Module Name	Nonlinear Dynamics
Module Level, if applicable	Bachelor of Physics
Code, if applicable	18H02134103
Subtitle, if applicable	-
Course, if applicable	-
Semester(s) in which the module is taught	3rd
The person responsible for the module	Drs. Bansawang BJ., M.Si
Lecturer	1. Prof. Dr.rer.nat. Wira Bahari Nurdin, 2. Drs. Bansawang B.J., M.Si.
Language	Indonesia [Bahasa Indonesia]
Relation to Curriculum	This course is an elective course and is offered in the 3rd semester.
Type of teaching, contact hours	Teaching methods: [group discussion], [collaborative learning], [problem-based learning]. Teaching forms: [lecture], [tutorial] CH: 13.00 - 15.30

	- 40.00 hours for lectures, - 48.00 hours for structured assignments, - 48.00 hours for private study
Credit points	3 Credit Points (equivalent to 5.1 ECTS)
Requirements according to the examination regulations	A student must have attended at least 80% of the lectures to sit on the final examination
Recommended prerequisites	1. Basic Mathematics I & II 2. Mathematical Physics I & II
Module objectives/intended learning outcomes	After completing the course, Students are able: **Intended Learning Outcomes (ILO):** **ILO 2**: Students are able to use the fundamental principles of physics in modeling and computation to solve complex physical problems. **ILO 6**: Students are able to use the mathematical method to solve the physically related- problem. **Course Learning Objective (CLO):** Upon completing this course, students are anticipated to acquire proficiency in comprehending the principles and applications of mathematical physics, computational physics, and instrumentation pertaining to fluid dynamics in one and two dimensions, as well as bifurcation. Furthermore, they will be adept at employing mathematical or physical models in accordance with hypotheses or predictions concerning the ramifications of the phenomena under consideration. **Sub CLO:** **ILO 2 ⇒ CLO 1:** Students will develop the capacity to

	fixed points and stability, analyze population growth dynamics, engage in linear stability analysis, and adeptly solve equations using computational methods. **ILO 6 ⇒ CLO 2:** Students will be equipped to comprehend complex topics including bifurcation theory, the dynamics of overdamped systems on rotating circles, and the phenomena surrounding insect outbreaks. **ILO 2 ⇒ CLO 3:** Students will gain the ability to understand the subject of flow dynamics on circular geometries, which includes uniform and nonuniform oscillatory behavior. In addition, they will gain insight into pendulum dynamics under external pressure, firefly population synchronization patterns, and Josephson junctions evident in superconducting systems. **ILO 6 ⇒ CLO 4:** Students possess the capability to comprehend the categorization pertaining to the application of Two Dimensional Flow in Linear and Nonlinear Systems on Phase Fields and Phase Portraits. Furthermore, they demonstrate proficiency in executing tasks such as Fixed Points and Linearization and analyzing scenarios like Rabbits versus Sheep and Reversible Systems. **ILO 6 ⇒ CLO 5:** Students possess the capacity to comprehend concepts including Cycle Limit (Poincaré-Bendixson Theorem), Lienard System, Relaxation Oscillator. **ILO 6 ⇒ CLO 6:** Students have the capability to grasp the concepts encompassing Bifurcation, specifically those of Saddle-Node, Trans critical, and Pitchfork bifurcations. Furthermore, they are proficient in both demonstrating and employing the knowledge of Hopf bifurcations, Chemical Oscillation Reactions, and Poincaré Maps.
Content	Students will learn about 1. Flows on the Line 2. Bifurcations 3. Flows on the Circle 4. Two-Dimensional Flow 5. Limit Cycles 6. Bifurcations Revisited

Forms of Assessment	Assessment techniques: [written test] Assessment forms: [midterm exam], [final term exam], [assignment] Assignment = 40%, Midterm exam = 30%, Final term Exam = 30% CLO 1 ⇒ ILO 2: 8% (Assignment 1) CLO 1 ⇒ ILO 2: 10% (Number 1 in Midterm Exam) CLO 2 ⇒ ILO 6: 10% (Number 2 in Midterm Exam) CLO 3 ⇒ ILO 2: 8% (Assignment 2) CLO 3 ⇒ ILO 2: 10% (Number 3 in Midterm Exam) CLO 4 ⇒ ILO 6: 8% (Assignment 3) CLO 4 ⇒ ILO 6: 10% (Number 1 in Final Exam) CLO 5 ⇒ ILO 6: 8% (Assignment 4) CLO 5 ⇒ ILO 6: 10% (Number 2 in Final Exam) CLO 6 ⇒ ILO 6: 8% (Assignment 5) CLO 6 ⇒ ILO 6: 10% (Number 3 in Final Exam)
Study and examination requirements and forms of examination	**Study and examination requirements:** - Students must attend 15 minutes before the class stars. - Students must switch off all electronic devices. - Students must inform the lecturer if they do not attend the class due to sickness, etc. - Students must submit all class assignments before the deadline - Students must attend the exam to get the final grade **Form of examination:** Mid & Final Examination: Essay
Media employed	LED, Whiteboard, Textbook, Video, and Learning Management System (SIKOLA).
Reading List	**Main:** 1. S. Strogatz (1994): Nonlinear Dynamics and Chaos by, 1st edition, Westview Press. ISBN: 0-7382-0453-6. **Support:**

	2. Kaplan, D. and L. Glass (1995). Understanding Nonlinear Dynamics, Springer-Verlag New York. 3. Jurgens, H., H.-O. Peitgen, et al. (1993). Chaos and Fractals: New Frontiers of Science. New York, Springer Verlag.