Module Description/Course Syllabi

Study Programme : Magister of Mathematics
Faculty of Mathematics and Natural Sciences.
Universitas Andalas

1. *Course number and name*

MAT81231 Time Series Analysis

2. *Credits and contact hours/Number of ECTS credits allocated*

3 / 4,50 ECTS

3. *Instructors and course coordinator*

1. Dr. Dodi Devianto, M.Sc
2. Dr. Maiyastri, M.Sc

4. *Text book, title, outhor, and year*

a. R. S. Tsay. (2013). *Multivariate Time Series Analysis: With R and Financial Applications*. Wiley, New York. ISBN 978-1118617908.
b. S. G. Makridakis, S. C. Wheelwright, and R. J. Hyndman. (2008). *Forecasting: Methods and Application* (3rd Edition). John Wiley & Sons, New York. ISBN 978-0471532330.
c. P. J. Brockwell and R. A. Davis. (2009). *Time Series: Theory and Methods* (2nd Edition). Springer, New York. ISBN 978-1441903198.

5. *Recommended reading and other learning resources/tools*

a. C. Chatfield. (2003). *The Analysis of Time Series: An Introduction* (3rd Edition). Chapman and Hall, London. ISBN 978-0203491683.
b. G. Kitagawa. (2010). *Introduction to Time Series Modeling*. Chapman & Hall/CRC, Boca Raton. ISBN 978-1584889212.
c. W. S. Wei. (2006). *Time Series Analysis: Univariate and Multivariate Method* (2nd Edition). Pearson Addison-Wesley, New York. ISBN 978-0321322166.
d. G. E. P. Box, G. M. Jenkins, G. C. Reinsel, and G. M. Ljung. (2015). *Time Series Analysis. Forecasting and Control*. Wiley, New York. ISBN 978-1118675021.
e. J. D. Cryer and K. Chan. (2010). *Time Series Analysis with Application in R*. Springer, USA. ISBN 978-0387759586
f. A. Gharehbaghi. (2023). *Deep Learning in Time Series Analysis*. CRC Press, New York. ISBN 978-0367321789.
g. B. Auffarth. (2021). *Machine Learning for Time-Series with Python: Forecast, predict, and detect anomalies with state-of-the-art machine learning methods*. Packt Publishing, New York. ISBN 978-1801819626.
h. S. Sharma and V. Kumar. (2019). *Neural Network and Fuzzy Time Series: Forecasting using neural network and fuzzy time*. LAP LAMBERT Academic Publishing, London. ISBN 978-6200284990.

6. *Specific course information*

A. Brief description of the content of the course (catalog description)

This course applies Case Based Method (CBM). CBM is a learning method that uses cases as a medium for learning development. Students explore, assess, interpret, synthesize, and information based on cases to produce an analysis and develop a solution plan. Case-Solving Based Learning in this course provides knowledge about the concepts of time series mathematical models which include the basic concepts of time series and autoregressive models, deterministic and stochastic time series models, classical and hybrid models.

B. Prerequisites or co-requisites

MAT81131 Probability Theory

C. Indicate whether a required or elective course in the program

Elective Course

D. Level of course unit (according to EQF: first cycle Bachelor, second cycle Master)

Second Cycle master

E. Year of study when the course unit is delivered (if applicable)

2nd Year

F. Semester when the course unit is delivered

Third Semester

G. Mode of delivery (face-to-face, distance learning)

Mixture (Face to face and Distance learning)

7. *Intended Leening Outcomes*

ILO-2: Mastering mathematical concepts and applications (real analysis, advanced linear algebra, and statistics) in solving complex mathematical problems.

PI-1: Able to explain mathematical concepts (real analysis, advanced linear algebra, and statistics).

PI-2: Able to provide examples that are relevant to the basic concepts of mathematics

PI-3: Able to determine simple problem solutions using basic mathematical concepts.

ILO-3: Able to master one or several mathematical problems in analysis, algebra, applied mathematics, statistics and combinatorics.

PI-1: Able to identify theories used in related mathematical problems.

PI-2: Able to apply theories for advancement in related fields (advanced theory).

PI-3: Able to use advanced theory in solving related mathematical problems.

ILO-4: Mastering scientific techniques and developing them in solving research problems through multidisciplinary or interdisciplinary approaches.

PI-1: Able to apply mathematical techniques in research problem-solving.

PI-2: Able to analyze research problems.

PI-3: Able to formulate theorems/models and prove their validity.

PI-4: Able to use various mathematical software to solve complex mathematical problems.

ILO-5: Able to work and conduct research in mathematics and related fields of science

by developing the latest issues independently or collaboratively and communicating them academically.

PI-1. Capable of formally and correctly proving mathematical statements.

PI-2. Able to employ relevant techniques for conducting research.

PI-3. Capable of communicating research findings academically.

8. *Course Learning Outcomes* *ex. The student will be able to explain the significance of current research about a particular topic.*

1. Students are able to explain the concept of time series analysis in statistical studies. (ILO-2: PI-1, PI-2, PI-3)
2. Students are able to use advanced time series models with several classical model approaches. (ILO-3: PI-1, PI-2, PI-3)
3. Students are able to build a hybrid model of time series data with a fuzzy approach and artificial intelligence. (ILO-3: PI-1, PI-2, PI-3)
4. Students are able to use software using SPSS, Minitab, Eviews, R and Python applications in the process of estimating model parameters. (ILO-4: PI-1, PI-2, PI-3, PI-4)
5. Students are able to reason intuitively and analytically and are able to express the results of their reasoning in writing, systematically and rigorously. (ILO-5: PI-1, PI-2, PI-3)

9. *Brief list of topics to be covered*

1. Basic concepts of time series and autoregressive models.
2. Deterministic and stochastic time series models.
3. Preferred time series models in the form of volatility, seasonal, long memory and mixed models.
4. Hybrid fuzzy time series and artificial neural networks.

10. Learning and teaching methods

Presentation, Small Group Discussion, Directed Learning.

11. Language of instruction

Bahasa Indonesia

12. Assessment methods and criteria

Summative Assessment :

1. Assignments: 50%
2. Participations: 10%
3. Midterm exam: 20%
4. Final exam : 20%

Formative Assessment:

1. Thumb up and thumb down
2. Minutes paper

SEMESTER STUDY PLAN

TIME SERIES ANALYSIS

(ELECTIVE COURSES)

DEPARTMENT OF MATHEMATICS AND DATA SCIENCE

FACULTY OF MATHEMATICS AND NATURAL SCIENCES

UNIVERSITAS ANDALAS

2023

1 Semester Study Plan

	**SEMESTER STUDY PLAN** **STUDY PROGRAM OF S2 MATHEMATICS** **FACULTY OF MATHEMATICS AND NATURAL SCIENCES** **UNIVERSITAS ANDALAS**

SEMESTER STUDY PLAN

Course	Code	i-learn URL	Credits	Semester	Compilation Date
TIME SERIES ANALYSIS	**MAT 81231**	**http://sci.ilearn.unand.ac.id**	3	3	November 01, 2023
Person in Charge	**Study Plan Creator**		**Head of Research Group**	**Head of Study Program**	
	1. Dr. Dodi Devianto, M.Sc **2. Dr. Maiyastri, M.Sc**		**Yudiantri Asdi, M.Sc**	**Dr. Ferra Yanuar**	
Intended Learning Outcomes (ILO) and Performance Indicator (PI)	**ILO-Study Program**				
	ILO-2	Mastering mathematical concepts and applications (Real Analysis, Advanced Linear Algebra, and Statistics) in solving complex mathematical probl5ems. PI-1. Able to explain basic mathematical concepts PI-2. Able to provide examples that are relevant to basic mathematical concepts PI-3 Able to determine solutions to simple problems using basic mathematical concepts.			

	ILO-3	Master one or several theories comprehensively for development in the fields of analysis, algebra, applied mathematics, statistics and combinatoric mathematics. PI-1. Able to identify theories used in related mathematical problems. PI-2. Able to apply theory for development in related fields (advanced theory) PI-3. Able to use advanced theory in solving related mathematical problems.
	ILO-4	Mastering scientific techniques and developing them in solving research problems through a multidisciplinary or interdisciplinary approach. PI-1. Able to use scientific techniques in solving research problems PI-2. Able to analyze research problems PI-3. Able to formulate theorems/models and prove their correctness PI-4. Able to use several mathematical software to solve complex mathematical problems.
	ILO-5	Able to work and conduct research in the field of mathematics and related fields of science in accordance with developments in current issues independently or collaboratively and communicate it academically. PI-1. Able to prove mathematical statements formally and correctly. PI-2. Able to use related techniques to conduct research PI-3. Able to communicate research results academically.
	Course Learning Outcome (CLO)	
	CLO-1	Students are able to explain the concept of time series analysis in statistical studies. (**ILO-2**: PI-1, PI-2, PI-3)
	CLO-2	Students are able to use advanced time series models with several classical model approaches. (**ILO-3**: PI-1, PI-2, PI-3)
	CLO-3	Students are able to build a hybrid model of time series data with a fuzzy approach and artificial intelligence. (ILO-3: PI-1, PI-2, PI-3)

	CLO-4	Students are able to use software using SPSS, Minitab, Eviews, R and Python applications in the process of estimating model parameters. (ILO-4: PI-1, PI-2, PI-3, PI-4)
	CLO-5	Students are able to reason intuitively and analytically and are able to express the results of their reasoning in writing, systematically and rigorously. (ILO-5: PI-1, PI-2, PI-3)
Brief Description	This course applies Case Based Method (CBM). CBM is a learning method that uses cases as a medium for learning development. Students explore, assess, interpret, synthesize, and information based on cases to produce an analysis and develop a solution plan. Case-Solving Based Learning in this course provides knowledge about the concepts of time series mathematical models which include the basic concepts of time series and autoregressive models, deterministic and stochastic time series models, classical and hybrid models.	
Course Materials	1. Basic concepts of time series and autoregressive models. 2. Deterministic and stochastic time series models. 3. Preferred time series models in the form of volatility, seasonal, long memory and mixed models. 4. Hybrid fuzzy time series and artificial neural networks.	
References	**Main:**	
	1. R. S. Tsay. (2013). *Multivariate Time Series Analysis: With R and Financial Applications*. Wiley, New York. ISBN 978-1118617908. 2. S. G. Makridakis, S. C. Wheelwright, and R. J. Hyndman. (2008). *Forecasting: Methods and Application* (3rd Edition). John Wiley & Sons, New York. ISBN 978-0471532330. 3. P. J. Brockwell and R. A. Davis. (2009). *Time Series: Theory and Methods* (2nd Edition). Springer, New York. ISBN 978-1441903198.	
	Additional:	
	1. C. Chatfield. (2003). *The Analysis of Time Series: An Introduction* (3rd Edition). Chapman and Hall, London. ISBN 978-	

<table>
<tr><td></td><td colspan="2">0203491683.
2. G. Kitagawa. (2010). Introduction to Time Series Modeling. Chapman & Hall/CRC, Boca Raton. ISBN 978-1584889212.
3. W. S. Wei. (2006). Time Series Analysis: Univariate and Multivariate Method (2nd Edition). Pearson Addison-Wesley, New York. ISBN 978-0321322166.
4. G. E. P. Box, G. M. Jenkins, G. C. Reinsel, and G. M. Ljung. (2015). Time Series Analysis. Forecasting and Control. Wiley, New York. ISBN 978-1118675021.
5. J. D. Cryer and K. Chan. (2010). Time Series Analysis with Application in R. Springer, USA. ISBN 978-0387759586
6. A. Gharehbaghi. (2023). Deep Learning in Time Series Analysis. CRC Press, New York. ISBN 978-0367321789.
7. B. Auffarth. (2021). Machine Learning for Time-Series with Python: Forecast, predict, and detect anomalies with state-of-the-art machine learning methods. Packt Publishing, New York. ISBN 978-1801819626.
8. S. Sharma and V. Kumar. (2019). Neural Network and Fuzzy Time Series: Forecasting using neural network and fuzzy time. LAP LAMBERT Academic Publishing, London. ISBN 978-6200284990.</td></tr>
<tr><td rowspan="2">Instructional Media</td><td>Software:</td><td>Hardware:</td></tr>
<tr><td>• LMS Unand (http://sci.ilearn.unand.ac.id/)
• Zoom meeting
• Whatsapp</td><td>• Computer/Laptop
• Smartphones</td></tr>
<tr><td>Team Teaching</td><td colspan="2">1. Dr. Dodi Devianto, M.Sc
2. Dr. Maiyastri, M.Sc</td></tr>
<tr><td>Assessment</td><td colspan="2">Assignment, Participation, Mid-Term exam, Final exam</td></tr>
<tr><td>Required courses</td><td colspan="2">MAT81131 Probability Theory</td></tr>
<tr><td>Academic Norms</td><td colspan="2">Follow the Academic Regulations of Undergraduate Program, Universitas Andalas</td></tr>
</table>

	(https://akademik.unand.ac.id/images/2022-03-30%20Peraturan%20Rektor%20Nomor%207%20Tahun%202022%20Penyelenggaraan%20Pendidikan-khusus%20Bab%20II.pdf)

Week (1)	Course Outcome (2)	Indicators (3)	Form of Assessment (4)	Learning Activities [Estimated Time]					Learning Materials [Reference] (10)	Weight (11)
				Synchronous		Asynchronous		Media (9)		
				Face to Face Offline (5)	Face to Face Online (6)	Individual (7)	Collaboration (8)			
1-2	CLO 1: Students are able to explain the concept of time series analysis in statistical studies (**ILO-2**: PI-1, PI-2, PI-3).	• Discipline in implementing the college contract • Accuracy in understanding related material	Midterm exam (10%) Independent assignment (5%)	Class: – introduction of semester learning plan – discussion about course material [2 x 3 x 50 minutes]		Students find the references and learn material on basic concepts in statistics and time series analysis in the form of autoregressive models,		LMS (ilearn UNAND)	• Introduction to Lectures (Assessment, Semester Study Plan, Syllabus, Tuition Contract) • Basic concepts of time series and autoregressive models.	**15%**

						as well as time series models are deterministic and stochastic. [2 x 3 x 120 minutes]			• The concept of deterministic and stochastic time series models.	
3-7	CLO 2: Students are able to use advanced time series models with several classical model approaches (ILO-3: PI-1, PI-2, PI-3).	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness of assignment execution • Originality of assignment results	Midterm exam (10%) Assignment (10%)	Class: - explanation of concepts - discussion about course materials [5 x 3 x 50 minutes]		Students find out the references and study materials [5 x 3 x 60 minutes]	Students's discussion in groups [5x3x60] minutes	LMS (ilearn UNAND)	• Basic concepts of advanced classical time series models with volatility, seasonal and long memory models and exogenous variables.	**20%**
8	**Mid-term exam**									

9-11	CLO 3: Students are able to build a hybrid model of time series data with a fuzzy approach and artificial intelligence (ILO-3: PI-1, PI-2, PI-3).	• Accuracy in understanding of related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Final exam (5%) Participation (5%) Assignment (10%)	Class: - Explanation the concepts, - discussion about course materials [3 x 3 x 50 minutes]		Students find out references and study material [3x 3 x 60 minutes]	Students discuss in groups [3x3x60]	• LMS	• Basic concept of hybrid model of time series data a fuzzy approach and artificial intelligence.	**20%**
12-13	CLO 4: Students are able to use software using SPSS, Minitab, Eviews, R and Python applications in the process of estimating model parameters (ILO-4: PI-1, PI-2, PI-3, PI-4).	• Accuracy in understanding of related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Final exam (5%) Assignment (10%)	Class: - Use of SPSS, Minitab, EViews, R and Python applications. - Discussion about course materials. [2 x 3 x 50 minutes]		Students find out references and study material [2x 3 x 60 minutes]	Students discuss in groups [2x3x60]	• LMS	• Data analysis using SPSS, Minitab, and EViews apps • R or Python codes for estimating model (select estimated method that have been learned).	**15%**

14-15	CLO 5: Students are able to reason intuitively and analytically and are able to express the results of their reasoning in writing, systematically and rigorously (ILO-5: PI-1, PI-2, PI-3).	• Accuracy in understanding of related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Assignment (15%) Final exam (10%) Participation (5%)	Practice: – Discussion about course materials. – Presentation group [2 x 3 x 50 minutes]		Students find out references and study material [2x 3 x 60 minutes]	Students discuss in groups [2x3x60 minutes]	• LMS	• Time series hybrid method with fuzzy and artificial neural networks • Bayesian hybrid implementation with data cases using SPSS, Minitab, EViews, R and Python	**30%**
16	**Final exam**									

II. Indicators, Criteria and Proportions of Assessment

NO	FORM OF ASSESSMENT	PROPORTION (%)
1	Assignment	50%
2	Participation	10%
3	Midterm exam	20 %
4	Final exam	20%
TOTAL		**100**

Assessment proportion for each Course Learning Outcome (CLO):

- CLO 1: 15 %
- CLO 2: 20%
- CLO 3: 20 %
- CLO 4: 15 %
- CLO 5: 30 %

III. Assessment Plan Table

Form of assessment Course Learning Outcomes (CLO)	Final exam	Mid-term exam	Assignments	Participation	Total of Proportion
1. Students are able to explain the concept of time series analysis in statistical studies (ILO-2: PI-1, PI-2, PI-3).		10%	5%		15%
2. Students are able to use advanced time series models with several classical model approaches (ILO-3: PI-1, PI-2, PI-3).		10%	10%		20%
3. Students are able to build a hybrid model of time series data with a fuzzy approach and artificial intelligence (ILO-3: PI-1, PI-2, PI-3).	5%		10%	5%	20%
4. Students are able to use software using SPSS, Minitab, EViews, R and Python applications in the process of estimating model parameters (ILO-4: PI-1, PI-2, PI-3, PI-4).	5%		10%		15%
5. Students are able to reason intuitively and analytically and are able to express the results of their reasoning in writing, systematically and rigorously (ILO-5: PI-1, PI-2, PI-3).	10%		15%	5%	30%
Total of Proportion	20%	20%	50%	10%	100%

Matrix of CLO and ILO

CLO	ILO																	
	1		2			3			4				5			6		
	PI		PI			PI			PI				PI			PI		
	1	2	1	2	3	1	2	3	1	2	3	4	1	2	3	1	2	3
1			✓	✓	✓													
2						✓	✓	✓										
3						✓	✓	✓										
4									✓	✓	✓	✓						
5													✓	✓	✓			
6																		