PORTOFOLIO MATA KULIAH

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) **FAKULTAS TEKNOLOGI INDUSTRI DAN REKAYASA SISTEM** **DEPARTEMEN TEKNIK SISTEM DAN INDUSTRI**

Mata Kuliah (MK)	**Kode**	**RMK**	**Bobot (sks)**	**Semester**	**Waktu Review**
Simulasi Sistem Industri	TI 184522	QMIPA	3	5	Januari 2021
Otorisasi / Pengesahan	**Dosen MK / Koordinator MK**		**Ketua RMK**	**Kadep / Kaprodi**	
	Nurhadi Siswanto		Nurhadi Siswanto	Nurhadi Siswanto	
Team Teaching	Diesta Iva Maftuhah, Dody Hartanto, Stefanus Eko Wiratno, Hafidz Ridho				

Capaian Pembelajaran Lulusan (CPL) sesuai dengan IABEE / *Program Learning Outcomes (PLO) based on IABEE criteria*

Kode / *code*	Deskripsi CPL / *PLO description*
(a)	Kemampuan menerapkan pengetahuan matematika, ilmu pengetahuan alam dan/atau material, teknologi informasi dan keteknikan untuk mendapatkan pemahaman menyeluruh tentang prinsip-prinsip keteknikan. *Ability to apply knowledge of mathematics, natural and / or material science, information technology and engineering to gain a comprehensive understanding of engineering principles.*
(b)	Kemampuan mendesain komponen, system dan/atau proses untuk memenuhi kebutuhan yang diharapkan didalam batasan-batasan realistis, misalnya hukum, ekonomi, lingkungan, sosial, politik, kesehatan dan keselamatan, keberlanjutan serta untuk mengenali dan/atau memanfaatkan potensi sumber daya local dan nasional dengan wawasan global. *Ability to design components, systems and / or processes to meet expected needs within realistic boundaries, for example legal, economic, environmental, social, political, health and safety, sustainability and to recognize and / or utilize potential local and national resources by global insight.*
(c)	Kemampuan mendesain dan melaksanakan eksperimen laboratorium dan/atau lapangan serta menganalisis dan mengartikan data untuk memperkuat penilaian teknik. *Ability to design and carry out laboratory and / or field experiments and analyze and interpret data to strengthen technical assessments.*
(d)	Kemampuan mengidentifikasi, merumuskan, menganalisis dan menyelesaikan permasalahan teknik. *Ability to identify, formulate, analyze and solve technical problems.*
(e)	Kemampuan menerapkan metode, keterampilan dan piranti teknik yang modern yang diperlukan untuk praktek keteknikan. *Ability to apply modern technical methods, skills and tools necessary for engineering practice.*
(f)	Kemampuan berkomunikasi secara efektif baik lisan maupun tulisan. *Ability to communicate effectively both orally and in writing.*

(g)	Kemampuan merencanakan, menyelesaikan dan mengevaluasi tugas didalam batasan-batasan yang ada. *Ability to plan, complete and evaluate tasks within existing constraints.*
(h)	Kemampuan bekerja dalam tim lintas disiplin dan lintas budaya. *Ability to plan, complete and evaluate tasks within existing constraints.*
(i)	Kemampuan untuk bertanggung jawab kepada masyarakat dan mematuhi etika profesi dalam menyelesaikan permasalahan teknik. *Ability to be responsible to society and comply with professional ethics in solving technical problems.*
(j)	Kemampuan memahami kebutuhan akan pembelajaran sepanjang hayat, termasuk akses terhadap pengetahuan terkait isu-isuke kinian yang relevan. *Ability to understand the needs of lifelong learning, including access to knowledge related to current issues.*

RENCANA PEMBELAJARAN SEMESTER

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) **FAKULTAS TEKNOLOGI INDUSTRI DAN REKAYASA SISTEM** **DEPARTEMEN TEKNIK SISTEM DAN INDUSTRI**

Mata Kuliah (MK)	Kode	RMK	Bobot (sks)	Semester	Waktu Review
Simulasi Sistem Industri *Industrial System Simulation*	TI 184522	QMIPA	3	5	Agustus 2020

1. Deskripsi Mata Kuliah (*Course Description*)

Simulasi merupakan teknik untuk meniru proses/operasi dengan menggunakan perangkat komputer dari suatu sistem kompleks yang sulit (tidak dapat) dimodelkan secara matematika. Model simulasi yang dirancangakan digunakan untuk mempelajari sistem dengan cara melakukan eksperimen untuk mendapatkan nilai variabel keputusan tunggal atau kombinasi yang dapat memenuhi objektif yang ditetapkan.Mata kuliah ini akan membahas bagaimana cara merancang model simulasi yang benar, sehingga diharapkan setelah menyelesaikan mata kuliah ini mahasiswa mampu mengembangkan model simulasi yang valid dan melakukan eksperimen dengan menggunakan model simulasi. Kegiatan pembelajaran terdiri dari perkuliahan yang membahas konsep simulasi dan teknik pemodelan simulasi serta tugas studi kasus sistem nyata yang dipresentasikan pada akhir mata kuliah

Simulation is a technique for imitating processes / operations using computer devices from a complex system that is difficult (cannot) be modeled mathematically. The simulation model is designed to be used to study the system by conducting experiments to get the value of a single decision variable or combination that can meet the objectives set. This course will discuss how to design the correct simulation model, so that it is hoped that after completing this course students are able to develop a valid simulation model and perform experiments using a simulation model. Learning activities consist of lectures that discuss simulation concepts and simulation modeling techniques as well as real system case study assignments that are presented at the end of the course.

2. Capaian Pembelajaran Mata Kuliah (CPMK) / *Course Learning Outcomes (CLO)*

Dengan berakhirnya kuliah, diharapkan mahasiswa / *By the end of this course, students will be able to:*

Kode	Uraian CPMK / *Description of CLO*
CPMK 1	Kemampuan untuk memahami konsep dan dasar-dasar simulasi kejadian diskrit (Discrete Event Simulation – DES). *Ability to understand the concepts and basics of discrete event simulation (DES).*
CPMK 2	Kemampuan untuk memahami konsep pembangkit bilangan acak dan mampu menjelaskan kegunaannya di dalam model DES. *Ability to understand the concept of random number generators and are able to explain their use in the DES model.*
CPMK 3	Kemampuan untuk menjelaskan perbedaan antara DES dengan metode optimasi eksak dan metode simulasi lainnya (Simulasi Monte Carlo, System Dynamics, dan Agent Based Simulation). *Ability to explain the difference between DES and the exact optimization method and other simulation methods (Monte Carlo Simulation, System Dynamics, and Agent Based Simulation).*

Kode	Uraian CPMK / *Description of CLO*
CPMK 4	Kemampuan untuk memahami dan menguasai langkah-langkah membangun model DES manual dan model DES spreadsheet, serta menggunakan berbagai teknik membangun model konseptual *Ability to understand and master the steps of building a manual DES model and a DES spreadsheet model, as well as to use a variety of techniques to build conceptual models.*
CPMK 5	Kemampuan untuk menggunakan software DES komersial untuk membangun model DES, melaksanakan eksperimen dan menginterpretasikan output eksperimen. *Ability to use commercial DES simulation software to build DES models, carry out experiments and interpret experimental output.*
CPMK 6	Kemampuan untuk menentukan jenis data yang dibutuhkan dalam memodelkan DES dan menganalisa data input. *Ability to determine the type of data needed to model DES and analyze input data.*
CPMK 7	Kemampuan untuk menggunakan metode statistik dalam menganalisa output DES, serta mengembangkan berbagai alternatif skenario perbaikan dan membandingkannya untuk mendapatkan skenario terbaik. *Ability to use statistical methods in analyzing DES output and to develop various alternative improvement scenarios and compare them to get the best scenario*
CPMK 8	Kemampuan untuk mempresentasikan hasil eksperimen DES dengan bekerja sama dalam suatu tim. *Ability to present DES experimental results by working together in a team.*

3. CPL yang dibebankan kepada Mata Kuliah (Matriks CPL-CPMK / *PLO-CLO Matrix*)

CPMK	CPL Program Studi berbasis IABEE / *CLO based on IABEE*									
	(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**
CPMK 1	***									
CPMK 2	***									
CPMK 3	***									
CPMK 4	***	***	***							
CPMK 5		***								
CPMK 6	***		***	***						
CPMK 7	***		***	***						
CPMK 8						***				

4. Mata Kuliah Prasyarat / *Prerequisites*

- Statistik Industri 1 / *Industrial Statistics 1*
- Statistik Industri 2 / *Industrial Statistics 2*
- Riset Operasional 2 / *Operations Research 2*

5. Referensi / *References*

a. Referensi utama / Main reference

Harrell, C., Gosh, B. K., & Bowden, R. O. Simulation Using PROMODEL: Second. McGraw Hill, Singapore

b. Referensi Pendukung / Additional references

1. Kelton, W. David. Simulation with ARENA. McGraw-hill, 2014.
2. Robinson, Stewart. "Simulation: The Practice of Model Development and Use. Inglaterra: John Willey and Sons." Inc. Cap 1, no. 2 (2004): 5.

3. Robinson, S., Brooks, R., Kotiadis, K. and Van Der Zee, D.J. eds., 2010. Conceptual modeling for discrete-event simulation. CRC Press.
4. Borshchev, Andrei. The Big Book of Simulation Modeling, 2013. AnyLogic North America.
5. Arena User Manual

6. Jadwal Perkuliahan / *Learning Schedule*

Minggu	CPMK	Topik	Sub Topik (pustaka)	Capaian pembelajaran (sub CPMK)	Metode Pembelajaran	Sarana Pembelajaran	Bentuk Asessment
1	CPMK 1	1. Introduction to Simulation 2. Sistem Dynamics	1. 4W1H - simulation 2. What is a system 3. What are the elements of a system 4. What makes system complex	Students are able to define a system and how the system is complex	SGD / RPS / DL / CI / PBL	Harrell – Chapter Borshchev – Chapter 1 PPT Modul 1, 2	Case study: Examples of common cases (inventory, fast food restaurants, ATMs, the ups and downs of fuel prices and their impact, cases of the spread of pandemics, forest fires, etc.) Assignment 1: - Choosing a system that is suitable to be simulated by simulation methods (DES, SD, ABS) and identifying the system elements. The results are then compiled in ppt
2	CPMK 1 CPMK 2	Simulation basics	1. Types of simulation 2. Random behaviour 3. Generating random number	Students are able to understand the the basics of simulation		Harrell – Chapter Introduction to simulation PPT Modul 3	Presentation of Assignment 1: - Analysis of system elements Assignment 2: - Generate random numbers and variates (discrete and continuous, other than exponential and normal)
3	CPMK 3	DES vs Other simulation methods	1. The similarity and differences of the methods	Students are able to analyze the difference		Robinson (2004) – Chapter 1 Borshchev – Chapter 2	Assignments can be combined with Week 1:

Minggu	CPMK	Topik	Sub Topik (pustaka)	Capaian pembelajaran (sub CPMK)	Metode Pembelajaran	Sarana Pembelajaran	Bentuk Asessment
			2. When to used DES and other methods 3. Possibility to combine simulation methods (brief explanation)	between DES and other simulations		Discrete event simulation and monte carlo PPT Modul 4, 5	
4	CPMK 3	DES	DES			Harrell – Chapter PPT Modul 4, 5	
5	CPMK 4	Simple manual and spreadsheet simulation	1. Simple manual simulation 2. Spreadsheet simulation 3. Montecarlo Simulation	Students are able to design and analyze manual and spreadsheet simulation	Response session with assistant RPS	Harrell – Chapter PPT Modul 4, 5	Assignment 3: - Perform Monte Carlo and Spreadsheet simulations (for example: 10 arrivals)
6	CPMK 4	Conceptual Model for simulation	1. Conceptual model frameworks 2. Understanding the problems 3. Determine the objective 4. Identify the model output 5. Identify the model input 6. Define the scope and level of details	Students are able to design conceptual models of a system		Robinson (2010) – Chapter 4 Building conceptual model PPT Modul 6	Tugas 4: - Membuat conceptual model dari sistem yang dipilih sesuai Tugas 1

Minggu	CPMK	Topik	Sub Topik (pustaka)	Capaian pembelajaran (sub CPMK)	Metode Pembelajaran	Sarana Pembelajaran	Bentuk Asessment
			7. Assumptions and simplification Model conceptual assessments				
7	CPMK 5	Building simulation model using Arena – Basic Process		Students are able to design simulation models using the basic process modules of Arena	Response session with assistant	Kelton – Chapter Building conceptual model using ARENA PPT Modul 7	Responsi Assignments (Basic Process)
8		Mid-term Examination.					Mid-term Examination
9	CPMK 5	Building simulation model using Arena – Advanced Process		Students are able to be able to design simulation models using the advanced process modules of Arena	Response session with assistant	Kelton – Chapter PPT Modul 7	Group Final Assignment (@2 members)
10	CPMK 6	Data Collection & Input Analysis	1. Data Collection 2. Input Analysis	Students are able to understand data collection procedures and analyze input		Harrell – Chapter PPT Modul 8	
11	CPMK 7	Output Analysis	1. Verification 2. Validation 3. Replication calculation	Students are able to analyze simulation output		Harrell – Chapter PPT Modul 9, 10	

Minggu	CPMK	Topik	Sub Topik (pustaka)	Capaian pembelajaran (sub CPMK)	Metode Pembelajaran	Sarana Pembelajaran	Bentuk Asessment
						(Basics of Verification and Validation - Analysis of monte carlo output non-terminating & terminating simulation	
12	CPMK 7	Generating Scenarios and Comparing Systems	1. Generating Scenarios 2. Comparing System	Students are able to analyze existing system problems and design improvement scenarios		Harrell – Chapter Comparing system with improvement scenarios PPT Modul 11	
13	CPMK 5	Building simulation model using Arena – Advanced Transfer & Process Analyzer			Response session with assistant Guest Lecture	Kelton – Chapter	
14	CPMK 8	Project Presentation			PBL		
15	CPMK 8	Project Presentation			PBL		
16		Final Examination.					Final Examination

7. Bentuk assessment dan keterkaitannya dengan CPMK (*Assessment Method and CLO*)

No.	CPMK	Bobot CPMK	Bentuk Assessment	Bobot setiap assessment
1	CPMK 1	8,5%	Homework	2,5%
			UTS	6,0%
2	CPMK 2	9,5%	Homework	2,5%
			UTS	7,0%
3	CPMK 3	6,5%	Homework	2,5%
			UTS	4,0%
4	CPMK 4	9,5%	Homework	2,5%
			UTS	7,0%
5	CPMK 5	26,0%	Project	10,0%
			UTS	6,0%
			UAS	10,0%
6	CPMK 6	15,0%	Project	5,0%
			UAS	10,0%
7	CPMK 7	15,0%	Project	5,0%
			UAS	10,0%
8	CPMK 8	10,0%	Project	10,0%
Total		100,0%		100,0%

Homework	UTS	UAS	Project
2,5%			
	6,0%		
2,5%			
	7,0%		
2,5%			
	4,0%		
2,5%			
	7,0%		
			10,0%
	6,0%		
		10,0%	
			5,0%
		10,0%	
			5,0%
		10,0%	
			10,0%
10,0%	30,0%	30,0%	30,0%

No	Nama	NRP	CPMK 1	CPMK 2	CPMK 3	CPMK 4	CPMK 5	CPMK 6	CPMK 7	CPMK 8	CPMK 9	NA	NH

HASIL EVALUASI PROSES DAN MATERI PEMBELAJARAN MK. SIMULASI SISTEM INDUSTRI

Tanggal : 14 Desember 2021 Koordinator : Nurhadi Siswanto

Evaluator : Stefanus EW, Hafidz R

No	Deksripsi Permasalahan	Rencana Perbaikan	Jadwal Perbaikan	PIC
1	Penyampaian materi di kelas tidak selaras dengan RPS	Penyesuaian urutan materi perkuliahan	Jan 2022	ALL
2	Penyampaian materi di kelas tidak selaras dengan pelaksanaan responsi tugas besar	Penyelarasan jadwal perkuliahan per topik dengan jadwal responsi tugas besar	Jan 2022	ALL
3	Materi dan topik kuliah tamu perlu disesuaikan dengan materi perkuliahan	Perlu koordinasi dan seleksi pemilihan naras umber kuliah tamu	Jan 2022	ALL
4	Pengayaan materi modeling dengan software simulasi	Pengayaan pada modul praktikum	Jan 2022	ALL
6	Evaluasi terkait pelaksanaan perkuliahan online	Perlunya feedback dari mahasiswa dan asisetn	Jan 2022	ALL