

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
Operation Research 2	TI 184416	QMIPA	3	3	March 2021
Otorisasi / Pengesahan	Dosen MK / Koordinator MK		Ketua RMK	Kadep / Kaprodi	
	Stefanus Eko Wiratno		Diasta Iva Maftuhah	Nurhadi Siswanto	
Team Teaching	Budisantoro Wirjodirjo, Budi Santosa, Nurhadi Siswanto, Stefanus Eko Wiratno, Diasta Iva Maftuhah				

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. <i>Ability to apply knowledge of mathematics, natural and / or material science, information technology and engineering to gain a comprehensive understanding of engineering principles.</i>
(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. <i>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.</i>
(c)	Kemampuan mendesain dan melaksanakan eksperimen laboratorium dan/atau lapangan serta menganalisis dan mengartikan data untuk memperkuat penilaian teknik. <i>Ability to design and carry out laboratory and / or field experiments and analyze and interpret data to strengthen technical assessments.</i>
(d)	Kemampuan mengidentifikasi, merumuskan, menganalisis dan menyelesaikan permasalahan teknik. <i>Ability to identify, formulate, analyze and solve technical problems.</i>
(e)	Kemampuan menerapkan metode, keterampilan dan piranti teknik yang modern yang diperlukan untuk praktek keteknikan. <i>Ability to apply modern technical methods, skills and tools necessary for engineering practice.</i>
(f)	Kemampuan berkomunikasi secara efektif baik lisan maupun tulisan. <i>Ability to communicate effectively both orally and in writing.</i>
(g)	Kemampuan merencanakan, menyelesaikan dan mengevaluasi tugas di dalam batasan-batasan yang ada. <i>Ability to plan, complete and evaluate tasks within existing constraints.</i>
(h)	Kemampuan bekerja dalam tim lintas disiplin dan lintas budaya. <i>Ability to plan, complete and evaluate tasks within existing constraints.</i>

(i)	Kemampuan untuk bertanggung jawab kepada masyarakat dan mematuhi etika profesi dalam menyelesaikan permasalahan teknik. <i>Ability to be responsible to society and comply with professional ethics in solving technical problems.</i>
(j)	Kemampuan memahami kebutuhan akan pembelajaran sepanjang hayat, termasuk akses terhadap pengetahuan terkait isu-isu kekinian yang relevan. <i>Ability to understand the needs of lifelong learning, including access to knowledge related to current issues.</i>

RENCANA PEMBELAJARAN SEMESTER

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FAKULTAS TEKNOLOGI INDUSTRI DAN REKAYASA SISTEM DEPARTEMEN TEKNIK SISTEM DAN INDUSTRI					
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1. Deskripsi Mata Kuliah (*Course Description*)

MK Operation Research (OR) 2 merupakan seri kedua dari Operations Research (OR) yang menekankan pada pengenalan pemodelan optimasi dalam pengambilan keputusan. Tidak seperti seri pertama yang fokus pada model dan metode deterministik dasar, mata kuliah ini akan membahas pemodelan matematis, seperti model dan metode deterministik lanjutan serta model stokastik dalam Operations Research dan mengaplikasikannya untuk menyelesaikan permasalahan industri maupun bisnis. Melalui pemodelan matematis, maka membantu untuk merancang, meningkatkan, dan mengoperasikan sistem kompleks dalam solusi terbaik (optimal). Metode matematis yang digunakan bisa berupa deterministik ataupun stokastik, bergantung pada karakteristik dari sistem yang diamati. Materi yang dibahas meliputi formulasi Integer Programming, Goal Programming, Game Theory, Dynamic Programming, Markov Chain, Teori Antrian, termasuk penggunaan software Solver (MS Excel) dan LINDO/LINGO.

Operations Research 2 course is the second series of Operations Research which gives the lecture in introduction to optimization modelling in decision making. Unlike the first series which focuses on the basic deterministic models and methods, this course focuses on mathematical modeling, such as advanced deterministic models and methods in Operations Research as well as stochastic models and applies them on the industrial and business problems. Through mathematical modeling, it seeks to design, improve and operate complex systems in the best possible way (optimal solution). The mathematical tools used for the solution of such models are either deterministic or stochastic, depending on the nature of the system modeled. Topics discussed are Integer Programming, Game Theory, Dynamic Programming, Markov Chain, and Queuing Theory, including the use of optimization software, such as Solver and LINDO/LINGO.

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

Dengan berakhirnya kuliah, diharapkan mahasiswa

Code	Detail Learning Outcomes
CPMK 1	Kemampuan untuk memahami karakteristik model deterministik dan stokastik dari berbagai jenis lingkungan pengambilan keputusan dan pendekatan pengambilan keputusan yang sesuai, serta overview metode, seperti Integer Programming, Goal Programming, Dynamic Programming, Game Theory, Markov Chain, and Queuing Theory <i>Ability to understand the characteristics of deterministic and stochastic model from different types of decision-making environments and the appropriate decision making approaches, as well as methods overview, such as Integer Programming, Goal Programming, Dynamic Programming, Game Theory, Markov Chain, and Queuing Theory (knowledge and understanding)</i>

Code	Detail Learning Outcomes
CPMK 2	Kemampuan untuk memformulasikan, membangun, dan menyelesaikan masalah dengan model deterministik yang sesuai, seperti Integer Programming, Goal Programming, dan Dynamic Programming <i>Ability to formulate, build and solve problems by using appropriate deterministic models, such as Integer Programming, Goal Programming, and Dynamic Programming (Cognitive skills - thinking and analysis)</i>
CPMK 3	Kemampuan untuk memformulasikan, membangun, dan menyelesaikan masalah dengan beberapa model deterministik dan stokastik yang sesuai, seperti Game Theory, Markov Chain, dan Teori Antrian <i>Ability to formulate, build and solve problems by using some appropriate deterministic and stochastic models, such as Game Theory, Markov Chain, and Queuing Theory (Cognitive skills - thinking and analysis)</i>
CPMK 4	Kemampuan untuk menggunakan software optimasi, seperti Solver-MS Excel dan LINDO/LINGO untuk mendapatkan solusi model deterministik dan stokastik serta menganalisis dan menginterpretasikan hasil output software <i>Ability to use optimization software, such as Solver-MS Excel and LINDO/LINGO to solve deterministic and stochastic models and to explain and interpret the output of optimization software (Practical and Subject Specific Skills)</i>
CPMK 5	Kemampuan untuk menggunakan model, mempresentasikan, dan bekerja dalam teamwork guna membangun dan mengembangkan model matematis untuk permasalahan di industri maupun bisnis <i>Ability to apply models, present and work in a team to build and develop mathematical model for industrial and business cases (communication skills)</i>

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						***	***			

Note :

- Hubungan antara CPL dan CPMK (PLO – CLO Matrix) :
 - * low relationship
 - ** medium relationship
 - *** strong relationship

4. Mata Kuliah Prasyarat / Prerequisites

- Operations Research 1 (TI181306)

5. Referensi / References

- Winston, Wayne. L. (2003). **Operations Research: Applications and Algorithms**, 4th Edition, Cengage Learning.

- b) Lieberman, G. J., and Hillier, F. S. (2015). **Introduction to Operations Research**, 10th Edition, McGraw-Hill Education.
- c) Bazaraa, Mokhtar S., Jarvis, John J., and Sherali, Hanif D. (2010). **Linear Programming and Network Flows**, 4th Edition, John Wiley & Sons.
- d) Taha, Hamdy. A. (2017). **Operations Research: An Introduction**, 10th Edition, Pearson Education Limited.

6. Course Schedule and Learning Strategy

Week	Course Learning Outcomes	Topic	Sub Topic (literature)	Sub-Learning Outcomes (sub- CPMK)	Learning Method	Learning tools	Assessment Type
1	CPMK 1 CPMK 2	- Overview OR modeling - Introduction to Integer Programming	- Introduction to OR modeling (deterministic and stochastic model) - Types of IP model - Building model of IP - Solving IP model using Branch & Bound method	Ability to understand OR modeling (deterministic and stochastic model), comprehend integer programming concept, and to formulate as well as develop IP model using Branch and Bound method	SGD	Presentation slide, literature references	Exercises of IP problem
2	CPMK 1 CPMK 2 CPMK 4 CPMK 5	Integer Programming Formulation (Solving IP with Optimization Software)	- Examples of IP Formulation - Solving IP model using Optimization software (excel, LINDO/LINGO)	Ability to understand cases in IP problems and address them using optimization software	SGD, Tutorial	Presentation slide, literature references	IP Assignment
3	CPMK 1 CPMK 2	Goal Programming	- Concept of Goal Programming - Types of GP model - GP Formulation	Ability to identify and comprehend GP basics by comparing GP	SGD	Presentation slide, literature references	Exercises of GP problem

Week	Course Learning Outcomes	Topic	Sub Topic (literature)	Sub-Learning Outcomes (sub- CPMK)	Learning Method	Learning tools	Assessment Type
				and LP, to develop GP formulation, as well as understand technique solution in GP model			
4	CPMK 1 CPMK 2 CPMK 4 CPMK 5	Goal Programming (Exercises)	- Solving GP Formulation using geometric/graphical - Examples of GP using software	Ability to apply graphical methods to solve GP problems, and software application	SGD, Tutorial	Presentation slide, literature references	GP Assignment
5	CPMK 1 CPMK 2 CPMK 4	Evaluation 1	Integer Programming & Goal Programming		Online test		Quiz 1 & Discussion
6	CPMK 1 CPMK 2	Deterministic Dynamic Programming	- Concept of DP - Building DP formulation - Technique of DP (forward and backward approaches)	Ability to understand DP basics, develop DP formulation, and know the steps of problem solving in DP	SGD	Presentation slide, literature references	Exercise of DP problem
7	CPMK 1 CPMK 2 CPMK 4	Deterministic Dynamic Programming	- Examples of DP	Ability to understand DP cases, to	SGD, Tutorial	Presentation slide, literature references	DP Assignment

Week	Course Learning Outcomes	Topic	Sub Topic (literature)	Sub-Learning Outcomes (sub- CPMK)	Learning Method	Learning tools	Assessment Type
	CPMK 5		- Solving DP using manual methods and software	implement DP techniques using manual methods and software			
8	CPMK 1 CPMK 2	Evaluation 2	Integer Programming, Goal Programming, and Dynamic Programming		Online test		Mid-term Test (EBTS)
9	CPMK 1 CPMK 3	Game Theory	- Concept of GT - Types of games (zero-sum and non-zero sum) - Building payoff matrix in a game - Prisoner's dilemma	Ability to comprehend GT concept, identify types of game, and to develop payoff matrix in the game, and concept of Nash's Equilibrium	SGD	Presentation slide, literature references	Exercises of Game Theory
10	CPMK 1 CPMK 3 CPMK 4 CPMK 5	Game Theory	- Examples of GT - Solving GT model using some strategies for stable and unstable game (dominant, maximin-minimax criteria, etc.)	Ability to know Game Theory cases and apply some techniques using manual methods and software	SGD, Tutorial	Presentation slide, literature references	GT Assignment

Week	Course Learning Outcomes	Topic	Sub Topic (literature)	Sub-Learning Outcomes (sub- CPMK)	Learning Method	Learning tools	Assessment Type
			- Software application				
11	CPMK 1 CPMK 3	Markov Chain	- Stochastic Process - Markov Chain basics - Transition Matrix - Properties of Markov Chain	Ability to understand stochastic systems and markov chain basic, to develop transition matrix, and know properties of Markov Chain	SGD	Presentation slide, literature references	Exercises of Markov Chain
12	CPMK 1 CPMK 3 CPMK 4 CPMK 5	Markov Chain	- Steady state probability (long-run properties) - Mean First Passage Times - Examples of MC	Ability to determine steady state probability and mean first passage times, as well as know some MC cases	SGD, Tutorial	Presentation slide, literature references	MC Assignment
13	CPMK 1 CPMK 3 CPMK 4	Evaluation 3	Game Theory and Markov Chain		Online test		Quiz 2 and discussion
14	CPMK 1 CPMK 3	Queuing Theory	- Examples of queuing in daily life - Queuing factors	Ability to learn some cases in queuing system, identify some factors influencing	SGD	Presentation slide, literature references	Exercises of Queuing Theory

Week	Course Learning Outcomes	Topic	Sub Topic (literature)	Sub-Learning Outcomes (sub- CPMK)	Learning Method	Learning tools	Assessment Type
			- Basics and assumptions for queuing model	queuing system, and know some basics and assumptions for queuing model			
15	CPMK 1 CPMK 3 CPMK 4 CPMK 5	Queuing Theory	- Benefits and cost of queuing system configuration - Single server queuing system - Multiple server queuing system - Policy scenario to improve queuing system	Ability to analyze advantage and disadvantages of queuing system configuration, to simulate single and multiple server queuing model, as well as interpret the results for improvement	SGD, Tutorial	Presentation slide, literature references	QT Assignment
16	CPMK 1 CPMK 3	Evaluation 4	Game Theory, Markov Chain, and Queuing Theory		Online test		Final test (EBAS)

Note:

Metode Pembelajaran: menunjukkan berbagai **cara belajar yang dilakukan mahasiswa** terkait dengan satu topik atau sub topik, **bukan aktivitas yang dilakukan dosen**, menunjukkan variasi belajar berfokus pada siswa atau *Student Center Learning (SCL)* dan menunjukkan *blended learning*.

Opsi metode pembelajaran, bisa dilakukan secara individu maupun kelompok:

1. Small Group Discussion (SGD): ada topik diskusi kelompok, membahas/menyimpulkan, membuat rancangan kelompok, presentasi

2. Role-Play & Simulation (RPS): mempraktekkan berbagai model atau peran yang ditugaskan, menganalisis, presentasi
3. Discovery Learning (DL) : Mencari, mengumpulkan, dan menyusun informasi yang ada untuk mendeskripsikan suatu pengetahuan, laporan
4. Contextual Instruction (CI): melakukan studi lapangan / terjun di dunia nyata untuk mempelajari kesesuaian teori, presentasi
5. Project Based Learning (PBL): Mengerjakan proyek, menggali informasi (inquiry) untuk memecahkan masalah faktual, presentasi
6. Responsi/tutorial
7. Seminar/kuliah tamu

Sarana Pembelajaran: alat atau bahan yang digunakan untuk menunjang metode pembelajaran, selain ppt/pdf materi dari dosen.

Opsi sarana pembelajaran: study guide, prototype, video, case study

Bentuk Assessment: Quiz, homework (PR), exercise (tugas di kelas), ujian tulis, praktikum, presentasi

akan menghasilkan grade/penilaian, mhs akan diukur capaiannya melalui berbagai bentuk assessment, menjadi acuan dalam penyusunan RAE (Rancangan Assesment dan Evaluasi), serta RT (Rancangan Tugas)

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

No.	CPMK	Bobot CPMK	Bentuk Assessment	Bobot setiap assessment
1	CPMK 1	23%	Tugas	3%
			Quiz 1	5%
			EBTS	5%
			Quiz 2	5%
			EBAS	5%
2	CPMK 2	30%	Quiz 1	10%
			EBTS	20%
3	CPMK 3	30%	Quiz 2	10%
			EBAS	20%
4	CPMK 4	10%	Tugas	5%
			Quiz 1	2.5%
			Quiz 2	2.5%
5	CPMK 5	7%	Tugas	7%

HASIL EVALUASI PROSES DAN MATERI PEMBELAJARAN MK. OPERATIONS RESEARCH 2

Tanggal : 14 Desember 2021 Koordinator : Stefanus EW

Evaluator : Nurhadi Siswanto, Hafidz R

No	Deksripsi Permasalahan	Rencana Perbaikan	Jadwal Perbaikan	PIC
1	Penyampaian materi di kelas tidak selaras dengan RPS	Penyesuaian urutan materi perkuliahan dan realokasi distribusi materi	Jan 2022	ALL
2	Pemberdayaan peranan asisten	Asisten perlu diberi peranan yang lebih besar	Jan 2022	ALL
3	Materi terkait stochastic perlu diperkuat	Perlu pengulangan materi statistic?	Jan 2022	ALL
4	Pengayaan materi modeling dengan software optimasi: Lindo, Lingo atau Excel	Pengayaan pada tugas	Jan 2022	ALL
6	Evaluasi terkait pelaksanaan perkuliahan online	Perlunya feedback dari mahasiswa dan asisetn	Jan 2022	ALL
7	Penyesuaian RPS bila memasukkan unsur studi kasus	Perlu realokasi materi	Jan 2022	ALL