MODULE HANDBOOK

MATRICES

STATISTICS UNDERGRADUATE PROGRAM
DEPARTMENT OF STATISTICS
FACULTY OF SCIENCE AND DATA ANALYTICS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA

ENDORSEMENT PAGE

	MODULE HANDBOOK **MATRICES** **STATISTICS UNDERGRADUATE PROGRAM** **DEPARTMENT OF STATISTICS** **INSTITUT TEKNOLOGI SEPULUH NOPEMBER**

Proses *Process*	Penanggung Jawab *Person in Charge*			Tanggal *Date*
	Nama *Name*	Jabatan *Position*	Tanda tangan *Signature*	
Perumus *Preparation*	Dr. Wibawati, S.Si, M.Si	Dosen Lecturer		
Pemeriksa dan Pengendalian *Review and Control*	Dr. Wibawati, S.Si, M.Si, Dr. Purhadi, M.Sc Dra. Madu Ratna, M.Si	Tim kurikulum Curriculum team		
Persetujuan *Approval*	Dr. Wibawati, S.Si., M.Si	Koordinator RMK Course Cluster Coordinator		
Penetapan *Determination*	Dr. Kartika Fithriasari, M.Si	Kepala Departemen Head of Department		

MODULE HANDBOOK
MATRICES

Module name	MATRICES	
Module level	Undergraduate	
Code	SS234102	
Course (if applicable)	MATRICES	
Semester	1	
Person responsible for the module	Dr. Wibawati, S.Si, M.Si	
Lecturer	Dr. Wibawati, S.Si, M.Si, Dr. Purhadi, M.Sc Dra. Madu Ratna, M.Si	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergradute degree program, mandatory, 1th semester.	
Type of teaching, contact hours	Case Method (12,5%) Other SCL Methods(87,5%)	
Workload	1. Lectures [L]: 3 x 50 = 150 minutes per week. 2. Exercises and Assignments [EA] : 3 x 60 = 180 minutes (3 hours) perweek. 3. Independent learning [IL] : 3 x 60 = 180 minutes (3 hours)per week.	
Credit points	4 credit points (SKS), equivalent to 6,4 ECTS	
Requirements according to the examination regulations	A student must have attended at least 80% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	CLO.1 Able to master the concepts of vectors, basic matrix operations, determinants, inverses, vectors and random matrix, systems of linear equations, vector spaces, values and eigenvectors, and their application to statistical models CLO.2 Be able to formulate Vector problems, Basic Matrix Operations, Determinants, Inverses, Random Matrix Vectors, Systems of Linear Equations, Vector Spaces, Eigenvalues and Vectors and their application to statistical models CLO.3 Able to solve problems related to matrix differential, matrix factorization, and matrix norm. CLO.4 Able to choose methods in solving Linear Equation Systems related to Inverse Moore	PLO-4 PLO-5 PLO-8

	Penrose, Inverse Generalization and Least Square Inverse CLO.5 Be able to choose a special matrix and its operations as well as the shape of the quadratic distribution	
Content	Matrix is a subject in the field of theory, which aims to master the basic concepts of mathematics to understand the theory of vectors, basic operations of matrices, determinants, inverses, random vectors, systems of linear equations, vector spaces, values, and eigenvectors. Besides that, students able to use this concept for processing random variables, formulating modeling and calculating univariate and multivariate calculations. To achieve this goal, the learning strategy used is discussion and practice both manually and with a computer program package	
Assessment and its weight	Assignment & Test I – 20% Midterm Exam – 30% Assignment & Test II – 20% Final Exam– 30%	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom	
Reading list	1. Schott, J. R. (2016). Matrix analysis for statistics. John Wiley & Sons 2. Anton, H., & Rorres, C. (2013). Elementary linear algebra: applications version. John Wiley & Sons. 3. Basilevsky, A. (2013). Applied matrix algebra in the statistical sciences. Courier Corporation. 4. Searle, S. R., & Gruber, M. H. (2016). Linear models. John Wiley & Sons.	

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **FAKULTAS SAINS DAN ANALITIKA DATA** **PROGRAM STUDI SARJANA STATISTIKA** **DEPARTEMEN STATISTIKA**	**Kode Dokumen**

RENCANA PEMBELAJARAN SEMESTER
SEMESTER LEARNING PLAN

MATA KULIAH (MK)/ ***Course***	**KODE/** ***Code***	**Rumpun MK/** ***Course Group***	**BOBOT (sks) /** ***Weight (Credit)***		**SEMESTER/** ***Semester)***	**Tgl Penyusunan/** ***Drafting Date***
MATRIKS / ***MATRICES***	SS234102	STATISTIKA BISNIS DAN INDUSTRI	**T=4**	**P=0**	I	11 Januari 2023/ *January 11, 2023*

OTORISASI/ ***AUTHORIZATION***	**Pengembang RPS/** ***RPS Developer***	**Koordinator RMK/** ***Course Group Coordinator***	**Ketua PRODI/** ***Head of Department***
	Dr. Wibawati, S.Si, M.Si, Dr. Purhadi, M.Sc Dra. Madu Ratna, M.Si	Dr. Wibawati, S.Si, M.Si	Dr. Kartika Fithriasari, M.Si

Capaian Pembelajaran (CP)/ ***Learning Achievement***	**CPL-PRODI yang dibebankan pada MK** ***PLO***	
	CPL-4 CPL-5	Mampu menerapkan sains dan Matematika untuk mendukung pemahaman metode statistika Mampu menerapkan teori statistika pada metode statistika
	CPL-8	Mampu menggunakan perangkat komputasi modern untuk menyelesaikan permasalahan statistik
	PLO-4	*Able to apply science and mathematics to support the understanding of statistical methods*
	PLO-5	*Able to apply statistical theory to statistical methods*
	PLO-8	*Able to use modern computing devices to solve statistical problems*
	Capaian Pembelajaran Mata Kuliah (CPMK) ***CLO***	

<table>
<tr><td></td><td>CPMK.1 Mampu menguasai konsep Vektor, Operasi Dasar Matriks, Determinan, Invers, Vektor dan Mariks Random , Sistem Persamaan linier, Ruang Vektor, Nilai dan Vektor Eigen, serta penerapannya pada modek statistika
CPMK.2 Mampu memformulasikan masalah Vektor, Operasi Dasar Matriks, Determinan, Invers, Vektor an Mariks Random Random, Sistem Persamaan Linier, Ruang Vektor, Nilai dan Vektor Eigen serta penerapannya apda modek statistika
CPMK.3 Mampu menyelesaikan permasalahan yang berkaitan dengan Diferensial matriks, Faktorisasi matriks, dan Norm matriks.
CPMK.4 Mampu memilih metode dalam penyelesaian Sistim Persamaan Linear yang berkaitan dengan Invers Moore Penrose, Generalisasi Invers dan Least Square Invers
CPMK.5 Mampu memilih matriks khusus dan operasinya serta bentuk distribusi kuadratik

CLO.1 Able to master the concepts of vectors, basic matrix operations, determinants, inverses, vectors and random matrix, systems of linear equations, vector spaces, values and eigenvectors, and their application to statistical models
CLO.2 Be able to formulate Vector problems, Basic Matrix Operations, Determinants, Inverses, Random Matrix Vectors, Systems of Linear Equations, Vector Spaces, Eigenvalues and Vectors and their application to statistical models
CLO.3 Able to solve problems related to matrix differential, matrix factorization, and matrix norm.
CLO.4 Able to choose methods in solving Linear Equation Systems related to Inverse Moore Penrose, Inverse Generalization and Least Square Inverse
CLO.5 Be able to choose a special matrix and its operations as well as the shape of the quadratic distribution</td></tr>
<tr><td></td><td>Matrik CPL – CPMK
PLO-CLO Matrix

<table>
<tr><td>CLO</td><td>PLO-4</td><td>PLO-5</td><td>PLO-8</td></tr>
<tr><td>CLO.1</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>CLO.2</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>CLO.3</td><td>√</td><td>√</td><td></td></tr>
<tr><td>CLO.4</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>CLO.5</td><td>√</td><td>√</td><td></td></tr>
</table></td></tr>
<tr><td>Deskripsi Singkat MK/
Course Description</td><td>Matriks merupakan salah satu mata kuliah di bidang teori, yang bertujuan menguasai konsep dasar matematika untuk memahami teori tentang Vektor, Operasi Dasar Matriks, Determinan, Invers, Vektor Random, Sistem Persamaan Linier, Ruang Vektor, Nilai dan Vektor Eigen, Dekomposisi matrik, Generalized invers, turinan matrik serta operasi mariks khusus. Disamping itu mampu menggunakan konsep tersebut untuk pengolahan variabel random, perumusan pemodelan dan perhitungan univariate dan multivariate. Untuk mencapai tujuan tersebut, maka strategi pembelajaran yang digunakan adalah diskusi dan latihan baik secara manual maupun dengan paket program</td></tr>
</table>

	komputer *Matrix is a subject in the field of theory, which aims to master the basic concepts of mathematics to understand the theory of vectors, basic operations of matrices, determinants, inverses, random vectors, systems of linear equations, vector spaces, values, and eigenvectors. Besides that, students able to use this concept for processing random variables, formulating modeling and calculating univariate and multivariate calculations. To achieve this goal, the learning strategy used is discussion and practice both manually and with a computer program package*
Pustaka/ ***References***	Dasar Sains, Teori Statistika, Pengumpulan Data, Deskripsi dan Eksplorasi, Komputasi dan Data Processing, dan Pemodelan *Basic Science, Statistical Theory, Data Collection, Description and Exploration, Computation and Data Processing, and Modeling*
Dosen Pengampu/ ***Lecturers***	**Utama/ *Primary*** 1. Schott, J. R. (2016). Matrix analysis for statistics. John Wiley & Sons **Pendukung/*Secondary*** 1. Anton, H., & Rorres, C. (2013). Elementary linear algebra: applications version. John Wiley & Sons. 2. Basilevsky, A. (2013). Applied matrix algebra in the statistical sciences. Courier Corporation. 3. Searle, S. R., & Gruber, M. H. (2016). Linear models. John Wiley & Sons.
Matakuliah syarat/ ***Pre-requisite Course***	Dr. Wibawati, S.Si, M.Si, Dr. Purhadi, M.Sc Dra. Madu Ratna, M.Si

Mg Ke- ***Week***	**Kemampuan akhir tiap tahapan belajar (Sub-CPMK)** ***Final capability for each learning step***	**Penilaian** ***Evaluation***		**Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa,** **[Estimasi Waktu]** **Learning Format** **Learning Methods** **Assignment for Student** **[Estimated Time]**		**Materi Pembelajaran** **[Pustaka]** ***Learning Material [References]***	**Bobot Penilaian (%)** ***Evaluation Weight (%)***
		Indikator ***Indicator***	**Kriteria & Bentuk** ***Criteria and Format***	**Luring (*offline*)**	**Daring (*online*)**		
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1	Mampu memahami konsep Vektor, Operasi Dasar Matriks *Able to understand*	1.1. Mampu membedakan scalar, vector, dan matrik serta berbagai jenis matrik. 1.2. Mampu mengoperasikan aritmatika scalar, vector, dan matrik, secara manu-al	Tes Tulis, Tugas Tulis, Observasi di kelas *Written*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive*		Vektor dan Matriks [1] Bab 1 [3] Bab 1 *Vectors and*	10%

	the concept of Vector, Basic Operations of Matrix. .	serta dengan Minitab/Matlab/R. *1.1. Able to distinguish scalar, vector, and matrices as well as various types of matrices.* *1.2. Able to operate scalar, vector, and matrix arithmetic, manually and*	*Tests, Writing Assignments, Observation in class*	*Lectures, Discussions, Exercise* **TM: 2x3x50"** **LT: 2x3x60"** **BM: 2x3x60"**		*Matrix* *[1] Chapter 1* *[3] Chapter 1*	
2	Mampu memahami konsep Determinan, dan Invers *Able to understand the concept of Determinants and Inverses*	2.1. Dapat menjelaskan tentang : Determinan dan invers matriks 2.2. Dapat menyelesaikan operasi matriks, determinan dan invers suatu matriks manual serta menggunakan Minitab, Matlab, dan R. *2.1. Can explain about: Determinants and inverse matrices* *2.2. Able to complete matrix operations, determinants and inverses of a matrix manually and using Minitab, Matlab, and R.*	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing Assignments, Observation in class*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions, Exercise* **TM: 3x50"** **LT: 3x60"** **BM: 3x60"**		Determinan dan Invers [1] Bab 1 [2] Bab 2 *Determinants and Inverses* *[1] Chapter 1* *[2] Chapter 2*	10%
3-4	Mampu menjelaskan konsep vektor random Mampu menghitung perkalian titik (perkalian inner) dua vector. *Be able to explain*	3.1. Mampu menjelaskan pengertian vector random, vector mean, dan distribusinya. 3.2. Mampu menjelaskan pengertian matrik varian kovarian dan matrik korelasi, serta menghitung matrik tersebut secara manual dan menggunakan	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing Assignments, Observation*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions, Exercise*		Vektor Random dan aplikasinya [1] Bab 1 *Vector Random and its applications* *[1] Chapter 1*	10%

	the concept of random vector Be able to calculate the dot product (inner product) of two vectors.	program paket. 3.3. Mampu menalarkan formula serta menghitung ekspektasi fungsi variable random dan fungsi vector random. 3.4. Mampu menghubungkan ekspektasi fungsi vector random dengan mean dan variansi penaksir koefisien regresi. *3.1. Be able to explain the meaning of vector random, vector mean, and their distribution.* *3.2. Able to explain the meaning of covariance variance matrix and correlation matrix, as well as calculating these matrices manually and using package programs.* *3.3. Able to reason formulas and calculate expectations of random variable functions and random vector functions.* *3.4. Be able to relate the expectation of the random vector function with the mean and variance of the regression coefficient estimator.*	*in class*	**TM: 2x3x50"** **LT: 2x3x60"** **BM: 2x3x60"**			
4-6	Mampu menjelaskan konsep Ruang Vektor	4.1. Mampu menjelaskan konsep Ruang Vektor, Kombinasi Linier, Bebas Linier, Basis, Dimensi,	Tes Tulis, Tugas Tulis, Observasi di kelas	Ceramah Interaktif, Diskusi, Latihan Soal		Ruang Vektor [1] Bab 2 [2] Bab 4 [3] Bab 2	10%

		Span, Rank, dan Orth. Gram- Schmidt 4.2. Dapat menyelesaiakan permasalahan Ruang Vektor, Kombinasi Linier, bebas linier, basis, dimensi, span, Rank, dan Orth. Gram-Schmidt, secara manual maupun dengan paket program. *4.1. Able to explain the concept of Vector Space, Linear Combination, Linear Free, Base, Dimension, Span, Rank, and Orth. Gram-Schmidt* *4.2. Can solve problems of Vector Space, Linear Combination, linear free, basis, dimension, span, Rank, and Orth. Gram-Schmidt, manually or with a*	*Written Tests, Writing Assignments, Observation in class*	*Interactive Lectures, Discussions, Exercise* **TM: 2x3x50"** **LT: 2x3x60"** **BM: 2x3x60"**		*Vector Space* *[1] Chapter 2* *[2] Chapter 4* *[3] Chapter 2*	
6-7	Mampu menyelesaikan Sistem Persamaan linier *Be able to explain the concept of Vector Space*	5.1 Dapat menjelaskan dan menghitung tentang : a. Sistem Persamaan Linier Homogen dan Non homogen b. Beberapa metode penyelesaian sistem Persamaan Liner 5.2 Dapat menyelesaikan SPL dan menginterpretasika	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing Assignments, Observation in class*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions, Exercise* **TM:**		Sistem Persamaan Linier [2] Bab 1 [3] Bab 3 *System of Linear Equations* *[2] Chapter 1* *[3] Chapter 3*	10%

		dengan berbagai metode : Gaussian, Gauss Jordan, Cramer dan Invers secara manual maupun paket program *5.3 Can explain and calculate about:* *a. System of Homogeneous and Non-homogeneous Linear Equation* *b. Several methods of solving the system of Liner Equations* *5.4 Can solve SPL and interpret with various methods: Gaussian, Gauss Jordan, Cramer and Invers manually or program packages*		**2x3x50"** **LT: 2x3x60"** **BM:** **2x3x60"**			
8	**ETS**						
9	Mampu menerapkan akar dan vektor karakteristik untuk diagonalisasi dari suatu matriks *Be able to apply roots and characteristic vectors for the diagonalization of a matrix*	6.1. Mampu menentukan nilai dan vektor eigen, ruang eigen dan diagonalisasi baik secara manual maupun paket program 6.2. Mampu menganalisis hubungan antara nilai eigen dan kedefinitan. *6.1. Able to determine eigenvalues and vectors, eigenspace and diagonalization both manually and program packages* *6.2. Be able to analyze the relationship between eigenvalues and definitions*	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing Assignments, Observation in class*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions, Exercise* **TM: 3x3x50"** **LT: 3x3x60"** **BM: 3x3x60"**		- Nilai dan vektor eigen - Diagonalisasi [1] Bab 3 [3] Bab 5 *Eigenvalues and vectors - Diagonalized* *[1] Chapter 3* *[3] Chapter 5*	10%

10-11	Mampu menerapkan akar dan vektor karakteristik untuk dekomposi suatu matrik *Be able to apply roots and characteristic vectors for the decomposition of a matrix*	7.1 Mampu menghitung dekomposisi nilai singular dan spectral suatu matrik. 7.2 Mampu menghitung norm matrik. *7.1 Be able to calculate the decomposition of singular and spectral values of a matrix.* *7.2 Be able to calculate matrix norms*	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing Assignments, Observation in class*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions, Exercise* **TM: 3x3x50"** **LT: 3x3x60"** **BM: 3x3x60"**		- Dekomposisi Matrix - Norm Matrik [1] Bab 4 *- Matrix Decomposition* *- Norm Matrix* *[1] Chapter 4*	10%
11-13	Mampu menerapkan Generalized invers untuk penyelesaian SPL *Able to apply Generalized inverse for solving SPL*	8.1. Mampu menjelaskan konsep berbagai Generalized invers, yaitu : g^-, g^+ (Invers Moore Penroze), dan Invers Least Square. 8.2. Mampu menganalisis hubungan antara Invers Least Square dengan penaksir koefisien regresi. 8.3. Mampu menggunakan General Invers untuk meng,hitung solusi sistim persamaan linier dengan matrik koefisien ti-ak full rank *8.1. Be able to explain the concept of various Generalized inverses, namely: g-, g+ (Inverse Moore Penroze), and Inverse Least Square.* *8.2. Able to analyze the relationship between the*	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing Assignments, Observation in class*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions, Exercise* **TM: 3x3x50"** **LT: 3x3x60"** **BM: 3x3x60"**		Generalized Invers [1] Bab 5,6 [3] Bab 6 [4] Bab 1 *Generalized Inverse* *[1] Chapter 5,6* *[3] Chapter 6* *[4] Chapter 1*	1p

		Inverse Least Square with the regression coefficient estimator. 8.3. *Able to use General Inverse to calculate the solution of a system of linear equations with a matrix of full rank non-coefficients*					
14	Mampu mendiferensialkan scalar fungsi, vector fungsi, dan matrik fungsi dan mengaplikasikan pada penaksiran parameter model regresi. *Be able to differentiate scalar functions, function vectors, and function matrices and apply them to the estimation of regression model parameters.*	8.1. Mampu membedakan scalar fungsi, vector fungsi, dan matrik fungsi. 8.2. Mampu mendiferensialkan scalar fungsi, vector fungsi, dan matrik fungsi. 8.3. Mampu mengaplikasikan pendiferensialan pada penaksiran parameter model regresi. *9.1. Be able to distinguish scalar functions, vector functions, and function matrices.* *9.2. Able to differentiate scalar functions, function vectors, and function matrices.* *9.3. Able to apply differentiation to the estimation of regression model parameters*	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing Assignments, Observation in class*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions, Exercise* **TM: 3x3x50"** **LT: 3x3x60"** **BM: 3x3x60"**		- Diferensial scalar fungsi, vector fungsi, dan matrik fungsi, serta aplikasinya. [1] Bab 9 [2] Bab 7 [3] Bab 4 *Differential scalar functions, function vectors, and function matrices, and their applications.* *[1] Chapter 9* *[2] Chapter 7* *[3] Chapter 4*	10
15	Mampu menjelaskan dan menghitung Operasi Matrik Khusus *Able to explain and calculate Special Matrix Operations*	10.1. Mampu menjelaskan matrik idempoten, dan sifatnya. 10.2. Mampu menjelaskan dan menghitung perkalian : Kronecker dan Hadamard. 10.3. Mampu menjelaskan dan mengoperasikan Operator	Tes Tulis, Tugas Tulis, Observasi di kelas *Written Tests, Writing*	Ceramah Interaktif, Diskusi, Latihan Soal *Interactive Lectures, Discussions,*		Matrik Dan Operasi Matrik Khusus [1] Bab 11 *Matrix And Special Matrix*	10

		Vec. *10.1. Be able to explain the idempotent matrix, and its properties.* *10.2. Able to explain and calculate multiplication: Kronecker and Hadamard.* *10.3. Able to explain and operate Operator Vec.*	*Assignments, Observation in class*	*Exercise* **TM: 3x3x50"** **LT: 3x3x60"** **BM: 3x3x60"**		*Operations [1] Chapter 11*	
16	**Evaluasi Akhir Semester / Ujian Akhir Semester**						