UNIVERSITAS GADJAH MADA
Faculty of Mathematics and Natural Sciences
Department of Mathematics
Sekip Utara Bulaksumur Yogyakarta 55281 Telp: +62 274 552243 Fax: +62 274 555131 Email: math@ugm.ac.id Website: http://math.fmipa.ugm.ac.id

Doctor in Mathematics

Telp : +62 274 552243
Email : maths3@ugm.ac.id; kaprodi-s3-matematika.mipa@ugm.ac.id
Website : http://s3math.fmipa.ugm.ac.id/

MODULE HANDBOOK

Module Name	*Topics in Control Theory*
Code, if applicable	*MMM 7314*
Subtitle, if applicable	-
Semester(s) in which the module is taught	1st or 2nd semester
Person responsible for the module	*Chair of the Lab. of Applied Mathematics*
Language	*Bahasa Indonesia*
Relation to curriculum	*Elective course in the first year (1st semester) Doctoral in Mathematics.*
Teaching methods	*Lectures, structured activities (assignments, quizzes), seminar, project*
Workload (incl. contact hours, self-study hours)	*Total workload is 232 hours per semester, which consists of 50 minutes lectures per week, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 16 weeks per semester, including mid exam and final exam.*
Credit points in Credit Units	*3*
Required and recommended prerequisites for joining the module	*Students must be competence in linear algebra and differential equations.*
Module objectives/intended learning outcomes	*After completing this course, the students have ability to:* *CO 1. modelling the control problems.* *CO 2. design the controller systems.* *CO 3. competence in the advanced control design.* *CO 4. apply the control theory in real problems.*

<table>
<tr><td>Content</td><td>In this lecture, students must carry out several academic activities under the supervision of the lecturer. Academic activities are carried out based on literature studies to competences one or more of the topics in control theory, including: control system modeling, advanced system theory such as descriptor systems, bilinear systems, nonlinear systems, and bisimulation, linear quadratic optimal control theory and Riccati equations, advanced control methods, such as model predictive control (MPC), distributed MPC, hierarchical control, adaptive predictive control, robust control, dynamic game theory, model order reduction, Kalman Filter, and application of control theory to real problems.</td></tr>
<tr><td>Examination forms</td><td>Written assignments, oral presentation and essay exam.</td></tr>
<tr><td>Study and examination requirements</td><td>To pass the course, the minimum grade is B.
The final mark will be weighted as follows:
<table>
<tr><th>No</th><th>Assessment methods (components, activities)</th><th>Weight (percentage)</th><th>Cognitive</th><th>Case/Project Based</th></tr>
<tr><td>1.</td><td>Final Examination (essay exam)</td><td>30 %</td><td>10 %</td><td>20 %</td></tr>
<tr><td>2.</td><td>Mid-Term Examination</td><td>30 %</td><td>20 %</td><td>10 %</td></tr>
<tr><td>3.</td><td>Quiz, Homework (Written assignments)</td><td>20 %</td><td>10 %</td><td>10 %</td></tr>
<tr><td>4.</td><td>Oral presentation</td><td>20 %</td><td></td><td>20 %</td></tr>
<tr><td></td><td>Total</td><td>100 %</td><td>40 %</td><td>60 %</td></tr>
</table></td></tr>
<tr><td>Media employed</td><td>Projector, board, computer, online lecture via Zoom.</td></tr>
<tr><td>Reading list</td><td>1. Lewis F.L., 1992, Applied Optimal Control, Prentice Hall International.
2. Geert Jan Olsder, 1994, Mathematical Systems Theory, 1’st Edition, Delft University of Technology.
3. Katsuhiko Ogata, 1990, Modern Control Engineering, 2nd ed. Englewood Cliffs, N.J,: Prentice Hall, Inc.
4. Rama K. Yedavalli, 2014, Robust Control of Uncertain Dynamic System: A Linear State Space Approach, Springer Science+Business Media.
5. Yuri Shtessel, Christopher Edwards, Leonid Fridman and Arie Levant Sliding, 2014, Mode Control and Observation, Springer Science+Business Media.
6. Camacho,E.F., Bordons,C. 2007. Model Predictive Control, 2nd ed. Springer Verlag, London.</td></tr>
</table>

CO-PLO Mapping

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
CO 1	v	v	v			
CO 2	v	v	v			
CO 3	v	v	v	v	v	v
CO 4	v	v	v	v	v	v

Last Modified Date : 12 August 2022

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MODULE HANDBOOK

Module designation	*Topics in Control Theory*
Code, if applicable	*MMM 7314*
Subtitle, if applicable	*Control Theory*
Semester(s) in which the module is taught	*1st or 2nd (first or second semester)*
Person responsible for the module	*Chair of the Lab. of Applied Mathematics.*
Language	*Bahasa Indonesia*
Relation to curriculum	*Elective course in the first year (1st semester) Doctoral in Mathematics.*
Teaching methods	*Lectures, structured activities (assignments, quizzes), seminar, project based learning.*
Workload (incl. contact hours, self-study hours)	*Total workload is 232 hours per semester, which consists of 50 minutes lectures per week, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 16 weeks per semester, including mid exam and final exam.*
Credit points in Credit Units	*3*
Required and recommended prerequisites for joining the module	*Students must be competence in linear algebra and differential equations.*
Module objectives/intended learning outcomes	*After completing this course,* *CO 1. the students have skill in modelling the control problems.* *CO 2. the students competence to design the controller systems.* *CO 3. the students competence to design the advanced control.* *CO 4. the students know how to apply the control theory in the real problems.*

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CO-PLO Mapping

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
CO 1	**V**	**V**	**V**			
CO 2	**V**	**V**	**V**			
CO 3	**V**	**V**	**V**	**V**	**V**	**V**
CO 4	**V**	**V**	**V**	**V**	**V**	**V**

Last Modified Date : 2 September 2023

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MODULE HANDBOOK

Module designation	Topic in Control Theory
Code, if applicable	MMM 7314
Subtitle, if applicable	Mathematical System Theory
Semester(s) in which the module is taught	*1st or 2nd semester*
Person responsible for the module	*Chair of the Lab. of Applied Mathematics.*
Language	Bahasa Indonesia
Relation to curriculum	*Elective Course*
Teaching methods	*Lectures, structured activities (assignments, quizzes), seminar, project based*
Workload (incl. contact hours, self-study hours)	*Total workload is 232 hours per semester, which consists of 50 minutes lectures per week, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 16 weeks per semester, including mid exam and final exam.*
Credit points in Credit Units	*3*
Required and recommended prerequisites for joining the module	*Students must be competence in linear algebra and differential equations.*
Module objectives/intended learning outcomes	*After completing this course, the students have ability to:* *CO 1. formulate the model from a real problem and construct solution of the system* *CO 2. Investigate the system properties, e.g. stability, controllability, observability, etc.* *CO 3. design the system in the form of minimal realization.*

<table>
<tr><td>Content</td><td>In this lecture, students must carry out several academic activities under the supervision of the lecturer. Academic activities are carried out based on literature studies to competences one or more of the topics in system theory, including: advanced system theory such as descriptor/DAE systems, bilinear systems, nonlinear systems, and bisimulation. System properties: stability, controllability and observability. Minimal realization/reduction system technique.</td></tr>
<tr><td>Examination forms</td><td>Written assignments, oral presentation and essay exam.</td></tr>
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W.M.Wonham, 1985, Linear Multivariable Control: A geometric approach, SpringerVerlag, NewYork.
L.Dai, 1989, Singular Control Systems, Springer-Verlag, NewYork Inc.,Secaucus, NJ,USA.
H.L.Trentelman, A.A.Stoorvogel, and M.L.J.Hautus, 2001, Control theory for linear systems, Springer-Verlag, London.
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CO-PLO Mapping

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
CO 1	**V**	**V**	**V**			
CO 2	**V**	**V**	**V**			
CO 3	**V**	**V**	**V**	**V**	**V**	**V**
CO 4	**V**	**V**	**V**	**V**	**V**	**V**

Last Modified Date : September 5, 2023

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MODULE HANDBOOK

Module designation	*Topics in Control Theory*
Code, if applicable	
Subtitle, if applicable	*Dynamic Game*
Semester(s) in which the module is taught	*1st or 2nd (first or second semester)*
Person responsible for the module	*Chair of Applied Mathematics Research Group*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory / elective / specialisation* *Names of other study programmes with which the module is shared*
Teaching methods	*3x50 minutes lectures, 3x60 minutes structured activities.*
Workload (incl. contact hours, self-study hours)	*Total workload is 232 hours per semester, which consists of 50 minutes lectures per week, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 16 weeks per semester, including mid exam and final exam.*
Credit points in Credit Units	*3*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	On successful completion of this course, students should be able to: CO 1: to solve noncooperative dynamic games. CO 2: To solve cooperative dynamic games. CO 3: To solve feedback dynamic game CO 4: to relate between the theory and applications of simple dynamic game problems and to interpret the solutions. CO 5: to consider control method that based on dynamic game

Content	In this lecture, students must carry out several academic activities under the supervision of a lecturer. Academic activities are carried out based on literature studies to master one or more of the topics in Optimization Theory, including: Topics include two players and n players noncooperative and cooperative game (static game), noncooperative linear quadratic dynamic game finite horizon, noncooperative linear quadratic dynamic game infinite horizon, couple of differential Riccati equation, couple of algebraic Riccati equation, cooperative game, feedback game, example of application of noncooperative linear quadratic dynamic game, control method based on dynamic game
Examination forms	*Quiz, homework, report, manuscript, oral presentation, essay.*
Study and examination requirements	*Requirements for successfully passing the module*
Reading list	1. *Engwerda, Jacob, 2005, LQ Dynamic Optimization and Differential Games, John wiley & sons.* 2. *Tamer Basar, Geert Jan Olsder, 1998, Dynamic Noncooperative Game Theory, 2nd Edition, SIAM.*

CO-PLO Mapping

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
CO 1	√	√				
CO 2	√	√				
CO 3	√	√				
CO 4	√				√	√
CO 5	√				√	√

Last Modified Date : September 7, 2023