CURRICULUM DOCUMENT 2018-2023

INFORMATICS MASTER PROGRAM

INFORMATICS DEPARTMENT

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SEPULUH NOPEMBER INSTITUTE OF TECHNOLOGY

2017

1. VISION, MISSION, AND EDUCATION OBJECTIVE OF THE STUDY PROGRAM

The preparation of the new curriculum for 2018-2023 is carried out simultaneously bu all Study Programs at ITS based on ITS Chancellor Decree No.17 of 2017 concerning ITS Curriculum Evaluation Guidelines. In preparing the curriculum, the study program must align with the ITS vision, which is to become a university with an international in science, technology, and arts, especially those that support environmentally sound industry and marine. The Informatics Engineering Masters Study Program (PSMTIF) formulates the vision, mission, and objective of the study program in line with the ITS vision as follows.

- PSMTIF's vision is to become a provider of quality master's education in the field of informatics and has a reputation for excellence in the fields of education, research and application of the informatics at the national and international levels,
- PSMTIF has three missions to support the vision that has been set as follows.
    1. Organizing quality master program education and capable of producing human resources who are responsive to developments in science and technology through education and research that meet national and international education standards.
    2. Ensuring the quality of education to produce scientific contributions through superior, creative, quality, useful and sustainable research.
    3. Take an active role in contributing by forming partnerships with outsiders through community service activites or services to the community, industry and government.

- PSMTIF's educational objectives are described in the following points.
    1. Educate and produce **competent graduates** as researchers, educators and professionals in the field of informatics who have superior in the field of informatics who have superior abilities in designing, analyzing, and experimenting with computer-based systems.
    2. Educating and producing graduates who **have the ability to think critically, innovatively**, and have the ability to develop themselves through a lifelong learning process.
    3. Educating and producing graduates who are **competitive and independent** to compete at the national and international levels in the field of informatics through the ability to conduct research and scientific publications.
    4. Educate and produce graduates who are **able to contribute** to improving the quality of people's lives through the application of knowledge in the field of informatics in various fields.

2. GRADUATED LEARNING OUTCOMES (CAPAIAN PEMBELAJARAN LULUSAN/CPL)

Based on the Law of the Republic of Indonesia Number 12 of 2012 concerning Higher Education, article 29 states that the National Qualifications Framework must be used as the main reference in determining the competence of academic education graduates. The formulation of competency standards is also contained in the Presidential Regulation of the Repulic of Indonesia Number 8 of 2012 concerning the Indonesian National Qualification Framework.

In Permenristekdikti No. 44 of 2015 article 5 paragraph 1 it is also stated that the competency standards of graduates are the minimum criteria regarding the **qualifications of graduate abilities which include attitudes, knowledge and skills stated in the formulation of Graduate Learning Outcomes**, while in article 5 paragraph 3 it states that The learning outcomes of graduates refer to the learning outcomes of KKNI graduates and are equivalent to the qualification levels of the KKNI.

The skills referred to in article 5 paragraph 1 are general skills and special skills as work abilities that must be possessed by every graduate. Related to this, the preparation of the PSMTIF curriculum also applies to the KKNI standards which determine the level of the master program at **qualification level 8 (Masters).** In addition, the preparation of the CPL is also adjusted to the scientific field in the Subject Cluster in the Department of Informatics (DI). There are **8 subject clusters** in the Informatics Department, namely **Programming Algorithms (AP), Architecture and Computer Networks (AJK), Basic and Applied Computing (DTK), Interaction, Graphics and Art (IGS), Network-Based Computing (KBJ), Intelligent Computing and Vision (KCV), Information Management (MI), and Software Engineering (RPL).** Each Subject Clusters is led by the Head of the Subject Cluster who is also the Head of the Laboratory.

Based on this, PSMTIF compiles Graduate Learning Outcomes as follows:

1. ATTITUDE
    a. Being devoted to God Almighty and able to show a religious attitude;
    b. Upholding human values in carrying out duties based on religion, morals and ethics;
    c. Contributing to improving the quality of life in society, nation, state, and advancement of civilization based on Pancasila;

d. Acting as citizens who are proud and love the country, have nationalism and a sense of responsibility to the state and nation;
e. Respect the diversity of cultures, views, and beliefs , as well as the original opinions or findings of others;
f. Cooperate and have social sensitivity and care for society and the environment;
g. Obeying laws and discipline in social and state life;
h. Internalizing academic values, norms, and ethics;
i. Demonstrate an attitude of responsibility for work in their field of expertise independently;
j. Internalizing the spirit of independence, struggle and entrepreneurship;
k. Try your best to achieve perfect results; and
l. Work together to be able to make the most of their potential.

2. GENERAL SKILLS
   a. Able to develop logical, critical, systematic, and creative thinking through scientific research, design creation or works of art in the field of science and technology that pay attention to and apply humanities values in accordance with their areas of expertise, compile scientific conceptions and study results based on rules, procedures, and scientific ethics in the form of a thesis or other equivalent form, and uploaded on the college website, as well as papers that have been published in accredited scientific journals or accepted in international journals;
   b. Able to carry out academic validation or studies according to their field of expertise in solving problems in the relevant community

or industry through the development of their knowledge and expertise;

c. Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community;
d. Able to identify the scientific field that becomes the object of his research and position it on a research map developed through an interdisciplinary or multidisciplinary approach;
e. Able to make decisions in the context of solving problems in the development of science and technology that pay attention to and apply humanities values based on analytical or experimental studies of information and data;
f. Able to manage, develop and maintain networks with colleagues, peers within the wider research institute and community;
g. Able to increase learning capacity independently;
h. Able to document, store, secure, and recover research data in order to ensure validity and prevent plagiarism;
i. Able to develop themselves and compete at the national and international levels;
j. Able to implement the principle of sustainability in developing knowledge; and
k. Able to implement information and communication technology in the context of the implementation of their work.

3. MASTER OF KNOWLEDGE

a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;
b. Mastering theory and application theory as well as architectural priciples and computer networks;
c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;
d. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software;
e. Mastering the theory and theory of computer graphics applications including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions;
f. Mastering theory and application theory for solving computational problems using linear and non-linear optimization as well as modeling and simulation;

g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;

h. Mastering the theory and application theory in algorithm development in various programming language concepts;

4. SPECIAL SKILLS

a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;

b. Able to model computer architecture and operating system working principles for the development and management of network systems that have high performance, are safe and efficient;

c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

d. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

e. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;

f. Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently;

g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective information access;

h. Able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and be able to apply programming models that underlie various existing programming languages, and be able to choose a programming language to produce suitable applications;

3. RELATIONSHIP LEARNING OUTCOMES TO GRADUATES PROFILE

PSMTIF formulates the following graduate profiles:

- Academics
- Researcher
- Software enginer / developer
- System analyst / developer
- Computer network specialist
- Data scientist
- Data analyst
- IT consultant
- Software project manager

The mapping of CPL for Mastery of Special Knowledge and Skills on the profile of PSMTIF graduates is as shown in Table 3.1 and Table 3.2 as follows.

Tabel 3.1 Pemetaan CPL terhadap Profil Lulusan

NO	SPECIAL SKILLS	MASTER OF KNOWLEDGE	Academics	Researc her	Software engineer/ developer	System analyst/ developer
1	Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;	Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;	V	V	V	V
2	Able to model computer architecture and operating system working principles for the development and management of network systems that have high performance, are safe and efficient;	Mastering theory and application theory as well as architectural principles and computer networks;	V	V		V
3			V	V		

	Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;	Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;				
4	Able to model, analyze and develop software using software engineering process principles to produce software that meets both technical and managerial quality;	Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software;	V	V	V	V
5	Able to model, analyze and develop applications using the principles of computer graphics including modeling,	Mastering the theory and theory of computer graphics applications including modeling, rendering, animation and visualization, as well	V	V	V	V

	rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;	as mastering the theory and application theory of human and computer interactions;				
6	Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently;	Mastering theory and application theory for solving computational problems using linear and nonlinear optimization as well as modeling and simulation;	V	V		
7	Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective information access;	Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;	V	V	V	
8	Able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and	Mastering the theory and application theory in algorithm development in various programming language concepts;	V	V	V	V

	be able to apply programming models that underlie various existing programming languages, and be able to choose a programming language to produce suitable applications;					

Tabel 3.2 Pemetaan CPL terhadap Profil Lulusan (lanjutan)

NO	KETRAMPILAN KHUSUS	PENGUASAAN PENGETAHUAN	Computer network specialist	Data Scienctist	Data Analyst	IT consultant	Software Project manager
1	Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;	Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing		V			

		multimedia, and numerical analysis;					
2	Able to model computer architecture and operating system working principles for the development and management of network systems that have high performance, are safe and efficient;	Mastering theory and application theory as well as architectural principles and computer networks;	V			V	
3	Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;	Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;	V				
4	Able to model, analyze and develop software using software engineering process principles to produce software that meets both	Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing,			V	V	V

	technical and managerial quality;	implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software;					
5	Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;	Mastering the theory and theory of computer graphics applications including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions;				V	V
6	Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently;	Mastering theory and application theory for solving computational problems using linear and nonlinear optimization as well as modeling and simulation;			V		

7	Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective information access;	Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;		V	V	V	V
8	Able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and be able to apply programming models that underlie various existing programming languages, and be able to choose a programming language to produce suitable applications;	Mastering the theory and application theory in algorithm development in various programming language concepts;				V	V

4. RELATIONSHIP BETWEEN CPL WITH THE STUDY MATERIALS AND COURSE

The next stage of curriculum preparation after the CPL was compiled was mapping the CPL against the courses and study materials in the old curriculum. In the previous curriculum, the preparation of study materials referred to the international level Computer Science curriculum references such as the ACM / IEEE Computing Curricula.

A. Preparation of Study Materials

In preparing the Curriculum for the Master of Informatics Engineering Study Program (PSMTIF) referring to several international level computer science curriculum references including the Computer Science Curriculum 2013 (including the Information Technology Curriculla, Computer Engineering Curriculla, Software Engineering Curriculla, and Information System Curriculla) published by ACM and the IEEE Computer Society and body of knowledge in related fields, such as the Software Engineering Body of Knowledge (SWEBOK) and the Project Management Body of Knowledge (PMBOK).

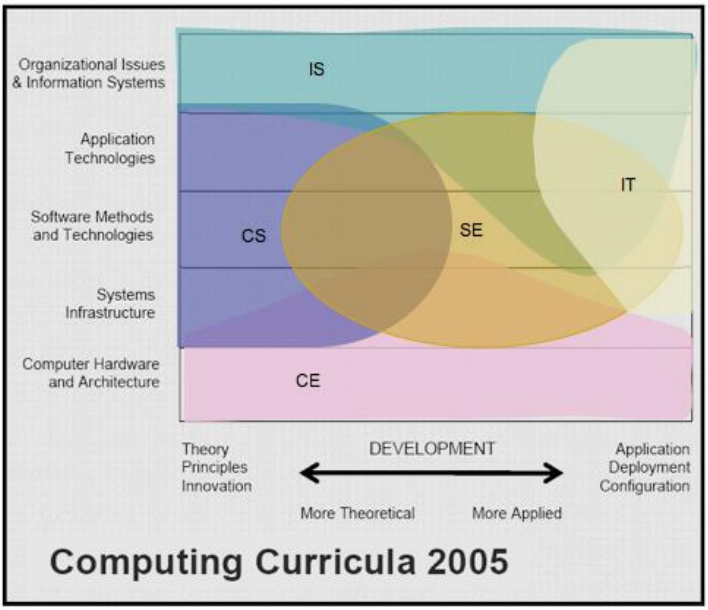
According to the Computing Curricula 2005, there are 5 programs for the *Computing Degree* namely:

1. Computer engineering (CE),
2. Computer science (CS),
3. Software Engineering (SE).
4. Information technology (IT), and
5. Information systems (IS)

In the Computing Curricula 2005 document, several computational disciplines includes:

- Computer Science (CS) basically has three main parts, which are related to the theory of algorithm development as the basis for making software application programs, related to theory and algorithms to be used as a driver of hardware components in computing systems (read: micro programming), and related to theories and algorithms to develop mathematical models to solve certain computational problems.
- Computer Engineering (CE) focuses on the theory, principles and practice of applied electronics and mathematics to be implemented in the form of computer or technology design.
- Software Engineering (SE) focuses on software development with a systematic and reliable approach.
- Information Systems (IS) focuses on information management and information technology governance to provide business solutions and support the achievement of organizational goals.
- Information Technology (IT) fokus pada penggunaan teknologi komputer dan tren teknologi untuk mempertemukan kebutuhan bisnis, pemerintahan, dan organisasi lainnya.

Figure 2.1 illustrates the scope of the Computer Science (CS) discipline compared to other computational disciplines.



Gambar 2.1 Disiplin Ilmu berdasarkan Computing Curricula 2005

The compilation of the PSMTIF is based on the main science clusters, namely Computer Science (CS) as well as some of the software enginerring cluters and Information Technology. Based on the 2013 Computer Science Curriculum published by the ACM and the IEEE Computer Society, there are 18 body of knowledge including:

1. AL - Algorithms and Complexity
2. AR - Architecture and Organization
3. CN - Computational Science
4. DS - Discrete Structures
5. GV - Graphics and Visual Computing
6. HC - Human-Computer Interaction
7. IAS - Information Assurance and Security
8. IM - Information Management
9. IS - Intelligent Systems

10. NC- Networking and Communications
11. OS - Operating Systems
12. PBD - Platform-based Development
13. PD - Parallel and Distributed Computing
14. PL - Programming Languages
15. SDF - Software Development Fundamentals
16. SE - Software Engineering
17. SF - Systems Fundamentals
18. SP - Social and Professional Issues

Of the 18 knowledge areas divided into several sub areas totaling 163. From these sub areas, PSMTIF determined the study materials used as the basis for determining the course. The study material that supports course preparation and mapping of CPL is described in the next section.

B. The link between CPL and Study Materials and Subjects

The relationship between CPL, especially in the CPL component of Mastery of Knowledge and Special Skills, with study materials and subjects in the old curriculum of the Informatics Engineering master program can be seen in Table 2 to Table 15 as follows. Whereas the CPL component of General Skills is related to Research Methodology, Pre-Thesis and Thesis courses, while the linkages with other subjects are more towards giving assignments so that the CPL component of General Skills is achieved.

Tabel 4.1 Matrix of the Relationship between CPL and Study Materials and Compulsory Subjects (Computional Intelligence and Software Engineering)

CPL COMPONENTS	Learning Outcomes of Graduates (CPL)	Computational Intelligence		Software engineering
		IS/Basic Machine Learning	IS/Advanced Machine Learning	SE/Software Design
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;	**1**	**1**	
	b. Mastering theory and application theory as well as architectural principles and computer networks;			
	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;			

	d. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software.			**1**
	e. Mastering the theory and theory of computer graphics applications including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions.;			
	f. Mastering theory and application theory for solving computational problems using linear and non-linear optimization as well as modeling and simulation;			
	g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;			
	h. Mastering the theory and application theory in algorithm development in various programming language concepts;			
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;	**1**	**1**	
	b. Able to model computer architecture and operating system working principles for the development and management of network systems that have high performance, are safe, and efficient.;			
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design			

	computational problem-solving algorithms in various fields and scientific disciplines.;			
	d. Able to model, analyze and develop software using software engineering process principles to produce software that meets both technical and managerial quality.;			**1**
	e. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with appropriate interfaces.;			
	f. Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently.;			
	g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective information access.;			
	h. Be able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and be able to apply programming models that underlie various existing programming languages, and be able to choose programming languages to produce suitable applications;			

Tabel 4.2 Matrix of the Relationship between CPL and Study Materials and Compulsory Subjects (Network-Based Computing)

CPL COMPONENTS	Learning Outcomes of Graduates (CPL)	Network Based Computing					
		NC/Networked Applications	NC/Reliable Data Delivery	NC/Routing & Forwarding	NC/Resource Allocation	OS/RealTime and Embedded Systems	SF/Proximity
PENGETAHUAN	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as						

	intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;						
	b. Mastering theory and application theory as well as architectural principles and computer networks;	**1**	**1**	**1**	**1**	**1**	**1**
	c. Mastering the theory and application	**1**	**1**	**1**	**1**		**1**

	theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;						
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart						

	application products in various fields and scientific disciplines;						
	b. Able to model computer architecture and operating system working principles for the development and management of network systems that have high performance, are safe, and efficient.;	**1**	**1**	**1**	**1**	**1**	**1**
	c. Able to develop network-based computing concepts, parallel computing,	**1**	**1**	**1**	**1**		**1**

	distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines.;						

Tabel 4.3 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics in Programming Languages)

CPL COMPONENTS	Graduate Learning Outcomes (CPL)	Topics in Programming Languages	
		PBD/Introduction	PBD/Mobile Platforms
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;		

	d. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software.	**1**	**1**
	e. Mastering the theory and theory of computer graphics applications including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions.;	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;		
	d. Able to model, analyze and develop software using software engineering process principles to produce software that meets both technical and managerial quality.;	**1**	**1**
	e. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with appropriate interfaces.;	**1**	**1**

Tabel 4.4 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics in Algorithm Design)

CPL COMPONENTS	Graduate Learning Outcomes (CPL)	Topics in Algorithm Design						
		AL/Basic Analysis	AL/Algorithmic Strategies	AL/Fundamental Data Structures and Algorithms	AL/Basic Automata, Computability and Complexity	AL/Advanced Computational Complexity	AL/Advanced Automata Theory and Computability	AL/Advanced Data Structures, Algorithms, and Analysis
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;							

	h. Mastering the theory and application theory in algorithm development in various programming language concepts;	**1**	**1**	**1**	**1**	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;							
	h. Be able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and be able to apply programming models that underlie various existing programming languages, and be able to choose programming languages to produce suitable applications;	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Tabel 4.5 Matrix of Linkage between CPL and Study Materials and Elective Subjects (Topics in Operating Systems)

CPL COMPONENTS	Graduate Learning Outcomes (CPL)	Topics in Operating Systems							
		OS/Overview of Operating Systems	OS/Operating System Principles	OS/Scheduling and Dispatch	OS/Memory Management	OS/Security and Protection	OS/VirtualMachines	OS/File Systems	OS/FaultTolerance
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing								

	multimedia, and numerical analysis;								
	b. Mastering theory and application theory as well as architectural principles and computer networks;	**1**	**1**	**1**	**1**	**1**	**1**	**1**	1
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;								
	b. Able to model computer architecture and operating system working principles for the development and management of network systems that	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

	have high performance, are safe, and efficient.;								

Tabel 4.6 Matrix of Linkage between CPL and Study Materials and Elective Subjects (Topics in Network Design and Audit)

CPL COMPONENTS	Graduate Learning Outcomes (CPL)	Topics In Network Design and Auditing							
		IAS/Foundational Concepts in Security	IAS/Principles of Secure Design	IAS/Defensive Programming	IAS/Threats and Attacks	IAS/Network Security	IAS/Web Security	IAS/Platform Security	IAS/Security Policy and Governance
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques,								

	intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;								
	b. Mastering theory and application theory as well as architectural principles and computer networks;	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

	computing and mobile computing, multimedia computing, high-performance computing and information and network security;								
SPECIAL SKILL	a. Mampu mengembangkan aplikasi dengan menerapkan prinsip-prinsip sistem cerdas dan ilmu komputasi untuk menghasilkan produk aplikasi cerdas pada berbagai bidang dan disiplin keilmuan;								
	b. Able to model computer architecture and operating system working principles for the development and management of network systems that have high	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

	performance, are safe, and efficient.;								
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines.;	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Tabel 4.7 Matrix of Correlation between CPL and Study Materials and Elective Subjects (Topics in Modeling and Simulation)

CPL COMPONENTS	**Graduate Learning Outcomes (CPL)**	**Topics in Modeling and Simulation**			
		AL/Algorithmic Strategies	**CN/Introduction to Modeling and Simulation**	**CN/Modeling and Simulation**	**CN/Processing**

KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;				**1**
	f. Mastering theory and application theory for solving computational problems using linear and non-linear optimization as well as modeling and simulation;	**1**	**1**	**1**	**1**
KETRAMPILAN KHUSUS	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart				

	application products in various fields and scientific disciplines;				
	f. Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently.;	**1**	**1**	**1**	**1**

Tabel 4.8 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics in Optimization Techniques)

CPL COMPONENTS	**Graduate Learning Outcomes (CPL)**	**Topics In Optimization**		
		AL/Algorithmic Strategies	**CN/Processing**	**CN/Numerical Analysis**
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and		**1**	**1**

	principles of computational science including information management, data processing multimedia, and numerical analysis;			
	f. Mastering theory and application theory for solving computational problems using linear and nonlinear optimization as well as modeling and simulation;	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;		**1**	**1**
	f. Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently.;	**1**	**1**	**1**

Tabel 4.9 Matrix of Correlation between CPL and Study Materials and Elective Subjects (Topics in Human and Computer Interaction)

	Graduate Learning Outcomes (CPL)	**Topics in Human and Computer Interaction**

CPL COMPONENTS		HCI/Designing Interaction	HCI/User-Centered Design & Testing	HCI/Human Factors & Security
PENGETAHUAN	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;			
	e. Mastering the theory and theory of computer graphics applications including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions.;	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;			
	e. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with appropriate interfaces.;	**1**	**1**	**1**

Tabel 4.10 Matrix of the Relationship between CPL and Study Materials and Elective Subjects (Topics in Game Development and Topics in Virtual Reality)

CPL COMPONENTS	Graduate Learning Outcomes (CPL)	Topics in Game Development			Topics In Virtual Reality
		HCI/New Interactive Technologies	GV/Visualization	PBD/Game Platforms	HCI/Mixed, Augmented and Virtual Reality
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;				
	e. Mastering the theory and theory of computer graphics applications including	**1**	**1**	**1**	**1**

	modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions.;				
SPECIAL SKILLS	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;				
	d. Able to model, analyze and develop software using software engineering process principles to produce software that meets both technical and managerial quality.				
	e Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;	**1**			**1**

Table 4.11 Matrix of Relationship between CPL with Study Materials and Elective Subjects (Topics in Computer Graphics)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL) / Learning Outcomes of Graduates (LOG)	Topics in Computer Graphics					
		GV/Fundamental Concepts	GV/Basic Rendering	GV/Geometric Modeling	GV/Advanced Rendering	GV/Computer Animation	GV/Visualization
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;						

	e. Mastering the theory and theory of computer graphics applications including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions;	**1**	**1**	**1**	**1**	**1**	**1**
SPECIAL SKILLS	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;						
	e. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;	**1**	**1**	**1**	**1**	**1**	**1**

Table 4.12 Matrix of Linkage between CPL with Study Materials and Elective Subjects (Topics in Multimedia Networks)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL) / Learning Outcomes of Graduates (LOG)	Topics in Multimedia Networks				
		IAS/Threats and Attacks	IM/Multi Media Systems	NC/Networked Applications	NC/Reliable Data Delivery	NC/Resource Allocation
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as					

	intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;					
	b. Mastering theory and application theory as well as architectural principles and computer networks;			**1**	**1**	**1**
	c. Mastering the theory and application theory of network-based computing and the latest technology	**1**		**1**	**1**	**1**

	related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;					
	g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;		**1**			
SPECIAL SKILLS	a. Able to develop applications by applying the principles of smart systems and computational science to					

	produce smart application products in various fields and scientific disciplines;					
	b. Able to model computer architecture and operating system working principles for the development and management of high performance, safe, and efficient network systems;			**1**	**1**	**1**
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and	**1**		**1**	**1**	**1**

	scientific disciplines;					
	g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective information access;		**1**			

Table 4.13 Matrix of Correlation between CPL with Study Materials and Elective Subjects (Topics in Distribution Systems)

		Topics in Distributed Systems

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL) / Learning Outcomes of Graduates (LOG)	AL/ Algorithmic Strategies	NC/Network end Applications	NC/Reliable Data Delivery	NC/Resource Allocation	OS/Scheduling and Dispatch	OS/ Virtual Machines	OS/RealTime and Embedded Systems	PD/Communication and Coordination	PD/Parallel Algorithms, Analysis, and Programming	PD/ Parallel Performance	PD/ Distributed Systems
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including											

	information management, data processing multimedia, and numerical analysis;											
	b. Mastering theory and application theory as well as architectural principles and computer networks;		**1**	**1**	**1**	**1**	**1**	**1**				
	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and		**1**	**1**	**1**				**1**	**1**	**1**	**1**

	information, and network security;											
	h. Mastering the theory and application theory in algorithm development in various programming language concepts;	**1**										
SPECIAL SKILLS	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;											

	b. Able to model computer architecture and operating system working principles for the development and management of network systems that have high performance, are safe and efficient;		**1**	**1**	**1**	**1**	**1**	**1**				
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;		**1**	**1**	**1**				**1**	**1**	**1**	**1**

	h. Able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and be able to apply programming models that underlie various existing programming languages, and be able to choose a programming language to produce suitable applications;	**1**										

Table 4.14 Matrix of Relationship between CPL with Study Materials and Elective Subjects (Topics in Cloud Computing)

		Topics In Cloud Computing

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL) / Learning Outcomes of Graduates (LOG)	IAS/Threats and Attacks	IAS/Platform Security	NC/Reliable Data Delivery	NC/Resource Allocation	OS/Virtual Machines	OS/Fault Tolerance	PD/Distributed Systems	PD/Cloud Computing
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;								
	b. Mastering theory and application theory as well as architectural principles and computer networks;			**1**	**1**	**1**	**1**		
	c. Mastering the theory and application theory of network-based computing and the latest technology related to it,	**1**	**1**	**1**	**1**			**1**	**1**

	in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;								
SPECIAL SKILLS	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;								
	b. Able to model computer architecture and operating system working principles for the development and management of high performance, safe, and efficient network systems			**1**	**1**	**1**	**1**		
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;	**1**	**1**	**1**	**1**			**1**	**1**

Table 4.15 Matrix of Linkage between CPL with Study Materials and Elective Subjects (Topics in Network Security)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL) / Learning Outcomes of Graduates (LOG)	Topics in Network Security					
		IAS/Principles of Secure Design	IAS/Defensive Programming	IAS/Threats and Attacks	IAS/Network Security	IAS/Web Security	IAS/Platform Security
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;						

	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;	**1**	**1**	**1**	**1**	**1**	**1**
SPECIAL SKILLS	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;						
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;	**1**	**1**	**1**	**1**	**1**	**1**

Table 4.16 Matrix of Relationship between CPL with Study Materials and Elective Subjects (Topics in Parallel Computing and High Performance)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL) / Learning Outcomes of Graduates (LOG)	Topics In Parallel Computing and High Performance						
		PD/Parallelism Fundamentals	PD/Parallel Decomposition	PD/Communication and Coordination	PD/Parallel Algorithms, Analysis, & Programming	PD/Parallel Architecture	PD/Parallel Performance	PL/Concurrencyand Parallelism
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;							

	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;	**1**	**1**	**1**	**1**	**1**	**1**	
	h. Mastering the theory and application theory in algorithm development in various programming language concepts;							**1**
SPECIAL SKILLS	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;							
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various	**1**	**1**	**1**	**1**	**1**	**1**	

	fields and scientific disciplines;							
	h. Able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and be able to apply programming models that underlie various existing programming languages, and be able to choose a programming language to produce suitable applications;							**1**

Table 4.17 Matrix of Relationship between CPL with Study Materials and Elective Subjects (Topics in Mobile Computing)

CPL COMPONENTS	**Capaian Pembelajaran Lulusan (CPL) / Learning Outcomes of Graduates (LOG)**	**Topics In Mobile Computing**				
		NC/Networked Applications	**NC/Reliable Data Delivery**	**NC/Mobility**	**PD/Communication and Coordination**	**PD/Distributed Systems**

KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;					
	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;	**1**	**1**	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;					

	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;	**1**	**1**	**1**	**1**	**1**
	h. Be able to model, analyze and develop algorithms to solve problems effectively and efficiently based on strong programming principles, and be able to apply programming models that underlie various existing programming languages, and be able to choose programming languages to produce suitable applications;					

Table 4.18 Matrix of Correlation between CPL and Study Materials and Elective Subjects (Topics In Digital Forensics)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)	Topics In Digital Forensics		
		IAS/Web Security	IAS/Digital Forensics	IAS/Secure Software Engineering
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;			
	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the fields of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;			
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;	**1**	**1**	**1**

Table 4.19 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics In Wireless Networks)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)	Topics In Wireless Networks				
		NC/Networked Applications	NC/Reliable Data Delivery	NC/Routing & Forwarding	NC/Local Area Networks	NC/Resource Allocation
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;					
	c. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the fields of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;	**1**	**1**	**1**	**1**	**1**

SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;					
	c. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;	**1**	**1**	**1**	**1**	**1**

Table 4.20 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics In Data Mining and Topics in Digital Image Processing)

CPL COMPONENTS	**Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)**	**Topics In Data Mining**			**Topics In Digital Image Processing**
		CN/Data, Information, and Knowledge	**IM/Data Mining**	**IS/Advanced Machine Learning**	**IS/Perception and Computer Vision**

KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;	**1**		**1**	**1**
	f. Mastering theory and application theory for solving computational problems using linear and nonlinear optimization as well as modeling and simulation;	**1**			
	g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;		**1**		
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;	**1**		**1**	**1**
	f. Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently;	**1**			

	g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective access to information;		**1**		

Table 4.21 Matrix of the Relationship between CPL and Study Materials and Elective Subjects (Topics In Information Retrieval Systems and Topics in Computer Vision)

CPL COMPONENTS	**Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)**	**Topics In Information Retrieval Systems**		**Topics In Computer Vision**	
		CN/Data, Information, and Knowledge	**IM/Information Storage and Retrieval**	**IS/Perception and Computer Vision**	**IS/Advanced Machine Learning**
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data	**1**		**1**	**1**

	processing multimedia, and numerical analysis;				
	f. Mastering theory and application theory for solving computational problems using linear and nonlinear optimization as well as modeling and simulation;	**1**			
	g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;		**1**		
	h. Mastering the theory and application theory in algorithm development in various programming language concepts;				
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;	**1**		**1**	**1**
	f. Able to model, analyze and develop computational problem solving and mathematical modeling through exact,	**1**			

	stochastic, probabilistic and numerical approaches effectively and efficiently;				
	g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective access to information;		**1**		

Table 4.22 Matrix of Correlation between CPL and Study Materials and Elective Subjects (Topics In Business Process Response Information Systems)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)	Topics In Business Process Response Information Systems		
		IM/Information Management Concepts	IM/Data Modeling	IM/Transaction Processing
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;			
	g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;			
	g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective access to information;	**1**	**1**	**1**

Table 4.23 Matrix of Linkage between CPL and Study Materials and Elective Subjects (Topics In Knowledge-Based Systems Engineering)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)	Topics In Knowledge Based Systems Engineering			
		IM/Database Systems	IM/Relational Databases	IM/Data Mining	IM/Information Storage and Retrieval
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;				
	g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;	**1**	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;				

	g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective access to information;	**1**	**1**	**1**	**1**

Table 4.24 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics In System Audit)

CPL COMPONENTS	**Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)**	**Topics In System Audit**		
		IM/Transaction Processing	**IM/Data Mining**	**IM/Information Storage and Retrieval**
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;			
	g. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;	**1**	**1**	**1**

SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;			
	g. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective access to information;	**1**	**1**	**1**

Table 4.25 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics In OT Evolution, Topics in OT Quality Assurance, and Topics in OT Economics)

CPL COMPONENTS	**Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)**	**Topics In Software Evolution**	**Topics In Software Quality Assurance**	**Topics In Software Economics**
		SE/Software Evolution	**SE/Software Verification and Validation**	**SP/Economies of Computing**
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the			

	concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;			
	d. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software.	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;			
	d. Able to model, analyze and develop software using software engineering process principles to produce software that meets both technical and managerial quality;	**1**	**1**	**1**

Table 4.26 Matrix of Relationship between CPL and Study Materials and Elective Subjects (Topics in Completion of OT Processes, and Topics in Requirements Engineering)

CPL COMPONENTS	Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)	Topics In Software Process Improvement		Topics In Requirements Engineering
		SE/Software Processes	SE/Software Project Management	SE/Requirements Engineering
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;			
	d. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software.	**1**	**1**	**1**
SPECIAL SKILL	a. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;			

	d. Able to model, analyze and develop software using software engineering process principles to produce software that meets both technical and managerial quality;	**1**	**1**	**1**

Table 4.27 Matrix of Linkage between CPL and Study Materials and Elective Subjects (Topics in OT Project Management)

CPL COMPONENTS	**Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)**	**Topics In Software Project Management**			
		SE/Software Processes	**SE/Software Project Management**	**SE/Requirements Engineering**	**SE/Software Construction**
KNOWLEDGE	a. Mastering intelligent system application theory and theory which includes representational and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as intelligent application development in various fields, and master the concepts and principles of computational science including information management, data processing multimedia, and numerical analysis;				
	b. Mastering theory and application theory in software design and development with standard and scientific methods of planning,	**1**	**1**	**1**	**1**

	requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are useful in development software.				
SPECIAL SKILL	c. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;				
	d. Able to model, analyze and develop software using software engineering process principles to produce software that meets both technical and managerial quality;	**1**	**1**	**1**	**1**

CPL COMPONENTS	**Capaian Pembelajaran Lulusan (CPL)/ Learning Outcomes of Graduates (LOG)**	**Research Methodology**	**Pre Thesis & Thesis**
		Research Methodology	**Thesis**
GENERAL SKILLS	a. able to develop logical, critical, systematic, and creative thinking through scientific research, design creation or works of art in the field of science and technology that pay attention to and apply humanities values in accordance with their areas of expertise, compile scientific conceptions and study results based	**1**	**1**

	on rules, procedures, and scientific ethics in the form of a thesis or other equivalent form, and uploaded on the college website, as well as papers that have been published in accredited scientific journals or accepted in international journals;		
	b. able to carry out academic validation or studies according to their field of expertise in solving problems in the relevant community or industry through the development of their knowledge and expertise;		**1**
	c. able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community;		**1**
	d. able to identify the scientific field that is the object of his research and position it into a research map developed through an interdisciplinary or multidisciplinary approach;	**1**	**1**
	e. able to make decisions in the context of solving problems in the development of science and technology that pay attention to and apply the value of the humanities based on analytical or experimental studies of information and data;	**1**	**1**
	f. able to manage, develop and maintain networks with colleagues, peers within the institution and the wider research community;		**1**
	g. able to increase learning capacity independently;		**1**

	h. able to document, store, secure, and recover research data in order to ensure validity and prevent plagiarism;		**1**
	i. able to develop themselves and compete at the national and international levels;		**1**
	j. able to implement the principles of sustainability in developing knowledge; and		**1**
	k. able to implement information and communication technology in the context of the implementation of their work.		**1**

A. Analysis of Course Closing and Opening

After mapping the CPL linkage with study materials and old curriculum subjects, the next stage is evaluation of the closure and opening of new courses.

- Closing of Courses

From the results of the discussion of teaching lecturers at the Subject Clusters (RMK) level, there are several reasons for the closure of several courses at PSMTIF, including the study materials overlapping with other courses so it is necessary to merge, evaluate the old curriculum, there are several courses offered but students who take these courses are very little below the specified threshold number, as well as evaluation in terms of content, very basic materials such as S1 subject matter have no development into research.. From the results of the discussion, the following is a list of subjects in the old curriculum that were deleted and no longer included in the new curriculum.

Table 4.28 Removed Elective Subject List

RMK	Courses	Reason
AJK	Topics In Operating Systems	The study material overlaps with several other courses and the basic material at the S1 level does not develop into research
AP	Topics In Algorithm Design	Basic materials at the S1 level do not develop into research
AP	Topics In Programming Languages	Basic materials at the S1 level do not develop into research
DTK	Topics In Optimization Techniques	The study material overlaps with several other courses and the number of enthusiasts to take these courses is very small
IGS	Topics in Game Development	Study material is few, so it is combined with the Topics in Virtual Reality and Augmentation courses

IGS	Topics In Virtual Reality	There is little study material, so it is combined with the Topics in Game Development course
KBJ	Topics In Parallel Computing and High Performance	The study material overlaps with several other courses and the number of enthusiasts to take these courses is very small
MI	Topics In Business Process Response Information Systems	The study material overlaps with several other courses and the number of enthusiasts to take these courses is very small
RPL	Topics In Software Improvement	The study material overlaps with several other courses and the number of enthusiasts to take these courses is very small so that the class is never opened
RPL	Topics In Software Engineering Economics	The study material overlaps with several other courses and the number of enthusiasts to take these courses is very small so that the class is never opened

- Opening of New Courses

From the results of the discussion of teaching lecturers at the Subject Clusters (RMK) level, There are several reasons for the opening of several new courses in the 2018-2023 PSMTIF curriculum, namely the development of research roadmaps on several RMKs and the merging of several courses with quite a lot of overlap study materials.

Table 4.29 List of New Elective Courses

RMK	Courses	Reason
AJK	Topics In Cybersecurity	Adjusted to the development of the research roadmap at RMK AJK.
DTK	Topics In Time Series Data Analysis	Adjusted to the development of the research roadmap in Applied Basic Computer RMK.

IGS	Topics In Game Development, Virtual Reality, and Augmented Reality	There is an overlap of study materials so that two courses are combined into one
MI	Topics In Geospatial Data Analysis	Adjusted to the development of the research roadmap in RMK Information Management

1. CURRICULUM STRUCTURE

The PSMTIF curriculum was developed in accordance with the guidelines for curriculum preparation at the ITS and National levels. ITS Chancellor's Decree No. 17 of 2017 concerning ITS Curriculum Evaluation Guidelines in article 8, the master program has a study load of 36 credits after completing the Undergraduate Program or Applied Undergraduate Program.

Based on ITS Chancellor Regulation No. 17 of 2017 concerning Guidelines for ITS Curriculum Evaluation Article 9, the number of thesis credits is 8-12 credits. PSMTIF designed a curriculum with a total of 36 credits consisting of 24 credits of compulsory courses and 12 credits of elective courses. The compulsory subjects are divided into two, namely 12 credits for 4 subjects, each with 3 credits including Computational Intelligence, Network-Based Computing, Software Engineering, and Research Methodology, and 12 credits for 3 related subjects with Thesis including Thesis - Proposal (3 credits), Thesis - Scientific Publication (3 credits), and Thesis - Final Session (6 credits). The PSMTIF curriculum is structured in four semesters, but students who want to quickly graduate can study in three semesters. The following is the structure of the 2018-2023 PSMTIF curriculum as in Table 5.1 and Table 5.2.

Tabel 5.1 Curriculum Structure of PSMTIF 2018 - 2023

1st Semester		
Course Code	Course Name	Credit
IF185101	Computational Intelligence	3
IF185102	Net-Centric Computing	3
IF185103	Software Engineering	3
IF1859XY	Elective Course 1	3
		12

2nd Semester		
Course Code	Course Name	Credit
IF185201	Research Methodology	3
IF1859XY	Elective Course 2	3
IF1859XY	Elective Course 3	3
IF1859XY	Elective Course 4	3
		12

3rd Semester		
Course Code	Course Name	Credit
IF185301	Thesis - Proposal	3
IF185302	Thesis - Scientific Publication	3
		6
	TOTAL SKS	**36**

4th Semester		
Course Code	Course Name	Credit
IF185401	Thesis - Final Defense	6
		6

Tabel 5.2. List of Elective Courses for Curriculum of PSMTIF 2018 - 2023

RMK (Subject Cluster)	**Course Code**	**Course Name**	**Credit**	**Semester**
Computer Architecture and Networking (AJK)	IF185911	Advance topics in Network Design and Audit	3	1
Computer Architecture and Networking (AJK)	IF185912	Advance topics in Cyber Security	3	2
Applied Modelling and Computation (DTK)	IF185921	Advance topics in Modelling and Simulation	3	1

Applied Modelling and Computation (DTK)	IF185922	Advance topics in Time series Data Analysis	3	2
Graphic, Interaction, and Game (IGS)	IF185931	Advance topics in Human and Computer Interaction	3	1
Graphic, Interaction, and Game (IGS)	IF185932	Advance topics in Game Development, Virtual Reality, and Augmented Reality	3	2
Graphic, Interaction, and Game (IGS)	IF185933	Advance topics in Computer Graphics	3	2
Net-Centric Computing (KBJ)	IF185941	Advance topics in Multimedia Networking	3	1
Net-Centric Computing (KBJ)	IF185942	Advance topics in Distributed Systems	3	1
Net-Centric Computing (KBJ)	IF185943	Advance topics in Digital Forensic	3	2
Net-Centric Computing (KBJ)	IF185944	Advance topics in Network Security	3	2
Net-Centric Computing (KBJ)	IF185945	Advance topics in Mobile Computing	3	2
Net-Centric Computing (KBJ)	IF185946	Advance topics in Cloud Computing	3	2
Net-Centric Computing (KBJ)	IF185947	Advance topics in Wireless Network	3	2
Inteligent Computing and Vision (KCV)	IF185951	Advance topics in Data Mining	3	1
Inteligent Computing and Vision (KCV)	IF185952	Advance topics in Information Retrieval	3	1

Inteligent Computing and Vision (KCV)	IF185953	Advance topics in Image Processing	3	2
Inteligent Computing and Vision (KCV)	IF185954	Advance topics in Computer Vision	3	2
Information Intelligent Management (MI)	IF185961	Advance topics in System Audit	3	1
Information Intelligent Management (MI)	IF185962	Advance topics in Knowledge Based Engineering	3	2
Information Intelligent Management (MI)	IF185963	Advance topics in Geospatial Data Analysis	3	2
Software Engineering (RPL)	IF185971	Advance topics in Software Evolution	3	1
Software Engineering (RPL)	IF185972	Advance topics in Software Project Management	3	2
Software Engineering (RPL)	IF185973	Advance topics in Requirement Engineering	3	2
Software Engineering (RPL)	IF185974	Advance topics in Software Quality Assurance	3	2

6. HUMAN RESOURCES

The number of lecturers at PSMTIF is as many as 16 people, with **the latest educational qualifications of S3 (Doctorate) and have academic positions as many as 4 professors, 7 head lecturers, and 4 lecturers**. **The assignment of a teaching lecturer to a course is adjusted to the RMK (Subject Cluster) and the scientific field of each lecturer**. The list of courses

taught by a RMK has been explained in Chapter 5. While the list of the Lecturers and scientific fields possessed by each RMK can be seen in Table 6.1.

Tabel 6.1. List of The Lecturers and Scientific Fields in Each RMK

RMK (Subject Cluster)	Lecturer Name	Academic Position	Scientific Field
Computer Architecture and Networking (AJK)	Prof. Ir. Supeno Djanali, M.Sc., Ph.D.	Professor	Net-Centric Computing
Computer Architecture and Networking (AJK)	Royyana Muslim I, S.Kom, M.Kom, Ph.D.	Lecturer	Net-Centric Computing, E-Learning
Computer Architecture and Networking (AJK)	Dr. Eng. Radityo Anggoro, S.Kom, M.Sc.	Lecturer	Net-Centric Computing, Mobile Ad-hoc Network
Applied Modelling and Computation (DTK)	Prof. Dr. Ir. Joko Lianto Buliali, M.Sc.	Professor	Modelling & Simulation, Optimization, Time Series Analysis
Graphic, Interaction, and Game (IGS)	Dr. Eng. Darlis Heru Murti, S.Kom, M.Kom	Lecturer	Virtual and Augmented Reality, Human and Computer Interaction, Image processing
Net-Centric Computing (KBJ)	Tohari Ahmad, S.Kom, MIT, Ph.D.	Head Lecturer	Net-Centric Computing, Data Hiding
Net-Centric Computing (KBJ)	Waskitho Wibisono, S.Kom, M.Eng, Ph.D.	Head Lecturer	Net-Centric Computing, Distributed System

Net-Centric Computing (KBJ)	Bagus Jati Santoso, S.Kom, Ph.D.	-	Net-Centric Computing
Inteligent Computing and Vision (KCV)	Prof. Ir. Handayani Tjandrasa, M.Sc, Ph.D.	Professor	Image Processing, Computational Intelligence
Inteligent Computing and Vision (KCV)	Dr. Agus Zainal Arifin, S.Kom, M.Kom	Head Lecturer	Image Processing, Information Retrieval
Inteligent Computing and Vision (KCV)	Dr.Eng. Nanik Suciati, S.Kom, M.Kom	Head Lecturer	Computer Graphics, Image Processing, Computer Vision
Inteligent Computing and Vision (KCV)	Dr. Eng. Chastine Fatichah, S.Kom, M.Kom	Head Lecturer	Computational Intelligence, Data Mining, Image Processing
Information Intelligent Management (MI)	Prof. Drs.Ec., Ir., Riyanarto Sarno, M.Sc., Ph.D.	Professor	Process Mining, Software Engineering, Audit TI
Information Intelligent Management (MI)	Dr. Ir. R V Hari Ginardi, M.Sc	Lecturer	Geographic Information System, Geospatial Data Analysis
Software Engineering (RPL)	Dr. Ir. Siti Rochimah, M.T.	Head Lecturer	Software Engineering: Software Evolution, Software Quality
Software Engineering (RPL)	Daniel Oranova Siahaan, S.Kom, PD.Eng.	Head Lecturer	Software Engineering: Requirements Engineering; Natural Language Processing; Semantic Web

7. FACILITIES AND INFRASTRUCTURE

Facilities and infrastructure that support the academic process at PSMTIF are provided by the Informatics Department very well. There are a number of lecture classrooms, research laboratory rooms, reading rooms, courtrooms, and halls. The details can be seen in Table 7.1. For the postgraduate study programs, in addition to research laboratories, a residency laboratory is also provided for S2 (Magister) and S3 (Doctoral) students.

Tabel 7.1 List of Main Infrastructure

No	Type of Infrastructure	Number of units	Total area (m2)	Condition	Utilization (Hours/week)
(1)	(2)	(3)	(4)	(5)	(6)
1	Lecture Classroom	10	845,56	Good	65
2	Laboratory	10	861,44	Good	84
3	Department's Reading Room	1	144,46	Good	55
4	Administration Room	2	80,94	Good	40
5	Court Room & Hall	2	290,66	Good	14
6	Central Library	1	12.858	Good	65

The Postgraduate in the Informatics Department manages 2 residency laboratories on the 1st floor, namely the Residency Laboratory for S2 (Magister) (Room 109) and the Residency Laboratory for S3 (Doctoral) (Room 110). The laboratory is opened following the working hours of ITS employees (guarded by the officers). The existence of this residency laboratory is very important for the

new students for doing the lecture assignments and is also included in the accreditation assessment for postgraduate level.

Gambar 7.1 S2(Magister) Residency Laboratory

In 2017, there was also a rejuvenation of the computer specifications at the Residency Laboratory. In the S2 (Magister) residency laboratory previously, 25 computers with 2GB memory and i3 processor specifications have now been upgraded to 25 computers with 8GB memory and i5 processor specifications. Data of the computer equipment for the 1st floor of Postgraduate Residency Laboratory can be seen in Table 7.2.

Tabel 7.2 Data of The Computer in the Residency Laboratory, 1st floor.

No	Types of goods	Specification	Amount	Information
1	Computer	Processor i2 with 8GB memory	25	Allocation of Magister Student
2	Computer	Processor i3 with 4GB memory	7	Allocation of Doctoral Student
3	Computer	Processor i3 with 2GB memory	3	Admin
4	Server	Processor Xeon with 2GB memory	2	Post Data Server and For Student Trials
5	Printer	HP Scanjet	2	Printer for Magister (S2)

Because the number of Doctoral (S3) students increased, the Postgraduate Program in the Informatics Department also opened a Doctoral (S3) Residency Lab on the 3rd floor (Table 7.3) with 24 hour access. The following is the equipment data in the Doctoral (S3) 3rd floor residency laboratory.

Tabel 7.3 Data of The Computer in the Residency Laboratory, 3rd floor

No	Types of goods	Specification	Amount	Information
1	Computer	Processor i3 with 4GB memory	23	Allocation of Doctoral Student
2	Server	Processor Xeon with 2GB memory (1 in CS NET)	2	1 Montes Server and Student Trial Server
3	Printer	HP Scanjet	2	Printer for Doctoral (S3) (above)
4	Scanner	Hp	1	Scaner for Doctoral (S3) (above)

Gambar 7.2 Doctoral Residency Laboratory on the 1st and 3rd Floor

Apart from the Residency Laboratory for S2 (Magister) and S3 (Doctoral), S2 and S3 students are also provided to join the Research Laboratory in the Informatics Department. **There are 8 Research Laboratories each subject cluster (RMK) including Algorithm and Programming (AP) laboratories, Computer Architecture and Networking (AJK) laboratories, Applied Modelling and Computation (DTK) laboratories, Graphic, Interaction, and Game (IGS) laboratories, Net-Centric Computing (KBJ) laboratories, Inteligent Computing and Vision (KCV) laboratories, Information Intelligent Management (MI) laboratories, and Software Engineering (RPL) laboratories.** The eight laboratories are located on the 3rd Floor.

The Informatics Department also provides a reading room for the Department, which has a large collection of books, proceedings, and national as well as international journals related to the field of informatics/computer science. More details of the collections owned by the department reading room can be

seen in Table 7.4. While a number of collections related to journals in the form of hardcopy, e-journal, open access can be seen in Table 7.5.

Tabel 7.4 List of the Amount of Literature Availability Relevant to the Field of Informatics/Computer Science

Type of Literature	Number of Titles	Number of Copies
(1)	**(2)**	**(3)**
Textbook	2136	3181
Accredited National Journal	7	207
International journal with complete numbers	6	6
Proceedings	13	54
Thesis	577	577
Dissertation	2	2
Total	**2741**	**4027**

Tabel 7.5 List of Journals that Available/Received Regularly (Complete), published in the last 3 years

Type	Journal Name	Details of Year and Number	Amount
(1)	**(2)**	**(3)**	**(4)**
ACCREDI-TED JOURNAL BY DIKTI*	*TELKOMNIKA	Year 2015, Vol.13 No.1-4	4 (Complete)
		Year 2016, Vol.14 No.1-4	4 (Complete)

Type	Journal Name	Details of Year and Number	Amount
(1)	**(2)**	**(3)**	**(4)**
		Year 2017, Vol.15 No.1-4	4 (Complete)
	*Jurnal Nasional Teknik Elektro dan Teknologi Informasi (JNTETI)	Year 2015, Vol.4 No.1-4	4 (Complete)
		Year 2016, Vol.5 No.1-2	4 (Complete)
		Year 2017, Vol.6 No. 1-2	4 (Complete)
	*Jurnal Ilmu Komputer dan Informasi	Year 2015, Vol.8 Issue 1-2	2 (Complete)
		Year 2016. Vol.9 Issue 1-2	2 (Complete)
		Year 2017 Vol.10. Issue 1-2	2 (Complete)
	*Lontar Komputer: Jurnal Ilmiah Teknologi Informasi	Year 2015 Vol.6 No. 1-3	3 (Complete)
		Year 2016 Vol.7 No. 1-3	3 (Complete)
		Year 2015 Vol.8 No. 1-3	3 (Complete)
e-journal (subscribed centrally by ITS)	Academic one file from GALE Cangage Learning, sub database: IT Information Science	http://www.infotrac.galegroup.com/itweb/idits	

Type	Journal Name	Details of Year and Number	Amount
(1)	**(2)**	**(3)**	**(4)**
	IEEE paket e-journal	http://www.ieeexplore.ieee.org/xplore	
	Proquest Science Journal	http://www.proquest.com	
	Sciencedirect (multi subyek)	http://www.sciencedirect.com	
	Springer link	www.link.springer.com	
	Emerald engineering	www.emeraldinsight.com	
Open Access	Jurnal Telkomnika	http://journal.uad.ac.id/index.php/TELKOMNIKA	
	Lontar Komputer : Jurnal Ilmiah Teknologi Informasi	https://ojs.unud.ac.id/index.php/lontar/issue/archive	
	Jurnal Nasional Teknik Elektro dan Teknologi Informasi (JNTETI)	http://ejnteti.jteti.ugm.ac.id/index.php/JNTETI/issue/archive	
	Bulletin of Electrical Engineering and Informatics	http://journal.portalgaruda.org/index.php/EEI/	
	Jurnal Ilmu Komputer dan Informasi	http://jiki.cs.ui.ac.id/index.php/jiki/issue/archive	

Type	Journal Name	Details of Year and Number	Amount
(1)	(2)	(3)	(4)
	Communication and Information Technology Journal	http://journal.binus.ac.id/index.php/commit/issue/view/94	
	Journal of Engineering and Technological Sciences	http://journal.itb.ac.id/	
	IAENG Engineering Letters, IAENG Internatiounal Journal of Computer Science,	http://www.iaeng.org/journals.html	
	ITB Journal	http://journal.itb.ac.id/	

2. COURSE SYLABUS OF PSMTIF CURRICULUM 2018-2023

COURSE	**Course Name: Computational Intelligence**
	Course Code : IF185101
	Credit : 3
	Semester : 1

DESCRIPTION OF COURSE
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 Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Independent Component Analysis (ICA).

GRADUATE LEARNING OUTCOMES

1. Mastering theory and application theory of representation and reasoning techniques, searching technique, intelligent agent, data mining, machine learning, and development of intelligent application in various fields, and also mastering concept and principles of computation science such as manage information, multimedia data processing, and numerical analysis;
2. Capable of developing applications using principles of intelligent systems and computing science to produce intelligent applications in various fields and disciplinary of science;

COURSE LEARNING OUTCOME

1. Students are able to explain the kinds of input data, description of the process, data extraction, feature vectors, and classifier.
2. Students are able to explain the function of the Fourier transform, Wavelet, and its application to feature extraction.
3. Students are able to explain the various methods of clustering and its applications.
4. Students are able to explain the various methods of artificial neural networks, multilayer perceptron, RBF, ANFIS, SVM, and the soft SVM.
5. Students are able to explain the clustering method and artificial neural networks, ANFIS, and SVM in an application and analyze the related research.
6. Students are able to explain the methods of optimization with evolutionary algorithms: Genetic Algorithm (GA), Ant Colony (ACO), Particle Swarm Optimization (PSO), and Artificial Bee Colony (ABC).
7. Students are able to explain the Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), PCA and LDA difference, Independent Component Analysis (ICA), and its application.
8. Students are able to apply classifier combination with optimization methods or with PCA and LDA in an application and analyze the related research.
9. Students are able to apply the feature vector extraction and classification, and also analyze the results of related research.
10. Students are able to write reports and papers from the implementation of classification models.

MAIN SUBJECT

1. DATA INPUT: available dataset, static data, dynamic data, machine perception, model illustration consisting of preprocessing, 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, hierachical 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 9 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 OF THE IMPLEMENTATION OF CLASSIFICATION MODELS.

PREREQUISITES

REFERENCE

1. Sergios Theodoridis, Konstantinos Koutroumbas, Pattern Recognition, 4th ed., Elsevier Inc., 2009.

2. R.O. Duda, P.E.Hart, D.G.Stork, Pattern Classfication, John Wiley & Sons, Inc., 2001
3. Amit Konar, Computational Intelligence, Springer, 2005.
4. C. H. Bishop, Pattern Recognition and Machine Learning, Springer Science, 2006.
5. Journal: a. Expert Systems with Applications, www.sciencedirect.com
   b. IEEE Intelligent Systems Magazine
   c. Journal of Biomedical Informatics, Elsevier
6. Simon Haykin, Neural Networks: A Comprehensive Foundation (2nd Edition), Prentice Hall, 1998.
7. Christian Blum, Daniel Merkle, Swarm Intelligence : Introduction and Applications, Springer-Verlag 2008.

COURSE	**Course Name : Net-Centric Computing**
	Course Code : IF185102
	Credit : 3
	Semester : 1

DESCRIPTION OF COURSE

This course is an introduction of a variety of topics related to Network-Based Computing. In this course will discuss various issues and technology trends to provide further insights in the Network-Based Computing.

GRADUATE LEARNING OUTCOMES

1. Mastering theory and application theory of net-centric computing and related-recent technologies, in the fields of distributed and mobile computing, multimedia computing, high performance computing along with information and network security;
2. Able to develop the concept of net-centric computing, parallel computing, distributed computing for analyzing and designing algorithms that can be used to solve computation problem in various fields and disciplinary of science;

COURSE LEARNING OUTCOME

1. Students are able to explain and assemble knowledge in the field of Network-Based Computing in terms of concepts, theories, and terms in a variety of supporting technology.

2. Students are able to provide a critical assessment of a problem in Network-Based Computing technology support.
3. Students are capable of analyzing and assessing the Network-Based Computing assistive technologies to be applied in the field of new / different.
4. Students are able to plan / find a scientific solution to resolve the problems in the field of assistive technologies Network-Based Computing.

MAIN SUBJECT

Discussion and introduction of technology and research in the field areas: Wireless Network, Mobile Computing, Distributed Systems, Cloud Computing, Network Security and Multimedia Network.

PREREQUISITES

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REFERENCE

1. Stallings, W., "Wireless Communications and Networking 2nd Edition", Prentice Hall, 2004.
2. Abdessalam Helal, et. al," Anytime, Anywhere Computing, Mobile Computing Concepts and Technology" , McGraw-Hill.
3. Richard Hill, "Guide to Cloud Computing, Principles and Practice", Springer.
4. Cryptography and Network Security: Principles and Practice (6th Edition) by William Stallings (Mar 16, 2013).
5. Secure Coding in C and C++ (2nd Edition) (SEI Series in Software Engineering) by Robert C. Seacord (Apr 12, 2013).
6. Coleman, D., Westcott, D., "CWNA: Certified Wireless Network Administrator Official Study Guide", Wiley Publishing Inc., 2009.
7. Schiller, J.H., "Mobile Communications 2nd Edition", Addison-Wesley, 2004.
8. Mobile Computing Principles Designing And Developing Mobile Applications With Uml And Xml and the Environment", Oxford Publisher 2002.
9. Location Management and Routing in Mobile Wireless Networks, Amitava Mukherjee, Somprakash Bandyopadhyay, Debashis Saha, Artech House Publisher
10. Andreas Heinemann, Max Muhlhauser'', Peer-to-Peer Systems and Application
11. Mohammad Ilyas and Imad Mahgoub, Mobile Computing Handbook, Auerbach Publication

12. George Coulouris, Distributed Systems, Concepts and Design 3rd edition Addison-Wesley, 2001
13. Biometric Cryptography Based on Fingerprints: Combination of Biometrics and Cryptography Using Information from fingerprint by Martin Drahansky (May 23, 2010).
14. Information Security The Complete Reference, Second Edition by Mark Rhodes-Ousley (Apr 3, 2013)
15. IEEE Transactions on Mobile Computing, IEEE
16. Pervasive and Mobile Computing, Elsevier
17. IEEE Transactions on Cloud Computing, IEEE
18. IEEE Transactions on Network Science and Engineering, IEEE
19. IEEE Transactions on Services Computing, IEEE
20. IEEE Transactions on Parallel & Distributed Systems, IEEE

COURSE	**Course Name: Software Engineering**
	Course Code : IF185103
	Credit : 3
	Semester : 1

DESCRIPTION OF COURSE
Software engineering study about aspects related to method.
GRADUATE LEARNING OUTCOMES
1. Mastering theory and application theory of design and development of software using standardized and scientific methods of planning, requirement engineering, design, implementation, testing, and product releasing, to produce software products that meet various parameters of quality, i.e. technical, managerial, and efficient; 2. Capable of modelling, analyzing, and developing software using software engineering process principles to produce software that meets both technical and managerial qualities;
COURSE LEARNING OUTCOME
Students are able to organize the road map of software engineering research.
MAIN SUBJECT
In this course, students will learn the following subjects:

1. Concept and principle of Software Engineering: sofwatre concept, SDLC, types of apllication.

2. Software engineering approach on specific systems: real time system, client-server system, distributed system, Parallel system, web-based system, high integrity system, games, mobile computing, and domain specific (business application and scientific computing)

3. Issues of each specific system: project management effectively and efficiently, software quality, process business, software process improvement.

PREREQUISITES

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REFERENCE

1. Pressman, R.S., Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill, 2006
2. Sommerville, I., Software Engineering 8th Edition, Addision Westley, 2007
3. Articles in Scientific Journals related to Software Engineering
4. Others supporting references given during lecturer.

COURSE	**Course Name: Research Methodology**
	Course Code : IF185201
	Credit : 3
	Semester : 2

DESCRIPTION OF COURSE

The research methodology or the systematic study of the stages of the scientific method in developing a research. The output of this course is draft of research proposals associated with each research topic.

GRADUATE LEARNING OUTCOMES

Being able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other

equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;
COURSE LEARNING OUTCOME
Students are able to do the stages in developing a research method research to produce good research proposal.
MAIN SUBJECT
Scientific methodology consisted of how to do a literature review, analysis and formulation of the problem, determining the purpose and scope of the study, design and implementation of the proposed method, how to test the correctness and validity, as well as the conclusions.
PREREQUISITES
-
REFERENCE
-

COURSE	**Course Name: Advance topics in Network Design and Audit**
	Course Code : IF185911
	Credit : 3
	Semester : 1

DESCRIPTION OF COURSE
Student learns to analyze and design computer network with correct methodology and doing computer network audit.
GRADUATE LEARNING OUTCOMES
1. Mastering theory and application theory of architecture and network computer principles; 2. Able to model computer architecture and principles of operating system tasks to develop and manage network system with high performance, safety, and efficient;
COURSE LEARNING OUTCOME
• Students capable of analyzing and designing computer networks. • Student also capable of auditing existing computer networks with correct methodology.
MAIN SUBJECT

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 14 management, performance, security, and privacy architecture.
4. NETWORK DESIGN: Design concept, process concept, evaluation, network layout, metrics.

PREREQUISITES

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REFERENCE

McCabe, J.,"Network Analysis, Architecture, and Design 3rd Edition", Morgan Kauffman, 2007.

COURSE	**Course Name: Advance topics in Modeling and Simulation**
	Course Code : IF185921
	Credit : 3
	Semester : 1

DESCRIPTION OF COURSE

Modeling and simulation systems study aspects related to the modeling and simulation of simple problems, solve variations of problem that related to simple problems that contains various probability distributions and create alternative simulation models for the problems encountered.

GRADUATE LEARNING OUTCOMES

1. Mastering theory and application theory to solve computation problems by using linear and non linear optimization, modelling and simulation;
2. Able to model, analyze and develop solution of computation problems, and mathematical modelling through exact, stochastic, probabilistic, and numeric approaches effectively and efficiently;

COURSE LEARNING OUTCOME

1. Students capable to explain modeling concepts and modeling abstraction on the problems
2. Students capable to explain the relationship between modeling and simulation

3. Students capable to create simulation models of simple problems with a spreadsheet
4. Students capable to explain the role of probability distribution and visualization in modeling and simulation
5. Students capable to solve variations of problem related to simple problems that contain various probability distributions
6. Students capable to perform an output analysis
7. Students capable to compare the outputs of simulation models
8. Students capable to perform input modeling
9. Students capable to create simulation models using simulation tools
10. Students capable to create an alternative simulation model for the problem encountered
11. Students capable to analyze alternative simulation models for the problems encountered
12. Students capable to examine research papers on the topic of systems simulation and presents the results
13. Students capable to create an alternative simulation model for the problem encountered
14. Students study and understand the contemporary research topics in the field of systems simulation Students study and understand the contemporary research topics in the field of systems simulation

MAIN SUBJECT

1. Modeling and simulation concepts.
2. Problem solving with simulation, benefits of using simulation, linkage of modeling and simulation. Sample case.
3. Basic simulation with spreadsheets, Monte Carlo simulation. Sample case.
4. Statistical model in simulation. Sample case.
5. Steady-state simulation, Confidence interval with the desired accuracy
6. Output comparison of two simulations. Sample case.
7. Data Collection, identifying data distribution, estimating parameters, goodness-of-fit test. Sample case.
8. Creating model and simulation model execution using simulation tools
9. Create an alternative simulation model and compare it with the desired performance. Sample case.
10. Analyze simulation output and compare with desired performance. Sample case.
11. Research papers on the topic of simulation systems
12. Analyze simulation output and compare with desired performance

13. Research papers on the topic of systems simulation

PREREQUISITES

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REFERENCE

1. Banks, Jerry., John S Carson. Berry L Nelson. David M Nicol. “Discrete Event system Simulation”, 5th Edition. Pearson Education. 2010.
2. Law, Averill M., W David Kelton. “Simulation Modelling and Analysis”, 3rd Edition. McGraw Hill. New York. 2000.
3. Joko Lianto Buliali, “Dasar Pemodelan dan Simulasi Sistem”, ITSPress, Surabaya, 2013.
4. James R. Evans, David L. Olson (Author), “Introduction to Simulation and Risk Analysis”, McGraw-Hill, Ltd., 1998.

COURSE	**Course Name: Advance topics in Time series Data Analysis**
	Course Code : IF185922
	Credit : 3
	Semester : 2

DESCRIPTION OF COURSE

This course give knowledge and prespective to student about several problems representing time series form, and give knowledge about methods that are used to obtain optimal solution from those problems.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering theory and application theory for solving computational problems using linear and non-linear optimization as well as modeling and simulation;
2. Able to model, analyze and develop computational problem solving and mathematical modeling through exact, stochastic, probabilistic and numerical approaches effectively and efficiently;

COURSE LEARNING OUTCOMES

1. Students are able to understand the concept of time series problems;
2. Students are able to understand linear optimization problems;

3. Students are able to understand optimization problems without a limiting function;
4. Students are able to understand non-linear optimization problems.

MAIN SUBJECT

- Time Series and Forecasting Basics
- Linear Processes
- State Space Models
- Spectral Analysis
- Estimation Methods
- Nonlinear Time Series
- Prediction
- Nonstationary Processes
- Seasonality
- Time Series Regression
- Discussion of research papers on new methods in time series problems.

PREREQUISITES

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REFERENCES

1. Ratnadip Adhikari, Agrawal R. K., R. K. Agrawal, ***An Introductory Study on Time Series Modeling and Forecasting,*** Lambert Academic Publishing GmbH KG, 2013 - 76 pages;
2. Palma, Wilfredo, ***Time Series Analysis***, John Wiley & Sons, 2016;
3. Harya Widiputra, ***Multiple Time-Series Analysis and Modelling: An Adaptive Integrated Multi-Model Framework,*** Lambert Academic Publishing, 2012;

COURSE	**Course Name : Topics in** Human and Computer Interaction
	Course Code : IF185931
	Credit : 3 Credits
	Semester : 1

COURSE DESCRIPTION

This course is an introduction to research on the topic of Human and Computer Interaction (HCI). This course introduces the theories of human physiology and psychology, the principles of human-computer interaction, the user-focused

application development process, the stages of research in the HCI field, and the implementation of experimentation and evaluation in research in the HCI field. Through this course, students will have the opportunity to further explore research topics in thefield HCI.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering computer graphics application theory and theory including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions;
2. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;

COURSE LEARNING OUTCOMES

1. Students are able to report and discuss the latest research in the HCI field.
2. Students are able to understand the importance of human physiological and psychological factors and their effects on human and computer interactions.
3. Students are able to understand basic knowledge of interactions between humans and computers.
4. Students are able to apply HCI principles, guidelines, methodologies and techniques for user-centered software or information system development.
5. Students are able to conduct evaluation and usability studies on HCI.
6. Students are able to provide criticism on HCI designs belonging to other people or parties.

MAIN SUBJECT

1. Introduction to HCI and the history of the development of HCI research topics over time.
2. Assessment of aspects of human physiology and psychology (Human Factor) such as sensory, motor and cognitive characteristics in relation to HCI.
3. The study of the elements of interaction: display and control relations, mental models and metaphors, interaction errors.
4. User-focused application development process.
5. Introduction to the basic and stages of research in the HCI field: research methods, observation and measurement, validation, and evaluation.
6. Perancangan metodologi dan eksperimen pada penelitian di bidang HCI.

7. Evaluation and hypothesis testing in HCI research.
8. Writing research publications in the HCI field.

PREREQUISITES

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REFERENCES

5. MacKenzie, I. Scott. Human-computer interaction: An empirical research perspective. Newnes, 2012.
6. Alan Dix, Janet E. Finlay, Gregory D. Abowd, and Russell Beale. Human-Computer Interaction (3rd Edition). Prentice-Hall, Inc., Upper Saddle River, NJ, USA. 2003.
7. Lazar, Jonathan, Jinjuan Heidi Feng, and Harry Hochheiser. *Research methods in human-computer interaction*. John Wiley & Sons, 2010.

COURSE	**Course Name : Topics in Game Development, Virtual Reality and Augmentation Reality**
	Course Code : IF185932
	Kredit : 3 Credits
	Semester : 2

COURSE DESCRIPTION

In this course, students will discuss and learn about the history of game development and technology, get to know various popular games available and classifications based on genres and other classifications. The next stage will study and analyze how the game development process, *theory of* fun and educational value in games. Until the end of the lecture, students and their team will be able to implement simple educational game making. Virtual Reality studies aspects related to the development of virtual reality, augmented reality, and mixed reality. Understand the input and output elements present in virtual reality and optical modeling to produce stereoscopic views. Creating modeling and programming in virtual reality as well as 3-dimensional virtual reality applications using a game engine.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering computer graphics application theory and theory including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions;
2. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;

COURSE LEARNING OUTCOMES

- Students are able to analyze and classify games based on genre, theme and rating.
- Students are able to explain and analyze the educational value in a game.
- Students are able to form teams and make simple educational games.
- Students are able to understand advanced theories of Virtual Reality (VR) and Augmented Reality (AR).
- Students are able to create 3D VR and AR applications.

MAIN SUBJECT

Basic theory of game development, game development process, Game Design Document (GDD), game middleware, educational games, theory of fun

Introduction to Virtual Reality

1. History of the development of Virtual Reality
2. Benefits of Virtual Reality
3. General Virtual Reality Systems
4. Virtual environment

3D Computer Graphics

5. Transformation and 3D world, Object modeling, object dynamics
6. Physical Modeling: Constraints
7. Impact detection, Surface deformation
8. Perspective view
9. Stereoscopic vision

Perangkat keras VR

10. Input Device
11. Output Device

VR Software Device

12. Virtual environment construction
13. Graphics Rendering

14. Interaction in virtual environments
15. Collision Detection
16. Collision Response
17. The power of feedback
18. Haptic Interface

Human Factor

19. Sight and Appearance
20. Hearing and Touch

Health and Safety Issues

PREREQUISITES

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REFERENCES

1. Arnest Adam, "Fundamentals of Game Design", New Riders Press, 2nd Edition 2010
2. David Michael, "Serious Games, Games that Educate, Train and Inform", Thomson Course Tech, 2005
3. Grigore, C Burdea & Philippe, Coiffet, "Virtual Reality Technology", Wilye Interscience, 2003
4. William R. Sherman, Alan B.Craig, "Understanding Virtual Reality", Morgan-Kaufmann, Inc., 2003.
5. Theory of Fun for Game Design, Ralph Koster, 2nd Edition Nov 2013.
6. "Learning and Teaching with Computer Games", aace.org

COURSE	**Course Name : Topics in Computer Graphics**
	Course Code : IF185933
	Kredit : 3 credits
	Semester : 2

COURSE DESCRIPTION

Computer Graphics studies aspects related to the development of curve and surface modeling, Scattered-data approximation, curve and surface analysis and design, rendering, and animation.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering computer graphics application theory and theory including modeling, rendering, animation and visualization, as well as mastering the theory and application theory of human and computer interactions;
2. Able to model, analyze and develop applications using the principles of computer graphics including modeling, rendering, animation and visualization, as well as applying the principles of human and computer interaction and evaluating the efficiency of building applications with a suitable interface;

COURSE LEARNING OUTCOMES

Students are able to apply curve and surface models to various rendering techniques, visualization systems, animation techniques, and CAD systems.

MAIN SUBJECT

- Curve and surface modeling
- Scattered-data approximation
- The model for the design analysis of curves and surfaces
- Rendering technique
- Animation technique.

PRASYARAT

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PUSTAKA

1. Computer Animation: Algorithms and Techniques. Rick Parent, Morgan Kaufmann, Third edition 2012
2. G. Farin, *Curves and Surfaces for CAGD,* Academic Press, 1997.
3. FS Hill Jr, "*Computer Graphics using OpenGL".*
4. Proceeding of ACM SIGGRAPH.

COURSE	**Course Name : Topic in Multimedia Network**
	Course Code : IF185941
	Kredit : 3 credits
	Semester : 1

COURSE DESCRIPTION

This course discusses multimedia data and its format, along with data security methods: cryptography, steganography and watermarking. In addition, it also discusses data compression and the latest technology in multimedia networks.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;
2. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

Students are able to understand the concept of multimedia networks, both in the form of text, image, audio and video data, in terms of network and security. Based on these concepts, students are able to develop them further, either individually or in groups in teams.

MAIN SUBJECT

1. Visual data format: DCT and wavelet based systems.
2. Data security basics: cryptography, steganography, watermarking.
3. Compression of multimedia data.

PREREQUISITES

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REFERENCES

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)

COURSE	**Course Name : Topics in Distributed Systems**
	Course Code : IF185942
	Kredit : 3 credits
	Semester : 1

COURSE DESCRIPTION

Topics in distributed systems study aspects related to the development and management of distributed systems. This includes basic issues in distributed systems for example, replication, fault tolerance, consistency, scalability, isolation, privacy, and so on. Technical aspects related to distributed system development are also the study of this subject, for examplecommunication direct / indirect, middleware, programming, distributed system security, and so on. In this course, current research issues in the development and management of distributed systems are also studied.

LEARNING OUTCOMES OF THE SUPPORTED PROGRAM

1. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;
2. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

Students are able to design, develop and analyze distributed systems with limitations and constraints that arise in realizing the goals of developing the system.

MAIN SUBJECT

- Introduction to distributed systems, concepts, goals, and limitations
- *Interprocess Communication: message passing, remote procedure call, distributed object and naming*

- Based programming distributed systems: *socket* UDP / TCP and the use of *middleware*
- *Indirect communication (publish subscribe and tuple space)*
- *Middleware for distributed systems (middleware for publish subscribe, map reduce, peer to peer, and message queue)*
- Concepts, standards and *middleware* on a *multi-agent* and *mobile agent*
- *Distributed file systems and examples of application*
- Topics of research in mobile computing, pervasive computing,computing, *ubiquitous*and cloud computing
- Research issues in distributed systems (*load balancing*, load estimation, load migration, and *big data*)

PREREQUISITES

Net-Centric Computing

REFERENCE

1. Coulouris, G., Dollimore, J., Kindberg, T., Blair, G., "Distributed Systems: Concepts and Design 5th Edition", Addison-Wesley, 2011
2. Varela, C.A., "Programming Distributed Computing Systems: A Foundational Approach", The MIT Press, 2013

COURSE	**Course Name : Topics In Digital Forensics**
	Course Code : IF185943
	Kredit : 3 credits
	Semester : 1

COURSE DESCRIPTION

Digital Forensics studies the concept of digital forensics, both computer forensics and network forensics.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;

2. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

Students are able to understand the concept of digital forensics, both computer forensics and network forensics. Based on these concepts, students are able to develop them further, and carry out evaluations, both individually and in groups in teams.

MAIN SUBJECT

- Digital proof concept: real proof, best evidence, direct evidence, digital proof.
- Forensic investigation methodology: obtaining information, strategizing, gathering evidence, analysis, reporting.
- The collection of evidence: physical tapping (cable, radio frequency, etc.), software to get the data (tcpdump, wireshark, etc.)
- File concept: file signature, forensic imaging, file allocation table (FAT), NTFS, volume, partition.
- Technical basics: packet analysis, flow analysis, network-based evidence sources (firewalls, proxies, routers, switches, server logs etc.)

PREREQUISITES

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REFERENCES

1. Cyber Forensics: From Data to Digital Evidence (Wiley Corporate F&A) by Albert J. Marcella Jr. and Frederic Guillossou (May 1, 2012).
2. Network Forensics: Tracking Hackers through Cyberspace by Sherri Davidoff and Jonathan Ham (Jun 23, 2012).
3. Introduction to Security and Network Forensics by William J. Buchanan (Jun 6, 2011).
4. Digital Forensics and Cyber Crime: 4th International Conference, ICDF2C 2012, Lafayette, IN, USA, October 25-26... by Marcus K. Rogers and Kathryn C. Seigfried-Spellar (Oct 7, 2013)
5. Digital Forensics with Open Source Tools by Cory Altheide and Harlan Carvey (Apr 28, 2011).

COURSE	Course Name : Topics in Network Security
	Course Code : IF185944
	Kredit : 3 credits
	Semester : 2

COURSE DESCRIPTION

This course discusses the concept of network security. Included in this is the basic computer security, several methods of attack and anticipation

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;
2. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

Students are able to understand the concept of network security. Based on these concepts, students are able to develop them further, either individually or in groups in teams.

MAIN SUBJECT

1. The basic concept of computer security, information system security, software security; Security properties: confidentiality, integrity, availability, authenticity, non-repudiation, scalability.
2. DDOS, session management, SQL injection, XSS, cookies
3. Symmetric and asymmetric methods; classical and modern encryption theories and examples, blocks and streams; use of substitution, transposition
4. Data security methods: hash function, steganography, MAC, digital signature.
5. Authentication method: password, token, fingerprint; principle of remote authentication; use of symmetric and asymmetric encryption for remote authentication; protocol: kerberos; federated identity
6. IDS, IPS, firewall types and characteristics
7. Use of VPN, IDS, firewall, honeypot

PREREQUISITES

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REFERENCES

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 fingerprint by Martin Drahansky (May 23, 2010).
4. Information Security The Complete Reference, Second Edition by Mark Rhodes-Ousley (Apr 3, 2013).

COURSE	**Course Name : Topics in Mobile Computing**
	Course Code : IF185945
	Kredit : 3 credits
	Semester : 2

COURSE DESCRIPTION

This course studies and analyzes issues related to system development in a mobile computing environment by understanding the characteristics of the environment and the infrastructure in which the system is located, moves, or interacts. This course also studies supporting technology and methodologies to solve related problems so that the objectives of system development are achieved.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;
2. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

Students are able to analyze, synthesize concepts, and be able to build systems that run in a mobile computing environment with an understanding of technology and related methodologies that support the development of these systems.

MAIN SUBJECT

1. Wireless network technology and its limitations.
2. Characteristics and dimensions of systems that work in a mobile environment.
3. Modeling and characteristics of mobility in a mobile environment.
4. Location management by systems that work in a mobile environment.
5. Ad hoc and delay tolerant network and their limitations, routing, and its advantages.
6. Recent issues related to mobile information access, application adaptation related to location, energy, and availability of resources.
7. Development of Spontaneous Networking, mobile peer-to-peer, and its applications.
8. Various research topics in mobile computing.

PREREQUISITES

Net-Centric Computing

PUSTAKA

1. Ilyas, M., Mahgoub, I., "Mobile Computing Handbook", Auerbach, 2005
2. B'Far, R., "Mobile Computing Principles Designing and Developing Mobile Applications With UML and XML", Cambridge University Press, 2005
3. Steinmetz, R., Wehrle, K., "Peer-to-Peer Systems and Application", Springer, 2005
4. Mukherjee, A., Bandyopadhyay, S., Saha,D., "Location Management and Routing in Mobile Wireless Networks", Artech House Publisher, 2003
5. Helal, A.A., Haskell, B., Carter, J.L., Brice, R., Woelk, D., Rusinkiewicz, M., "Anytime, Anywhere Computing: Mobile Computing Concepts and Technology", Springer, 1999
6. IEEE Transaction of Mobile Computing, IEEE
7. Pervasive and Mobile Computing, Elsevier

COURSE	**Course Name : Topics in Cloud Computing**

	Course Code : IF185946
	Kredit : 3 credits
	Semester : 2

COURSE DESCRIPTION

Cloud computing is a new paradigm in the information technology industry. Cloud computing technology is user-oriented in terms of services, providing computing resources in a transparent manner. This course will discuss the basics and introduction of cloud technology, its mechanisms, and architecture along with the latest technology and research in cloud computing.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security;
2. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

1. Students are able to explain and arrange knowledge in the field of cloud computing in terms of concepts, theories, and terms in various kinds of supporting technologies.
2. Students are able to provide critical assessments of challenges and opportunities in Cloud Computing technology and its supporters.
3. Students are able to conduct and analyze and assess Cloud Computing technology and its supporters to be applied in new / different fields.
4. Students are able to plan / find a scientific solution to solve problems / challenges / problems in the field of cloud computing technology.

MAIN SUBJECT

Fundamentals introduction to cloud computing, security mechanisms and handling of cloud computing, architecture and delivery models in cloud computing, cloud computing supporting technologies, cases in cloud computing and their implementation. management on systems and service quality in cloud computing.

PREREQUISITES

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REFERENCES
• Thomas Erl et al, "Cloud Computing, Concepts, Technology. And Architecture". Prentice Hall. • Hill et al, "Guide to Cloud Computing, Principles and Practice". Springer. • George Coulouris, Distributed Systems, Concepts and Design 3rd edition Addison-Wesley, 2001 • Tanenbaum wet all, "Distributed Systems. Principles and Paradigms", Prentice Hall. • IEEE Transactions on Mobile Computing, IEEE • IEEE Transactions on Cloud Computing, IEEE • IEEE Transactions on Services Computing, IEEE • IEEE Transactions on Parallel & Distributed Systems, IEEE

COURSE	**Course Name : Topics in Wireless Network**
	Course Code : IF185947
	Kredit : 3 credits
	Semester : 2

COURSE DESCRIPTION
This course explains issues related to Wireless Networks, identifies and analyzes limitations and finds solutions, and discusses the development trends of Wireless Networks.
GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE
1. Mastering the theory and application theory of network-based computing and the latest technology related to it, in the field of distributed computing and mobile computing, multimedia computing, high-performance computing and information and network security; 2. Able to develop network-based computing concepts, parallel computing, distributed computing to analyze and design computational problem-solving algorithms in various fields and scientific disciplines;
COURSE LEARNING OUTCOMES
1. Students are able to identify issues related to Wireless Networks: challenges, limitations and developments. 2. Students are able to analyze existing limitations to find solutions. 3. Students are able to search and analyze several topics in wireless networks.

4. Students are able to write scientific papers that can be submitted at seminars or as a thesis proposal.

MAIN SUBJECT

1. **Mobile and Wireless Systems Challenges:** Evolution of telecommunication, computing, and mobile / wireless systems, models of mobile computing, Mobile and wireless systems, Challenges & problems: low power, variable bandwidth, mobility, security.
2. **Wireless Channel:** Allocation of radio spectrum and characteristics to different frequencies. Simple wireless channel model: propagation, path loss, multipath fading, interference source, packet radio link model, radio channel incapacity coping techniques: channel coding, equalization, diversity, smart antennas.
3. **Sharing Wireless Link**: Channels are shared on the dimensions of time, frequency and code, Static multiple access techniques: TDMA, FDMA, CDMA, Spread spectrum - direct sequence, frequency hopping, interference resistance, Packet-oriented MAC, hidden terminal, exposed terminal, random -access MAC: MACA, MACAW, CSMA / CA 802.11 DCFS mode, Controlled-access MAC: 802.11 PCFS mode, Bluetooth.
4. **Ad Hoc Wireless Networks - MANET**: Wireless ad hoc networks, Classes of Wireless Ad Hoc Networks, Unicast Routing in MANET, Various MANET routing schemes: flooding, Dynamic Source Routing (DSR), Location Aided Routing (LAR), etc.
5. **Sensor Network**: Networked Sensor: Centralized & Distributed Approach, Sensor Network Characteristics, Sensor Protokol.

PREREQUISITES

Net-Centric Computing

REFERENCES

- Tse, D. & Viswanath, P., Fundamentals of Wireless Communication; Cambridge University Press, 2005.
- Rappaport, Theodore S., Wireless Communications: Principles And Practice; Prentice Hall, 1995.
- Kasera, S. & Narang, N., 3G Mobile Networks; McGraw-Hill, 2005.
- Jurnal, Majalah, Proceeding di berbagai sumber.

Course	**Course Name : Topics in Data Mining**
	Course Code : IF185951
	Kredit : 3 credits
	Semester : 1

COURSE DESCRIPTION

In this course, students learn about concepts, basic techniques, and general data mining, including cleaning data from noise, outliers, and duplication; data transformation including smoothing, normalization, and feature formation; data exploration and visualization; classification methods,handling imbalaced data, association rules mining; techniques clustering; and recommendation system application. As well as studying and applying data mining techniques on a variety of data types eg, text mining, multimedia mining database, data time seriesmining,mining, sequential data and mining data streams.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Students are able to master the theory and theory of intelligent systems applications which include representation and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as the development of smart applications in various fields, and master the concepts and principles of computational science including information management, multimedia data processing, and numerical analysis;
2. Able to develop applications by applying the principles of intelligent systems and computational science to produce smart application products in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

1. Students are able to preprocess, explore and visualize data.
2. Students are able to understand the basic techniques and general data mining.
3. Students are able to apply data mining techniques in a variety of types of data on the real problems.
4. Students are able to examine some of the articles published in international publications on data mining

MAIN SUBJECT

1. Introduction to data mining, data mining tasks, data mining processes, data mining applications, data definition, types of attributes in data, variations in data types.
2. Data preprocessing

- data quality: related to noise, outliers, missing values, and data duplication.
- data cleaning:handling techniques noise, identification and removal of outliers, imputation techniques.
- Data transformation: smoothing, normalization, aggregation, formation of features or attributes, and generalization
- data reduction: dimension reduction (pca, svd, lda), feature selection (filter, wrapper, hybrid), data sampling.
- discretization of data: binning, entropy-based

3. Data exploration and visualization
   - Statistical methods: the frequency or mode, percentile, mean and median, range and variance
   - visualization: histogram, box plot, scatter plot, contour plot, star plot, Chernoff face, with examples of application to dataset
4. Classification: classification methods (Nave Bayes, Decision Tree, SVM, Method Ensemble: Bagging, Boosting, Random Forest)
5. Handling of imbalanced data: undersampling, oversampling, SMOTE algorithm
6. Association rules: concept of association rules, frequent itemset, a algorithm priori, closed itemset, FP-algorithm growth, rule generation, mining with multiple minimum support
7. Clustering: jenis clustering, tipe-tipe klaster, algoritma clustering (Hierarchical-based, Density-based, Graph-based), validitas klaster, dan cara mengukurnya.
8. Recommender systems and collaborative filtering: recommendation system concept, recommendation types, content-based recommendations, techniques collaborative filtering.
9. Mining multimedia data: definition of multimedia data, CBIR, and application examples
10. Mining time series and sequential data: definition ofdata time series and sequential, trend analysis, similarity analysis and some application examples
11. Mining data stream: data stream definition , model, and application examples; dataextraction techniques stream (sliding window, counting bits, DGIM)

PREREQUISITES

Computational intelligence

REFERENCES

1. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education (Addison Wesley), 2006.
2. Jiawei Han and Micheline Kamber, "Data mining: Concepts and Techniques", Morgan Kaufmann Publishers, 2011.
3. Anand Rajaram, Jure Leskovec and Jeff Ullman, "Mining of Massive Data Sets", Cambridge University Press, 2011.
4. Ian H. Witten, Eibe Frank and M. Hall Morgan Kaufmann, "Data mining - practical machine learning tools and techniques with Java implementations", 3rd edition, 2011
5. Artikel dalam jurnal IEEE Transactions on Knowledge and Data Engineering, IEEE Computer Society.
6. Artikel dalam jurnal ACM Transactions on Knowledge Discovery from Data, ACM Society.

COURSE	**Course Name : Topics in Information Retrieval Systems**
	Course Code : IF185952
	Kredit : 3 credits
	Semester : 1

COURSE DESCRIPTION

In this course students will learn about various text data processing techniques to retrieve information in text-form data. Students are expected to be able to design, analyze and apply information retrieval system methods to real problems and raise them in a study with a multidisciplinary approach either independently or teamwork.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Students are able to master the theory and theory of intelligent systems applications which include representation and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as the development of intelligent applications in various fields, and master the concepts and principles of computational science including information management, multimedia data processing, and numerical analysis;
2. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

1. Students are able to explain various concepts, theories, terms in various models of information retrieval systems and their applications
2. Students are able to implement problem solving techniques such as indexing, searching, query processing in the need of information retrieval
3. Students are able to create a search engine for information extraction as an example of simple implementation and categorize results for easy visualization
4. Students are able to analyze the need for information grouping for easy retrieval using classification or clustering techniques
5. Students are able to apply one of the choice of information retrieval techniques such as Latent Semantic Indexing, social data analysis, text summarization, user recommendations / profiles as a result of paper analysis from related research.

MAIN SUBJECT

Retrieval model with boolean, vector space, probabilistic, Lucene library, performance evaluation, relevance feedback, web search, classifying and clustering, applications: image-based retrieval, latent semantic indexing, recommendation system, information extraction.

PREREQUISITES

Kecerdasan Komputasional

REFERENCES

1. Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The Concepts and Technology behind Search 2nd Ed", Addison-Wesley, New Jersey, 2011
2. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2008
3. IEEE Transactions on Knowledge & Data Engineering
4. ACM Transactions on Asian Language Information Processing
5. ACM Transactions on Knowledge Discovery from Data
6. Special Interest Group on Information Retrieval

COURSE	**Course Name : Topics in Digital Image Processing**

	Course Code : IF185953
	Kredit : 3 credits
	Semester : 2

COURSE DESCRIPTION

1. Students learn digital image preprocessing such as contrast improvement, equalization of illumination, removal of reflections, and noise.`
2. Students learn Fourier transform, FFT, wavelet, and Hough transform.
3. Students learn image filtering in the frequency domain, the image restoration process to improve visually degraded images or geometric image registration and the zooming process.
4. Students apply digital image preprocessing and image processing in the frequency and wavelet domains, and analyze related research results.
5. Students learn segmentation using various methods, both based on margins, threshold values, and regions.
6. Students learn a variety of feature extraction methods to be used as feature vectors in pattern classification.
7. Students learn classification methods with artificial neural networks, clustering, neurofuzzy, Bayesian.
8. Students apply digital image feature extraction and classification and analyze related research results.

GRADUATE LEARNING OUTCOMES CHARGED FOR COURSE

1. Students are able to master the theory and theory of intelligent systems applications which include representation and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as the development of intelligent applications in various fields, and master the concepts and principles of computational science including information management, multimedia data processing, and numerical analysis;
2. Able to develop applications by applying the principles of smart systems and computational science to produce smart application products in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

Students are able to apply digital image classification starting from pre-process and analyze related research results, both with individual performance and in teamwork.

SUBJECT

1. DIGITAL IMAGE PRAPROCESS: contrast enhancement, equalization of illumination, elimination of reflections and noise..
2. IMAGE TRANSFORMATION: Fourier transform, wavelet, Hough transform..
3. IMAGE FILTERING IN DOMAIN FREQUENCY AND RESTORATION PROCESSES.
4. APPLICATION OF DIGITAL IMAGE PROCESSES AND PAPER ANALYSIS OF RELATED RESEARCH RESULTS.
5. SEGMENTATION METHODS WITH VARIOUS METHODS: methods based on margins, threshold values, and areas.
6. EXTRACTION METHOD FEATURES: boundary descriptor, Fourier descriptor, topological descriptor, moment, texture.
7. CLASSIFICATION METHOD: artificial neural network, clustering, neurofuzzy, Bayesian.
8. pplication of digital image feature extraction and classification, analysis of papers from related research.
9. Application of digital image classification model in group project.
10. Analysis of the results of applying and improving the model.

PREREQUISITE

Computational Intelligence

REFERENCES

1. Gonzales, R.C., and Woods, R. E., "Digital Image Processing", Prentice Hall,2008
2. Pratt,W.K., "Digital Image Processing", John Wiley & Sons, Inc., 2007
3. Journal: a. IEEE Transactions on Pattern Analysis and Machine Intelligence
   b. Medical Image Analysis, www.sciencedirect.com
   c. IEEE Transactions on Medical Imaging
4. Forsyth, David A., and Ponce, Jean, "Computer Vision: A Modern Approach", 2nd Ed., Pearson Education, Inc.,2012
5. Petrou, Maria, and Petrou, Costas, "Image Processing: The Fundamentals", John Wiley & Sons Ltd, 2010
6. Costaridou, Lena (Ed.), "Medical Image Analysis Methods", Taylor & Francis Group, 2005
7. Russ, John C., "The Image Processing Handbook", fifth edition, CRC Press, 2007.

COURSES	Course Name : Topics In Computer Vision
	Course Code : IF185954
	Credit : 3
	Semester : 2

COURSES DESCRIPTION

This course discusses comprehensive knowledge of computer vision (computer vision). Topic areas covered include image processing, physics concepts in image formation, geometry (tracking and reconstruction), and statistical methods for detection and classification. In addition, students will also explore advanced topics in the field of computer vision through the study of related papers..

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Students are able to master the theory and theory of intelligent system application which includes representation and reasoning techniques, search techniques, intelligent agents, data mining, and machine learning, as well as the development of smart applications in various fields, and master the concepts and principles of computational science including management. information, multimedia data processing, and numerical analysis;;
2. Able to develop applications by applying the principles of intelligent systems and computational science to produce smart application products in various fields and scientific disciplines;

COURSE LEARNING OUTCOMES

1. Students are able to analyze the concept of digital image processing for real problems.
2. Students are able to analyze geometric concepts to solve tracking and reconstruction problems.
3. Students are able to analyze statistical methods for object recognition.
4. Students are able to do independent research on certain topics, write research reports with a small scope, and present them orally.
5. Students are able to criticize various methods to solve computer vision problems.

SUBJECT

1. Image Processing: Pyramid Image, Edge Detection, Hough Transform.
2. Physics Based Vision: Appearance and BRDF, Photometric Stereo, Shape from Shading, Direct and Indirect Illumination.
3. Tracking and Reconstruction: Image Formation and Projection Geometry, Optical Flow, Image Alignment and Tracking, Binocular Stereo, Structured Light Range Imaging, Photo-tourism and Internet Stereo.
4. Statistical methods: Principal Component Analysis, Feature Detection (BLOB and SIFT), classification.
5. Recent Researches: Image Based Rendering, Open Challenges in Computer Vision.

PREREQUISITE

Computational Intelligence

REFERENCES

1. David A. Forsyth dan Jean Ponce, "Computer Vision: A Modern Approach, 2nd Edition", Prentice Hall, 2012.
2. Christian Wöhler, "3D Computer Vision: Efficient Methods and Applications", Springer-Verlag, Berlin Heidelberg, 2009.
3. Francisco Escolano, Pablo Suau, Boyán Bonev, "Information Theory in Computer Vision and Pattern Recognition", Springer Verlag, London, 2009.
4. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer-Verlag, London, 2011.

COURSES	**Course Name : Topics in System Audit**
	Course Code : IF185961
	Credit : 3
	Semester : 1

COURSES DESCRIPTION

Topics in System Audit System audit studies the concept of information technology auditing and the function of control procedures. This lecture discusses the understanding of information control procedures, various types of control procedures and their effects on organizations, as well as how to manage control

procedures and audit them. The lecture also studied planning and activities carried out to determine the effectiveness of an implementation by means of investigation, testing, evaluation of the maturity and appropriateness of standard procedures and regulations that apply in information technology governance.

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;
2. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective information access;

COURSE LEARNING OUTCOMES

1. Students are able to understand the role and objectives of information technology audits
2. Students are able to build an audit process that suits enterprise requirements
3. Students are able to identify process and information risks related to confidentiality, integrity and availability
4. Students are able to design and implement procedures and control measures to manage risk effectively.
5. Students are able to make recommendations for improving system performance by referring to best practice examples, standards and regulations on information technology governance.
6. Students are able to build disaster recovery and business continuity plans.

SUBJECT

Planning and audit activities. Methods of investigation, testing, evaluation of maturity and appropriateness against standard procedures and applicable documents. Recommendations for improving the effectiveness of risk management, control and system governance processes.

PREREQUISITE

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REFERENCES

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. Simha R. Magal, Integrated Business Processes with ERP Systems, John Wiley & Sons, Inc., 2012
4. Riyanarto Sarno & Irsyat Iffano, Sistem Manajemen Keamanan Informasi, ITS Press, 2009.
5. ISO, Information Technology – Security Techniques – Information Security Management Systems ISO/IEC 27001:2005, Switzerland, 2005.
6. ISACA, The IT Governance Institute, COBIT 5, USA, 2012.

COURSES	**Course Name : Topics In Knowledge Based Systems Engineering**
	Course Code : IF185962
	Credit : 3
	Semester : 2

COURSES DESCRIPTION

This course studies the concepts and stages in knowledge engineering, knowledge representation from real problem analysis into the scope of knowledge engineering, model design, implementation of knowledge engineering to computer systems either independently or in teamwork, and explores the renewal of the topics. related and able to define research topics in the field of knowledge engineering.

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Mastering theory and application theory for the development of the process of gathering, processing and storing information in various forms;
2. Able to develop techniques and algorithms for collecting, digitizing, representing, transforming, and presenting information, for efficient and effective information access;

COURSE LEARNING OUTCOMES

1. Able to understand the use of basic theories and techniques introduced within the scope of knowledge engineering so that they can be applied to real problems..
2. Able to analyze data and information to define a knowledge-based model of a computer system. Students are able to implement model designs in a computer system that manages knowledge.
3. Able to work together in solving real problems related to knowledge engineering from analysis to implementation.

4. Able to explore research topics in the field of knowledge engineering..
5. Able to define topics or research ideas in the field of knowledge engineering.

SUBJECT

- **Introduction to Knowledge Engineering:** Data, information and knowledge, knowledge gaining techniques, knowledge modeling techniques.
- **Knowledge Acquisition**: definition of knowledge acquisition, methods and techniques for knowledge acquisition, recent research in knowledge acquisition.
- **Knowledge validation:** definitions, parameters and processes of validation measurement, techniques and methods of validation of knowledge and current research in knowledge validation.
- **Knowledge** Representation: definitions, knowledge engineering processes, techniques in knowledge engineering, and current research related to knowledge representation.
- **Inference, Explanation & Justification**
- **Semantic Web:** semantic web roadmap, ontology and knowledge representation on semantic web, semantic web education.
- **Discussion of papers with related topics**

PREREQUISITE

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REFERENCES

1. Simon Kendal and Malcolm Creen, *an Introduction to Knowledge Engineering*, Springer, 2006.
2. R.J. Brachman and H.J. Levesque, *Knowledge Representation and Reasoning*, Elsevier 2004. (chapter 1-7)
3. Segaran, Evans, and Taylor, *Programming the Semantic Web*, O'Reilly, 2009.
4. P. Jackson, *Introduction to Expert Systems*, Addison-Wesley, 1999.
5. Jeffrey T Pollock, *Semantic Web for Dummies*, Wiley Publishing, Inc., 2009.
6. Devedziq, Vladan, *Semantic Web and Education (Integration Series in Information System)*, Springer-Verlag, 2006.
7. Makalah-makalah terkait akan diberikan kemudian di kelas.

COURSES	Course Name : Topics In Software Evolution
	Course Code : IF185971
	Credit : 3
	Semester : 1

COURSES DESCRIPTION

In this course, students will learn about definitions and activities in the field of software evolution, as well as techniques in doing them. At the end of the lecture, students are expected to be able to bring up new thesis topics in the field of software evolution.

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are efficient in software development..
2. Able to model, analyze and develop software using the principles of software engineering processes to produce software that meets both technical and managerial quality;

COURSE LEARNING OUTCOMES

1. Able to explain the definition and activities in the field of software evolution.
2. Able to explain the definition, method and application of cloning in software evolution.
3. Able to explain the definition, method, and application of software repositories in software evolution.
4. Able to explain the definition, method, and application of error prediction from history and software development logs..
5. Able to explain the definition, method, and object-oriented reengineering application.
6. Able to come up with new thesis topics in the field of software evolution.

SUBJECT

1. Roadmap of software evolution, equations and differences with PL care, research topics in ot evolution
2. Introduction to cloning, cloning types, cloning sources, cloning evolution, cloning management, cloning detection, cloning presentations, cloning algorithms, and the latest developments on cloning.
3. Introduction to software repositories, analysis of software repositories, release history, analysis software evolution, tools to help software repositories.
4. Analysis algorithms software repository.
5. Introduction to prediction of errors, causes of defect-prones in PL, PL metrics, error prediction techniques, code churn, issues that are still open and relevant to be discussed, threats to validity.
6. Object-oriented reengineering: refactoring.
7. Software reengineering success and failure factors.
8. Current research topics such as Software re-engineering patterns.
9. Exploration and development of research topics.

PREREQUISITE

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REFERENCES

1. Tom Mens dan Serge Demeyer, *Software Evolution*, Springer-Verlag, Berlin, 2008.
2. Nazim H. Madhavji, Juan Fernandez-Ramil, dan Dewayne Perry, *Software Evolution and Feedback: Theory and Practice*, John Wiley & Sons, England, 2006.
3. M. M. Lehman, *Program* Evolution, Academic Press, London, 1985.
4. M. M. Lehman, *The Programming Process*, IBM Res. Rep. RC 2722, IBM Research Centre, Yorktown Heights, NY 10594, Sept. 1969.
5. M. M. Lehman & L. A. Belady, *Program Evolution – processes of software change,* Academic Press, London, 1985.

COURSES	**Course Name : Topics In Software Project Management**
	Course Code : IF185972
	Credit : 3 sks
	Semester : 2

Course Description

Topics in Software Project Management include 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 about project management, identify new problems and define solutions based on the methodology studied. Learning is also carried out in the laboratory and in the field to experiment with the solutions offered. Students are invited to write problem identification, proposed solutions and experimental results in a paper that can be published in seminars and journals.

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are efficient in software development..
2. Able to model, analyze and develop software using the principles of software engineering processes to produce software that meets both technical and managerial quality;

COURSE LEARNING OUTCOMES

- Students know and understand the activities in the software project management life cycle
- Students know the latest research topics on software project management
- Students are able to identify current problems in software project management topics.
- Students are able to identify and propose solutions to problems in the previous points in the form of scientific writing
- Students are able to present and present problems and solutions proposed in scientific forums in class
- Students are able to conduct experiments based on the methodology produced and are able to present the results obtained in scientific writing

- Students are able to write scientific papers to present problems, solutions, experiments, results and discussion of the results of topics that have been selected and studied.

SUBJECT

- Initiation and definition of software project scope: determination and negotiation of requirements, feasibility analysis, process for reviewing and revising requirements
- Software project planning; process planning, determining deliverables, effort, schedule and cost estimation, resource allocation, risk management, quality management, planning management
- Software project enactment: implementation of plans, management of PL acquisition and supplier contracts, implementation of measurement processes, process monitoring, process control, reporting
- Evaluation and review of Software projects; determine satisfaction of needs, review and evaluate performance
- Completion of software projects; determine closure, project closure activities
- Software engineering measurements; establish and sustain measurement commitment, plan the measurement process, assess the measurement process, evaluate measurement
- Tool to assist software project management

PREREQUISITE

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REFERENCES

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, Soft ware Extension to the PMBOK® Guide Fifth Edition, Project Management Institute, 2013.
3. R.E. Fairley, Managing and Leading Soft ware Projects, Wiley-IEEE Computer Society Press, 2009.
4. Sommerville, Soft ware Engineering, 9th ed., Addison-Wesley, 2011.
5. B. Boehm and R. Turner, Balancing Agility and Discipline: A Guide for the Perplexed, Addison-Wesley, 2003.

COURSES	Course Name : Topics in Requirements Engineering
	Course Code : IF185973
	Credit : 3
	Semester : 2

COURSES DESCRIPTION

Requirements engineering studies related aspects of approaches, methods, frameworks, and requirements engineering tools that can solve certain real problems..

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are efficient in software development..
2. Able to model, analyze and develop software using the principles of software engineering processes to produce software that meets both technical and managerial quality;

COURSE LEARNING OUTCOMES

Students are able to develop approaches, methods, frameworks, and needs engineering tools that can solve certain real problems.

SUBJECT

Dalam Matakuliah ini mahasiswa akan mempelajari SUBJECT-SUBJECT sebagai berikut:

1. CONCEPTS AND PRINCIPLES OF ENGINEERING NEEDS OF SOFTWARE: the concept of requirements engineering, functional / non-functional requirements, types of stakeholders,
2. ELICITATION: methods, approaches, frameworks, and needs elicitation technology, as well as current issues and research
3. MODELING: methods, models, assistive tools and technology for modeling needs, as well as current issues and research
4. SPECIFICATIONS: methods, models, assistive tools, and technology requirements specification, as well as current issues and research

5. VERIFICATION AND VALIDATION OF REQUIREMENTS SPECIFICATION: methods, models, assistive tools, and verification and validation technologies for needs, as well as current issues and research.

PREREQUISITE

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REFERENCES

1. Daniel Siahaan, "Rekayasa Kebutuhan, "Penerbit Andi, 2012.
2. Artikel dari Jurnal dan Konferensi di bidang Rekayasa Kebutuhan Perangkat Lunak
3. Materi dan bahan bacaan yang diberikan di kelas.

COURSES	**Course Name : Topics In Software Quality Assurance**
	Course Code : IF185974
	Credit : 3 sks
	Semester : 2

COURSES DESCRIPTION

The purpose of this course is to provide knowledge to students about the concept of quality, characteristics, and value of software, as well as its application to software that is being developed or maintained. The important concept is that the software requirement will determine the quality attributes of the software. Software requirements determine the quality measurement method and acceptance criteria to conclude the predetermined level of software quality level attainment.

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Mastering theory and application theory in software design and development with standard and scientific methods of planning, requirements engineering, designing, implementing, testing, and launching, to produce software products that meet various technical and managerial quality parameters, and are efficient in software development..
2. Able to model, analyze and develop software using the principles of software engineering processes to produce software that meets both technical and managerial quality;;

COURSE LEARNING OUTCOMES

1. Be able to find and identify current issues in at least one of the areas of software quality management: testing, standards, metrics, error estimation, etc.
2. Able to find and identify problems that still exist / arise and are still developing in one of these areas.
3. Able to formulate core problems in one of the selected domains, and write hypotheses to describe the proposed solutions.
4. Able to formulate a solution description in a conceptual framework that represents a complete range of solutions.
5. Able to describe the conceptual framework into components / subsystems that can be implemented.
6. Able to implement components / subsystems into a system that can be tested and measured the results / correctness, as a preliminary experimental tool.
7. Able to determine the dataset that will be used in the initial experimental process in the solution system.
8. Able to perform initial testing to support predetermined hypotheses, using a prepared dataset.
9. Able to analyze initial test results.
10. Able to discuss the results of the analysis of the initial test in the form of critical discussions that lead to initial conclusions..
11. Able to formulate and conclude the results of preliminary experiments on proposed solutions in the form of scientific articles.
12. Able to publish scientific articles (hypothetical articles / position papers) in at least national conferences or national journals.

SUBJECT

- The basics of quality software
    - Software ethics and culture
    - Value and cost of software quality
    - Model characteristics and software quality
    - Software quality improvement
    - Aspects related to software security (safety)
- Software quality management process
    - Quality assurance
    - Verification and validation
    - Audits and reviews
- Practical consideration of software quality
    - Software quality requirements
    - Characterization of defects (defects)

- SQM technique (software quality management)
- Measurement of software quality

- Tool to assist software quality
- Measurement standards and software quality
- Software quality metrics
- Software quality costs and cost estimates
- S oftware quality enhancements
- Other topics relevant to software quality assurance.

PREREQUISITE

Minimum score of C in the Software Engineering course

REFERENCES

1. S. Naik and P. Tripathy, Software Testing and Quality Assurance: Theory and Practice, Wiley-Spektrum, 2008.
2. S.H. Kan, Metrics and Models in Software Quality Engineering, 2nd ed., Addison-Wesley, 2002.
3. D. Galin, Software Quality Assurance: From Theory to Implementation, Pearson Education Limited, 2004.
4. J.W. Moore, *The Road Map to Software Engineering: A Standards-Based Guide*, Wiley-IEEE Computer Society Press, 2006.
5. *IEEE Std. 12207-2008 (a.k.a. ISO/IEC 12207:2008) Standard for Systems and Software Engineering—Software Life Cycle Processes*, IEEE, 2008.
6. *ISO 9000:2005 Quality Management Systems—Fundamentals and Vocabulary*, ISO, 2005.
7. *IEEE Std. 1012-2012 Standard for Systemand Software Verification and Validation*, IEEE, 2012.
8. *IEEE Std. 1028-2008, Software Reviews and Audits*, IEEE, 2008.
9. Artikel-artikel tentang Kualitas Perangkat Lunak terbaru pada IEEE, ACM, Elsevier, dll.

COURSES	**Course Name : Thesis - Proposal**
	Course Code : IF185301
	Credit : 4
	Semester : 3

COURSES DESCRIPTION
This pre-thesis course is a seminar to present the thesis proposal that has been compiled to a team of examiners and other students.
GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE
1. Able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology that pay attention to and apply the values of the humanities in accordance with their fields of expertise, compile scientific conceptions and study results based on rules, procedures , and scientific ethics in the form of a thesis or other equivalent, and uploaded on the college website, as well as papers that have been published in accredited scientific journals or accepted in international journals 2. Able to carry out academic validation or studies according to their field of expertise in solving problems in the relevant community or industry through the development of their knowledge and expertise; 3. Able to identify the scientific field that becomes the object of his research and position it on a research map developed through an interdisciplinary or multidisciplinary approach; 4. Able to make decisions in the context of solving problems in the development of science and technology that pay attention to and apply humanities values based on analytical or experimental studies of information and data; 5. Able to document, store, secure, and recover research data in order to ensure validity and prevent plagiarism;
COURSE LEARNING OUTCOMES
Students are able to present a thesis proposal that has been made according to the related research topic.
SUBJECT
Thesis proposal includes making a thesis proposal and presenting it in front of the examiner team and other students.
PREREQUISITE
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REFERENCES
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COURSES	Course Name : Thesis - Scientific Publication
	Course Code : IF185302
	Credit : 2
	Semester : 3

COURSES DESCRIPTION

This scientific publication subject is the writing of scientific articles and publishing them in accredited national journals or international journals.

GRADUATE LEARNING OUTCOMES CHARGED IN THE COURSE

1. Able to develop logical, critical, systematic, and creative thinking through scientific research, creation of designs or works of art in the field of science and technology that pay attention to and apply the values of the humanities in accordance with their areas of expertise, compile scientific conceptions and study results based on rules, procedures , and scientific ethics in the form of a thesis or other equivalent, and uploaded on the college website, as well as papers that have been published in accredited scientific journals or accepted in international journals;
2. Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community;;
3. Able to document, store, secure, and recover research data in order to ensure validity and prevent plagiarism;

COURSE LEARNING OUTCOMES

Students are able to make scientific articles according to related research topics and publish in accredited national journals or international journals.

SUBJECT

Making scientific articles according to related research topics and according to the format of the articles in the intended scientific journals.

PREREQUISITE

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REFERENCES

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COURSES	Course Name : Thesis - Final Session
	Course Code : IF185401
	Credit : 6
	Semester : 4

COURSES DESCRIPTION

A thesis requires students to develop research according to research methodology, write a thesis report and publish it as a scientific paper at the national and international levels

SUPPORTED STUDY PROGRAM LEARNING OUTCOMES

6. Able to develop logical, critical, systematic and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology that pay attention to and apply the values of the humanities in accordance with their fields of expertise, compile scientific conceptions and study results based on rules, procedures , and scientific ethics in the form of a thesis or other equivalent, and uploaded on the college website, as well as papers that have been published in accredited scientific journals or accepted in international journals;
7. Able to carry out academic validation or studies according to their field of expertise in solving problems in the relevant community or industry through the development of their knowledge and expertise;
8. 8. Be able to identify the scientific field that is the object of research and position it on a research map developed through an interdisciplinary or multidisciplinary approach.;
9. Able to make decisions in the context of solving problems in the development of science and technology that pay attention to and apply humanities values based on analytical or experimental studies of information and data;
10. Able to document, store, secure, and retrieve research data in order to ensure validity and prevent plagiarism;

COURSE LEARNING OUTCOMES

Students are able to develop a thesis, write it in a thesis report and publish scientific papers at the national and international levels.

SUBJECT

Develop a thesis according to research methodology and write a thesis report and publish it as a scientific paper at the national and international levels.
PREREQUISITE
-
REFERENCES
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