TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

VIBRATIONS AND WAVES

by

Dr. Djonaedi Saleh

Undergraduate Program in Physics
Faculty of Mathematics and Natural Sciences
Universitas Indonesia
Depok
December 2017

PREFACE

Teaching Instructional Design, or BRP for short, contains a learning plan for one semester. BRP was prepared to be used as a reference for the Vibrations and Waves course at the Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Indonesia for the curriculum of 2016.

Vibrations and Waves course is scheduled to be followed by 4th-semester physics students, with the requirement that students have taken Basic Physics 3, Mathematical Physics 1, and Mathematical Physics 2 courses. This course synergizes with the Electromagnetic Field 1, Mathematical Physics 3, and Classical Mechanics courses.

In the Vibrations and Waves, students will study vibrations and waves phenomena in general and then learn in more detail about the properties of vibrations and waves and their use to analyze events in nature. At the end of the lecture, students will present the assignment given by the lecturer according to the topic of the lecture.

Vibrations and Waves BRP is expected to be a reference for the lectures on the student's learning process and for the public who want to learn it.

Depok, 22 Desember 2017

Dr. Djonaedi Saleh

I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Vibrations and Waves
3.	Course Code	:	SCFI602118
4.	Semester	:	4
5.	Credit	:	2 credits
6.	Teaching Method(s)	:	In-class lectures, group and individual assignments, and written tests
7.	Prerequisite course(s)	:	Electricity and Magnetism; Vibrations, Waves, and Optics; Mathematical Methods in Physics 2; Mathematical Methods in Physics 3
8.	Requisite for course(s)	:	None
9.	Integration Between Other Courses	:	None
10.	Lecturer(s)	:	Dr. Djonaedi Saleh
11.	Course Description	:	Provide an overview of vibration events or oscillation motion and waves both mechanical and electrical either one-dimensional or more. Students are expected to be able to analyze and explain well and correctly about events that occur in the natural environment related to vibrations and waves.

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

A. CLO

Upon completion of this study course, students in semester 5 are expected to be able to apply their knowledge to explain the events related to vibrations and waves when faced with such problems in the field of science and technology.

B. Sub-CLOs

After students complete the learning process of this course, when faced with problems related to Vibration and Waves students will be able to:

1. Understand the basic principles of simple and damped harmonic motion
2. Understand the principle of force on the oscillator
3. Understand the combined principle of oscillatory motion
4. Understand theoretical concepts and formulating solutions to the problem of transverse waves motion
5. Understand theoretical concepts and formulating solutions to the problem of longitudinal waves motion
6. Understand theoretical concepts of linear waves transmission
7. Understand theoretical concepts and formulating solutions to electromagnetic waves problems
8. Understand theoretical concepts and applications of more than one-dimension waves
9. Understand theoretical concepts of the Fourier method in waves.
10. Understand theoretical concepts and waves applications in optical systems
11. Understand theoretical concepts and applications of non-linear oscillation motion
12. Understand the basic theoretical concepts of waves mechanics

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	1	Simple Harmonic Motion (SHM) and Damped Harmonic Motion (DHM)	In-class lectures	100 minutes	70% O, 30% F	6	Students are able to understand the concept of Simple Harmonic Motion (SHM) and Damped Harmonic Motion (DHM)	[1] pp 1-48
2	2	Oscillator	In-class lectures	100 minutes	70% O, 30% F	6	Students are able to understand the concept of oscillators	[1] pp 49-73
3	3	Combined Oscillators	In-class lectures	100 minutes	70% O, 30% F	6	Students are able to understand the combination of various oscillators	[1] pp 74-99
4	4	Transversal Waves	In-class lectures	100 minutes	70% O, 30% F	6	Students are able to understand the concept of transverse waves	[1] pp 100-143
5	5	Longitudinal Waves	In-class lectures	100 minutes	70% O, 30% F	6	Students are able to understand longitudinal waves	[1] pp 144-163
6	6	Waves on Transmission Line	In-class lectures	100 minutes	70% O, 30% F	10	Students are able to understand the concept of wave on the transmission line	[1] pp 164-186
7	7	Electromagnetic Waves	In-class lectures	100 minutes	70% O, 30% F	10	Students are able to understand the concept of electromagnetic waves	[1] pp 187-218
8	**Mid-Term Exam**							

9	8	Many Dimensions Waves	In-class lectures	100 minutes	70% O, 30% F	10	Students are able to understand the waves with many dimensions	[1] pp 219-247
10	9	Fourier Method	In-class lectures	100 minutes	70% O, 30% F	10	Students are able to apply the Fourier method	[1] pp 248-277
11	10	Waves on Optical Systems	In-class lectures	100 minutes	70% O, 30% F	10	Students are able to understand the application of waves in optical systems	[1] pp 278-358
12	10	Waves on Optical Systems	In-class lectures	100 minutes	30% O, 40% E, 30% F	6	Students are able to understand the application of waves in optical systems	[1] pp 278-358
13	11	Non-linear Oscillation	In-class lectures	100 minutes	30% O, 40% E, 30% F	4	Students are able to understand non-linear oscillations	[1] pp 359-377
14	11	Non-linear Oscillation	In-class lectures	100 minutes	30% O, 40% E, 30% F	6	Students are able to understand non-linear oscillations	[1] pp 359-377
15	12	Waves Mechanics	In-class lectures	100 minutes	30% O, 40% E, 30% F	4	Students are able to apply and formulate wave mechanics	[1] pp 378-411
16	**Final Exam**							

*) O : Orientation
E : Exercise
F : Feedback

References:

[1] Pain, H. J. *The Physics of Vibrations and Waves*. 3rd edition. John Wiley & Sons, 1968.

[2] Bekefi, George, and Alan H. Barrett. *Electromagnetic Vibrations, Waves, and Radiation*. MIT Press, 1977.

[3] French, A. P. *Vibrations and Waves*. WW Norton, 1971.

[4] G., Iain. *Vibrations and Waves in Physics*. Cambridge University Press, 1993.

.

III. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
3	Individual assignment 1	1	Problem set	Simple Harmonic Motion (SHM) and Damped Harmonic Motion (DHM)	Individual tasks at home (HW)	1 week	Answer sheet
5	Individual assignment 2	2	Problem set	Oscillator	Individual tasks at home (HW)	1 week	Answer sheet
7	Individual assignment 3	3	Problem set	Combination of various oscillators	Individual tasks at home (HW)	1 week	Answer sheet
11	Individual assignment 4	4	Problem set	Transverse waves	Individual tasks at home (HW)	1 week	Answer sheet
12	Individual assignment 5	5	Reading material according to reference	Longitudinal waves	Group tasks consist of 3-4 people	2 weeks	Presentation results in the form of power points
13	Individual assignment 6	6	Problem set	Waves on the transmission line	Individual tasks at home (HW)	1 week	Answer sheet
13	Individual assignment 7	7	Reading material according to reference	Electromagnetic waves	Group tasks consist of 3-4 people	2 weeks	Presentation results in the form of power points
15	Individual assignment 8	9	Problem set	Fourier method	Individual tasks at home (HW)	1 week	Answer sheet

*) HW: Homework

IV. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Personal Assignments	1-4	Answer sheet	6	20
Group-Assignments	5-6	Evaluation sheet	2	20
Mid-Term Exam	1-3	Answer sheet	1	30
Final Exam	4-6	Answer sheet	1	30
			Total	**100**

V. Rubric(s)

A. Criteria of Presentation Score

Score	Presentation Delivery
85-90	The group is able to deliver the explanation logically, fluently, and punctual and be able to answer the questions from other students and the lecturer
75-84	The group is able to deliver the explanation logically and fluently and be able to answer the questions from other students and lecturer, but be less punctual in delivering the explanation
65-74	The group is able to deliver the explanation fluently, but be less able to deliver the reasoning logic of the explanation
55-64	Group is less able to deliver the explanation fluently and punctual and be less able to deliver the reasoning logic of the explanation
<55	

B. Criteria of Assignment and Exam Score

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

VI. Appendix: Example of Exam Problems

1. Three identical springs loaded with weight as shown in figure 1. Each spring increase in length by 4 cm when pulled with a force of 500 N. The mass of each spring is 100 grams and the load mass is 200 grams. This time, the load is pulled down as far as 5 cm and then released creating oscillation motion. When air resistance coefficient r = 0. 01. Specify:
   a. combined spring constant
   b. vibration frequency (ω)
   c. oscillating motion function

2. A solenoid consists of 2000 coils of wire with a coil length of 25 cm and a 10 cm cross-sectional line of the solenoid. The wire has a cross-sectional area of 0.1 mm^2 and resistivity $\rho = 4 \times 10^{-6}$ Ωm. A capacitor with a capacity of 5000 μF is charged to the brim with a 24-volt battery and then mounted parallel to the solenoid above so that there is an electric current in the solenoid. Specify:
   a. electrical resistance of solenoid
   b. inductance (L)
   c. amount of current through the circuit

3. Three golf balls each have a mass of 200 grams where the center is penetrated with a 100 cm wire length as shown in figure 2. Both ends of the wire are bolted and then pulled using a force of 200 N so that they are stretched. If the balls are disturbed so that they move as far as 2 mm from the original position, how many possibilities of the ball's position due to the oscillation motion, and at what frequency. Explain your answer.

4. A sound wave with a frequency of 800 Hz propagates in the air (air is considered the ideal diatomic gas with MW = 29 gr/mole) starting from a point with a temperature of 27^{o}C to another point with a temperature of 0^{o}C. Specify:
   a. air pressure in both places
   b. reflection coefficient when propagates on the border of the two air media
   c. percentage of the intensity of the transmitted sound waves

5. A 1m string with a cross-section area of 1 mm^3 has a mass of 50 grams pulled so that they are stretched and undergo stress of 5 x 10^8 Pa. When the string is disturbed so that a standing wave occurs with an amplitude of 0.5 cm and 0.4 cm. Specify:
   a. the fundamental tone frequency
   b. the total energy in strings
   c. reflection coefficient of the wave

6. A solid matter consists of a regular arrangement of atoms that has an elastic force constant of 20 N/m, a reduction mass of 30 x 10^{-27} kg, and a wavenumber of ~1 x 10^{10} /m. Specify:
   a. speed of the transverse wave
   b. the density of solids
   c. the oscillation frequency of constituent atoms