SEMESTER LEARNING ACTIVITY PLANS
(SLAP)
SEMESTER ODD 2022/2023

Theoretical Acoustics

MFF5431 / 2 Credits

Lecturer Coordinator:

Dr. Mitrayana, S.Si., M.Si.

UNIVERSITAS GADJAH MADA
FACULTY OF MATHEMATICS AND NATURAL SCIENCE
2022

Universitas Gadjah Mada
Faculty of Mathematics and Natural Science
Physics Department / Study Program Master Physics
Semester Odd 2022/2023

SEMESTER LEARNING ACTIVITY PLANS (SLAP)

Code	Course Name	Credits (credits)	Semester	Status	Prerequisite
MFF5431	*Theoretical Acoustics*	*2*	*Odd*	*Elective*	*None*

Short Description

Theoretical Acoustics course is Elective course 2 credits (Theory) in the 2022 Curriculum Master Physics Study Program, Faculty of Mathematics and Natural Science UGM.

The syllabus of this course is as follows:
Basic linear acoustics; Acoustic propagation in the atmosphere; Underwater acoustics; Physical acoustics; Photoacoustic; Thermo acoustic; Nonlinear acoustics in fluids; Acoustic signal processing; Acoustics and Structural Vibration; Medical acoustics; Photoacoustic tomography; Modulated ultrasound optical tomography.

The courses are held in class for 14 weeks, each week's session last for 2 x 50 minutes. Four weeks of course period is used for Midterm Exam and Final Exam, each held for two weeks as scheduled.

Student evaluation for course assessments is performed summative and formative. The summative evaluation is implemented as written exams, both Midterm and Final Exam, which take a maximum of 120 minutes. The formative evaluation is implemented as individual assignments for each student in the form of completing an assignment individually. Monitoring is carried out by observing student activities during the course, such as attendance, Q&A and discussion about the material presented, and student performance in completing individual assignments.

Program Learning Outcomes (PLO) Imposed on the Course

PLO 3	Mastering further knowledge of classical and modern physics theory, and its relationship with other disciplines, and has mastered an advanced field of physics specialization that allows him to keep up with the latest international research developments.
PLO 4	Mastering various mathematical disciplines related to an advanced field of physics, and able to develop physical models using various mathematical and computational tools with an inter or multidisciplinary approach to solving problems related to an advanced field of physics.
PLO 6	Able to apply knowledge to analyze, synthesize, formulate problems and solve problems comprehensively in one of advanced field of physics, through experimental or theoretical research, then be able to classify and draw conclusions about their findings for the development of science and technology.

Course Outcomes (CO)

Upon completion of this course, students should be able to:

CO1	Analyze concepts and solve cases related to Acoustic Theory and Applications in the classical era.

	CO2	Analyze concepts and solve cases of Acoustic Theory and Applications in the modern era.		
	CO3	Work in groups in reviewing the latest developments in Acoustic Theory and Applications.		
	CO4			
	CO5			
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Introduction: Acoustics The Science of Sound, Sounds We Hear, Sounds We Can't Hear: Ultrasound and Infrasound, Sounds We Shouldn't Hear.	Lecture, discussion	2 x 50 minutes
	CO1	Environmental Noise Control, Sound Aesthetics: Music, Human Voices: Speech and Singing, How We Hear: Physiological and Psychological Acoustics, Architectural Acoustics, Harnessing Sound: Physical and Engineering Acoustics, Medical Acoustics, Sounds from the Sea.	Lecture, discussion	2 x 50 minutes
	CO1	Basic linear acoustics: Continuum Mechanics Equations, Linear Acoustic Equations, Variation Formulation, Constant Frequency Waves, Plane Waves.	Lecture, discussion	2 x 50 minutes
	CO2	Sound Attenuation, Acoustic Intensity and Power, Impedance, Reflection and Transmission, Spherical Waves, Cylindrical Waves, Simple Sound Sources, Integral Equations in Acoustics, Waveguides, Channels and Resonators, Ray Acoustics, Diffraction, Parabolic Equation Methods.	Lecture, discussion	2 x 50 minutes
	CO2	Atmospheric Sound Propagation: A Brief History of Outdoor Acoustics, Applications of Outdoor Acoustics, Diffusion Losses, Atmospheric Absorption, Diffraction and Resistance, Soil Effects, Attenuation Through Trees and Foliage, Effects of Wind and Temperature Gradients on Outdoor Sound.	Lecture, discussion	2 x 50 minutes

	CO2	Underwater Acoustics: Marine Acoustic Environment, Physical Mechanisms, SONAR and SONAR Equations, Sound Propagation Models, Quantitative Description of Propagation, SONAR Array Processing, Acoustics and Marine Animals.	Lecture, discussion	2 x 50 minutes
	CO2	Physical Acoustics: Theoretical Overview, Physical Acoustic Applications, Equipment, Surface Acoustic Waves, Nonlinear Acoustics.	Lecture, discussion	2 x 50 minutes
	CO3	Thermoacoustics: History, Common Concepts, Engines, Dissipation, Cooling, Separation of Mixtures.	Lecture, discussion	2 x 50 minutes
	CO3	Acoustic signal processing: definition, Fourier series, Fourier transform, Power, Energy and Power Spectrum, Statistics, Noise, Sample data, Discrete Fourier transform.	Lecture, discussion	2 x 50 minutes
	CO3	Medical Acoustics: Introduction to Medical Acoustics, Medical diagnosis; Physical Examination, Basic Physics of Ultrasound Propagation in Tissue, Ultrasound Medical Examination Methods, Medical Contrast Agents, Hyperthermia Ultrasound in Fission Therapy, High Intensity Focused Ultrasound (HIFU) in Surgery, Kidney Stone Lithotripsy, Thrombolysis, Low Frequency Therapy, Ultrasound Safety.	Lecture, discussion	2 x 50 minutes
	CO4	Photoacoustics: Introduction, Inventions by Bell, Photophone and Early Days, Rise as an Optoacoustic Effect and Early 20th Century Applications, The Physics behind Photophonic Effects.	Lecture, discussion	2 x 50 minutes
	CO4	Thermal Piston Model, Pulsating Effect, Rediscovery of Intensity-Modulated Photophonic Effects in Solids as Photoacoustic Effects, Evolution of Biomedical Applications, Sources of Modern Naming Conventions.	Lecture, discussion	2 x 50 minutes

	CO4	Photoacoustic Tomography: Introduction, Motivation for Photoacoustic Tomography, Initial Photoacoustic Pressure, General Photoacoustic Equations, General Forward Solutions, Delta-Pulse Excitation of the Slab, Delta-Pulse Excitation of the Sphere.	Lecture, discussion	2 x 50 minutes
	CO4	Finite-Duration Pulse Excitation from Thin Slabs, Finite-Duration Pulse Excitation from Small Balls, Dark Field Confocal Photoacoustic Microscopes, Synthetic Aperture Image Reconstruction, General Image Reconstruction.	Lecture, discussion	2 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture, discussion			
Student Learning Experience	Learn to analyze and review: Introduction: Acoustics The Science of Sound, Sounds We Hear, Sounds We Can't Hear: Ultrasound and Infrasound, Sounds We Shouldn't Hear., Environmental Noise Control, Sound Aesthetics: Music, Human Voices: Speech and Singing, How We Hear: Physiological and Psychological Acoustics, Architectural Acoustics, Harnessing Sound: Physical and Engineering Acoustics, Medical Acoustics, Sounds from the Sea., Basic linear acoustics: Continuum Mechanics Equations, Linear Acoustic Equations, Variation Formulation, Constant Frequency Waves, Plane Waves., Sound Attenuation, Acoustic Intensity and Power, Impedance, Reflection and Transmission, Spherical Waves, Cylindrical Waves, Simple Sound Sources, Integral Equations in Acoustics, Waveguides, Channels and Resonators, Ray Acoustics, Diffraction, Parabolic Equation Methods., Atmospheric Sound Propagation: A Brief History of Outdoor Acoustics, Applications of Outdoor Acoustics, Diffusion Losses, Atmospheric Absorption, Diffraction and Resistance, Soil Effects, Attenuation Through Trees and Foliage, Effects of Wind and Temperature Gradients on Outdoor Sound., Underwater Acoustics: Marine Acoustic Environment, Physical Mechanisms, SONAR and SONAR Equations, Sound Propagation Models, Quantitative Description of Propagation, SONAR Array Processing, Acoustics and Marine Animals., Physical Acoustics: Theoretical Overview, Physical Acoustic Applications, Equipment, Surface Acoustic Waves, Nonlinear Acoustics., Thermoacoustics: History, Common Concepts, Engines, Dissipation, Cooling, Separation of Mixtures., Acoustic signal processing: definition, Fourier series, Fourier transform, Power, Energy and Power Spectrum, Statistics, Noise, Sample data, Discrete Fourier transform., Medical Acoustics: Introduction to Medical Acoustics, Medical diagnosis; Physical Examination, Basic Physics of Ultrasound Propagation in Tissue, Ultrasound Medical Examination Methods, Medical Contrast Agents, Hyperthermia Ultrasound in Fission Therapy, High Intensity Focused Ultrasound (HIFU) in Surgery, Kidney Stone Lithotripsy, Thrombolysis, Low Frequency Therapy, Ultrasound Safety., Photoacoustics: Introduction, Inventions by Bell, Photophone and Early Days, Rise as an Optoacoustic Effect and Early 20th Century Applications, The Physics behind Photophonic Effects., Thermal Piston Model, Pulsating Effect, Rediscovery of Intensity-Modulated Photophonic Effects in Solids as Photoacoustic Effects, Evolution of Biomedical Applications, Sources of Modern Naming Conventions., Photoacoustic Tomography: Introduction, Motivation for Photoacoustic Tomography, Initial Photoacoustic Pressure, General Photoacoustic Equations, General Forward Solutions, Delta-Pulse Excitation of the Slab, Delta-Pulse Excitation of the Sphere., Finite-Duration Pulse Excitation from Thin Slabs, Finite-Duration Pulse Excitation from Small Balls, Dark Field Confocal Photoacoustic Microscopes, Synthetic Aperture Image Reconstruction, General Image Reconstruction..		
Access to Learning Media/ LMS and Offline	LCD, whiteboard, laptop, Zoom Meeting and Google Classroom			

and Online Percentage	
Assessment Methods and Synchronization with CO	

Assessment Methods	**Assessment Percentage**	**Criteria/Indicators**	**CO1**	**CO2**	**CO3**	**CO4**
Participatory Activity*						
Project Results/ Case Study Results/ PBL Results*						
Cognitive						
Assignment	30%		7,5%	7,5%	7,5%	7,5%
Quiz						
Midterm Exam	35%		17,5%	17,5%		
Final Exam	35%				17,5%	17,5%

*) can also be obtained from the Midterm or Final Exam as the result of participatory activities or project/ case study results. According to IKU 7, the percentage of project results/ case study/ PBL results is at least 50%.

References	**Main references:** 1. Rossing T.D., 2007, Handbook of Acoustics, Springer Science BusinessMedia, LLC New York. 2. Lihong V. Wang and Hsin-i Wu, 2007, Biomedical Optics, John Wiley & Sons, Inc. 3. Mitrayana, M.Ali Joko W., and R. Ikhsan, 2017, Laser Photoacoustic Spectroscopy and Its Applications, Gadjah Mada University Press.
Lecturers (*Team Teaching*)	1. Dr. Mitrayana, S.Si., M.Si. 2. Dr. Moh. Ali Joko Wasono, M.S. 3. 4.

Authorization	**Date of Drafting**	**Lecturer Coordinator**	**Head of Curriculum Committee**	**Head of Study Program**
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