects • Thermodynamic equilibrium of the system and its parameter variations, first and second-order transitions, and chemical equilibrium in thermodynamic parameters • Statistical thermodynamics: isolated systems, Boltzmann hypothesis, partition function, Maxwell-Boltzmann distribution	120 minutes		Answer sheets uploaded to EMAS
16	Final Exam	2-4	Problem set	• Thermal equilibrium and the Boltzmann equation and heat flow and entropy • Thermodynamic functions: Enthalpy, Helmholtz free energy, Gibss free energy • Closed systems, chemical potentials, the Maxwell, and Gibbs-Helmholtz Equations • Introduction to phase diagrams • Solid defects • Material surfaces and interfaces • Diffusion and reaction kinetics	120 minutes		Answer sheets uploaded to EMAS

IV. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Individual assignments	1-4	Summary or homework	1 per week	40
Mid-Term Exam	1-2	Exam questions via EMAS UI	1	30
Final Exam	2-4	Exam questions via EMAS UI	1	30
			Total	**100**

V. Rubric(s)

A. Criteria for Individual Assignments

Score	Presentation Delivery
>90	If students can complete more than 90% of the questions correctly
70-89	If students can complete more than 70% to 89% of the questions correctly
60-69	If students can complete more than 60% to 69% of the questions correctly
55-59	If students can complete more than 55% to 59% of the questions correctly
50-54	If students can complete more than 50% to 54% of the questions correctly

B. Criteria for Mid-Term Exam and Final Exam

1. Able to express ideas in solving problems (25%)
2. Able to determine the right basic concepts in problem-solving (35%)
3. Able to formulate the final solution to correct language errors (30%)
4. Able to use the appropriate important units and figures (10%)