TEACHING INSTRUCTIONAL DESIGN (BRP) COURSE

STATISTICAL PHYSICS

By

BUDHY KURNIAWAN

Undergraduate Program in Physics
Faculty of Mathematics
and Natural Sciences
Universitas Indonesia
Depok, July 20th 2020

UNIVERSITAS INDONESIA
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
PROGRAM STUDI FISIKA

TEACHING DESIGN BOOK

COURSE	**Statistical Physics**	**CREDITS**	**Prerequisite course(s)**	**Requisite for course(s)**	**Integration Between Other Courses**
COURSE CODE	SCPH603124	3	Thermodynamics	Solid-State Physics 1, Quantum Physics 2	Intoroduction to Solid-State Physics, Quantum Physics 1
Course Cluster	Compulsory Course				
Semester	5				
Lecturer(s)	Dr. Budhy Kurniawan				
Course Description	The Statistical Physics course is a continuation of Thermodynamics, this course supports analysis tools for advanced courses such as Solid-State Physics and Quantum Physics. The material provided includes random walks, statistical descriptions of particle systems, statistical thermodynamics, statistical mechanics methods, applications of statistical mechanics, equilibrium between phases and chemical species, quantum statistics, interacting particle systems, magnetism and low temperatures, transport phenomena, and irreversible processes and fluctuations. *The language of instruction used in this course is Indonesian.*				
Online Course Link	https://emas.ui.ac.id/course/view.php?id=9637				

LO-STUDY PROGRAM charged to the course	
CLO-1	Competent in applying classical and modern physics concepts and statistical approaches in thermodynamic problems.
CLO-2	Competent in formulating problems and solving thermodynamics, vibrations, waves, optics, electricity and magnetism.
CLO-3	Competent in deriving specific formulas for the problems being handled.
Course Learning Outcomes (CLO)	
CLO	After following this course, students are competent in applying the concepts of classical and quantum Statistical Physics to solve calculation problems correctly in condensed matter and nuclear physics.
Sub-CLO	
Sub-CLO 1	Competent in explaining the concept of random walk as a model for the description of particle motion on various conditions. (C2)
Sub-CLO 2	Competent in applying and categorizing statistical thermodynamics classical & quantum and use Statistical Physics for simple applications according to the characteristics of the existing methods in statistical mechanics (C3)
Sub-CLO 3	Competent in applying interphase balance and quantum statistics to analyze phenomena in solids. (C3)
Sub-CLO 4	Competent in calculating Statistical Physics for applications to condensed matter physics problems, magnetism at low temperatures, nuclear physics, particle physics, transport phenomena, irreversible processes, and fluctuations (C3)
Study Materials: Learning materials	1. Introduction 2. Description of Statistical Particle System 3. Statistical Thermodynamics

	4. Statistical Mechanics Method 5. Statistical Mechanics Application 6. Equilibrium between Phases and Chemical Species 7. Quantum Statistics 8. Interacting Particle System 9. Magnetism and Low Temperature 10. Transport Phenomenon 11. Process of Irreversible and Fluctuation
References	**1.** Sears, Salinger : Thermodynamics, kinetics theory and statistical thermodynamics Addison Wesley 1975. **2.** Pathria, R.K., Beale, P.D. : Statistical Mechanics. Elsevier, Ltd, 2011 **3.** Sears, Salinger : Thermodynamics and Statistical Mechanics, Springer-Verlag New York Inc, 1997

LESSON PLAN

*Wk	Sub-CLO (Expected final competence)	Study Material (Learning materials) [Reference]	Study Method [Time Estimation]	Learning mode	Learning Experience		Outcome Indication Sub-CLO	Quality of application of sub-CLO in the Course
					Orientation; Exercise; Feedback		General Indicators; Special Indicators	
					Online	Offline		
1-2	**Sub-CLO 1** Competent in explaining the concept of random walk as a	- **Introduction**	**- Interactive lectures (40 minutes)**	**Synchronous**, ms Team **Asynchronous**, EMAS	**O (40%)- Synchronous:** Interactive lectures via ms Team.		**General Indicators:** after the following lectures (synchronous), reading material and watching	10%

	model for the description of particle motion on various conditions.(C2)		**- Structured self-study:** 1. Read the material on EMAS (2x20 minutes). 2. Watch lecturing videos on EMAS (2x10 minutes) 3. Exercise questions (50 minutes)		Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.		videos on EMAS (asynchronous), students can explain the concept of random walk model to describe particle motions in various conditions.. **Special Indicators:** Students can apply basic mathematical and statistical equations in understanding the concept of random walk model to describe particle motions in various conditions.	
3	**Sub-CLO 2** Competent in applying and categorizing statistical thermodynamics classical & quantum and use Statistical Physics for simple applications according to the characteristics of the existing methods in	- Description of Statistical Particle System	**- Interactive lectures** (40 minutes) **- Structured self-study:** 1. Read the material on EMAS (2x20 minutes). 2. Watch lecturing videos on EMAS (2x10 minutes) 3. Exercise questions (50 minutes)	**Synchronous**, ms Team **Asynchronous**, EMAS	**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:**		**General Indicators:** after the following lectures (synchronous), reading material and watching videos on EMAS (asynchronous), students can apply and categorize statistical thermodynamics in classical cases. **Special Indicators:** Students can derive equations and apply them to various classical cases	10%

	statistical mechanics (C3)				Q&A in class. Asynchronous: Answers to exercise questions.			
4-5		- Statistical Thermodynamics	**Structured Self-Learning** **Flipped class** 1. Read the materials in EMAS (2x20 minutes). 2. Watch lecture videos in EMAS (2x10 minutes) 3. Read other reading sources to answer the exercise questions (40 minutes) 4. Exercise Questions (50 minutes)		**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.	**E (30%)-** Students look for reading references to answer questions in the exercises.	**General Indicators:** after reading the materials on EMAS, other reading sources, and viewing videos on EMAS (asynchronous), students can apply and categorize statistical thermodynamics in classical and quantum cases. **Special Indicators:** Students can apply them to various classical and quantum cases.	10%
6-7		- Statistical Mechanics Method and Applications of Statistical Mechanics	**Structured Self-Learning** **Flipped class** 1. Read the materials in EMAS (2x20 minutes).		**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing	**E (30%)-** Students look for reading references to answer questions in the exercises.	**General Indicators:** after reading the materials on EMAS, other reading sources, and viewing videos on EMAS (asynchronous), students can apply and use Statistical Physics for simple applications	15%

			2. Watch lecture videos in EMAS (2x10 minutes) 3. Read other reading sources to answer the exercise questions (40 minutes) 4. Exercise Questions (50 minutes)		lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.		according to the characteristics of the methods in statistical mechanics **Special Indicators:** Students can apply mathematical equations to statistical mechanics correctly.	
8	**Midterm Exam**							
9-10	**Sub-CLO 3** Competent in applying interphase balance and quantum statistics to analyze phenomena in solids. (C3)	- Equilibrium between Phases and Chemical Species	**- Interactive lectures** (40 minutes) **- Structured self-study:** 1. Read the material on EMAS (2x20 minutes). 2. Watch lecturing videos on EMAS (2x10 minutes) 3. Exercise questions (50 minutes)	**Synchronous**, ms Team **Asynchronous**, EMAS	**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.		**General Indicators:** after the following lectures (synchronous), reading material and watching videos on EMAS (asynchronous), students can apply the balance between phases and chemical species **Special Indicators:** Students can derive equations regarding the balance between phases and chemical species	10%

11-12		- Quantum Statistics	**Structured Self-Learning** **Flipped class** 1. Read the materials in EMAS (2x20 minutes). 2. Watch lecture videos in EMAS (2x10 minutes) 3. Read other reading sources to answer the exercise questions (40 minutes) 4. Exercise Questions (50 minutes)		**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.	**E (30%)-** Students look for reading references to answer questions in the exercises.	**General Indicators:** after reading the materials on EMAS, other reading sources, and watching videos on EMAS (asynchronous), students can explain quantum statistics correctly. **Special Indicators:** Students can apply quantum statistical equations appropriately.	10%
7		- Interaction of Particle Systems	**Structured Self-Learning** **Flipped class** 1. Read the materials in EMAS (2x20 minutes). 2. Watch lecture videos in EMAS (2x10 minutes) 3. Read other reading sources to answer the exercise		**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises	**E (30%)-** Students look for reading references to answer questions in the exercises.	**General Indicators:** after reading the materials on EMAS, other reading sources, and watching videos on EMAS (asynchronous), students can analyze phenomena in solids correctly. **Special Indicators:** Students can apply interphase balance	10%

			questions (40 minutes) 4. Exercise Questions (50 minutes)		at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.		and quantum statistics to analyze phenomena in solids.	
13	**Sub-CLO 4** Competent in calculating Statistical Physics for applications to condensed matter physics, nuclear physics, particle physics	- Magnetism and Low Temperature	**- Interactive lectures** (40 minutes) **- Structured self-study:** 1. Read the material on EMAS (2x20 minutes). 2. Watch lecturing videos on EMAS (2x10 minutes) 3. Exercise questions (50 minutes)	**Synchronous**, ms Team **Asynchronous**, EMAS	**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.	**E (30%)-** Students look for reading references to answer questions in the exercises.	**General Indicators:** after the following lectures (synchronous), reading material and watching videos on EMAS (asynchronous), students can calculate statistical physics for magnetism and low temperatures **Special Indicators:** Students can derive equations for the phenomenon of magnetism and low temperature	10%
14		- Transport Phenomena	**Structured Self-Learning Flipped class** 1. Read the materials in EMAS (2x20 minutes).		**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous:	**E (30%)-** Students look for reading references to answer questions in the exercises.	**General Indicators:** after the following lectures (synchronous), reading material and watching videos on EMAS	5%

			2. Watch lecture videos in EMAS (2x10 minutes) 3. Read other reading sources to answer the exercise questions (40 minutes) 4. Exercise Questions (50 minutes)		reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to exercise questions.		(asynchronous), students can explain statistical physics on transport phenomena **Special Indicators:** Students can apply statistical physics in transport phenomena appropriately.	
15		- Process of Irreversible and Fluctuation	**Structured Self-Learning** **Flipped class** 1. Read the materials in EMAS (2x20 minutes). 2. Watch lecture videos in EMAS (2x10 minutes) 3. Read other reading sources to answer the exercise questions (40 minutes) 4. Exercise Questions (50 minutes)		**O (40%)- Synchronous:** Interactive lectures via ms Team. Asynchronous: reading material and viewing lecturing videos on EMAS. **E (30%)- Asynchronous:** Doing exercises at EMAS. **F (30%)- Synchronous:** Q&A in class. Asynchronous: Answers to	**E (30%)-** Students look for reading references to answer questions in the exercises.	**General Indicators:** after the following lectures (synchronous), reading material and watching videos on EMAS (asynchronous), students can explain statistical physics on irreversible processes and fluctuations **Special Indicators:** Students can explain and apply statistical physics equations on irreversible processes and fluctuations appropriately.	5%

					exercise questions.			
16	**Final Term Exam**							

*) Wk: Week

**) Synchronous: learning interactions between lecturers and students are carried out at the same time, using video conferencing or chat technology.

Asynchronous: learning interactions are carried out flexibly and do not have to be at the same time, for example using discussion forums or independent study/student assignments.

RANCANGAN TUGAS DAN LATIHAN

Week	Assignment Name	Sub-CLO	Assignment	Scope	Working Procedure	Deadline	Outcome
1	Exercise 1	1	Problem Set	1. Introduction a. Random walk b. Probability c. Gaussian Distribution	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
2	Exercise 2	1	Problem Set	Statistical Description of Particle System	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
3	Exercise 3	1	Problem Set	Statistical Thermodynamics	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
	Group Discussion	1, 2, 3, 4	Bahan diskusi	**All Materials**	Online via EMAS by 5 groups	60 minutes	Discussion Rubric
4	Exercise 4	1	Problem Set	Statistical Mechanics Method	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
	Homework 1	1	Problem Set	**Statistical Mechanics Method**	Individual Assignment at home		Answer Sheet
5	Exercise 5	2	Problem Set	Statistical Mechanics Application	Online via EMAS	Exercise time 50 minutes (Questions	Online Score

						open 24 hours)	
6	Exercise 6	2	Problem Set	Equilibrium between Phases and Chemical Species	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
	Group Discussion	1, 2, 3, 4	Discussion	**All Materials**	Online via EMAS by 5 groups	60 minutes	Discussion Rubric
7	Exercise 7	2	Problem Set	Quantum System	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
	Homework 2	2	Problem Set	**Quantum Statistics**	Individual Assignment at home		Answer Sheet
9	Exercise 8	2	Problem Set	Interacting Particle Systems	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
10	Exercise 9	2	Problem Set	Magnetism and Low Temperature	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
11	Exercise 10	3	Problem Set	Transport Phenomena	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
12	Exercise 11	3	Problem Set	Irreversible and Fluctuation Processes	Online via EMAS	Exercise time 50 minutes (Questions	Online Score

						open 24 hours)	
	Homework 3	3	Problem Set	Irreversible and Fluctuation Processes	Individual Assignment at home		Answer Sheet
13	Exercise 12	3	Problem Set	Applications in Condensed Matter Physics	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
13	Exercise 13	4	Problem Set	Applications in Particle Physics	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
	Group Discussion	1, 2, 3, 4	Discussion	Applications in Particle Physics	Online via EMAS by 5 groups	60 minutes	Discussion Rubric
14	Exercise 14	4	Problem Set	Applications in Medical Physics, Instrumentation, etc.	Online via EMAS	Exercise time 50 minutes (Questions open 24 hours)	Online Score
	Homework 4	4	Problem Set	Applications in Medical Physics, Instrumentation, etc.	Individual Assignment at home		Answer Sheet
	Group Presentation	1, 2, 3, 4	Discussion	**All Materials**	Vidcon, msTeam	60 minutes	Presentation Video

Assessment Criteria (Evaluation of Learning Outcomes)

Sub-CLO	Evaluation Form	Assessment Instrument	Frequency	Evaluation Quality (%)
1, 2	- Midterm Exam	Written test via EMAS	1x	20
2, 3, 4	- Final Term Exam	Written test via EMAS	1x	20
1, 2, 3, 4	- Weekly Assignment	Online test via EMAS (multiple choice and short answer question) with online scoring directly at EMAS	14x	30
1, 2, 3, 4	- Problem Set Homework	Homework Answer Sheet	4x	10
1, 2, 3, 4	- Online Discussion	Discussion scoring rubric via EMAS	3x	10
1, 2, 3, 4	- Final Presentation via video conference.	Final presentation grading rubric	1x	10
Total				**100**

Guidance of Grading Criteria

Conversion of student final grades based on the applicable provisions at the University of Indonesia. The conversion grades are:

Score	Grade	Quality
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

Rubric:

a. Essay Question Assessment Criteria (Assignments, UTS, and UAS)

Score	Answer Quality
100	Answers are very precise and all the concept and main component are explained completely
76-99	Answers are fairly precise and the concept and main component are explained fairly complete
51-75	Answers are less precise and the concept and main component are explained less complete
26-50	Answers are poorly precise and the concept and main component are explained poorly complete
<25	Answers are wrong

b. Group Presentation Assessment Rubric Nilai

No	Category	4	3	2	1
1	Group member collaboration	Collaborate well with members in the group and become a facilitator for the group	Collaborate less with the group	Very individual. Only collaborate with one person	Does not collaborate well with group members
2	Material Understanding	Understand the material well and without text when presenting.	Understand less of the material and no text when presenting.	Understand less of the material and use of text when presenting.	Does not understand the material.
3	Material Delivery	The material is easy to understand with good body language.	Part of the material can be understood	The material is not understandable.	The material cannot be understood.

			with good body language.		

Presentation Grade = (total score/12) x 100

c. Assessment Rubric Group Discussion

No	Category	4	3	2	1
1	Involvement of group member	All of the members of the group are involved in the discussion	Most of the members of the group are involved in the discussion	Some of the members of the group are involved in the discussion	All of the members of the group does not intend and put the effort to discuss
2	Discussion Result	Answers all of the given questions correctly	Answer most of the given questions correctly.	Answers some of the given questions and most of them were less correct	Does not answer the given question at all
3	References use	Using the appropriate references to answer the problems in the discussion materials	Using the most appropriate references to answer the problems in the discussion materials	Using a little part of the references in answering the problems in the discussion materials.	Does not use any references in answering questions in the discussion materials.

Discussion Grade = (total score/12) x 100