UNIVERSITAS GADJAH MADA
Faculty of Mathematics and Natural Sciences
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Doctoral Program in Mathematics

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MODULE HANDBOOK
Doctoral in Mathematics

Module name:	Control Theory
Module level, if applicable:	Doctoral Program
Code, if applicable:	MMM 5309
Semester(s) in which the module is taught:	-
Person responsible for the module:	Chair of Applied Mathematics Research Group
Lecturer(s):	1. Salmah
Language:	Indonesia
Relation to curriculum:	Doctoral Degree in Mathematics, Compulsory / Elective Course
Credit points:	3 Semester Credit Unit
Type of teaching, contact hours:	3x50 minutes lectures, 3x60 minutes structured activities.
Workload:	• 3x50 minutes lectures, • 3x60 minutes structured activities, • 3x60 minutes individual study, • In 16 weeks per semester (including assignments and examinations)
Recommended prerequisites:	-
Module objectives/intended learning outcomes:	On successful completion of this course, students should be able to: CO 1. To design feedback control systems. CO 2. To design observer, and understand separation principle of feedback control and observer. CO 3. To solve linear quadratic optimal control problems with Hamiltonian methods. CO 4. To solve differential Riccati and algebraic Riccati equation and relate the solution to optimal control problems. CO 5. To relate between the theory and applications of simple control system problems, and to interpret the solutions. CO 6. To understand (example) of advance control method
Content:	Control system and control method Syllabi: Topics include examples of open loop and closed loop control problems, models of control systems. Feedback control and pole placement. Observers. The separation principle. The open-loop linear quadratic optimal control. Lyapunov equation. The closed-loop linear quadratic regulator. The Riccati differential equations. The steady state linear quadratic regulator. The algebraic Riccati equations. Solution of algebraic Riccati equations with stable eigen vectors. Introduction to advance control method: Model Predictive Control, Sliding Mode Control, Adaptive Control
Study and examination requirements and forms of examination:	The final mark will be weighted as follows: No — Assessment methods (components, activities) — Weight (percentage) 1 — Final Examination — 40% 2 — Mid-Term Examination — 30% 3 — Class Activities: Quiz, Homework, etc — 30%

	Final grade will be determined as follows: Grade Criteria The initial cut-off points for grades A, B, C, and D should not be less than 80%, 65%, 50%, and 40%, respectively.
Media employed:	Board, LCD Projector, Laptop/Computer
Reading List:	1. Geert Jan Olsder, 1994, *Mathematical Systems Theory,* 1'st Edition, Delft University of Technology. 2. Katsuhiko Ogata, 1990, *Modern Control Engineering,* 2nd ed. Englewood Cliffs, N.J,: Prentice Hall, Inc. 3. Lewis F.L., 1992, Applied Optimal Control, Prentice Hall International.

Mapping of The COs and PLOs

	PLO – 1 S3 Mat	PLO – 2 S3 Mat	PLO – 3 S3 Mat	PLO – 4 S3 Mat	PLO – 5 S3 Mat	PLO –6 S3 Mat
CO 1	√	√				
CO 2	√	√				
CO 3	√	√				
CO 4	√	√				
CO 5	√	√			√	√
CO 6	√	√	√	√		√

Programme Learning Outcomes (PLO) Doctoral Programme in Mathematics

PLO-1	:	**Attitude:** Devote to God Almighty, uphold the humanity values, internalize academic values and ethics, responsible in working in the area of expertise independently.
PLO-2	:	**Knowledge:** Mastering philosophy of mathematics and one of the fields in mathematics (algebra, analysis, applied mathematics, statistics, computational mathematics, computational statistics).
PLO-3	:	**Knowledge:** Able to think logically, analytically, inductively, deductively, and structured; having the ability to manage, lead, and develop research programs independently, and able to communicate the thoughts as well as his work to the scientific community and the general public.
PLO-4	:	**Skill:** Creating new concepts and / or new methods (original) in the field of mathematics that are recognized nationally and internationally.
PLO-5	:	**Skill:** Able to apply mathematics according to their field of expertise to solve problems including those that require a multidisciplinary, cross-disciplinary, or trans-disciplinary approach.
PLO-6	:	***Life Long Learning:*** Having lifelong learning skills and adaptive to the development of science and technology, especially in fields related to Mathematics and its applications.