MODULE HANDBOOK

SIMULATION TECHNIQUES

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

ENDORSEMENT PAGE

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

Proses *Process*	Penanggung Jawab *Person in Charge*			Tanggal *Date*
	Nama *Name*	Jabatan *Position*	Tanda tangan *Signature*	
Perumus *Preparation*	Santi Wulan Purnami, S.Si, M.Si;	Dosen Lecturer		
Pemeriksa dan Pengendalian *Review and Control*	Santi Wulan Purnami, S.Si, M.Si; Jerry Dwi Trijoyo Purnomo, S.Si. M.Si.; Shofi Andari, S.Stat, M.Si	Tim kurikulum Curriculum team		
Persetujuan *Approval*	Prof. Dr. Bambang Widjanarko Otok, M.Si.	Koordinator RMK Course Cluster Coordinator		
Penetapan *Determination*	Dr. Kartika Fithriasari, M.Si	Kepala Departemen Head of Department		

MODULE HANDBOOK
SIMULATION TECHNIQUES

Module name	SIMULATION TECHNIQUES	
Module level	Undergraduate	
Code	SS234521	
Course (if applicable)	SIMULATION TECHNIQUES	
Semester	5	
Person responsible for the module	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D	
Lecturer	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D ; Adatul Mukarromah, S.Si, M.Si; Dr. Hidayatul Khusna, S.Si.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergradute degree program, mandatory, 5th semester.	
Type of teaching, contact hours	Team Based Project (25%) Other SCL Method (31.25%) Non-SCL Method (43.75%)	
Workload	1. Lectures[L]: 3 x 50 = 150 minutes per week. 2. Exercises and Assignments[EA]: 3 x 60 = 180 minutes (3 hours) per week. 3. Independent Learning [IL]: 3 x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS) Equivalent to 4.8 ECTS	
Requirements according to the examination regulations	A student must have attended at least 80% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	CLO.1 Be able to explain the use of the Simulation Engineering concept and procedures specifically in several fields CLO.2 Able to analyze data with appropriate statistical methods and interpret them using Simulation Techniques CLO.3 Able to identify, formulate, and solve statistical problems in various applied fields in the field of Simulation Engineering CLO.4 Able to use computational techniques and modern computer equipment needed in the field of Simulation Engineering CLO.5 Have knowledge of current and upcoming issues related to Simulation Techniques CLO.6 Able to motivate yourself to think creatively, work together in interdisciplinary &	PLO-2 PLO-3 PLO-5 PLO-6 PLO-7 PLO-8 PLO-10

	multidisciplinary teams, and communicate effectively CLO.7 Able to learn throughout life coupled with responsibility and professional ethics	
Content	Simulation technique course are computational courses. After attending this course, students will have the competence to create a valid simulator with the real system being emulated. The learning strategy applied in this lecture is an explanation of the understanding of the system and some examples. Students play an active role to (i) be able to determine the number and variety of system simulation inputs as well as create random number generation programs and random variables and applied into statistical models in accordance with the simulation inputs of the real system to be made the simulator ; and (ii) able to test the validity of random number generator representatives of the simulator input. The end of this lecture students can:(i) combine/ interact several input generator simulators to build a real simulator system and test its validity; (ii) utilize random number generators and variables to estimate distribution parameters and simple statistical models; (iii) use the simulator to experiment with determine the optimum condition of the real system	
Assessment and its weight	Cognitive - Assignment (23%) Quiz (11%) Cognitive - Midterm Exam (15%) Simulator building project (30%) Simulator project presentation (21%)	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom	
Reading list	1. Law, A. M., 2015. Simulation Modelling and Analysis. 5th edition. McGraw Hill. 2. Banks, J., Carson II, J. S., Nelson, B. L., dan Nicol, D. M. 2014. Discrete-Event System Simulation. Pearson, England 3. Brailsford, S., Churilov, L., dan Dangerfield, B, 2014. Discrete-event simulation and system dynamics for management decision making. John Wiley & Sons, West Sussex, United Kingdom	

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

RENCANA PEMBELAJARAN SEMESTER/
SEMESTER LEARNING PLAN

MATA KULIAH (MK)/ *Course*	**KODE/** *Code*	**Rumpun MK/** *Course Group*	**BOBOT (sks)/** *Weight (credit)*		**SEMESTER/** *Semester*	**Tgl Penyusunan/** *Drafting Date*
TEKNIK SIMULASI/ *SIMULATION TECHNIQUES*	SS234521	SKSD	**T=2**	**P=1**	V	17 Desember 2022

OTORISASI/ *AUTHORIZATION*	**Pengembang RPS/** *RPS Developer*	**Koordinator RMK/** *Course Group Coordinator*	**Ketua PRODI/** *Head of Department*
	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D	Dr. Kartika Fithriasari, M.Si

Capaian Pembelajaran (CP)/ *Learning Achievement*	**CPL-PRODI yang dibebankan pada MK/** *PLO*	
	CPL-2	Mampu mengkaji dan memanfaatkan ilmu pengetahuan dan teknologi dalam rangka mengaplikasikannya pada bidang keahlian tertentu, serta mampu mengambil keputusan secara tepat dari hasil kerja sendiri maupun kerja kelompok dalam bentuk laporan tugas akhir atau bentuk kegiatan pembelajaran lain yang luarannya setara dengan Tugas Akhir melalui pemikiran logis, kritis, sistematis dan inovatif.
	CPL-3	Mampu mengelola pembelajaran diri sendiri, dan mengembangkan diri sebagai pribadi pembelajar sepanjang hayat untuk bersaing di tingkat nasional, maupun internasional, dalam rangka berkontribusi nyata untuk menyelesaikan masalah dengan mengimplementasikan teknologi informasi dan komunikasi dan memperhatikan prinsip keberlanjutan serta memahami kewirausahaan berbasis teknologi.
	CPL-5	Mampu menerapkan teori statistika pada metode statistika
	CPL-6	Mampu merancang, mengumpulkan, dan melakukan manajemen data dengan metodologi yang tepat
	CPL-7	Mampu menggunakan perangkat komputasi modern untuk menyelesaikan permasalahan statistik
	CPL-8	Mampu menggunakan teknik komputasi untuk menyelesaikan permasalahan statistik
	CPL-10	Mampu menerapkan metode statistika Bisnis, Industri, Ekonomi, Sosial, Kesehatan, atau Lingkungan pada permasalahan riil
	PLO-2	*Able to study and utilize science and technology in order to apply it to certain areas of expertise, and be able to make appropriate*

		decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the Final Project through logical, critical thinking , systematic and innovative.
	PLO-3	*Able to manage self-learning and develop oneself as a personal lifelong learner to compete at national and international levels, to make a real contribution to solving problems by implementing information and communication technology and paying attention to the principles of sustainability and understanding technology-based entrepreneurship.*
	PLO-5	*Able to apply statistical theory in statistical methods*
	PLO-6	*Able to design, collect, and perform data management with the right methodology*
	PLO-7	*Able to use modern computing devices to solve statistical problems*
	PLO-8	*Able to use computing techniques to solve statistical problems*
	PLO-10	*Able to apply business, industrial, economic, social, health or environmental statistical methods to real problems*

Capaian Pembelajaran Mata Kuliah (CPMK)/
CLO

CPMK.1 Mampu menjelaskan penggunaan konsep Teknik Simulasi dan prosedurnya secara khusus di beberapa bidang
CPMK.2 Mampu menganalisis data dengan metode statistika yang tepat dan mengintepretasikannya menggunakan Teknik Simulasi
CPMK.3 Mampu mengindentifikasi,memformulasi, dan menyelesaikan masalah statistika di berbagai bidang terapan di bidang Teknik Simulasi
CPMK.4 Mampu menggunakan teknik komputasi dan perangkat komputer modern yang diperlukan dalam bidang Teknik Simulasi
CPMK.5 Memiliki pengetahuan tentang isu terkini dan mendatang yang berkaitan dengan Teknik Simulasi
CPMK.6 Mampu memotivasi diri untuk berpikir kreatif, bekerjasama dalam tim interdisiplin & multidisiplin, dan mengkomunikasikan secara efektif
CPMK.7 Mampu belajar sepanjang hayat yang dibarengi dengan tanggung jawab dan etika profesi
CLO.1 Be able to explain the use of the Simulation Engineering concept and procedures specifically in several fields
CLO.2 Able to analyze data with appropriate statistical methods and interpret them using Simulation Techniques
CLO.3 Able to identify, formulate, and solve statistical problems in various applied fields in the field of Simulation Engineering
CLO.4 Able to use computational techniques and modern computer equipment needed in the field of Simulation Engineering
CLO.5 Have knowledge of current and upcoming issues related to Simulation Techniques
CLO.6 Able to motivate yourself to think creatively, work together in interdisciplinary & multidisciplinary teams, and communicate effectively
CLO.7 Able to learn throughout life coupled with responsibility and professional ethics

Matrik CPL – CPMK
PLO-CLO Matrix

CPMK	CPL-1	CPL-2	CPL-3	CPL-5	CPL-6	CPL-7	CPL-8	CPL-10
CPMK-1					V			
CPMK-2				V				
CPMK-3								V
CPMK-4						V	V	
CPMK-5					V			V
CPMK-6		V						

		CPMK-7	V		V					
Deskripsi Singkat MK/ ***Course Description***	Mata kuliah teknik simulasi merupakan mata kuliah bidang komputasi. Setelah mengikuti mata kuliah ini, mahasiswa akan mempunyai kompetensi dapat membuat simulator yang valid dengan sistem riil yang ditirukan. Strategi pembelajaran yang diterapkan dalam perkuliahan ini dimulai dari penjelasan tentang pengertian sistem, cara pembuatar simulator, dan cara validasinya yang dibarengi dengan beberapa contoh rill. Mahasiswa berperan aktif untuk (i) mampu menentukan jumlah dan macam-macam input simulasi sistem serta membuat program pembangkitan bilangan random & variabel random dan diaplikasikan ke dalam model statistika sesuai dengan input simulasi dari sistem riil disimulasikan; dan (ii) mampu menguji validitas pembangkit bilangan random wakil dari input simulator. Di akhir perkuliahan mahasiswa dapat: (i) memadukan/ menginteraksikan beberapa pembangkit input simulator untuk membangun simulator system riil dan menguji kevalidan simulatornya; dan (ii) menggunakan simulator untuk bereksperimen menenentukan kondisi optimum sistem riil yang disimulasikan. *Simulation technique course are computational courses. After attending this course, students will have the competence to create a valid simulator with the real system being emulated. The learning strategy applied in this lecture is an explanation of the understanding of the system and some examples. Students play an active role to (i) be able to determine the number and variety of system simulation inputs as well as create random number generation programs and random variables and applied into statistical models in accordance with the simulation inputs of the real system to be made the simulator ; and (ii) able to test the validity of random number generator representatives of the simulator input. The end of this lecture students can:(i) combine/ interact several input generator simulators to build a real simulator system and test its validity; (ii) utilize random number generators and variables to estimate distribution parameters and simple statistical models; (iii) use the simulator to experiment with determine the optimum condition of the real system*									
Bahan Kajian: Materi Pembelajaran/ ***Course Material***	Teori Statistika, Pengumpulan dan manajemen Data, Teknik Komputasi dan Data Processing, Pemodelan, Industri dan Bisnis, Pemerintahan dan Kependudukan, Ekonomi dan Manajemen, Kesehatan dan Lingkungan *Statistical Theory, Data Collection and Management, Computing Engineering and Data Processing, Modeling, Industry and Business, Government and Population, Economics and Management, Health, and Environment*									
Pustaka/ ***References***	**Utama/*Primary*:** 4. Law, A. M., 2015. Simulation Modelling and Analysis. 5th edition. McGraw Hill. **Pendukung/*Secondary*:** 5. Banks, J., Carson II, J. S., Nelson, B. L., dan Nicol, D. M. 2014. Discrete-Event System Simulation. Pearson, England 6. Brailsford, S., Churilov, L., dan Dangerfield, B, 2014. Discrete-event simulation and system dynamics for management decision making. John Wiley & Sons, West Sussex, United Kingdom									
Dosen Pengampu/	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D ; Adatul Mukarromah, S.Si, M.Si;									

Lecturers	Dr. Hidayatul Khusna, S.Si.
Matakuliah syarat/ ***Pre-requisite Course***	-

Mg Ke- ***Week***	**Kemampuan akhir tiap tahapan belajar (Sub-CPMK)** ***Final capability for each learning step***	**Penilaian** ***Evaluation***		**Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa,** **[Estimasi Waktu]** ***Learning Format Learning Methods Assignment for Student [Estimated Time]***		**Materi Pembelajaran** **[Pustaka]** ***Learning Material [References]***	**Bobot Penilaian (%)** ***Evaluation Weight (%)***
		Indikator ***Indicator***	**Kriteria & Bentuk** ***Criteria and Format***	**Luring** ***Offline***	**Daring** ***Online***		
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1	Dapat menjelaskan Teknik Simulasi dan prosedurnya *Can explain simulation techniques and it's procedures*	1.1 Dapat menjelaskan pengertian objek & sistem 1.2 Dapat membedakan model & simulasi 1.3 Dapat mengidentifikasi objek sementara dan permanen dalam sistem 1.4 Dapat mengidentifikasi klasifikasi sistem *1.1 Can explain the meaning of objects & systems.* *1.2 Can distinguish models & simulations.* *1.3 Can identify temporary and permanent objects in the system.* *1.4 Can identify the system qualification*	Observasi Aktifitas di kelas Tugas 1 *Observation Activities in class Task 1*	Ceramah Interaktif, Diskusi Praktikum *Interactive lectures Discussion, Exercise, Practices* **TM: 1x3x50"** **PT: 1x3x60"** **BM: 1x3x60"**		Pengantar Pemodelan Sistem, Kerangka Kerja Teknik Simulasi. *Introduction to System Modeling; Simulation Engineering Framework.* **[1] BAB 1, Sub-Bab 1.1-1.3** **[2] BAB 2**	5%

2	Dapat mengimplementasikan simulasi sistem antrian M/M/1, M/M/2, dan Inventory baik secara manual, spreadsheet, maupun Pascal atau C++ *Can implement M/M/1, M/M/2, and Inventory queue system simulations either manually, spreadsheets, or Pascal or C++*	2.1 Dapat menjelaskan komponen penyusun organisasi simulasi even diskrit 2.2 Dapat menjelaskan keterkaitan hubungan antara setiap komponen penyusun organisasi simulasi even diskrit 2.3 Dapat menjelaskan macam-macan even dalam sistem M/M/1, M/M/2, M/M/3 2.4 Dapat membuat & menjelaskan Event graph, State Diagram sistem M/M/1, M/M/2, M/M/3 2.5 Dapat membuat gambaran logika pola kerja sistem inventory 2.6 Dapat menjelaskan Algoritma simulasi sistem inventory *2.1 Can explains the constituent components of the organization simulation even discrete.* *2.2 Can explains the relationship between each component of the organization simulation organization discrete event.* *2.3 Can explains the kinds of even in the system M/M/1, M/M/2, M/M/3* *2.4 Can create & explain Event graph, State Diagram system M/M/1, M/M/2, M/M/3* *2.5 Can create a logical picture of the working pattern of the inventory system.* *2.6 Can explains inventory system simulation algorithm*	Observasi Aktifitas di kelas Tugas 2 *Observation Activities in class Task 2*	Ceramah Interaktif, Diskusi, Latihan Soal Praktikum *Interactive lectures Discussion, Exercise, Practices* **TM: 1x2x50”** **P: 1x1x170”** **PT: 1x2x60”** **BM: 1x2x60”**		Simulasi Even Diskrit M/M/1, M/M/2, dan Inventory. *Discrete Event Simulation M/M/1, M/M/2, and Inventory.* **[1] BAB 1, Sub-Bab 1.4-1.5** **BAB 2, Sub Bab 2.4.** **[2] BAB 6,**	15%
3	Dapat menjelaskan Probability Distribution	3.1 Dapat menjelaskan PDF distribusi diskrit dan kontinu	Observasi Aktifitas di kelas	Ceramah Interaktif, Diskusi, Latihan		Model-model statistika dan pemilihan Model Input	10%

	Function (PDF) & Cumulaive Distribution Function (CDF) untuk distribusi diskrit dan kontinu yang tepat untuk suatu input data simulasi system melalui uji Goodness of fit. *Can explain probability distribution function (PDF) & Cumulative Distribution Function (CDF) for discrete and continuous distribution right for a simulated data input system through Goodness of fit test.*	3.2 Dapat menjelaskan distribusi kumulatif (CDF) semua distribusi diskrit dan kontinu *3.1 Can describe PDF discrete and continuous distribution.* *3.2 Can describes the cumulative distribution (CDF) of all discrete and continuous distributions*	Tugas 3 *Observation Activities in class Task 3*	Soal Praktikum *Interactive lectures Discussion, Exercise, Practices* **TM: 1x2x50"** **P: 1x1x170"** **PT: 1x2x60"** **BM: 1x2x60"**		simulator sebagai input model dalam Teknik Simulasi; *Statistical models and selection of input simulator models as input models in Simulation Techniques;* **[1] BAB 1, Bab 4** **[2] BAB 5**	
4	Dapat mengetahui cara mengimplementasikan pembangkit variabel random ke dalam sebuah pembangkit bilangan random yang berdistribusi sesuai input simulasi *Can find out how to implement random variable generator into a random number generator that distributes according to simulation input*	4.1. Dapat membangkitkan variabel random berdistribusi dengan menggunakan metode Transformasi Invers dan memahami konsepnya 4.2. Dapat membangkitkan variabel random berdistribusi dengan menggunakan metode Komposisi dan memahami konsepnya 4.3. Dapat membangkitkan variabel random berdistribusi dengan menggunakan metode Konvolusi dan memahami konsepnya 4.4. Dapat membangkitkan variabel random berdistribusi dengan menggunakan metode AR & AAR dan memahami konsepnya 4.5. Dapat menentukan data random yang dibangkitkan	Observasi Aktifitas di kelas Tugas 4 *Observation Activities in class Task 4*	Ceramah Interaktif, Diskusi, Latihan Soal Praktikum *Interactive lectures Discussion, Exercise, Practices* **TM: 1x2x50"** **P: 1x1x170"** **PT: 1x2x60"** **BM: 1x2x60"**		Pembangkitan Bilangan Random (PBR) dan Variabel Random (PVR); Implementasi PBR dan PVR dalam Simulasi Monte Carlo. *Random Number Generation (PBR) and Random Variables (PVR); Implementation of PBR and PVR in Monte Carlo Simulation;* **[1] BAB 7 & 8** **[2] BAB 7 & 8**	10%

		adalah memenuhi pola distribusi tertentu sesuai dengan pola yang diinginkan *4.1. Able to generate variable random distribution by using inverse transformation method and understand the concept.* *4.2. Able to generate variable random distribution by using composition method and understand the concept* *4.3. Able to generate variable random distribution by using convolution method and understand the concept.* *4.4. Able to generate variable random distribution by using AR & AAR method and understand the concept.* *4.5. Able to determines the random data generated is to meet a specific distribution pattern according to the desired pattern*					
5	Dapat melakukan pengujian validitas hasil bangkitan bilangan random berdistribusi dengan menggunakan paket program MINITAB dan SPSS *Able to test the validity of random number rise results by using MINITAB and SPSS program packages*	5.1 Dapat menguji PBR berdistribusi dengan menggunakan paket program MINITAB dan SPSS 5.2 Dapat memilah cara pengujian PBR berdistribusi yang diskrit dan kontinyu dengan menggunakan paket program MINITAB dan SPSS *5.1 Able to test distributed PBR by using MINITAB and SPSS program packages.* *5.2 Able to sorts out discrete and*	Observasi Aktifitas di kelas Quiz 1 *Observation* *Activities in class* *Quiz 1*	Ceramah Interaktif, Diskusi, Latihan Soal Praktikum *Interactive lectures Discussion, Exercise, Practices* **TM: 1x2x50"** **P: 1x1x170"** **PT: 1x2x60"** **BM: 1x2x60"**		Pembuatan simulator dengan mengintegrasikan beberapa PBR dan PVR yang telah terpilih. *Simulator creation by integrating selected PBR and PVR;* **[1] Bab 5 dan Bab 6** **[2] BAB 9**	10%

		continuously distributed PBR testing methods by using MINITAB and SPSS program packages					
6	Dapat mengintegrasikan beberapa distribusi input simulator menjadi simulator system yang ditirukan. *Able to integrate multiple input simulator distributions into an emulated system simulator.*	6.1. Dapat mengetahui beberapa pola data input simulasi sistem riil-nya *6.1 Able to knows some of the input data patterns of his real system simulation*	Observasi Aktifitas di kelas Tugas 5 *Observation Activities in class Task 5*	Ceramah Interaktif, Diskusi, Latihan Soal Praktikum *Interactive lectures Discussion, Exercise, Practices* **TM: 1x2x50"** **P: 1x1x170"** **PT: 1x2x60"** **BM: 1x2x60"**		Pembuatan simulator dengan mengintegrasikan beberapa PBR dan PVR yang telah terpilih; Analisis Output Simulator *Simulator creation by integrating selected PBR and PVR; Analysis Output Simulator;* **[1] Bab 5** **[2] BAB 10**	10%
7	Dapat menguji kevalidan system simulator *Able to test the validity of system simulator*	7.1. Dapat menguji validasi input dengan paket program SPSS *7.1 Able to test input validation with SPSS program packages*	Observasi Aktifitas di kelas Tugas 6 *Observation Activities in class Task 6*	Ceramah Interaktif, Diskusi *Interactive lectures Discussion Practices* **TM: 1x2x50"** **P: 1x1x170"** **PT: 1x2x60"** **BM: 1x2x60"**		Validasi Simulator *Simulator validation* **[1] Bab 5** **[2] BAB 10**	10%
8	**ETS/*Midterm***						
9-12	Dapat membangun simulator baru sebagai system alternative dan mampu mengevaluasi perbedaan dan perbaikan dari system aslinya *Able to build a new simulator as an alternative system and able to evaluate the differences and*	8.1 Dapat menggunakan Kolmogorov-Smirnov sebagai alat uji goodness-of-fit data kontinu 8.2 Dapat melakukan pengujian validitas berbagai pembangkit pola data input, khususnya pengujian terhadap pola input simulsi sistem riil-nya 8.3 Dapat merencanakan proyek simulator yang akan dibuat	Observasi Aktifitas di kelas Tugas Besar (Tugas 7) *Observation Activities in class Final Project (Task 7)*	Ceramah Interaktif, Diskusi Praktikum *Interactive lectures Discussion Practices* **TM: 4x2x50"** **P: 4x1x170"** **PT: 4x2x60"**		Membangun sistem alternatif *Build alternative system.* **[1] Bab 5** **[2] BAB 11**	10%

	improvements of the original system	*8.1 Able to use KolmogorovSmirnov as a test tool for goodness-of-fit continue data.* *8.2 Able to test the validity of various input data pattern generators, especially tests on the input patterns of the real system simulation.* *8.3 Able to plan simulator projects that will be created*		**BM: 4x2x60"**			
13-14	Dapat bereksperimen menggunakan simulator sistem yang sudah valid untuk mengoptimasikan layanan system riil yang ditirukan dan dapat mereduksi varians rata-rata pelayanan dalam satu tahap layanan *Able to experiment using a valid system simulator to optimize real system services that are imitated and Able to reduce the average variance of services in one service stage*	9.1 Dapat memilih alternatif terbaik dari beberapa alternatif sistem yang telah dibuat 9.2 Dapat menentukan optimasi dan efisiensi system yang disimulasikan 9.3 Dapat mereduksi varians rata-rata pelayanan dalam satu tahap layanan 9.4 Dapat membuat rekomendasi perbaikan sistem yang lebih optimal *9.1 Able to choose the best alternative of several system alternatives that have been created.* *9.2 Able to determine optimization and simulated system efficiency.* *9.3 Able to reduce average variance of services on a service step.* *9.4 Able to make recommendations for more optimal system improvements*	Observasi Aktifitas di kelas Tugas Besar (Tugas 7) *Observation Activities in class* *Final Project (Task 7)*	Ceramah Interaktif, Diskusi **TM: 2x2x50"** **P: 2x1x170"** **PT: 2x2x60"** **BM: 2x2x60"**		Eksperimen sistem melalui simulator dan Optimasi Sistem menggunakan simulator *System experimentation with simulator and system optimization using simulator* **[1] Bab 11 dan Bab 12** **[2] BAB 12**	10%

15	Dapat mendemonstrasikan dan mempresentasikan karya simulator di kelas *Able to demonstrate and present simulator work in class*	10.1 Dapat membuat laporan mengenai simulator dengan baik 10.2 Dapat mempresentasikan simulator yang telah dibuat *10.1 Able to create report about simulator properly.* *10.2 Able to present the simulator that already made*	Observasi Aktifitas di kelas Tugas Besar (Tugas 7) *Observation* *Activities in class* *Final Project (Task 7)*	Ceramah Interaktif, Diskusi **TM: 1x2x50”** **P: 1x1x170”** **PT: 1x2x60”** **BM: 1x2x60”**			10%
16	**Evaluasi Akhir Semester / Ujian Akhir Semester/*Final Exam***						