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MODULE HANDBOOK

SIMULATION TECHNIQUES

BACHELOR DEGREE PROGRAM
DEPARTEMENT OF STATISTICS
FACULTY OF SCIENCE AND DATA ANALYTICS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE

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

Proses ***Process***	**Penanggung Jawab** ***Person in Charge***			**Tanggal** ***Date***
	Nama ***Name***	**Jabatan** ***Position***	**Tandatangan** ***Signature***	
Perumus *Preparation*	Prof. Drs. Nur Iriawan	Dosen *Lecturer*		**November 23, 2019**
Pemeriksa dan Pengendalian *Review and Control*		Tim kurikulum *Curriculum team*		**November 23, 2019**
Persetujuan *Approval*	Prof. NUR Iriawan	Koordinator RMK *Course Cluster Coordinator*		**November 23, 2019**
Penetapan *Determination*	Dr. Kartika Fithriasari, M.Si	Kepala Departemen *Head of Department*		**November 23, 2019**

MODULE HANDBOOK

SIMULATION TECHNIQUES

Module name	**Simulation Techniques**	
Module level	Undergraduate	
Code	KS184746	
Course (if applicable)	Simulation Techniques	
Semester	Seventh Semester (Ganjil)	
Person responsible for the module	Prof. Drs. Nur Iriawan	
Lecturer	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D ; Irhamah, S.Si, M.Si, Ph.D	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergradute degree program, **mandatory**, 7th semester.	
Type of teaching, contact hours	Lectures, <50 students	
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Exercises and Assignments : 3 x 60 = 180 minutes (3 hours) perweek. 3. Private learning : 3 x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (SKS)	
Requirements according to the examination regulations	A student must have attended at least 80% of the lectures to sit in the exams.	
Mandatory prerequisites	Pemrograman Komputer/ *Computer Programming*	
Learning outcomes and their corresponding PLOs	*CLO.1 Able to explain the use of the concept of Simulation Techniques and their procedures specifically in several areas* *CLO.2 Able to explain simulation procedures well* *CLO.3 Able to analyze data with the right statistical methods and interpret it using Simulation Techniques* *CLO.4 Able to identify, formulate, and solve statistical problems in various applied fields in the field of Simulation Engineering* *CLO.5 Able to use computing techniques and modern computer devices required in the field of Simulation Engineering* *CLO.6 Have knowledge of current and upcoming issues related to the field of CPMK Simulation Engineering.* *CLO.7 Able to communicate effectively and cooperate in interdisciplinary and multidisciplinary teams* *CLO.8 Have professional responsibilities and ethics*	PLO – 1 PLO – 3 PLO – 4 PLO – 5

	CLOs.9 Able to motivate yourself to think creatively and learn throughout life	
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 simulatornya ; 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.*	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3 • Mid-term examination • Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	1. Altiok, T. dan Melamed, B., *Simulation Modeling and Analysis with Arena*, Elsevier Inc, 2007. 2. Robinson, S., *Simulation: The Practice of Model Development and Use*, John Wiley & Sons, England, 2004 3. Fishman, G.S., *Discrete-Event Simulation Modeling, Programming, and Analysis,* Springer-Verlag New York, 2001 4. Allen, T.T. *Introduction to Discrete Event Simulation and Agent-based Modeling: Voting Systems, Health Care, Military, and Manufacturing*, Springer-Verlag, London, 2011 5. Banks, J.; Carson II, J.S. ; Nelson, B.L. ; Nicol, D.M. (2001) *Discrete Event System Simulation*. Third edition. Pretice Hall Inc. 6. Law, A. M., dan Kelton, D. "Simulation Modelling and Analysis", 3rd Edition, McGraw Hill, 2000 7. Hoover, S. V, dan Perry, R. F., *Simulation*: *A Problem-Solving Approach*, Addison Wesley, 1990 8. Kleinrock, Leonard, "Queuing Systems Volume I : Theory", John Wiley & Sons, 1975 9. Kleinrock, Leonard, "Queuing Systems Volume II : Computer Application", John Wiley & Sons, 1976 10. Kobayashi, H., "Modelling and Analysis Evaluation", Addison	

	Wesley, 1989 11. Trivedi, K. S., “Probability & Statistics with Reliability, Queuing and Computer Science Aplication”, Printice Hall, 1982

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	Mata Kuliah	Teknik Simulasi
	Kode Mata Kuliah	KS184746
	Semester/SKS	VII/3
	MK Prasyarat	Pemrograman Komputer
RP-S1	Dosen Pengampu	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D ; Irhamah, S.Si, M.Si, Ph.D

Bahan Kajian/*Study Materials*	Dasar Sains, Teori Statistika, Pengumpulan Data, Deskripsi dan Eksplorasi, Komputasi dan Data Processing, Pemodelan, Industri dan Bisnis, Pemerintahan dan Kependudukan, Ekonomi dan Manajemen, Kesehatan dan Lingkungan *Basic Science, Statistical Theory, Data Collection, Description and Exploration, Computing and Data Processing, Modeling, Industry and Business, Government and Population, Economics and Management, Health and Environment*
CPL yang dibebankan MK/*PLO*	CPL-1 Mampu menerapkan pengetahuan teori statistika, matematika, dan komputasi CPL-3 Mampu menganalisis data dengan metode statistika yang tepat dan mengintepretasikannya CPL-4 Mampu mengindentifikasi,memformulasi, dan menyelesaikan masalah statistika di berbagai bidang terapan CPL-5 Mampu menggunakan teknik komputasi dan perangkat komputer modern yang diperlukan dalam bidang statistika dan sains data *PLO-1 Able to apply statistical, mathematical, and computational theory knowledge* *PLO-3 Able to analyze data with the right statistical methods and interpret it* *PLO-4 Able to identify, formulate, and solve statistical problems in various applied fields* *PLO-5 Able to use the computing techniques and modern computer devices required in the field of statistics and data science*
CP-MK/*CLO*	CPMK.1 Mampu menjelaskan penggunaan konsep Teknik Simulasi dan prosedurnya secara khusus di beberapa bidang CPMK.2 Mampu menjelaskan prosedur simulasi dengan ba ik CPMK.3 Mampu menganalisis data dengan metode statistika yang tepat dan mengintepretasikannya menggunakan Teknik Simulasi CPMK.4 Mampu mengindentifikasi,memformulasi, dan menyelesaikan masalah statistika di berbagai bidang terapan di bidang Teknik Simulasi CPMK.5 Mampu menggunakan teknik komputasi dan perangkat komputer modern yang diperlukan dalam bidang Teknik Simulasi CPMK.6 Memiliki pengetahuan tentang isu terkini dan mendatang yang berkaitan dengan bidang Teknik Simulasi CPMK.7 Mampu berkomunikasi secara efektif dan bekerjasama dalam tim yang interdisiplin dan multidisiplin CPMK.8 Memiliki tanggung jawab dan etika profesi CPMK.9 Mampu memotivasi diri untuk berpikir kreatif dan belajar sepanjang hayat *CPMK. 1 Able to explain the usage of Simulation Techniques concept and procedures specifically in several fields* *CPMK. 2 Able to explain the simulation procedure well* *CPMK. 3 Able to analyze data with the right statistical methods and interpret it using Simulation Techniques* *CPMK. 4 Able to identify, formulate, and solve statistical problems in various applied fields in the field of Simulation Techniques* *CPMK. 5 Able to use computing techniques and modern computer devices required in the field of Simulation Techniques* *CPMK. 6 Have knowledge of current and upcoming issues related to the field of Simulation Techniques* *CPMK.7 Able to communicate effectively and cooperate in interdisciplinary and multidisciplinary teams* *CPMK.8 Has professional responsibilities and ethics* *CPMK.9 Able to motivate yourself to think creatively and learn throughout life*

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	MK Prasyarat	Pemrograman Komputer
RP-S1	Dosen Pengampu	Prof. Drs. Nur Iriawan, M.Ikom, Ph.D ; Irhamah, S.Si, M.Si, Ph.D

Perte-muan /*Meeting*	**Kemampuan Akhir Sub CP-MK/** *Sb CLO Final Capability*	**Keluasan (materi pembelajaran)/** *Extent (Study Materials)*	**Metode Pembelajaran/** *Learning Methods*	**Estimasi Waktu/** *Estimated Time*	Bentuk Evaluasi/ *Evaluation Form*	Kriteria dan Indikator Penilaian *Assessment Criteria and Indicator*	**Bobot Penilaian/** *Score Weight*
1-2	1. Dapat menjelaskan Teknik Simulasi dan prosedurnya *1. Can explain simulation techniques and it's procedures*	Pengantar Pemodelan Sistem; Kerangka Kerja Teknik Simulasi; *Introduction to System Modeling;* *Simulation Engineering Framework;*	Ceramah interaktif Diskusi (CID) *Interactive lectures* *Discussions (CID)*	200 menit *200 Minutes*	Observasi Aktifitas di kelas Tes 1 *Observation* *Activities in class* *Test 1*	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 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*	5%/5%
3-4	2. Dapat mengimplementasikan simulasi sistem antrian M/M/1, M/M/2, dan Inventory baik secara manual, spreadsheet, maupun Pascal atau C++	Simulasi Even Diskrit M/M/1, M/M/2, dan Inventory; *Discrete Event Simulation M/M/1, M/M/2, and Inventory;*	CIDLS *CIDLS*	200 menit *200 Minutes*	Observasi Aktifitas di kelas Tugas 1 Tes 1 *Observation* *Activities in class* *Assignment 1* *Test 1*	2.1 Dapat menjelaskan komponen penyusun organisasi simulasi even diskrit 2.2 Dapat menjelaskan keterkaitan hubungan antara setiap komponen penyusun organisasi simulasi even diskrit	15%/20%

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	2. Can implement M/M/1, M/M/2, and Inventory queue system simulations either manually, spreadsheets, or Pascal or C++					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*	

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						2.5 Can create a logical picture of the working pattern of the inventory system *2.6 Can explains inventory system simulation algorithm*	
5-6	3. Dapat menjelaskan Probability Distribution Function (PDF) & Cumulaive Distribution Function (CDF) untuk distribusi diskrit dan kontinu yang tepat untuk suatu input data simulasi system melalui uji Goodness of fit. *2. Can explain probability distribution function (PDF) & Cumulaive Distribution Function (CDF) for discrete and continuous distribution right for a simulated data*	Model-model statistika dan pemilihan Model Input simulator sebagai input model dalam Teknik Simulasi; *Statistical models and selection of input simulator models as input models in Simulation Techniques;*	CIDLS *CIDLS*	200 menit *200 Minutes*	Observasi Aktifitas di kelas Tes 1 *Observation Activities in class Test 1*	3.1 Dapat menjelaskan PDF distribusi diskrit dan kontinu 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*	10%/30%

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	input system through Goodness of fit test.						
7-8	4. Dapat mengetahui cara mengimplementasikan pembangkit variabel random ke dalam sebuah pembangkit bilangan random yang berdistribusi sesuai input simulasi *4. Can find out how to implement random variable generator into a random number generator that distributes according to simulation input*	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;*	CIDLS *CIDLS*	200 menit *200 Minutes*	Observasi Aktifitas di kelas Tes 2 *Observation Activities in class Test 2*	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 adalah memenuhi pola distribusi tertentu sesuai dengan pola yang diinginkan	10%/40%

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						4.1 Can generate variabelrandom beristribution by using inverse transformation method and understand the concept *4.2 Can generate variabelrandom berdistribution by using composition method and understand the concept* *4.3 Can generate variabelrandom beristribution by using convolution method and understand the concept* *4.4 Can generate variabelrandom beristribution by using AR & AAR method and understand the concept* 4.5 *Can determines the random data generated is to meet a specific distribution pattern according to the desired pattern*	
9-10	5. Dapat melakukan pengujian validitas hasil bangkitan bilangan random berdistribusi dengan	Pembuatan simulator dengan mengintegrasikan beberapa PBR dan PVR yang telah terpilih;	CIDLS *CIDLS*	200 menit *200 Minutes*	Observasi Aktifitas di kelas Tes 2 *Observation Activities in class*	5.1 Dapat menguji PBR berdistribusi dengan menggunakan paket program MINITAB dan SPSS 5.2 Dapat memilah cara pengujian PBR berdistribusi yang diskrit	10%/50%

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	menggunakan paket program MINITAB dan SPSS *5. Can test the validity of random number rise results by using MINITAB and SPSS program packages*	*Simulator creation by integrating selected PBR and PVR;*			*Test 2*	dan kontinyu dengan menggunakan paket program MINITAB dan SPSS *5.1 Can test distributed PBR by using MINITAB and SPSS program packages* 5.2 *Can sorts out discrete and continuously distributed PBR testing methods by using MINITAB and SPSS program packages*	
11-12	6. Dapat mengintegrasikan beberapa distribusi input simulator menjadi simulator system yang ditirukan. *6. Can integrate multiple input simulator distributions into a emulated system simulator.*	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;*	CIDLS *CIDLS*	200 menit *200 Minutes*	Observasi Aktifitas di kelas Tes 2 *Observation Activities in class* *Test 2*	6.1. Dapat mengetahui beberapa pola data input simulasi sistem riil-nya 6.1 *Can knows some of the input data patterns of his real system simulation*	10%/60%
13-14	7. Dapat menguji kevalidan system simulator	Validasi Simulator; *Simulator Validation;*	CID *CID*	200 menit *200 Minutes*	Observasi Aktifitas di kelas Tes 2	7.1. Dapat menguji validasi input dengan paket program SPSS *7.1 Can test input validation with SPSS program packages*	10%/70%

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	7. Can test the validity of system simulator				*Observation Activities in class Test 2*		
15-16	**ETS**/*Midterm*						
17-24	8. Dapat membangun simulator baru sebagai system alternative dan mampu mengevaluasi perbedaan dan perbaikan dari system aslinya *8. Can build a new simulator as an alternative system and able to evaluate the differences and improvements of the original system*	Eksperimen sistem melalui simulator *System Experiment via Simulator*	CID *CID*	800 menit *800 Minutes*	Observasi Aktifitas di kelas Tugas Besar (Tugas 2) *Observation Activities in class* *Big project (Task 2)*	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 *8.1 Able to use Kolmogorov-Smirnov as a test tool for goodness-of-fit continue data* *8.2 Can 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*	10%/80%

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25-28	9. Dapat bereksperimen menggunakan simulator sistem yang sudah valid untuk mengoptimasikan layanan system riil yang ditirukan *9. Able to experiment using a valid system simulator to optimize the real system services that are being emulated*	Optimasi Sistem menggunakan simulator *System Optimation using Simulator*	CID *CID*	400 menit *400 Minutes*	Observasi Aktifitas di kelas Tugas Besar (Tugas 2) *Observation Activities in class* *Big project (Task 2)*	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 membuat rekomendasi perbaikan sistem yang lebih optimal *9.1 Can choose the best alternative of several system alternatives that have been created* *9.2 Can determine optimization and simulated system efficiency* *9.3 Can make recommendations for more optimal system improvements*	10%/90%
29-30	10. Dapat mendemonstrasikan dan mempresentasikan karya simulator di kelas	Eksperimen sistem melalui simulator; Optimasi Sistem menggunakan simulator *System experimentation through simulators;* *System Optimization using simulator*	CID *CID*	100 menit *100 Minutes*	Presentasi Tugas Besar (Tugas 2) *Presentation* *Big project (Task 2)*	10.1 Dapat membuat laporan mengenai simulator dengan baik 10.2 Dapat mempresentasikan simulator yang telah dibuat *10.1 Can make a good report on the simulator*	10%/100%

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	10. Can demonstrate and present simulator work in class					*10.2 Can present simulators that have been created*	
31-32	**EAS**/*Finalterm*						

PUSTAKA/*References* **:**

1. Altiok, T. dan Melamed, B., *Simulation Modeling and Analysis with Arena*, Elsevier Inc, 2007.
2. Robinson, S., *Simulation: The Practice of Model Development and Use*, John Wiley & Sons, England, 2004
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