UNIVERSITAS GADJAH MADA
Faculty of Mathematics and Natural Sciences
Mathematics Department
Sekip Utara Bulaksumur Yogyakarta 55281 Telp: +62 274 552243 Fax: +62 274 555131 Email: math@ugm.ac.id Website: matematika.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 designation	Linear Algebra : Matrix Theory
Code, if applicable	MMM 7205
Subtitle, if applicable	-
Courses	Linear Algebra : Matrix Theory
Semester(s) in which the module is taught	1st or 2nd Semester
Person responsible for the module	Head of Algebra Research Group
Language	Bahasa Indonesia
Relation to curriculum	Elective Course
Teaching methods	Lecture, discussion, presentations, homework etc.
Workload (incl. contact hours, self-study hours)	The total workload is 232 hours per semester, which consists of 50 minutes lectures per week, 120 minutes of structured activities per week, and 120 minutes of individual study per week, in total is 16 weeks per semester, including mid and final exams.
Credit points in Credit Units	3
Required and recommended prerequisites for joining the module	Students should have prior knowledge in linear algebra.
Module objectives/intended learning outcomes	On successful completion of this course, students should be able to: CO 1 analyze various advanced concepts and techniques in matrix theory CO 2 utilize matrices as a tool to solve problems mathematics; CO 3 apply basic matrix techniques in various fields
Content	Matrix analysis Matrices over Rings Generalized Inverse Matrices
Examination forms	Oral presentation, essay.
Study and examination requirements	The final mark will be computed from a proportional weight of assignments, mid examination and final examination. The final mark will be weighted as follows: No — Assessment methods (components, activities) — Weight (percentage) 1. Final Examination — 25-40% 2. Mid-Term Examination — 25-40% 3. Quiz/Presentation, Homework — 20-30% To pass the course, the minimum grade is B
Media employed	White/Black Board, LCD Projector, Laptop/Computer, Zoom, E-Learning, Simaster
Reading List	1. Nicholson, W.K., 2019, Linear Algebra with Applications, Base Textbook, Version 2019 – Revision A 2. Zhang, F, 2011, Matrix Theory, Second Edition, Springer, Linear Park, Davie, Florida, USA 3. Brown, W. C., 1984, Matrices Over Commutative Rings, Marcel Dekker, Inc. 4. Laksov, D, 2013, Diagonalization of Matrices Over Rings, Journal of Algebra.

	5. Zabavsky B., 2005, Diagonalizability theorems for matrices over rings with finite stable range, Algebra and Discrete Mathematics. 6. Ara P., Goodearl K.R, O'meara K.C., and Pardo E., 1997, Diagonaliazation of matrices over regular rings, Linear Algebra and its Applications, Vol.265, pp-147-163.

PLO and CO Mapping

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

Compilation Date : July 25, 2022

Modified Date : February 5, 2024

UNIVERSITAS GADJAH MADA
Faculty of Mathematics and Natural Sciences
Mathematics Department
Sekip Utara Bulaksumur Yogyakarta 55281 Telp: +62 274 552243 Fax: +62 274 555131 Email: math@ugm.ac.id Website: matematika.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 designation	Linear Algebra : Matrix Theory
Code, if applicable	MMM 7205
Subtitle, if applicable	Matrix Analysis
Semester(s) in which the module is taught	1st or 2nd Semester
Person responsible for the module	Head of Algebra Research Group
Language	Bahasa Indonesia
Relation to curriculum	Elective Course
Teaching methods	Lecture, discussion, presentations, homework etc.
Workload (incl. contact hours, self-study hours)	The total workload is 232 hours per semester, which consists of 50 minutes lectures per week, 120 minutes of structured activities per week, and 120 minutes of individual study per week, in total is 16 weeks per semester, including mid and final exams.
Credit points in Credit Units	3
Required and recommended prerequisites for joining the module	Students should have prior knowledge in linear algebra.
Module objectives/intended learning outcomes	On successful completion of this course, students should be able to: CO 1 explain various advanced concepts and techniques in matrix theory CO 2 utilize matrices as a tool to solve problems mathematics; CO 3 apply basic matrix techniques in various fields such as mathematics, statistics, physics, computer science, and engineering, etc.
Content	a. Partitioned Matrices: Elementary Operations of Partitioned Matrices, The Determinant and Inverse of Partitioned Matrices, The Rank of Product and Sum, The Eigenvalues of AB b. Matrix Functions c. Matrix Norms d. Matrix Decompositions: Schur Decomposition, Spectral Decomposition, Singular Value Decomposition, Polar Decomposition, Jordan Canonical Forms. e. Special Types of Matrices: Idempotent matrices, nilpotent matrices, involutary matrices, projection matrices, tridiagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation matrices, doubly stochastic matrices, and nonnegative matrices.,
Examination forms	Oral presentation, essay.
Study and examination requirements	The final mark will be computed from a proportional weight of assignments, mid examination and final examination. The final mark will be weighted as follows: No / Assessment methods (components, activities) / Weight (percentage) 1. Final Examination 25-40% 2. Mid-Term Examination 25-40% 3. Quiz/Presentation, Homework 20-30% To pass the course, the minimum grade is B
Media employed	White/Black Board, LCD Projector, Laptop/Computer, Zoom, E-Learning, Simaster
Reading List	1. Nicholson, W.K., 2019, *Linear Algebra with Applications*, Base Textbook, Version 2019 – Revision A

	2. Zhang, F, 2011, *Matrix Theory*, Second Edition, Springer, Linear Park, Davie, Florida, USA 3. Papers and references related to the research.

PLO and CO Mapping

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

Compilation Date : July 25, 2022

Modified Date : February 5, 2024

UNIVERSITAS GADJAH MADA
Faculty of Mathematics and Natural Sciences
Mathematics Department
Sekip Utara Bulaksumur Yogyakarta 55281 Telp: +62 274 552243 Fax: +62 274 555131 Email: math@ugm.ac.id Website: matematika.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 designation	Linear Algebra : Matrix Theory
Code, if applicable	MMM 7205
Subtitle, if applicable	Matrices over Rings
Semester(s) in which the module is taught	1st or 2nd Semester
Person responsible for the module	Head of Algebra Research Group
Language	Bahasa Indonesia
Relation to curriculum	Elective Course
Teaching methods	Lecture, discussion, presentations, homework etc.
Workload (incl. contact hours, self-study hours)	The total workload is 232 hours per semester, which consists of 50 minutes lectures per week, 120 minutes of structured activities per week, and 120 minutes of individual study per week, in total is 16 weeks per semester, including mid and final exams.
Credit points in Credit Units	3
Required and recommended prerequisites for joining the module	Students should have prior knowledge in linear algebra.
Module objectives/intended learning outcomes	Upon successful completion of this course, students are able to: CO1: conclude and identify in detail an ideal of ring Mn×n(R) and prove their properties. CO2: conclude and identify in detail the generalization process of the rank of matrices and prove their properties. CO3: conclude, identify, and explain the solution of a system of linear equations over a ring, and prove the properties regarding the necessary and sufficient for a system of linear equations to have a solution (as generalization of linear equations over over field). CO 4: conclude and identify in detail the generalization process of Cayley-Hamilton Theorem and prove their properties CO 5: conclude and identify in detail the zero divisor in ring Mn×n(R) and prove the properties regarding the relation between zero divisor in ring R and zero divisor in ring Mn×n(R) CO 6: conclude and identify in detail the eigen values and eigen vector of matrices over rings (as generalization of matrices over field) and prove the properties regarding the relation between eigen values and eigen vector and diagonalization of matrices over rings (as generalization of matrices over field).
Content	a. Matrices with entries from a commutative ring R ($M_{n\times n}(R)$). b. Ideal of ring $M_{n\times n}(R)$. c. The rank of matrix over a commutative ring d. Linear system over rings. e. Primeness of ideal in R and primeness of ideal in $M_{n\times n}(R)$. f. The Cayley-Hamilton Theorem of Matrices over Rings. g. The Zero Divisor in ring $M_{n\times n}(R)$. h. The eigen values and eigen vector of matrices over rings i. Diagonalization of Matrices over Rings.

Examination forms	Oral presentation, essay.
Study and examination requirements	The final mark will be computed from a proportional weight of assignments, mid examination and final examination. The final mark will be weighted as follows: No Assessment methods (components, activities) Weight (percentage) 1. Final Examination 25-40% 2. Mid-Term Examination 25-40% 3. Quiz/Presentation, Homework 20-30% To pass the course, the minimum grade is B
Media employed	White/Black Board, LCD Projector, Laptop/Computer, Zoom, E-Learning, Simaster
Reading List	1. Brown, W. C., 1984, Matrices Over Commutative Rings, Marcel Dekker, Inc. 2. Laksov, D, 2013, Diagonalization of Matrices Over Rings, Journal of Algebra. 3. Zabavsky B., 2005, Diagonalizability theorems for matrices over rings with finite stable range, Algebra and Discrete Mathematics. 4. Ara P., Goodearl K.R, O'meara K.C., and Pardo E., 1997, Diagonaliazation of matrices over regular rings, Linear Algebra and its Applications, Vol.265, pp-147-163. 5. Papers and references related to the research.

PLO and CO Mapping

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
CO 1	v		v	v	v	v
CO 2	v		v	v	v	v
CO 3	v		v	v	v	v
CO4	v		v	v	v	v

Compilation Date : August 4, 2022

Modified Date : February 5, 2024

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 designation	Theory of Matrices
Code, if applicable	MMM 7205
Subtitle, if applicable	Generalized Inverse Matrices
Semester(s) in which the module is taught	1st or 2nd semester
Person responsible for the module	Head of Algebra Laboratory
Language	Bahasa Indonesia
Relation to curriculum	Elective course in the 1st or 2nd semester of doctor's degree
Teaching methods	Lecture, presentation, project
Workload (incl. contact hours, self-study hours)	Total workload is 232 hours per semester, which consists of 150 minutes lectures per week for 14 weeks, 180 minutes structured activities per week, 180 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 master the concepts of algebraic structure theory and linear algebraic theory
Module objectives/intended learning outcomes	After taking this course, students will be able to: CO 1. construct a generalized inverse of a matrix CO 2. characterize the generalized Inverse matrices in research topics. CO 3. prove the spectral properties (properties related to eigenvalues and eigenvectors) of generalized inverse matrices. CO 4. make conjectures related to the application of generalized inverse matrices to solving linear systems from the dissertation topic

Content	Existence and construction of the generalized inverse of a matrix. Linear Systems and the Characterization of Generalized Inverses. Generalized Inverse Spectral. Generalized Inverse of the Partition matrix. Computational Aspects of Generalized Inverses. Applications of Generalized Inverses.
Examination forms	Oral presentation, essay, paper
Study and examination requirements	The final mark will be computed from a proportional weight of assignments, mid examination and final examination. The final mark will be weighted as follows: No — Assessment methods (components, activities) — Weight (percentage) 1 — Final Examination — 20 - 30% 2 — Mid-Term Examination — 20 - 30% 3 — Class Activities: Quiz, Project, etc. — 50 - 60% To pass the course, the minimum grade is : B
Media employed	Whiteboard, LCD screen, laptop, zoom
Reading list	1. Adi Ben-Israel and Thomas N.E. Greville, 2003, *Generalized Inverses Theory and Applications*, Springer. 2. Boullion, T. L. and Odell, P. L., 1971, *Generalized Inverse Matrices*, John Wiley & Sons, New York. 3. Rao, C. R. And Mitra, S. K., 1971, *Generalized Inverse of Matrices and its Applications*, Wiley, New York.

CO-PLO Mapping

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

Compilation Date : August 19, 2022
Fist Update : October 12, 2023
Last Update : February 20, 2024