Syllabus Curriculum 2023

MASTER OF INFORMATICS PROGRAM (MIP)
DEPARTMENT OF INFORMATICS
FACULTY OF INTELLIGENCE ELECTRICAL AND INFORMATICS TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
2023

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PROGRAM LEARNING OUTCOMES
MASTER OF INFORMATICS PROGRAM (MIP)
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

The Program Learning Outcomes (PLO) of the MIP:

PLO-1	Able to show attitudes and characters that reflect: piety to God Almighty, noble character, sensitivity, and concern about social and environmental issues, respecting cultural differences and pluralism, upholding law enforcement, prioritizing the interests of the nation and the broader community through innovation, creativity, and innovation, excellence, strong leadership, synergy with other potentials to achieve maximum results.
PLO-2	Able to develop and solve science and technology problems in the fields of artificial intelligence, network-based computing, software engineering, and information management through research with inter- or multidisciplinary approaches to produce innovative and tested works in the form of theses and papers that have been accepted in national scientific journals accredited or accepted at reputable international seminars.
PLO-3	Able to manage their learning and develop themselves as lifelong learners to compete at national and international levels to make a real contribution to solving problems by paying attention to the principle of sustainability.
PLO-4	Able to improve logical, critical, systematic, and creative thinking through scientific research in the field of science and technology-based on scientific principles, procedures, and ethics in the form of theses and papers published in seminars or scientific journals at both national and international levels.
PLO-5	Able to improve the concepts and principles of intelligent system and computational science to produce intelligent applications in various scientific fields and disciplines.
PLO-6	Able to improve the concepts and principles of network architecture and network-based computing to have high performance and security.
PLO-7	Able to analyze and improve software quality both technically and managerial by using software engineering processes principles.
PLO-8	Able to model and improve the principles of computer graphics as well as human and computer interactions in software development.

PLO-9	Able to analyze and improve computational problem solving through modeling with exact, numerical, and probabilistic approaches effectively and efficiently.
PLO-10	Able to improve methods for managing data and information in various forms.

COURSE LIST OF MIP

No	Course Code	Course Name	Credit
1st Semester			
1	EF235101	Computational Intelligence	3
2	EF235102	Net-Centric Computing	3
3	EF235103	Software Engineering	3
4	EF235191	Matriculation-Object Oriented Programming*	3
5	EF235192	Matriculation-Python Programming*	3
6	EF235XXX	1st Elective Course	3
Total Credits in 1st Semester			**12-15**
2nd Semester			
1	EF235201	Research Methodology	3
2	EF235XXX	2nd Elective Course	3
3	EF235XXX	3rd Elective Course	3
4	EF235XXX	4th Elective Course	3
Total Credits in 2nd Semester			**12**
3rd Semester			
1	EF235301	Thesis - Proposal	3
2	EF235302	Thesis - Scientific Publication	3
Total Credits in 3rd Semester			**6**
4th Semester			
1	EF235401	Thesis - Final Defense	6
Total Credits in 4th Semester			**6**
Total Credits for MIP			**36-42**

**) only required for students of the Recognition of Past Learning (RPL) program - Previous study programs are not aligned with MIP.*

LIST OF MIP ELECTIVE COURSES

No	Course Code	Course Name	Credit
Odd Semester			
1	EF235112	Advance Topics in Distributed Systems	3
2	EF235113	Advance Topics in Digital Forensic	3
3	EF235115	Advance Topics in Mobile Computing	3
4	EF235116	Advance Topics in Cloud Computing	3
5	EF235122	Advance Topics in Time Series Data Analysis	3
6	EF235131	Advance Topics in Human and Computer Interaction	3
7	EF235142	Advance Topics in Knowledge Based Engineering	3
8	EF235143	Advance Topics in Information Technology Governance	3
9	EF235145	Advance Topics in Geospatial Data Analysis	3
10	EF235155	Advance Topics in Software Testing	3
11	EF235161	Advance Topics in Data Mining	3
12	EF235162	Advance Topics in Image Processing	3
Total Credits of Elective Courses in Odd Semester			**36**
Even Semester			
1	EF235211	Advance Topics in Multimedia Networking	3
2	EF235214	Advance Topics in Network Security	3
3	EF235217	Advance Topics in Wireless Network	3
4	EF235218	Advance Topics in Network Design and Audit	3
5	EF235221	Advance Topics in Modelling and Simulation	3
6	EF235223	Advance Topics in Multivariate Data Analysis	3
7	EF235232	Advance Topics in Game Development, Virtual Reality, and Augmented Reality	3
8	EF235233	Advance Topics in Computer Graphics	3
9	EF235241	Advance Topics in System Audit	3
10	EF235244	Advance Topics in Big Data	3
11	EF235246	Advance Topics in Quantum Computing	3
12	EF235251	Advance Topics in Software Evolution	3
13	EF235252	Advance Topics in Software Project Management	3
14	EF235253	Advance Topics in Requirement Engineering	3
15	EF235254	Advance Topics in Software Quality Assurance	3
16	EF235263	Advance Topics in Text Mining	3
17	EF235264	Advance Topics in Computer Vision	3
18	EF235265	Advance Topics in Biomedical Computing	3
Total Credits of Elective Courses in Even Semester			**54**
Total Credits of Elective Courses in MIP			**90**

Module designation	**Computational Intelligence**
Course Code	EF235101
Semester(s) in which the module is taught	1st
A Person responsible for the module	Prof. Dr.Eng. Nanik Suciati, S.Kom., M.Kom.
Language	Indonesian
Relation to curriculum	Compulsory
Teaching methods	Lecture, discussion, case method, discovery learning, project-based learning
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.
Credit points	3 credit points (SKS)
Required and recommended prerequisites for joining the module	-
Course Description	Students learn about several types of input data, Fourier and Wavelet transforms, a comprehensive understanding of the classification method with supervised and unsupervised learning, and methods of optimization with evolutionary algorithms, as well as the reduction and transformation of data. Students implement these methods to a case study in the form of project tasks, starting from data input, processing and data extraction, data reduction, optimization, and classification by applying the supervised and unsupervised learning, and write papers of the modeling results. Supervised learning includes the multilayer perceptron, RBF, ANFIS, SVM, and the soft SVM. Unsupervised learning covers a variety of clustering methods. Optimization methods cover evolutionary algorithms such as Genetic Algorithm (GA), Ant Colony (ACO), Particle Swarm Optimization (PSO), Artificial Bee Colony. Reduction and transformation of data includes Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Independent Component Analysis (ICA).

Module objectives/intended learning outcomes	Students are able to analyze the application of machine learning concepts to various types of applications.	PLO 2
	Students are able to analyze and develop clustering techniques.	PLO 3, PLO 5
	Students are able to analyze and develop classification techniques based on distance, probability and rules.	PLO 3, PLO 5
	Students are able to analyze and develop discriminant function-based classification techniques.	PLO 3, PLO 5
	Students are able to analyze and develop reinforcement learning techniques.	PLO 3, PLO 5
	Students are able to analyze and develop optimization techniques and combine them with clustering and/or classification techniques to solve real problems and publish the results of their research in seminars or journals at national and international levels.	PLO 2, PLO 3, PLO 5
Content	1. Data Input: available dataset, static data, dynamic data, machine perception, model illustration consisting of pre-processing, feature extraction, classification. 2. Bayesian classification: a review of the concept of Bayes decision theory and discriminant functions, discriminant functions for normal density and discuss the applications that use Bayesian classification. 3. Data Transformation: Discrete Fourier Transform, Fast Fourier Transform (FFT), Discrete Time Wavelet Transform. 4. Clustering: Hard clustering, vector quantization, fuzzy clustering, kernel clustering methods, hierarchical clustering, application examples. 5. Fuzzy Logic, Approximate Reasoning: a review of the various membership functions, reasoning approach with multiple rules, Mamdani implication function. 6. Linear and nonlinear classifiers: multilayer perceptron, Radial Basis Function, ANFIS, SVM, decision tree, combination classifiers. 7. Implementation of clustering method and neural networks, and analysis of research related papers.	

	8. Evolutionary Algorithm: a review of the concept of Genetic Algorithm (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC). 9. Dimensional reduction and data transformation: review the concept of Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), and application examples. 10. Implementation of classifiers combined with optimization methods or with PCA and LDA, and analysis of the related research. 11. Implementation of feature vector extraction and classification in a group project, and analysis the related research. 12. Writing reports and papers on the implementation of classification models.
Exams and assessment formats	Assignments, paper review, and final project presentation
Study and examination requirements	The final grade is drawn from the following components: • 1st assignments (Clustering and classification using python programming): 25% of grade • Paper review (International journal): 25% of grade • Final project presentation: 20% of grade • 2nd assignments (Simple programming: reinforcement learning, discriminant classification): 30% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Stuart Russel, Peter Norvig, Artificial Intelligence: A Modern Approach, Fourth edition, Pearson, 2020 2. Christopher Bishop, Pattern Recognition and Machine Learning. Springer, 2006 3. Andries P. Engelbrecht, Computational Intelligence An Introduction, Second Edition, John Wiley & Sons Ltd, 2007 4. Rudolf Kruse, Christian Borgelt, Frank Klawonn, Christian Moewes, Matthias Steinbrecher, Pascal Held, Computational Intelligence: A Methodological Introduction, Springer, 2013

	5. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, Second Edition, Addison Wesley, 2002 6. Arthur K. Kordon, Applying Computational Intelligence, Springer-Verlag Berlin Heidelberg 2010 7. S. Sumathi, Surekha P., Computational Intelligence Paradigms: Theory and Applications using MATLAB, CRC Press, 2010 8. Peter Harrington, Machine Learning in Action, Manning, 2012 9. Scientific articles related to Computational Intelligence in reputable international journals.

Module designation	**Net-Centric Computing**	
Course Code	EF235102	
Semester(s) in which the module is taught	1st	
A Person responsible for the module	Ir. Ary Mazharuddin Shiddiqi, S.Kom., M.Comp.Sc., Ph.D.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Lecture, discussion, discovery learning, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Network-Based Computing course provide knowledge of the unique characteristics that exist in mobile networks. Students are guided to be able to define problems that arise in mobile networks and are asked to design the right routing protocol to solve problems on mobile networks which can then be developed to improve performance.	
Module objectives/intended learning outcomes	Students are able to explain and assemble knowledge in the field of Network-Based Computing in terms of concepts, theories, and terms in various kinds of supporting technologies.	PLO 1, PLO 2, PLO 3, PLO 6
	Students are able to provide a critical assessment of a problem in the supporting technology of Network-Based Computing.	PLO 1, PLO 2, PLO 3, PLO 6
	Students are able to analyze and assess the supporting technology of Network-Based Computing to be applied in new or different fields.	PLO 1, PLO 2, PLO 3, PLO 6

	Students are able to plan or find a solution scientifically to solve problems in the field of supporting technology for Network-Based Computing.	PLO 1, PLO 2, PLO 3, PLO 6
Content	1. Data transmission 2. Data link concepts 3. Networking concepts 4. Network security 5. Application protocols 6. Net-centric computing and web programming	
Exams and assessment formats	Assignments, quizzes, midterm assessment, and final project	
Study and examination requirements	The final grade is drawn from the following components: • Assignments: 25% of grade • Quiz: 15% of grade • Midterm assessment: 25% of grade • Final project: 35% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Pei Zheng, Larry L. Peterson, Bruce S. Davie, Adrian Farrel, Wireless Networking Complete, 2009, Morgan Kaufmann 2. Abdessalam Helal, Et.Al," Anytime, Anywhere Computing, Mobile Computing Concepts and Technology", McGraw-Hill 3. Mobile Computing Principles Designing And Developing Mobile Applications With Uml And Xml and the Environment", Oxford Publisher 2002. 4. Location Management and Routing in Mobile Wireless Networks, Amitava Mukherjee, Somprakash Bandyopadhyay, Debashis Saha, Artech House Publisher 5. Andreas Heinemann, Max Muhlhauser", Peer-to-Peer Systems and Application 6. Mohammad Ilyas and Imad Mahgoub, Mobile Computing Handbook, Auerbach Publication 7. IEEE Transaction of Mobile Computing, IEEE 8. Pervasive and Mobile Computing, Elsevier	

Module designation	**Software Engineering**	
Course Code	EF235103	
Semester(s) in which the module is taught	1st	
A Person responsible for the module	Prof. Daniel Oranova Siahaan, S.Kom., M.Sc., PD.Eng., Dr. Ir. Umi Laili Yuhana, S.Kom., M.Sc.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Lecture, discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Software Engineering course provide knowledge about application theory in software design and development with standard and scientific planning, requirements engineering, design, implementation, testing, and launch methods, to produce software products that meet various quality parameters technically and managerially and are useful in software development.	
Module objectives/intended learning outcomes	Students are able to explain and assemble knowledge in the software engineering process in terms of concepts, theories, and terms in various kinds of supporting technologies.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and make a critical assessment of a problem in software design.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and make a critical assessment of a problem in software testing.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and conduct critical assessments of software risks.	PLO 2, PLO 3, PLO 7

	Students are able to analyze and make a critical assessment of software quality.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and conduct critical assessments of software maintenance.	PLO 2, PLO 3, PLO 7
Content	1. Basic concept of software engineering 2. Software project planning 3. Software analysis and design 4. System modeling 5. Software testing 6. Software risks 7. Software quality 8. Software maintenance	
Exams and assessment formats	Quizzes, presentation, paper review, and final assessment	
Study and examination requirements	The final grade is drawn from the following components: • 1st quiz (Software project planning): 10% of grade • 2nd quiz (System design): 10% of grade • Presentation of paper review: 20% of grade • 3rd quiz (Software testing strategy): 10% of grade • 4th quiz (Software risk control): 10% of grade • 5th quiz (Software technical metrics): 10% of grade • Final assessment: 30% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Pressman, R. S., Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill, 2014. 2. Sommerville, I., Software Engineering (10th Edition), Pearson; 2015 3. Kin, G, Debois, P., Willis, J., Humble, J., and Allspaw, J., The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations 4. IEEE Computer Society, SWEBOK v.3.0, IEEE, 2014 5. Annual Conference: International Requirements Engineering Conference, IEEE.	

Module designation	**Matriculation-Object Oriented Programming**	
Course Code	EF235191	
Semester(s) in which the module is taught	1st	
A Person responsible for the module	Agus Budi Raharjo, S.Kom., M.Kom., Ph.D.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Lecture, discovery learning, problem-based learning, small group discussion, collaborative learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Matriculation-Object Oriented Programming course introduces the concept of object-oriented programming for students who already have structured or procedural programming knowledge (mainly, C/C++ programming language). The topics taught include object-oriented principles and object-oriented programming techniques using object-oriented languages (mainly, Java).	
Module objectives/intended learning outcomes	Students are able to explain object-based programming concepts along with the features of object-oriented programming languages.	PLO 1, PLO 2, PLO 3
	Students are able to analyze problems using an object-oriented approach.	PLO 1, PLO 2, PLO 3
	Students are able to model problem solutions using an object-oriented approach.	PLO 1, PLO 2, PLO 3
	Students are able to implement problem solutions in the form of programs using object-oriented language.	PLO 1, PLO 2, PLO 3

Content	1. Eclipse IDE for Java Programming 2. Eclipse IDE: Debugging, Classes and Objects, Types, Various Conditions and Loops, Exercises 3. Array, ArrayList & Scanner; Exception and I/O 4. Javadoc, Testing & Objects, Interface 5. Inheritance 6. Collection & Generics 7. Graphical User Interface (GUI), Event Handling & Inner Class 8. Access control & polymorphism, GUI Programming & MVC design patterns 9. Collections: Advanced & Immutability
Exams and assessment formats	Quizzes, midterm assessment, and final assessment
Study and examination requirements	The final grade is drawn from the following components: • 1st quiz: 25% of grade • Midterm assessment: 25% of grade • 2nd quiz: 50% of grade • Final assessment: 25% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Murach, J. and Urban, M. (2015) Murach's Beginning Java with Eclipse. Fresno, CA, USA: Mike Murach & Associates, Inc. 2. Deitel, P. and Deitel, H. (2020) JavaTM—How to Program—Late Objects. Eleventh Edition. Global Edition. New Yok, USA: Pearson Education Limited.

Module designation	**Matriculation-Python Programming**	
Course Code	EF235192	
Semester(s) in which the module is taught	1st	
A Person responsible for the module	Shintami Chusnul Hidayati, S.Kom., M.Sc., Ph.D.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Lecture, discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	This course aims to study the basic concepts of programming and data structures with Python, as well as data processing concepts by utilizing Python libraries.	
Module objectives/intended learning outcomes	Able to understand software development methodologies (analysis, design, coding, testing, documentation) and apply these methodologies to a case study.	PLO 2, PLO 3, PLO 7
	Able to translate designs into algorithms correctly and structured.	PLO 2, PLO 3, PLO 7
	Able to design structured programs in a modular manner with a top-down approach using functions in Python language, and able to perform debugging and testing processes.	PLO 2, PLO 3, PLO 7
	Able to design and implement problem solutions using an object-oriented approach in Python language, and able to perform debugging and testing processes.	PLO 2, PLO 3, PLO 7

	Able to model and implement problem solutions using libraries and special functions in Python.	PLO 2, PLO 3, PLO 7
Content	1. Introduction to Python 2. Data Types, Variables, Basic Input-Output Operations, Basic Operators 3. Boolean values, conditional execution, loops, lists and list processing, logical and bitwise operations 4. Functions, tuples, dictionary, and data-processing 5. Modules, packages, pip 6. Strings, string and list methods, exceptions 7. Object-oriented programming 8. Generators, iterators, dan closures in Python 9. Pandas library	
Exams and assessment formats	Presentations and case studies	
Study and examination requirements	The final grade is drawn from following components: • Presentation of 1st case study: 20% of grade • Presentation of 2nd case study: 30% of grade • Presentation of 3rd case study: 30% of grade • Presentation of 4th case study: 20% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. McKinney, W. (2022). Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter. United States: O'Reilly. ISBN: 9781098104030. 2. Müller, A. C., Guido, S. (2016). Introduction to Machine Learning with Python: A Guide for Data Scientists. United States: O'Reilly Media. ISBN: 9781449369897. 3. Bengfort, B., Bilbro, R., Ojeda, T. (2018). Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning. Taiwan: O'Reilly Media. ISBN: 9781491962992. 4. Hilpisch, Y. J. (2019). Python for Finance: Mastering Data-driven Finance. Japan: O'Reilly Media. ISBN: 9781492024330.	

Module designation	**Advance Topics in Distributed Systems**	
Course Code	EF235112	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Royyana Muslim Ijtihadie, S.Kom., M.Kom., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Distributed Systems course discusses the characteristics of distributed systems, including issues and challenges in aspects of distributed systems. This lecture also discusses the identification of research problems and contributions in distributed systems.	
Module objectives/intended learning outcomes	Students are able to explain the definition, paradigm and characteristics of distributed systems, including also synthesizing based on the characteristics of distributed systems.	PLO 6
	Students are able to understand certain topics in distributed systems and can produce syntheses of certain topics in distributed systems.	PLO 2, PLO 6
	Students are able to identify research problems and carry out advanced elaboration on topics in distributed systems.	PLO 2, PLO 6
	Students are able to identify research problems and carry out advanced elaboration to contribute new knowledge.	PLO 2, PLO 6

Content	1. Introduction to distributed systems: concepts, goals, and limitations. 2. Inter-process communication: message passing, remote procedure calls, distributed objects, and naming. 3. Distributed systems-based programming: UDP/TCP socket and the use of middleware. 4. Indirect communication (publish-subscribe and tuple space). 5. Middleware for distributed systems (middleware for publish-subscribe, map-reduce, peer to peer, and message queue). 6. Concepts, standards, and middleware on multi-agent and mobile agent. 7. Distributed file systems and examples of their application. 8. Research topic in mobile computing, pervasive computing, ubiquitous computing, and cloud computing. 9. The issue of research in distributed systems (load balancing, load estimation, load migration, and big data).
Exams and assessment formats	Presentation, write and submit scientific article in national journals
Study and examination requirements	The final grade is drawn from following components: ● 1st presentation (The formulation of topic to be researched): 25% of grade ● Writing a draft of scientific article: 25% of grade ● 2nd presentation (The progress of the research): 25% of grade ● Submit paper in national journals: 25% of grade Students must have a final grade of 61% or higher to pass this course
Reading list	1. Distributed Systems an Algorithmic Approach Second Edition, Sukumar Ghosh, 2015, CRC Press. 2. Design Patterns for Cloud Native Applications, Patterns in Practice Using APIs, Data, Events, and Streams, Kasun Indrasiri and Sriskandarajah Suhothayan,2021, O'Reilly. 3. Distributed Systems Design, Jie Wu, CRC Press. 4. Distributed Computing Principles, Algorithms, and Systems, Ajay D. Kshemkalyani, Mukesh Singhal, 2008, Cambridge University Press.

	5. Distributed Systems Concepts and Design Fifth Edition, George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, 2012, Pearson. 6. IEEE Transaction on Parallel and Distributed Systems, IEEE 7. Distributed Computing, Springer 8. Communication of the ACM, ACM

Module designation	**Advance Topics in Digital Forensic**	
Course Code	EF235113	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Hudan Studiawan, S.Kom., M.Kom., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, discovery learning, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topic in Digital Forensics is an interdisciplinary course that uses various techniques to investigate and analyze digital evidence. Digital forensics is a highly specialized field for uncovering digital evidence from mobile devices, computers, and other digital storage devices. This course covers topics such as forensic techniques and tools, from obtaining evidence to digital evidence analysis. The course also covers the latest research in digital forensics, allowing students to gain research experience in this field.	
Module objectives/intended learning outcomes	Students are able to explain and assemble knowledge in the field of digital forensic methodology.	PLO 2, PLO 4, PLO 5, PLO 6
	Students are able to provide a critical assessment of a problem in forensic analysis on document files or other artifacts.	PLO 4, PLO 5, PLO 6
	Students are able to analyze and assess forensics on memory and disks to be applied in new or different fields.	PLO 4, PLO 5, PLO 6

	Students are able to plan or find a solution scientifically to solve forensic investigation problems in new devices such as Internet of Things devices and drones.	PLO 4, PLO 5, PLO 6
Content	1. The concept of digital evidence: tangible evidence, best evidence, direct evidence, digital evidence. 2. Methodology of forensic investigation: obtaining information, developing strategies, gathering evidence, analysis, reporting. 3. Collection of evidence: physical tapping (cable, radio frequency, etc.), software to get the data (tcpdump, wireshark, etc) 4. The concept of a file: file signature, forensic imaging, file allocation table (FAT), NTFS, volume, partition. 5. Technical basics: packet analysis, flow analysis, evidence-based resource network (firewalls, proxies, routers, switches, server logs, etc.)	
Exams and assessment formats	Paper review and presentations	
Study and examination requirements	The final grade is drawn from following components: • Paper review (Analysis with Autopsy): 20% of grade • Presentation of 1st paper: 20% of grade • Presentation of 2nd paper: 20% of grade • Presentation of 3rd paper: 20% of grade • Presentation of 4th paper: 20% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Forensic Science International: Digital Investigation, Elsevier 2. IEEE Transactions on Information Forensics and Security 3. Nelson, B., Phillips, A., & Steuart, C. (2019). Guide to Computer Forensics and Investigations. Cengage Learning. 4. Holt, T. J., Bossler, A. M., & Seigfried-Spellar, K. C. (2022). Cybercrime and digital forensics: An introduction. Routledge.	

Module designation	**Advance Topics in Mobile Computing**	
Course Code	EF235115	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Dr.Eng. Radityo Anggoro, S.Kom., M.Sc.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, discovery learning, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Net-Centric Computing (EF235102)	
Course Description	This course learns and analyzes related issues associated with the development of the system in a mobile computing environment with an understanding of the characteristics of the environment and infrastructure in which the system is located, move, or interacts. This course also studies supporting technologies and methodologies to solve problems related to the purpose of the development of the achieved system.	
Module objectives/intended learning outcomes	Students are able to master the concepts and principles of architecture, systems and the basics of networks in a mobile environment.	PLO 1, PLO 6
	Students are able to define specific protocols according to the network layer based on the characteristics of the mobile environment.	PLO 3, PLO 6
	Students are able to develop protocols at the network layer, both general and specific, including setting performance measurements in mobile environments.	PLO 3, PLO 6
	Students are able to improve protocol performance to solve problems effectively and efficiently.	PLO 2, PLO 6

Content	1. Wireless network technology and its limitations. 2. Characteristics and dimensions of a system that works in the mobile environment. 3. Modelling and mobility characteristics of the mobile environment. 4. Location management system that works on the mobile environment. 5. Ad hoc networks, delay-tolerant, and its limitations, routing, and superiority. 6. Latest issues related to mobile information access, location-related application adaptation, energy, and resource availability. 7. The development of spontaneous networking, mobile peer-to-peer, and its application. 8. A variety of research topics in mobile computing.
Exams and assessment formats	Quizzes, midterm assessment, and final project
Study and examination requirements	The final grade is drawn from the following components: • 1st quiz: 15% of grade • Midterm assessment: 35% of grade • 2nd quiz: 15% of grade • Final project: 35% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Abdessalam Helal, et., al., "Anytime, Anywhere Computing, Mobile Computing Concepts and Technology", McGraw-Hill, 2. Mobile Computing Principles Designing And Developing Mobile Applications With Uml And Xml and the Environment", Oxford Publisher 2002. 3. Location Management and Routing in Mobile Wireless Networks, Amitava Mukherjee, Somprakash Bandyopadhyay, Debashis Saha, Artech House Publisher 4. Andreas Heinemann, Max Muhlhauser, Peer-to-Peer Systems and Application 5. Mohammad Ilyas and Imad Mahgoub, Mobile Computing Handbook, Auerbach Publication 6. IEEE Transaction of Mobile Computing, IEEE 7. Pervasive and Mobile Computing, Elsevier

Module designation	**Advance Topics in Cloud Computing**	
Course Code	EF235116	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Royyana Muslim Ijtihadie, S.Kom., M.Kom., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	This course discusses basic cloud technology, mechanism, architecture, issues, challenges, and the newest research technology of cloud computing. In addition, this course discusses identifying research problems in cloud computing and their contributions.	
Module objectives/intended learning outcomes	Students are able to explain the definition, paradigm and relevance between distributed systems and cloud computing, including also synthesizing based on the characteristics of cloud computing.	PLO 6
	Students are able to understand certain topics in cloud computing and can produce syntheses of certain topics in cloud computing.	PLO 2, PLO 6
	Students are able to identify research problems and carry out advanced elaboration on cloud computing topics.	PLO 2, PLO 6
	Students are able to identify research problems and carry out advanced elaboration to contribute new knowledge.	PLO 2, PLO 6
Content	1. Introduction to cloud computing fundamentally.	

	2. The mechanism and holding security of cloud computing, architecture and delivery model on cloud computing, supporting cloud computing technologies, cloud computing cases and its implementations. 3. The management of system and quality service on cloud computing.
Exams and assessment formats	Presentations, write a paper and submit to national journals
Study and examination requirements	The final grade is drawn from the following components: • Presentation the topics to be researched: 25% of grade • Create an idea and draft for scientific papers: 25% of grade • Write a scientific paper: 25% of grade • Submit the scientific paper to national journals: 25% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Cloud Computing Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, 2013, Pearson 2. Data Center Handbook, Plan, Design, Build, and Operations of a Smart Data Center, Hwaiyu Geng, 2021, John Wiley & Sons, Inc 3. Design Patterns for Cloud Native Applications, Patterns in Practice Using APIs, Data, Events, and Streams, Kasun Indrasiri and Sriskandarajah Suhothayan,2021, O'Reilly 4. IEEE Transaction on Cloud Computing, IEEE 5. Communication of the ACM, ACM

Module designation	**Advance Topics in Time Series Data Analysis**	
Course Code	EF235122	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Dr. Ahmad Saikhu, S.Si., M.T.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, program demo	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Time Series Data Analysis course, various techniques and forecasting modeling based on statistics, neural networks and deep learning are studied. The multi-technique approach includes univariate and multivariate data and model evaluation based on forecasting model performance measures to obtain the best model. In this lecture, anomaly detection is also discussed. Learning is carried out through lectures, discussions, presentations and review of publication articles. In addition, students are given a case study assignment with the use of python tools, R-package.	
Module objectives/intended learning outcomes	Students are able to explain the characteristics of univariate and multivariate time-series data and modeling techniques.	PLO 9
	Students are able to create statistics-based time series models and analyze the results.	PLO 2, PLO 9
	Students are able to find the best time series model with neural networks and deep-learning and analyze the results.	PLO 2, PLO 9
	Students are able to review and explain publication articles in the field of forecasting.	PLO 2

Content	1. Modelling of Forecasting Time Series Univariat 2. Modelling of Forecasting Time Series Multivariat 3. Modelling of Forecasting based on Neural Networks/Deep Learning 4. Anomaly Detection dan Time Series Data Analysis
Exams and assessment formats	Presentations, paper review, and final project
Study and examination requirements	The final grade is drawn from the following components: • 1st paper review and presentation (Forecasting modelling with ARIMA): 25% of grade • 2nd paper review and presentation (Forecasting modelling of time series multivariate): 25% of grade • Project of time series multivariate with neural networks and deep learning: 25% of grade • Presentation of project: 25% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Time series Analysis, Univariate and Multivariate Methods, Second Edition, William W.S. Wei, 2006, Pearson Education Inc. Addison-Wesley 2. Time series Analysis and Its Application, with R Examples, fourth Examples Robert H. Shumway, David S. Stoffer, Springer, 2017 3. Deep Learning with R, François Chollet, 2017, Manning Publications 4. Neural Networks for Time Series Forecasting With R, 2017, Dr. N.D Lewis

Module designation	**Advance Topics in Human and Computer Interaction**	
Course Code	EF235131	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Dr.Eng. Darlis Herumurti, S.Kom., M.Kom.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	This course is an introduction to research in the field of Human-Computer Interaction (HCI). This course introduces the theory of human physiology and psychology, human-computer interaction principles, user-centered application development process, research in the field of HCI steps, and experiment and evaluation in the HCI research. Through this course, students will get the opportunity to further explore research topics for develop or evaluations in the field of HCI.	
Module objectives/intended learning outcomes	Students are able to report and discuss the latest research in the field of HCI.	PLO 3, PLO 8
	Students are able to apply HCI principles, guidelines, methodologies, and techniques to software development.	PLO 3, PLO 8
	Students are able to design, test, analyze, and evaluate research in the field of HCI.	PLO 3, PLO 8
	Students are able to produce papers on HCI topics in reputable international publications.	PLO 2, PLO 3
Content	1. Introduction of human-computer interaction and research history in the field of human-computer interaction.	

	2. Overview of human factors (physiology and psychology aspect) such as the sensory, motor, and cognitive characteristics in the relation to human computer interaction. 3. The core elements of human interaction with computers: relation between display and control, metal and metaphor model, and interaction errors. 4. Processes for user-centered development. 5. The introduction of research steps in human-computer interaction: research methodology, observation and measurement, validation, and evaluation. 6. Methodology and experiment design in the research in the field of human-computer interaction. 7. Evaluation and hypothesis testing in the research in the field of human-computer interaction. 8. Writing and publishing a research paper in the field of human-computer interaction.
Exams and assessment formats	Presentations, application demo, paper review, write a paper and submit to international conferences
Study and examination requirements	The final grade is drawn from the following components: • Presentation: 25% of grade • Application demo: 25% of grade • Paper review and presentation: 20% of grade • Presentation of research publication papers: 30% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Human-Computer Interaction: An Empirical Research Perspective; I. Scott MacKenzie • 2013 2. Research Methods in Human Computer Interaction; Jonathan Lazar et.al, Second Edition • 2017 3. ACM SIGCHI: https://dl.acm.org/sig/sigchi

Module designation	**Advance Topics in Knowledge Based Engineering**	
Course Code	EF235142	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Shintami Chusnul Hidayati, S.Kom., M.Sc., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The purpose of this course is to provide a solid advanced level of issues, challenges, concepts, and techniques dealing with the organization and management of knowledge with the help of computers for system engineering. At the end of the course, students should be able to improve knowledge engineering approaches for such systems either independently or cooperatively.	
Module objectives/intended learning outcomes	Mastering fundamental and advanced concepts behind the creation, acquisition, representation, dissemination, use and reuse, and management of knowledge.	PLO 2, PLO 3, PLO 10
	Mastering the fundamental and advanced principles, methods, techniques, and tools used in computer-supported knowledge engineering.	PLO 2, PLO 5, PLO 10
	Mastering fundamental and advanced concepts and principles in the implementation and integration of appropriate components and functions from various knowledge-based systems engineering.	PLO 2, PLO 10

	Able to critically evaluate current knowledge management trends and their manifestation in commerce and industry.	PLO 1, PLO 2, PLO 3, PLO 5, PLO 10
Content	1. Principles and advanced practices of knowledge management 2. Technical components of computer tools and technology for managing knowledge 3. Evaluation of the characteristics, representation, availability, and utilization of knowledge 4. Management and the future of knowledge engineering	
Exams and assessment formats	Presentations and case studies	
Study and examination requirements	The final grade is drawn from the following components: • 1st presentation: 20% of grade • 1st case study (Implementation of the improved artificial intelligence technology): 30% of grade • 2nd case study (Implementation of an improved system, which supports direction and routines): 30% of grade • 2nd presentation: 20% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Irma Becerra-Fernandez, Rajiv Sabherwal (2015). Knowledge Management: Systems and Processes. Taylor & Francis. ISBN: 978-1-315-71511-7. 2. Diane Kitchin, Mauro Vallati (2020). Knowledge Engineering Tools and Techniques for AI Planning. Springer International Publishing. ISBN: 978-3-030-38561-3. 3. Simon Kendal, Malcolm Creen (2007). An Introduction to Knowledge Engineering. Springer. ISBN: 978-1-846-28475-5. 4. Papers related to topics in knowledge-based engineering	

Module designation	**Advance Topics in Information Technology Governance**	
Course Code	EF235143	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Dr. Ahmad Saikhu, S.Si., M.T.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, small group discussion, collaborative learning, cooperative learning, discovery learning, problem-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Information Technology Governance course, students will learn the importance of information technology governance, frameworks in information technology governance, information technology governance development, maturity level calculations, gap analysis, and information technology governance recommendations.	
Module objectives/intended learning outcomes	Students are able to explain several frameworks for information technology governance.	PLO 9
	Students are able to gap analysis using information technology governance frameworks.	PLO 9
	Students are able to measure the maturity level of information technology implementation using an information technology governance framework.	PLO 4
	Students are able to provide recommendations for improving the implementation of	PLO 4

	information technology governance using the information technology governance framework.	
Content	1. Information technology governance framework (COBIT, TOGAF) 2. Calculation of the maturity level of information technology governance 3. Information technology governance implementation gap analysis 4. Analysis and provision of recommendations for the application of information technology governance	
Exams and assessment formats	Case studies, midterm assessment, project, and presentation	
Study and examination requirements	The final grade is drawn from the following components: • Case study: 25% of grade • Midterm assessment: 25% of grade • Project (Gap analysis between as-is and to-be in information technology governance): 25% of grade • Presentation of final project: 25% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Wallace, M., Webber, L. (2021). IT Governance: Policies & Procedures. Wolters Kluwer, New York 2. TOGAF 9 Foundation Study Guide 4th edition 3. COBIT 2019 Framework: Governance and Management Objectives 4. ArchiMate Modeling. Link: https://www.archimatetool.com/ 5. Frogeri, R. F., Pardini, D. J., Cardoso, A. M. P., Prado, L. Á., Piurcosky, F. P., & Junior, P. dos S. P. (2019). IT Governance in SMEs. International Journal of IT/Business Alignment and Governance, 10(1), 55–73. doi:10.4018/ijitbag.2019010104 6. Janahi, L., Griffiths, M., & Al-Ammal, H. (2015). A conceptual model for IT Governance: A case study research. International Conference on Computer Vision and Image Analysis Applications. doi:10.1109/iccvia.2015.7351894 7. Silva, E., & Chaix, Y. (2008). Business and IT Governance Alignment Simulation Essay on a Business Process and IT Service Model. Proceedings of the 41st Annual Hawaii	

	International Conference on System Sciences (HICSS 2008). doi:10.1109/hicss.2008.83

Module designation	**Advance Topics in Geospatial Data Analysis**	
Course Code	EF235145	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Dr. tech. Ir. Raden Venantius Hari Ginardi, M.Sc.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, small group discussion, project-based learning, case-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Geospatial Data Analysis course contain strengthening understanding of coordinate systems, digital maps, cartography, spatial analysis, and geographic information systems. In this course, methods and algorithms related to data management related to geographic spatial are discussed, including but not limited to global positioning systems, indoor positioning systems, location-based services, suitability analysis, 3d-spatial analysis, and interoperability in spatial data management, for example in the use of APIs to use online maps services. Lecture participants will explore research developments in the field of spatial data analysis and management and conduct experiments to produce research proposals and publications in the field of geospatial data analysis.	
Module objectives/intended learning outcomes	Students are able to present project planning topics related to spatial data management using GIS Desktop.	PLO 2
	Students are able to design and solve spatial analysis problems.	PLO 2

	Students are able to explain the progress of experiments in spatial data management using integrated online data.	PLO 10
	Students are able to present drafts of scientific articles that are ready to be published at international seminars or accredited national journals.	PLO 10
Content	1. Coordinate System, Map Projection System, Map Digitization 2. Spatial analysis and 3d-spatial analysis 3. Indoor positioning system and Global Positioning System 4. Location-based services 5. Data interoperability	
Exams and assessment formats	Practicum with project, assignment, presentation, literature review, and write a paper for research publication	
Study and examination requirements	The final grade is drawn from the following components: • Practicum with project (Managing spatial data of digital maps with Desktop GIS): 20% of grade • Project presentation (Suitability analysis): 20% of grade • Presentation of literature review (Proposal in field of location-based services): 30% of grade • Write a paper for research publication: 30% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Michael J de Smith, Michael F Goodchild, and Paul A Longley, Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Tools, 6-ed, The Winchelsea Press, 2018 2. A. Stewart Fotheringham, Chris Brunsdon, and Martin Charlton, Quantitative Geography: Perspectives on Spatial Data Analysis, SAGE Publications Ltd; First edition (May 2, 2000) 3. The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns and Relationships	

Module designation	**Advance Topics in Software Testing**	
Course Code	EF235155	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Prof. Daniel Oranova Siahaan, S.Kom., M.Sc., PD.Eng.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, case method brainstorming paper review	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Software Testing course is part of the Software Engineering family which discusses the process of validating and verifying a software using approaches, methods, and tools that are in accordance with the characteristics of the software. Students will also review current research related to software testing, as well as identify state-of-the-art methods, issues, and challenges in software testing.	
Module objectives/intended learning outcomes	Students are able to analyze and develop software verification and validation methods.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and develop testing-based software development methods.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and develop methods related to faults and defects in software.	PLO 2, PLO 3, PLO 7
Content	1. Statics and dynamics approach to software verification 2. Test-driven development 3. Planning and validation documentation 4. Object oriented testing; system testing	

	5. Verification and validation non-code artifacts (documentation, help files, training materials) 6. Fault logging 7. Fault tracking 8. Fault estimation dan testing termination 9. Defect seeding
Exams and assessment formats	Assignment, paper review, and presentation
Study and examination requirements	The final grade is drawn from the following components: • 1st assignment (Statics and dynamics approach to software verification): 15% of grade • 2nd assignment (Software development testing oriented): 20% of grade • 3rd assignment (Software verification and validation): 15% of grade • 4th assignment (Fault analysis): 30% of grade • Presentation of paper review: 20% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Ralf Bierig, Stephen Brown, Edgar Galvan, and Joe Timoney, Essentials of Software Testing, Cambridge University Press, 2021. 2. Ali Mili and Fairouz Tchier, Software Testing: Concepts and Operations (Quantitative Software Engineering Series) 1st Edition, Wiley, 2015. 3. Pressman, R. S., Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill, 2008. 4. IEEE Computer Society, SWEBOK v.3.0, IEEE, 2014 5. Annual Conference in Software Testing.

Module designation	**Advance Topics in Data Mining**	
Course Code	EF235161	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Prof. Dr.Eng. Chastine Fatichah, S.Kom., M.Kom.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, case method	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Computational Intelligence (EF235101)	
Course Description	In this course, students will learn and develop data mining techniques starting from the stages of data exploration, data preprocessing, clustering, association rule mining, and classification so that it becomes useful information to support decision making or solving a problem and publish the results of their research in seminars or journals at national and international levels.	
Module objectives/intended learning outcomes	Students are able to explore and preprocess data according to data characteristics and analyze the results of application to a problem.	PLO 3, PLO 5, PLO 10
	Students are able to analyze and develop class imbalance problem handling techniques and ensemble classification methods and their use in classification problems.	PLO 3, PLO 5
	Students are able to analyze and develop association rule techniques, sequential pattern analysis, and their use in a problem.	PLO 3, PLO 5
	Students are able to analyze and develop clustering methods and their use in a problem.	PLO 3, PLO 5

	Students are able to analyze and develop anomaly detection techniques and their use in anomaly data.	PLO 3, PLO 5
	Students are able to develop data mining techniques on a real problem and publish the results of their research at national and international levels.	PLO 2
Content	1. Introduction to data mining, data mining tasks, process in data mining, data mining application, data definition, attribute types of data, data types. 2. Pre-processing data: ● Quality of data: about noise, outliers, missing values, and data duplicate ● Cleaning of data: handling noise, identification, and removal outlier, imputation techniques. ● Transformation data: smoothing, normalization, aggregation, creating feature or attribute, and generalization ● Data Reduction: dimension reduction, feature selection, data sampling ● Discretization data: binning, entropy-based 3. Exploration and visualization of data ● Statistic method: frequency or mode, percentile, mean and median, range and variance ● Visualization: histogram, box plot, scatter plot, contour plot, star plot, Chernoff's face 4. Association rules: association rules concepts, frequent itemset, apriori algorithm, closed itemset, FP-growth algorithm, generate rules, mining multiple minimum support 5. Clustering: clustering types, clustering algorithm (K-Means, Hierarchical, Density-based, Graph-based), validity cluster, and how to measure. 6. Recommender systems and collaborative filtering: recommendation system, recommendation types, recommendation content bases, collaborative filtering technique. 7. Text mining: information retrieval, query, model, and relevance feedback; clustering and classification document.	

	8. Web mining: web content, web structure, and web usage 9. Mining spatial data: spatial data definition, analysis spatial association, classification data spatial. 10. Mining multimedia data: multimedia data, CBIR, and their application 11. Anomaly detection 12. Mining data stream: data stream, model, and some example applications. 13. Mining data stream technique (sliding window, counting bits, DGIM)
Exams and assessment formats	Assignment, paper review, final project, and presentation
Study and examination requirements	The final grade is drawn from the following components: • 1st assignment (Data exploration): 5% of grade • 2nd assignment (Data preprocess technique): 5% of grade • 3rd assignment (Classification method): 10% of grade • Paper review from reputable international journals: 20% of grade • 4th assignment (Association rule and sequential pattern analysis): 10% of grade • 5th assignment (Clustering method): 10% of grade • 6th assignment (Anomaly detection technique): 5% of grade • Presentation of final project: 35% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Pang-Ning Tan; Michael Steinbach; Anuj Karpatne; Vipin Kumar, "Introduction to Data Mining 2nd edition", Addison-Wesley, 2019. 2. Han, Jiawei, Kamber, Micheline, "Data Mining: Concept and Techniques 3rd edition", Morgan Kauffman Pub, 2011. 3. Rajaraman, Anand, "Mining of Massive Datasets", Stanford University, 2011. 4. Scientific articles of Data Mining in reputable international journal, such as IEEE Transactions on Knowledge and Data Engineering, ACM Transactions on Knowledge Discovery from Data, Expert System with Application, Data Mining and Knowledge Discovery, Journal of Big Data, etc.

Module designation	**Advance Topics in Image Processing**	
Course Code	EF235162	
Semester(s) in which the module is taught	Odd	
A Person responsible for the module	Prof. Ir. Handayani Tjandrasa, M.Sc., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, group discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Image Processing course is designed to provide students with knowledge about image processing systems and their components so that students are able to analyze research that has been carried out in the field of image processing and get concepts of how automated image processing systems are formed in various ways and methods so that they can apply them in the proposed system both individually and in teamwork.	
Module objectives/intended learning outcomes	Students are able to analyze and apply pre-processing of image processing in the spatial and frequency domains for further process preparation and are able to apply restoration methods to repair degraded images.	PLO 2, PLO 5
	Students are able to analyze and apply segmentation methods with various methods based on discontinuity and similarity, and morphological methods.	PLO 2, PLO 5
	Students are able to analyze and apply feature extraction methods that produce feature	PLO 2, PLO 5

	vectors as input to image classification systems with machine learning.	
	Students are able to analyze and apply pretrained and transfer learning CNN for image classification, as well as UNet-based deep learning for semantic segmentation.	PLO 2, PLO 5
	Students are able to analyze and develop methods and applications in the field of image processing.	PLO 2, PLO 5
Content	1. Introduction to Topics in Image Processing: Steps in digital image processing, components of image processing systems, uses and application examples. 2. Digital image preprocessing: contrast correction with intensity transformation functions, histogram processing, illumination equalization, reflection and noise removal, lowpass and high pass spatial filters, and spatial filter combination methods. 3. 2D Fourier transform, Discrete Fourier Transform (DFT) 2D, Fast Fourier Transform 2D (FFT 2D), DFT 2D and IDFT characteristics. Image filtering with lowpass and high pass in frequency domains. 4. Model restores image, Inverse filter. minimum mean square error Wiener filter, constrained least squares filter (CLSF), periodic noise reduction, geometric registration with bilinear equations, warping, zooming. 5. Segmentation by various methods: methods based on borders, threshold values, and regions. Detect lines and circles with the Hough transform. 6. Morphological methods for dilation, erosion, opening, closing, template matching, boundary extraction, thinning, image reconstruction, and watershed. 7. Feature extraction: Descriptors with boundary features, descriptors with region features, principal components as feature descriptors, whole image features, feature transformation with invariance to scale (SIFT). 8. Use of machine learning such as neural networks, SVM, and neuro-fuzzy, for digital image classification. 9. Image classification system using pretrained and transfer learning Convolutional Neural Networks (CNNs).	

	Semantic segmentation of images by using UNet-based deep learning architecture.
Exams and assessment formats	Assignment, paper analysis, midterm assessment, presentation and demo of final project
Study and examination requirements	The final grade is drawn from the following components: • 1st assignment (Paper analysis about implementation of digital image preprocessing and filtering in the frequency domain): 15% of grade • 2nd assignment (FFT 2D implementation and enhancement in spatial and frequency domain): 20% of grade • Midterm assessment: 20% of grade • 3rd assignment (Paper analysis about preprocess and segmentation, morphology method, or feature extraction): 15% of grade • Presentation and demo of final project (Design and solving biomedical data problems): 30% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. R.C. Gonzalez and R.E. Woods, "Digital Image Processing", 4th ed., Pearson Education, Inc., 2018. 2. W.K. Pratt, "Digital Image Processing", 4th ed., John Wiley & Sons, Inc., 2007. 3. D. A. Forsyth and J. Ponce, "Computer Vision: A Modern Approach", 2nd ed., Pearson Education, Inc., 2012. 4. I. Goodfellow, Y. Bengio, and A. Courville, "Deep Learning", MIT Press, 2016. 5. W. Birkfellner, "Medical Image Analysis Methods", Taylor & Francis Group, LLC., 2014. 6. IEEE Transactions on Image Processing. 7. IEEE Transactions on Medical Imaging. 8. Image and Vision Computing, Elsevier. 9. Expert Systems with Applications, Elsevier.

Module designation	**Research Methodology**	
Course Code	EF235201	
Semester(s) in which the module is taught	2nd	
A Person responsible for the module	Dr. Bilqis Amaliah, S.Kom., M.Kom.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Lecture, Project	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	Research Methodology course aims to sharpen the ability to think logically, critically, systematically, and creatively through scientific research in the field of science and technology based on scientific principles, procedures, and ethics in the form of theses and papers that have been published in seminars or scientific journals both at national and international levels. Research methodology studies the stages of the scientific method in developing research. The output of this course is a draft of research proposals associated with each research topic.	
Module objectives/intended learning outcomes	Students are able to identify and compile the background, formulation and limitations of problems, goals, and contributions (novelty) of research.	PLO 4
	Students are able to identify and compile methodologies and literature reviews.	PLO 2
	Students are able to identify and compile the scope of research, design and implementation of proposed methods, data analysis, how to test	PLO 3

	their correctness and validity, and draw conclusions.	
	Students are able to compile research proposals based on scientific rules, procedures, and ethics.	PLO 1
Content	1. Identify and understand background, formulation and limitations of problems, contributions, literature review of a scientific / research article. 2. Identification and understanding methodology, data analysis, and conclusion of a scientific/research article. 3. Plagiarism and citation procedures. 4. Identification of the scope of research, design and implementation of the proposed methods, data analysis. 5. Conduct tests of its correctness and validity, as well as make provisional conclusions.	
Exams and assessment formats	Assignments	
Study and examination requirements	The final grade is drawn from the following components: • 1st assignment (Background, problem formulations and limitations, objectives, and contributions): 25% of grade • 2nd assignment (Methodology evolution and literature review): 25% of grade • 3rd assignment (Design a methodology research): 25% of grade • 4th assignment (Write a draft of proposal research): 25% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. "Academic Writing: A Guide to Tertiary Level Writing", edited by Natilene Bowker, 2007. 2. "Study Writing", by Liz Hamp-Lyons and Ben Heasley, 2006.	

Module designation	**Advance Topics in Multimedia Networking**	
Course Code	EF235211	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Tohari Ahmad, S.Kom., MIT., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discovery learning, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Net-Centric Computing (EF235102)	
Course Description	The Advance Topics in Multimedia Networks course studies the concept of multimedia data, multimedia data delivery methods, and security methods in utilizing multimedia data.	
Module objectives/intended learning outcomes	Students are able to analyze multimedia data concepts.	PLO 6
	Students are able to explore methods of sending multimedia data.	PLO 6
	Students are able to develop and implement security methods utilizing multimedia data.	PLO 2
	Students are able to analyze the methods and results of trials and write them in a scientific report.	PLO 2
Content	1. The concept of multimedia data 2. Multimedia data transmission methods 3. Security methods in utilizing multimedia data	
Exams and assessment formats	Assignments, presentations, and write a scientific article	
Study and examination requirements	The final grade is drawn from following components: • 1st presentation (Multimedia data concepts): 20% of grade	

	• 2nd presentation (Multimedia data delivery methods): 20% of grade • Assignment (Security methods utilizing multimedia data): 25% of grade • Write a scientific article: 35% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Image and Video Encryption: From Digital Rights Management to Secured Personal Communication (Advances in Information security) by Andreas Uhl and Andreas Pommer (Feb 12, 2010). 2. Image and Video Processing in the Compressed Domain by Jayanta Mukhopadhyay (Mar 22, 2011). 3. Multimedia Communications and Networking by Mario Marques da Silva (Mar 14, 2012). 4. Fundamental Data Compression by Ida Mengyi Pu (Jan 11, 2006). 5. Cryptography and Network Security: Principles and Practice (6th Edition) by William Stallings (Mar 16, 2013).

Module designation	**Advance Topics in Network Security**	
Course Code	EF235214	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Tohari Ahmad, S.Kom., MIT., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discovery learning, small group discussion, project-based learning, self-directed learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Net-Centric Computing (EF235102)	
Course Description	The Advance Topics in Network Security course studies, analyzes, and develops network security methods and their applications. Case studies are used during the learning process to deepen students' understanding. This includes data concealment methods, intrusion detection systems and dynamic data protection.	
Module objectives/intended learning outcomes	Students are able to analyze the concept of network security and the factors that influence it.	PLO 6
	Students are able to explore methods of securing data in the network.	PLO 6
	Students are able to develop and implement security methods in more detail.	PLO 2
	Students are able to analyze the results of trials and write them down in a scientific report.	PLO 2
Content	1. The basic concept of computer security: information security, computer network security, information systems security, security software; Security properties:	

	confidentiality, integrity, availability, authentication, non-repudiation, scalability. 2. DDOS, session management, SQL injection, XSS, cookies 3. Method of symmetrical and asymmetrical; theory and examples of classical and modern encryption, block and stream; use of substitution, transposition 4. Method of securing data: hash function, steganography, MAC, digital signature. 5. Authentication method: password, token, fingerprint; principles of remote authentication; the use of symmetric and asymmetric encryption to authenticate remotely; protocols: The 53erberos; federated identity 6. Types and characteristics of IDS, IPS, firewalls 7. The use of VPN, IDS, firewall, honeypot
Exams and assessment formats	Assignments and write a scientific report
Study and examination requirements	The final grade is drawn from following components: • 1st assignment (Concepts and factors that influence network security): 20% of grade • 2nd assignment (Network data security methods): 20% of grade • 3rd assignment (Development of network data security methods: 25% of grade • Write a scientific report based on test results: 35% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Cryptography and Network Security: Principles and Practice (6th Edition) by William Stallings (Mar 16, 2013). 2. Secure Coding in C and C++ (2nd Edition) (SEI Series in Software Engineering) by Robert C. Seacord (Apr 12, 2013). 3. Biometric Cryptography Based on Fingerprints: Combination of Biometrics and Cryptography Using Information from a fingerprint by Martin Drahansky (May 23, 2010). 4. Information Security the Complete Reference, Second Edition by Mark Rhodes-Ousley (Apr 3, 2013).

Module designation	**Advance Topics in Wireless Network**	
Course Code	EF235217	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Ir. Supeno Djanali, M.Sc., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	Students are able to understand correctly the issues related to Wireless Networks, able to identify and analyze limitations and find solutions, able to explain applications related to Wireless Networks, and able to write scientific papers on topics related to Wireless Networks.	
Module objectives/intended learning outcomes	Students are able to identify issues related to wireless networks: challenges, limitations and developments.	PLO 3, PLO 5
	Students are able to search and analyze several topics in wireless networks.	PLO 2, PLO 5
	Students are able to explain applications related to wireless networks.	PLO 2, PLO 5, PLO 6
	Students are able to write scientific papers with topics related to wireless networks.	PLO 2, PLO 3, PLO 5, PLO 6
Content	1. The introduction and development of wireless networks	

	2. Pipelined protocols: Go-back-N, Selective Repeat, TCP: TCP reliable data transfer; TCP fast retransmit; TCP flow control 3. Encoding Technique, Routing Mobile Ad-hoc: Pro-active, Reactive, Hybrid 4. Wireless Standards IEEE 802.11: IEEE 802.11 MAC Protocol: CSMA/CA Coordination Function MAC: DCF; PCF 5. Overview VANET; Physical Layer and MAC protocols VANET, VANET Application 6. Wireless Sensor Network: Main feature WSN, WSN Application, WSN Limitations, Routing in WSN 7. IoT Layer Model; sensor and actuator. Information processing (Middleware), IoT application
Exams and assessment formats	Assignment, presentations, and write a scientific article
Study and examination requirements	The final grade is drawn from following components: • Assignment (Wireless networks issues and IEEE 802.11 standard): 20% of grade • 1st presentation (VANET, WSN, and IoT): 30% of grade • 2nd presentation (Proposed topics for scientific article): 20% of grade • Write a scientific article about wireless networks: 30% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Kurose & Ross, "Computer Networking – A Top-Down Approach 6th Edition". Addison-Wesley, 2013. 2. Stallings, W., "Wireless Communications and Networks 2nd Edition", Prentice Hall, 2005. 3. Eldad & Robert, "Next Generation Wireless LANs 802.11n and 802.11ac" Cambridge University Press 2008, 2013 4. Tanenbaum & Wetherall, "Computer Networks" 5th Edition, Prentice Hall, 2011. 5. Claudia, Antonella and Riccardo, Editors. "Vehicular ad hoc Networks: Standards, Solutions, and Research" 6. Springer International, 2015 7. Shuang-Hua Yang, "Wireless Sensor Networks: Principles, Design and Applications" Springer-Verlag London 2014

	8. Rajkumar Buyya and Amir Vahid Dastjerdi, Editors. "Internet of Things: Principles and Paradigms" Elsevier Inc. 2016

Module designation	**Advance Topics in Network Design and Audit**	
Course Code	EF235218	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Dr.Eng. Radityo Anggoro, S.Kom., M.Sc.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discovery learning, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Network Design and Audit course provides knowledge of the unique characteristics that exist in mobile networks. Students are guided to be able to define problems that arise in mobile networks and are asked to design the right routing protocol to solve problems on mobile networks which can then be developed to improve performance.	
Module objectives/intended learning outcomes	Students are able to master the concepts and principles of architecture, systems and the basics of mobile networks.	PLO 1, PLO 6
	Students are able to define the type of mobile network communication.	PLO 3, PLO 6
	Students are able to define specific routing protocols based on the characteristics of mobile networks.	PLO 3, PLO 6
	Students are able to improve protocol performance to solve problems effectively and efficiently.	PLO 2, PLO 6
Content	1. Requirement Analysis: User, application, device, network, and other requirements concept and process.	

	2. Flow Analysis: Data Sources and Sinks, Flow Model, Flow Prioritization. 3. Network Architecture: Network, routing, addressing, network management, performance, security, and privacy architecture. 4. Network Design: Design concept, process concept, evaluation, network layout, metrics.
Exams and assessment formats	Assignment and write a scientific article
Study and examination requirements	The final grade is drawn from following components: • 1st assignment (Concept and characteristics of conditions for the deployment of mobile networks): 15% of grade • 2nd assignment (Advantages and disadvantages of communication types in mobile networks): 35% of grade • 3rd assignment (Type of routing protocol): 15% of grade • Write a scientific article based on test results of routing protocol modification: 35% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Pei Zheng, Larry L. Peterson, Bruce S. Davie, Adrian Farrel, Wireless Networking Complete, 2009, Morgan Kaufmann 2. Abdessalam Helal, et. al., "Anytime, Anywhere Computing, Mobile Computing Concepts and Technology", McGraw-Hill, 3. Mobile Computing Principles Designing and Developing Mobile Applications with UML And XML and the Environment", Oxford Publisher 2002. 4. Location Management and Routing in Mobile Wireless Networks, Amitava Mukherjee, Somprakash Bandyopadhyay, Debashis Saha, Artech House Publisher 5. Andreas Heinemann, Max Muhlhauser", Peer-to-Peer Systems and Application 6. Mohammad Ilyas and Imad Mahgoub, Mobile Computing Handbook, Auerbach Publication 7. IEEE Transaction of Mobile Computing, IEEE 8. Pervasive and Mobile Computing, Elsevier

Module designation	**Advance Topics in Modelling and Simulation**
Course Code	EF235221
Semester(s) in which the module is taught	Even
A Person responsible for the module	Prof. Dr. Ir. Joko Lianto Buliali, M.Sc.
Language	Indonesian
Relation to curriculum	Elective
Teaching methods	Lecture, case-based learning, demo
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.
Credit points	3 credit points (SKS)
Required and recommended prerequisites for joining the module	-
Course Description	The Advance Topics in Modelling and Simulation course aims to explore the concepts of modelling, computing, and statistics that have been possessed by lecture participants at the previous level of education. The application of Modelling and Simulation can be found, among others, in the application of inventory control, scheduling, production processes in companies, business processes in industry, traffic management, etc. In general, the purpose of simulation is to obtain an estimate of the performance of the simulated system, which in turn is used as support for decision making on one or more parameters of the simulated system performance. This course contains advanced topics of modelling and simulation, namely topics that focus on system modelling and analysis, simulation and visualization, which are aimed at design, prototyping, operational problems, including maintenance and the life cycle of a system that considers more than one performance parameters. Other focuses in the course include systems modelling techniques, object-oriented simulation,

	continuous simulation. Case studies include traffic management, operations management, service management.	
Module objectives/intended learning outcomes	Students are able to explain the concept of simulation, how simulation works, and under what circumstances simulation helps find solutions to stochastic problems.	PLO 2, PLO 9
	Students are able to create a simulation model from a given problem description and execute the resulting simulation model using simulation tools.	PLO 2, PLO 9
	Students are able to analyze complex problems and use advanced simulation techniques to produce simulation models.	PLO 2, PLO 9
	Students are able to analyze the output of the simulation execution results.	PLO 2, PLO 9
Content	1. Simulation Fundamentals, Simulation Methodology, Problem Solving with Simulation, Simulation Formulation Model from Problem Description. 2. Analysis and System Modelling which consider more than one performance measure. 3. Advanced Simulation Technique to create simulation model, including agent-based simulation, object based simulation. 4. Output analysis based on result simulation execution.	
Exams and assessment formats	Exercises, demo program, and presentation	
Study and examination requirements	The final grade is drawn from following components: • 1st exercise and program demo (System simulation case): 25% of grade • 2nd exercise (Simulation models and problem analysis of scientific papers on system simulation): 25% of grade • 3rd exercise and demo program (Creating a system simulation model): 25% of grade • Presentation of simulation model case study: 25% of grade Students must have a final grade of 61% or higher to pass this course.	

Reading list	1. Discrete-Event System Simulation 5th Edition. Jerry Banks, John Carson, Barry Nelson, David Nicol. Pearson, 2009. 2. Simulation Modelling and Analysis, 5th Edition. Averill M. Law. McGraw-Hill Education. 2013. 3. Excel Simulations, Gerard M. Verschuuren. Holy Macro! Books. 2013. 4. Introduction to Simulation and Risk Analysis 2nd Edition. James R. Evans, David L. Olson, James R. Evans. Prentice Hall. 2001.

Module designation	**Advance Topics in Multivariate Data Analysis**	
Course Code	EF235223	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Dr. Ahmad Saikhu, S.Si., M.T.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, demo	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Multivariate Data Analysis course, is discussed including data dimension reduction methods, grouping methods both supervised and unsupervised, Factor Analysis and methods of modelling the relationship between multivariate dependent variables and independent variables which include MANOVA, MANACOVA, Multivariate Regression, Logistic Regression, and Qualitative Data Analysis (Log-Linear, Conjoint Analysis and Multi-Dimensional Scaling).	
Module objectives/intended learning outcomes	Students can identify types of analysis and models that are suitable for various types of data using univariate and multivariate methods.	PLO 2, PLO 9
	Students can find the best model for data dimension reduction, group modelling (clustering), classification, and factor analysis.	PLO 2, PLO 9
	Students can model interdependence relationships between variables that are multivariate using the PCA, Manova/Manacova and Canonical Correlation methods.	PLO 2, PLO 9

	Students are able to review and explain published articles in the field of multivariate data analysis and modelling.	PLO 2, PLO3, PLO 9
Content	1. Introduction to Multivariate Data Analysis and Requirements for using it methods for modelling 2. Interdependence Analysis on Multivariate Data Analysis 3. Analysis of Dependent and Independent multivariate models 4. Qualitative Multivariate Data Analysis (Log-linear, MDS, Conjoint) 5. Path Analysis and SEM	
Exams and assessment formats	Program demo and presentation	
Study and examination requirements	The final grade is drawn from following components: • 1st program demo (Group Prediction Model): 25% of grade • 1st presentation (Qualitative Data Model): 25% of grade • 2nd program demo (Perceptual Data Model): 25% of grade • 2nd presentation (Path Analysis and SEM): 25% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Barbara G. Tabachnick, Linda S. Fidell, “Using Multivariate Statistics”, Fifth Edition, Pearson Int., 2007. 2. Hair, Joseph F., et. al., "Multivariate Data Analysis", Sixth Edition, Prentice Hall, New Jersey, 2006. 3. Richard A. Johnson, Dean W. Wichern, “Applied Multivariate Statistical Analysis”, Sixth Edition, Prenctice Hall International Inc, 2006.	

Module designation	**Advance Topics in Game Development, Virtual Reality, and Augmented Reality**	
Course Code	EF235232	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Hadziq Fabroyir, S.Kom., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, group discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	This course covers the research needed for the implementation of immersive environments on the Reality X platform, namely virtual reality, augmented reality, and mixed reality, along with game mechanics into it. The discussion will combine computational and interaction topics including the evolution of several assistive technologies such as visual displays, motion tracking, interactive 3D graphics, multimodal sensor integration, spatial audio, user interfaces, IoT, games, experience design, game development techniques, and game mechanics. Through this lecture, students are expected to be able to conduct research on the realm of games and reality x, model objects in a virtual environment, program interactions between users and virtual objects, and develop reality x using game engines to solve problems in the real world.	
Module objectives/intended learning outcomes	Students are able to report and discuss the latest research in the fields of gaming, virtual reality and augmented reality.	PLO 2, PLO 8

	Students are able to apply principles, guidelines, methodologies and techniques for game-based software development, virtual reality and augmented reality.	PLO 2, PLO 8
	Students are able to carry out trial design, analysis and evaluation on research in the fields of games, virtual reality and augmented reality.	PLO 2, PLO 8
	Students are able to produce paper manuscripts on the topic of games, virtual reality, or augmented reality for international conference publications.	PLO 2, PLO 8
Content	1. Basics of Game Development and Research 2. Basis for Development and Research of X Reality 3. Spectrum Display X Reality (VR/AR/MR) 4. Interaction with Reality 5. Development of Game or Reality X Applications with Game Engines 6. Writing Scientific Papers in the Field of Games or Reality	
Exams and assessment formats	Presentation, paper review, and write a scientific report	
Study and examination requirements	The final grade is drawn from following components: • 1st presentation (Review of scientific papers in the field of gaming or X reality): 25% of grade • 2nd presentation (Research proposal of game application or X reality): 25% of grade • 3rd presentation (Research progress of game application or X reality): 20% of grade • 4th presentation (Final research of game application or X reality): 30% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Schell, Jesse. Tenth anniversary: The art of game design: A book of lenses. AK Peters/CRC Press, 2019. 2. Jerald, Jason. The VR book: Human-centred design for virtual reality. Morgan & Claypool, 2015. 3. IEEE Transactions on Computational Intelligence and AI in Games 4. IEEE Transactions on Cybernetics	

	5. IEEE Transactions Systems, Man and Cybernetics 6. ACM SIGCHI 7. Human-Computer Interaction: An Empirical Research Perspective; I. Scott MacKenzie • 2013 8. Research Methods in Human Computer Interaction; Jonathan Lazar et.al, Second Edition • 2017

Module designation	**Advance Topics in Computer Graphics**	
Course Code	EF235233	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Dr. Anny Yuniarti, S.Kom., M.Comp.Sc.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, group discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Computer Graphics course studies several types of methods that can be used to manipulate data to be visualized on computer output devices such as monitors. In this course, the latest methods in developing computer graphics applications are discussed.	
Module objectives/intended learning outcomes	Able to explain topics in computer graphics with the latest literature studies.	PLO 2, PLO 8
	Able to implement the latest methods in computer graphics.	PLO 2, PLO 8
	Able to implement scientific principles, procedures and ethics in the form of papers published in national or international journals.	PLO 2, PLO 8
Content	1. Non-photo realistic (NPR) rendering 2. Image-based rendering 3. Virtual painting 4. Silhouette detection 5. Texture generation/texture synthesis 6. Particle systems	
Exams and assessment formats	Presentation, paper review, and write a scientific report	

Study and examination requirements	The final grade is drawn from following components: • 1st assignment (NPR and image-based rendering): 10% of grade • 2nd assignment (Virtual painting and silhouette detection): 10% of grade • Program demo and analysis report: 30% of grade • 3rd assignment (Texture generation/texture synthesis and particle systems): 10% of grade • 4th assignment (Particles combination and textures): 40% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Bénard, Pierre; Hertzmann, Aaron (2019). "Line Drawings from 3D Models: A Tutorial". Foundations and Trends in Computer Graphics and Vision. 11 (1–2): 1–159. 2. Ce Zhu; Shuai Li (2016). "Depth Image Based View Synthesis: New Insights and Perspectives on Hole Generation and Filling". IEEE Transactions on Broadcasting. 62 (1): 82–93. doi:10.1109/TBC.2015.2475697 3. Beltramello A, Scalera L, Seriani S, Gallina P. Artistic Robotic Painting Using the Palette Knife Technique. Robotics. 2020; 9(1):15. https://doi.org/10.3390/robotics9010015 4. Ivo, Rafael Fernandes et al. “Improved silhouette rendering and detection of splat-based models.” Comput. Graph. 93 (2020): 39-50.

Module designation	**Advance Topics in System Audit**	
Course Code	EF235241	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Drs.Ec. Ir. Riyanarto Sarno, M.Sc., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discovery learning, cooperative learning, group discussion, project-based learning, case study	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Systems Audit course is designed to provide knowledge and encourage students to conduct analysis related to system auditing, from process design to making recommendations based on best practices.	
Module objectives/intended learning outcomes	Students are able to understand the purpose of information technology audits and identify and analyze process and information risks related to confidentiality, integrity and availability.	PLO 2, PLO 10
	Students are able to analyze and develop audit processes that suit enterprise needs.	PLO 2, PLO 10
	Students are able to analyze and develop control procedures and measurements to manage risk effectively.	PLO 2, PLO 10
	Students are able to identify, analyze and make recommendations for improving system performance by referring to examples of best practices, standards and regulations of information technology governance.	PLO 2, PLO 10

Content	1. Information System/Information Technology governance concepts 2. Governance framework 3. Control objectives 4. System audit planning 5. Business process audit 6. Audit implementation and evaluation 7. Audit reporting and recommendations
Exams and assessment formats	Presentation and write a scientific article
Study and examination requirements	The final grade is drawn from following components: • 1st assessment (Create a conceptual research design related to IS/IT System Audit): 20% of grade • 2nd assessment (Preparation of initial drafts of scientific articles and group presentations related to IS/IT System Audit): 30% of grade • 3rd assessment (Progress drafts of scientific articles and group presentations related to IS/IT System Audit): 20% of grade • 4th assessment (Final presentation of scientific articles related to IS/IT System Audit): 30% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Riyanarto Sarno, Audit Sistem Informasi/Teknologi Informasi, ITS Press, 2009. 2. Riyanarto Sarno, Strategi Sukses Bisnis dengan Teknologi Informasi Berbasis Balanced Scorecard dan COBIT, ITS Press, 2009, ISBN 978-979-8897-42-9. 3. ISO/IEC 38500:2008 Corporate Governance of Information Technology 4. Sandra Senft, Frederick Gallegos, Daniel P. Manson, Carol Gonzales. Information Technology Control and Audit Second Edition. CRC Press, 2009. ISBN 978-0849320323 5. Davis, M. Schiller, & K. Wheeler. IT auditing: using controls to protect information assets. New York: McGraw-Hill. 2007 6. Simha R. Magal, Integrated Business Processes with ERP Systems, John Wiley & Sons, Inc., 2014. 7. Riyanarto Sarno & Irsyat Iffano, Sistem Manajemen Keamanan Informasi, ITS Press, 2009.

Module designation	**Advance Topics in Big Data**	
Course Code	EF235244	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Abdul Munif, S.Kom., M.Sc.Eng.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Computational Intelligence (EF235101)	
Course Description	The Advance Topics in Big Data course material equips students to analyze the design and architecture of large-scale data storage systems, develop distributed computing frameworks on big data, develop large-scale data processing/mining processes in real cases, and optimize large-scale data processing.	
Module objectives/intended learning outcomes	Students are able to analyze the design and architecture of large-scale data storage systems (Hadoop, graph database, cloud storage, etc.).	PLO 2
	Students are able to develop distributed computing frameworks on big data (Map-Reduce, Apache Spark).	PLO 2
	Students are able to develop large-scale data processing/mining processes in real cases (classification, regression, clustering, recommendation systems, and social networks).	PLO 10
	Students are able to optimize large-scale data processing.	PLO 10
Content	1. Data mining 2. Map-Reduce and Distributed Computing	

	3. Large-scale data processing algorithms/modeling: Finding similar items, mining data streams, link analysis, frequent item sets, clustering, classification, recommendation systems, mining social-network graph. 4. Optimization of large-scale data processing: Dimensionality reduction, large-scale machine learning, neural network, deep learning
Exams and assessment formats	Assignments, presentation, midterm assessment, and final assessment
Study and examination requirements	The final grade is drawn from following components: • 1st presentation (Processing data streams): 25% of grade • Midterm assessment: 25% of grade • 2nd presentation (Social network data processing): 25% of grade • Final assessment: 25 % of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Leskovec, J., Rajaraman, A., & Ullman, J. D. (2019). Mining of Massive Datasets (3rd ed.). Stanford University. 2. Chambers, B., & Zaharia, M. (2018). Spark: The Definitive Guide. O'Reilly Media, Inc. 3. Shi, Y. (2022). Advances in Big Data Analytics. Springer Nature Singapore Pte Ltd. 4. Wolohan, J. T. (2019). Mastering Large Datasets with Python. Manning Publication Co.

Module designation	**Advance Topics in Quantum Computing**	
Course Code	EF235246	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Abdul Munif, S.Kom., M.Sc.Eng.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Quantum Computing course equips students with quantum computing paradigm material, the advantages and limitations of quantum computing, quantum mechanical postulates and their applications to computation, quantum information principles and quantum communication, fundamental quantum algorithms, and the implications of quantum computing on machine learning, cryptography and information security.	
Module objectives/intended learning outcomes	Students are able to explain the paradigm of quantum computing.	PLO 2
	Students are able to analyze the advantages and limitations of quantum computers.	PLO 2
	Students are able to explain the four postulates of quantum mechanics and their application to computing.	PLO 2
	Students are able to explain the principles of quantum information and quantum communication.	PLO 10
	Students are able to analyze fundamental quantum algorithms.	PLO 10

	Students are able to explain the implications of quantum computing on machine learning, cryptography and information security.	PLO 10
Content	1. Quantum computing paradigm a. Global perspective of quantum computing b. Quantum Bits c. Quantum Computing d. Quantum algorithms e. Experimental quantum information processing f. Quantum Information 2. Advantages and limitations of quantum computers a. Identify the advantages of quantum computing b. Identification of possible problems to be accelerated using quantum computing c. Limitations of quantum algorithms 3. Four postulates of quantum mechanics and their application to computing a. Design and analysis of quantum algorithms b. Quantum states, unitary evolution, measurements, composite systems c. Definition of postulates in density matrices 4. Principles of quantum information and quantum communication a. Quantum teleportation and its limitations b. Framework for quantum error correction code c. Everett's many worlds interpretation 5. Quantum algorithm fundamental a. Shor's algorithm b. Grover Search c. Berstein-Vazirani algorithm d. Simon's problem e. Deutsch-Jozsa paradigm 6. Implications of quantum computing on machine learning, cryptography and information security a. Quantum computing in machine learning: K-Means, linear equations, Support Vector Machine b. The basis of quantum cryptography c. RSA hacking using quantum computers d. Financial schemes using quantum mechanics	

Exams and assessment formats	Assignments, midterm assessment, and final project
Study and examination requirements	The final grade is drawn from the following components: • 1st assignment: 20% of grade • Midterm assessment: 20% of grade • 2nd assignment: 20% of grade • Final project: 40% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Bernhardt, C. (2019). Quantum computing for everyone. The MIT Press. 2. Nielsen, M. A., & Chuang, I. L. (2010). Quantum Computation and Quantum Information (10th Edition). Cambridge University Press. 3. Aaaronson, S. (2013). Quantum Computing Since Democritus. Cambridge University Press. 4. Hidary, J. D. (2021). Quantum Computing: An Applied Approach (Second Edition). Springer. 5. Johnston, E. R., Harrigan, N., & Gimeno-Segovia, M. (2019). Programming Quantum Computers (First Edition). O'Reilly Media, Inc. 6. Mermin, N. D. (2007). Quantum Computer Science: An Introduction. Cambridge University Press.

Module designation	**Advance Topics in Software Evolution**	
Course Code	EF235251	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Ir. Siti Rochimah, M.T., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, small group discussion, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Software Engineering (EF235103)	
Course Description	In this course, students will learn about definitions and activities in the field of software evolution, as well as techniques for doing so. At the end of the lecture, students are expected to be able to bring up new thesis topics in the field of software evolution. This course also provides the latest topics about software evolution. Students are encouraged to publish their research results in seminars or journals at national and international levels.	
Module objectives/intended learning outcomes	Students are able to understand the basics of software quality, understand software quality culture, define software quality needs, and describe software quality models.	PLO 3, PLO 9
	Students are able to analyze and develop software review and audit processes.	PLO 7, PLO 8, PLO 9
	Students are able to analyze and develop software verification and validation processes, as well as measure software quality using certain standards.	PLO 7, PLO 8, PLO 9

	Students are able to identify, describe, and analyze software risk management based on certain standards, as well as analyze and develop the contents of software quality assurance plan documents.	PLO 7, PLO 8, PLO 9
Content	1. Basic concepts and activities of software evolution: models and evolutionary processes; type of software evolution (corrective, adaptive, perspective and preventive); Legacy System 2. Program understanding techniques and activities 3. Identify bad smell codes and clone codes 4. Program refactorization 5. Analysis of the impact of software changes 6. Software repository management 7. Software reuse 8. Software crash 9. Software reengineering	
Exams and assessment formats	Presentation, write and submit scientific publication	
Study and examination requirements	The final grade is drawn from the following components: • 1st presentation (The topic of software evolution to be researched): 25% of grade • 2nd presentation (Conceptual framework of software evolution research): 25% of grade • 3rd presentation (Experiment progress and drafting scientific publication articles): 25% of grade • Final presentation (Scientific article ready to be published): 25% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Ralf Reussner et al., Managed Software Evolution, Springer Open, 2019. 2. P. Tripathy and K. Naik, Software Evolution and Maintenance: A Practitioner's Approach, Wiley, 2015. 3. Tom Mens, Serge Demeyer, Software Evolution, Springer-Verlag, Berlin, 2008. 4. P. Grubb and A.A. Takang, Software Maintenance: Concepts and Practice, 2nd ed., World Scientific Publishing, 2003.	

Module designation	**Advance Topics in Software Project Management**	
Course Code	EF235252	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Dr. Ir. Umi Laili Yuhana, S.Kom., M.Sc.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, small group discussion, project-based learning, demo, problem-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Software Engineering (EF235103)	
Course Description	The Advance Topics in Software Project Management contain deepening theories related to software project management, identification and analysis of problems that exist in software project management and methods of solving them. Through this course, students are invited to study and understand the latest papers in the field of software project management. Lectures are delivered in class in the form of lectures, discussions, and presentations. Students are also conditioned to be able to learn independently, understand current papers around project management, identify new problems and define solutions based on the methodology studied. Learning is also carried out in the laboratory and field to conduct experiments from the solutions offered. Students are invited to write down problem identification, proposed solutions and experimental results in a paper that can be published in seminars or journals.	
Module objectives/intended learning outcomes	Students are able to present the topic of software project planning and tools in planning and making research plans.	PLO 7

	Students are able to summarize and report the results of paper reviews and topic findings conducted from meetings 2 to 7.	PLO 2
	Students are able to explain the progress of experiments and draft scientific publication articles in software project management.	PLO 2
	Students are able to present scientific articles that are ready to be published and submit to international seminars or international journals.	PLO 2
Content	1. Initiation and definition of software project scope: requirements determination and negotiation, feasibility analysis, process for reviewing and revising requirements 2. Software project planning; process planning, determining deliverables, effort, schedule and cost estimation, resource allocation, risk management, quality management, planning management 3. Software project enactment: implementation of plans, management of PL acquisition and supplier contracts, implementation of measurement processes, process monitoring, process control, reporting 4. Evaluation and review of Software projects; determine satisfaction of needs, review and evaluate performance 5. Completion of software projects; Define closure, project closure activities 6. Software engineering measurements, establish and sustain measurement commitment, plan the measurement process, assess the measurement process, evaluate the measurement 7. Software project management tools	
Exams and assessment formats	Assignments, quizzes, and a team-based projects	
Study and examination requirements	The final grade is drawn from the following components: • Report writing and present the results of paper reviews (Software Project Management): 30% of grade. • Writing and evaluation proposal (Software project development): 20% of grade. • Progress experiment presentation and write draft scientific publication articles (Software project management): 20% of grade.	

	• Final presentation (Scientific article ready to be published): 30% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK(R) Guide), 5th ed., Project Management Institute, 2013. 2. Project Management Institute and IEEE Computer Society, Software Extension to the PMBOK® Guide Fifth Edition, Project Management Institute, 2013. 3. R.E. Fairley, Managing and Leading Software Projects, Wiley-IEEE Computer Society Press, 2009. 4. Sommerville, Software Engineering, 9th ed., Addison-Wesley, 2011. 5. B. Boehm and R. Turner, Balancing Agility and Discipline: A Guide for the Perplexed, Addison-Wesley, 2003

Module designation	**Advance Topics in Requirement Engineering**	
Course Code	EF235253	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Daniel Oranova Siahaan, S.Kom., M.Sc., PD.Eng.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, case method brainstorming paper review	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The Advance Topics in Requirement Engineering course is part of the Software Engineering family which discusses elicitation, analysis, specifications, software requirements validation, and requirements management during the software product life cycle. Researchers and industry practitioners have recognized that a software development project is very vulnerable to failure when activities related to software requirements are carried out poorly. Students will learn and analyze various elicitation techniques, analysis, specifications, validation, and management of the latest needs.	
Module objectives/intended learning outcomes	Students are able to analyze and develop software requirements elicitation techniques.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and develop software requirements models.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and develop methods for classifying software needs.	PLO 2, PLO 3, PLO 7

	Students are able to analyze and develop software requirement specification methods.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and develop software requirements management methods.	PLO 2, PLO 3, PLO 7
	Students are able to analyze and develop software needs verification methods.	PLO 2, PLO 3, PLO 7
Content	1. Elicitation of Requirements 2. Requirements Modelling 3. Classification of Needs 4. Requirement Specifications 5. Validation and Verification of Needs 6. Requirements Management	
Exams and assessment formats	Assignments, presentation, and paper review	
Study and examination requirements	The final grade is drawn from the following components: • 1st assignment (Scenario creation): 20% of grade • 2nd assignment (Requirement modelling): 10% of grade • 3rd assignment (Requirement classification): 10% of grade • 4th assignment (Software requirements specification document): 10% of grade • 5th assignment (Requirement verification and validation): 15% of grade • 6th assignment (Traceability metrics): 15% of grade • Presentation paper review: 20% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Daniel Siahaan, Analisis Kebutuhan dalam Rekayasa Perangkat Lunak, Penerbit Andi, 2011. 2. Karl Wiegers and Candase Hokanson, Software Requirements Essentials: Core Practices for Successful Business Analysis, Addison-Wesley Professional, 2023 3. Karl E Wiegers and Joy Beatty, Software Requirements, 3rd Edition, Microsoft, 2012. 4. Ian K. Bray, An Introduction to Requirements Engineering, Addison Wesley, 2002. 5. Pressman, R. S., Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill, 2008.	

	6. IEEE Computer Society, SWEBOK v.3.0, IEEE, 2014 7. Annual Conference: International Requirements Engineering Conference, IEEE

Module designation	**Advance Topics in Software Quality Assurance**	
Course Code	EF235154	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Ir. Siti Rochimah, M.T., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, small group discussion, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Software Engineering (EF235103)	
Course Description	The purpose of this course is to provide knowledge about the concept of quality, characteristics, and the value of the software, and software applications are being developed and treated (maintenance). The important concept is software requirement to determine the quality attributes of the software. Software requirements specify quality measurement methods and acceptance criteria to infer the level of achievement of the quality level of the software that had been predetermined.	
Module objectives/intended learning outcomes	Students are able to understand the basics of software quality; understand the culture of software quality; defining software quality needs; and describe models of software quality.	PLO 3, PLO 7
	Students are able to analyze and develop software review and audit processes.	PLO 7, PLO 8, PLO 9
	Students are able to analyze and develop software verification and validation processes, as well as measure software quality using certain standards.	PLO 7, PLO 8, PLO 9

	Students are able to identify, describe, and analyze software risk management based on certain standards, as well as analyze and develop the contents of software quality assurance plan documents.	PLO 7, PLO 8, PLO 9
Content	1. Software quality basics 2. Software quality culture 3. Software quality requirements 4. Software quality models and standards 5. Software review process 6. Software audit 7. Software verification and validation 8. Software quality measurement 9. Software risk management 10. Device quality assurance plan	
Exams and assessment formats	Presentation, write and submit scientific articles	
Study and examination requirements	The final grade is drawn from the following components: • 1st presentation (SQA topics to be researched): 25% of grade • 2nd presentation (Conceptual framework from SQA research): 25% of grade • 3rd presentation (Experiment progress and draft scientific publication articles): 25% of grade • Final presentation (Scientific article ready to be published): 25% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. C. Y. Laporte, A. April, Software Quality Assurance, Wiley-IEEE Press, 2018. 2. Stephan Goericke, The Future of Software Quality Assurance, Springer Open, 2020. 3. S. Naik dan P. Tripathy, Software Testing and Quality Assurance: Theory and Practice, Wiley-Spektrum, 2008. 4. G. Gordon Schulmeyer, Handbook of Software Quality Assurance, 4th Edition, Artech House London, 2008. 5. D. Galin, Software Quality Assurance: From Theory to Implementation, Pearson Education Limited, 2004.	

Module designation	**Advance Topics in Text Mining**	
Course Code	EF235263	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Dr. Ir. Diana Purwitasari, S.Kom., M.Sc..	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, project, presentation, demo	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	The availability of text data and the need to find information on the Internet are the basis for the need for special processing techniques for text. Extracting unstructured data (text) into information and knowledge requires a technique called Natural Language Processing. Starting with the basic process needs on text data are searching, labeling the subject of discussion, extracting information with entity recognition, predicting sentiment influenced by user opinions or positions on issues in the community, and identifying user profiles.	
Module objectives/intended learning outcomes	Able to understand the theory of text mining techniques and implement related processes using appropriate software tools.	PLO 2, PLO 3
	Able to analyze real problems, do self-learning in order to adapt the latest text data mining techniques to solve problems.	PLO 3
	Able to evaluate the stages of extracting text data that has been designed in the scope of testing under controlled conditions.	PLO 5
	Able to convey the results of implementation as a solution to real problems that have been carried out	PLO 3, PLO 5

	in the form of exposure, reports or papers published in international seminars or national scientific journals.	
Content	1. Fundamental concepts and algorithms of NLP, Python libraries for NLP, Information search 2. Extracting information, Named entity recognition 3. Author profiling 4. Sentiment Analysis, Topic Analysis 5. Transformers: Text Generation, Summarization, Question Answering 6. Problem solving with NLP techniques on a limited scope	
Exams and assessment formats	Presentation, quizzes, and a team-based projects.	
Study and examination requirements	The final grade is drawn from the following components: • 1st quiz (Fundamental concepts and algorithms of NLP, Python libraries for NLP, Information search): 10% of grade • 2nd quiz (Extracting information, Named entity recognition): 10% of grade • 1st project (Author profiling and Sentiment Analysis, Topic Analysis): 25% of grade • 2nd project (Transformers: Text Generation, Summarization, Question Answering): 25% of grade • Presentation (Problem solving with NLP techniques on a limited scope): 30% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Getting Started with Natural Language Processing, Ekaterina Kochmar, Manning Publications, ISBN: 9781617296765, 2022 2. Natural Language Processing with Transformers, Lewis Tunstall, Leandro von Werra, and Thomas Wolf, O'Reilly Media, ISBN: 9781098103248, 2022 3. Real-World Natural Language Processing, Masato Hagiwara, Manning Publications, ISBN: 9781617296420, 2021 4. Journal articles in accordance with the topic of discussion in Information Processing Management https://www.sciencedirect.com/journal/information-processing-and-management	

Module designation	**Advance Topics in Computer Vision**	
Course Code	EF235264	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Dr.Eng. Nanik Suciati, S.Kom., M.Kom.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, case method, project-based learning	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	-	
Course Description	In this course, students learn and develop vision computing techniques using hand-crafted and deep learning approaches in solving a real problem and publish the results of their research in seminars or journals at national and international levels.	
Module objectives/intended learning outcomes	Students are able to analyze the application of vision computing in various applications.	PLO 2
	Students are able to analyze and develop image recognition techniques using hand-crafted features.	PLO 3, PLO 5
	Students are able to analyze and develop image recognition techniques using deep learning.	PLO 3, PLO 5
	Students are able to analyze and develop image and video recognition techniques using Sequential-based deep learning.	PLO 3, PLO 5
	Students are able to analyze and develop object detection techniques using deep learning.	PLO 3, PLO 5
	Students are able to analyze and develop object segmentation techniques using deep learning.	PLO 3, PLO 5

	Students are able to analyze and develop generative-model techniques based on deep learning.	PLO 3, PLO 5
	Students are able to analyze and develop computational vision techniques to solve real problems and publish the results of their research in seminars or journals at national and international levels.	PLO 2, PLO 3, PLO 5
Content	1. Vision computing concepts 2. Image recognition with hand-crafted features 3. Image recognition with a deep learning approach 4. Image and video recognition with a sequential-based deep learning approach 5. Object detection 6. Object segmentation 7. Image captioning, style transfer	
Exams and assessment formats	Assignments, case study analysis, and a team-based projects.	
Study and examination requirements	The final grade is drawn from the following components: • Presentation (Computer vision scientific article): 25% of grade • Program Demo (Digital image classification): 25% of grade • Project progress presentation: 25% of grade • Presentation final project: 25% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Computer Vision: Algorithms and Applications (Texts in Computer Science), Richard Szeliski, 2011. 2. Computer Vision: Models, Learning, and Inference, Simon. J. D. Prince, 2012. 3. Digital Image Processing, Rafael C. Gonzalez, 2018. 4. Scientific articles related to Computational Vision in reputable international journals.	

Module designation	**Advance Topics in Biomedical Computing**	
Course Code	EF235265	
Semester(s) in which the module is taught	Even	
A Person responsible for the module	Prof. Ir. Handayani Tjandrasa, M.Sc., Ph.D.	
Language	Indonesian	
Relation to curriculum	Elective	
Teaching methods	Lecture, discussion, project	
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 SKS x 50 = 150 minutes (2 hours 30 minutes) per week. 2. Exercises and Assignments: 3 SKS x 60 = 180 minutes (3 hours) per week. 3. Private study: 3 SKS x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Computational Intelligence (EF235101)	
Course Description	The Advance Topics in Biomedical Computing course is designed to provide students with knowledge about computing applied in the biomedical field. In this course, students will learn and analyze various kinds of biomedical data including lab result data, bio-signal data such as electrocardiogram (ECG) and electroencephalogram (EEG), medical image data such as X-ray, Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI), and Ultrasound (USG), gene data, DNA, RNA, proteins, sequence alignment, and integrated medical information systems. Then students will learn how to process data and use machine learning and deep learning so that they can analyze and implement intelligent biomedical systems.	
Module objectives/intended learning outcomes	Students are able to understand the recording and analysis of bio-signal characteristics such as ECG, EEG, ENG, and EMG, including understanding blood pressure waveforms, heart sounds, and phonocardiogram frequency spectrum.	PLO 2, PLO 5

	Students are able to analyze and apply bio-signal classification modeling by utilizing pre-processing algorithms, feature extraction, and machine learning.	PLO 2, PLO 5
	Students are able to understand medical imaging instruments and their imaging results. Students are able to analyze and apply filtering processing, enhancement, edge detection, segmentation, digital subtraction angiography (DSA), and machine learning to model medical imaging solutions in either DICOM or other formats. Students are able to understand the use of deep learning for medical images.	PLO 2, PLO 5
	Students are able to analyze and apply sequence alignment methods to gene data.	PLO 2, PLO 5
	Students are able to understand and explain integrated medical information systems for processing and management of medical data.	PLO 2, PLO 5
Content	1. Introduction to biomedical computing, description of biomedical data, and examples of biomedical applications. 2. Electrocardiography and electrocardiogram (ECG or ECG): cardiac conduction system, P wave, QRS, T wave, ECG mechanism, 12-lead ECG system, normal ECG signal, heart rhythm. 3. Basic concepts of EEG, electroencephalography, The International 10-20 System, non-invasive, normal and epileptic EEG signal recording, and Brain-Computer Interface (BCI). ENG and EMG: biopotential, electroneurogram (ENG), conduction velocity ENG, action potential, electromyogram (EMG). 4. Blood pressure and heart sounds: cardiac physiology, blood pressure, invasive and non-invasive blood pressure measurement, blood pressure waveforms, heart sounds, auscultation techniques, stethoscope development, phonocardiogram recording, heart sounds and cardiac cycles, phonocardiogram frequency spectrum, murmurs, sphygmomanometer. 5. Bio-signal processing: noise filtering, Independent Component Analysis (ICA), frequency spectrum, wavelet denoising, preprocessing, feature extraction, and	

	classification. Examples of EEG classification, Brain-Computer Interface (BCI), functional Magnetic Resonance Imaging (fMRI). Examples of peak detection algorithms P, QRS, T on ECG signals, arrhythmia detection algorithms. 6. Medical imaging: X-ray instruments, Computed Tomography (CT) scanner, Magnetic Resonance Imaging (MRI), ultrasound imaging, Nuclear Medicine. X-ray projection, radiographic density, PA vs AP terminology, X-ray examples, X-ray dose. CT principles, Iterative reconstruction method, Hounsfield unit (HU), example of CT with 3D reconstruction. Basic physics of magnetic resonance imaging (MRI), contrast differences for T1 and T2 weighted, differences between MRI and CT imaging. Basic principles of ultrasound, examples of ultrasound imaging. Basic principles of nuclear medicine (nuclide imaging), SPECT, PET, examples of SPECT and PET imaging. 7. Medical image processing: image database, Digital Imaging and Communications in Medicine (DICOM), DICOM data model and instances, examples of DICOM datasets, other imaging formats, image quality, examples of DICOM viewer, examples of filtering operations, enhancement, edge detection, segmentation, digital subtraction angiography (DSA), examples of classification with machine learning and deep learning. 3DSlicer application. 8. Introduction to bioinformatics: Gene, DNA, RNA, protein/amino acid sequence. Computation and analysis of gene data, functional genomics, sequence alignment. 9. Telemedicine and PACS: benefits, scope and use of telemedicine, telemedicine equipment, mobile telemedicine and wide area networks, Radiology Information System (RIS), Hospital Information System (HIS), Picture Archiving and Communication System (PACS). PACS and RIS integration
Exams and assessment formats	Assignments, midterm assessment, presentation and demo of final project
Study and examination requirements	The final grade is drawn from the following components:

	• 1st assignment (Explains the mechanism for the formation of ECG signals and calculates normal and abnormal heart rates): 15% of grade • 2nd assignment (Explains the electrode configuration, the formation of EEG signals, and the characteristics of normal and epileptic EEG): 15% of grade • Midterm assessment: 20% of grade • 3rd assignment (Problem solving for medical image cases): 20% of grade • Presentation and demo of final project: 30% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Edward C Shortlife and James J. Cimino, Biomedical Informatics: Computer Applications in Health Care and Biomedicine, 3rd ed., Spring er, 2006. 2. Wolfgang Birkfellner, Applied Medical Image Processing, 2nd, CRC Press, Taylor & Francis Group, 2014. 3. J. G. Webster (editor), Medical Instrumentation: Application and Design,4th ed., Hoboken: Wiley, 2010. 4. Jaakko Malmivuo and Robert Plonsey, Bioelectromagnetism-Principles and Applications of Bioelectric andBiomagnetic Fields, Oxford University Press, 1995. 5. Biomedical Computing, MIT OCW, Harvard-MIT Division of Health Sciences and Technology, 2005. 6. Functional Magnetic Resonance Imaging - Data Acquisition and Analysis, MIT OCW, 2008. 7. H. Eren and J. G. Webster (editors), Telehealth and Mobile Health, CRC Press, Taylor & Francis Group, 2016. 8. W. J. Tompkins and J. G. Webster (editors), Design of Microcomputer-Based Medical Instrumentation, Englewood Cliffs: Prentice-Hall,1981. 9. IEEE Transactions on Biomedical Engineering. 10. IEEE Transactions on Medical Imaging.

Module designation	**Thesis - Proposal**	
Course Code	EF235301	
Semester(s) in which the module is taught	3rd	
A Person responsible for the module	Dr. Ahmad Saikhu, S.Si., M.T.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Supervisions/discussion, article reviews, presentation	
Workload (incl. contact hours, self-study hours)	1. Supervised Research Activity: 3 SKS x 170 = 510 minutes (8 hours 30 minutes) per week. 2. Report Writing.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	o Students have passed the Research Methodology (EF235201) course. o Student has completed a minimum 12 credits to program in 2nd Semester.	
Course Description	This course aims to provide students in writing research proposal and thesis development. It consists of knowledge in research topic to conduct, research methodology and development, experiment design and implementation using relevant tools. Writing of Thesis research proposals refers to the Guidelines for Writing Thesis Proposals and Reports published by the Directorate of Postgraduate and Academic Development.	
Module objectives/intended learning outcomes	Students are able to identify and compile the background, formulation and limitations of problems, goals and benefits, and contributions (novelty) of research.	PLO 2
	Students are able to write literature reviews.	PLO 2, PLO 3
	Students are able to compile research methods according to research objectives and contributions.	PLO 3, PLO 4
	Students are able to compile a thesis proposal based on scientific rules, procedures, and ethics.	PLO 2, PLO 4
Content	1. Excavation and exploration of research ideas through the review of scientific articles	

	2. Writing research background, research gap, motivation, and thesis research contribution 3. Review of literature relevant to the thesis research topic 4. Research method writing
Exams and assessment formats	Thesis proposal report, presentation, revision, and submit final thesis proposal report
Study and examination requirements	The final grade is drawn from the following components: • Material mastery: 25% of grade • Research contribution: 30% of grade • Problem complexity: 25% of grade • Scientific rules: 20% of grade Students must have a final grade of 61% or higher to pass this course.
Reading list	1. Guidelines for Writing Thesis Proposals and Reports published by the Directorate of Postgraduate and Academic Development

Module designation	**Thesis - Scientific Publication**	
Course Code	EF235302	
Semester(s) in which the module is taught	3rd	
A Person responsible for the module	Dr. Ahmad Saikhu, S.Si., M.T.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Supervision/discussion, presentation	
Workload (incl. contact hours, self-study hours)	1. Supervised Research Activity: 3 SKS x 170 = 510 minutes (8 hours 30 minutes) per week. 2. Writing, submit, and revise a scientific article.	
Credit points	3 credit points (SKS)	
Required and recommended prerequisites for joining the module	Thesis – Proposal (EF235301)	
Course Description	This course aims to provide students with knowledge and skills in writing and publishing articles from their research and development at international conference or national accredited journal or international journal.	
Module objectives/intended learning outcomes	Students master the concepts of making scientific writings ranging from abstracts, introductions, methodologies, analysis, conclusions, and bibliography.	PLO 3
	Students are able to explain the novelty of the research done.	PLO 3
	Students are able to understand the procedures in the implementation of publication of appropriate, valid and plagiarism-free research results.	PLO 4
	Students are able to create scientific articles in accordance with related research topics and publish in accredited national journals or international journals.	PLO 4
Content	1. Concepts and skills in reading scientific writings 2. The concept of finding novelty research from public articles 3. The concept of understanding Plagiarism 4. The concept of making scientific writing 5. Publication procedure	

Exams and assessment formats	The proof of acceptance or publication of the article.
Study and examination requirements	Students must meet the following requirements to pass this course: • Student got A grade if the scientific article has been accepted or published in Scopus-indexed international journal or accredited national journal with SINTA Score S1/S2. • Student got AB grade if the scientific article has been accepted or published in an accredited national journal with SINTA Score ≥ S3, or the article has been presented in a reputable international conference.
Reading list	1. Articles in Scientific Journals related to chosen topics.

Module designation	**Thesis - Final Defense**	
Course Code	EF235401	
Semester(s) in which the module is taught	4th	
A Person responsible for the module	Dr. Ahmad Saikhu, S.Si., M.T.	
Language	Indonesian	
Relation to curriculum	Compulsory	
Teaching methods	Supervisions/discussion, article reviews, presentation	
Workload (incl. contact hours, self-study hours)	1. Supervised Research Activity: 6 SKS x 170 = 1020 minutes (17 hours) per week. 2. Report Writing.	
Credit points	6 credit points (SKS)	
Required and recommended prerequisites for joining the module	Thesis - Proposal (EF235302)	
Course Description	In this course, students realize a thesis research plan based on an approved proposal, including improving the modeling framework, trials/experiments, evaluating and analyzing trial results, and writing a thesis research report with the supervision of the supervisor. The results of the thesis research are presented in the final thesis session, which is attended by students, supervisors, and examining lecturers.	
Module objectives/intended learning outcomes	Students are able to formulate elements of novelty and usefulness of thesis research.	PLO 1, PLO 2, PLO 3, PLO 4
	Students are able to realize the framework of research methods according to the thesis proposal.	PLO 1, PLO 2, PLO 3, PLO 4
	Students are able to conduct trials/experiments to validate the proposed novelty.	PLO 1, PLO 2, PLO 3, PLO 4
	Students are able to formulate and analyze the results of thesis research trials.	PLO 1, PLO 2, PLO 3, PLO 4

	Students are able to write thesis research reports based on the rules of writing scientific papers.	PLO 1, PLO 2, PLO 3, PLO 4
Content	1. Novelty and usefulness of thesis research 2. Research methods framework 3. Trials/experiments 4. Analysis of trial results 5. Writing a thesis research report	
Exams and assessment formats	Thesis report, presentation, revision, and submit final thesis report	
Study and examination requirements	The final grade is drawn from the following components: • Material mastery: 25% of grade • Research contribution: 30% of grade • Problem complexity: 25% of grade • Scientific rules: 20% of grade Students must have a final grade of 61% or higher to pass this course.	
Reading list	1. Guidelines for Writing Thesis Proposals and Reports published by the Directorate of Postgraduate and Academic Development	