TU Dortmund University

Faculty of Electrical Engineering and Information Technology

Module Book Master Program Sustainable Energy Systems

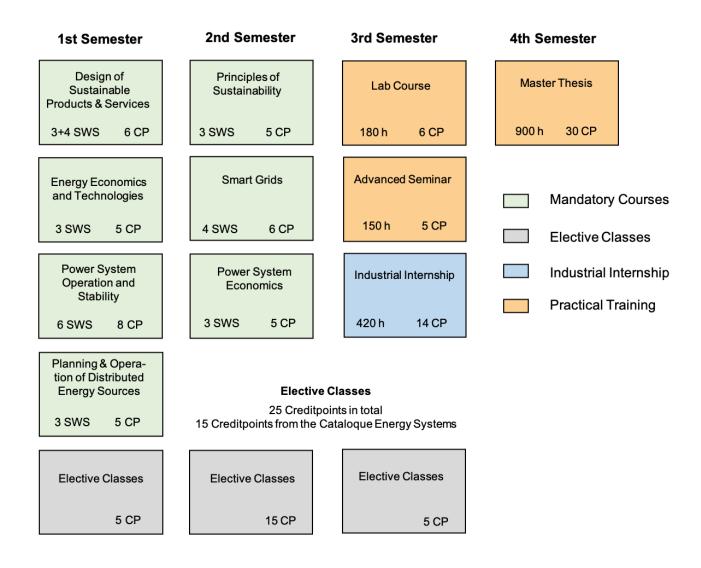
Aktualisierte Version gemäß Beschluss des Fakultätsrates vom 03.05.2023

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Version information

Structure of the Study Program



Mandatory Courses

Mandatory Courses

In the 1st and 2nd semesters, a total of 40 credit points in 7 modules must be successfully completed in the compulsory area.

Tu	rnus		Duration	Study section	СР	Attenda	ance rate	Self-stu	udy
An	nually a	at WS	1 semester	Xnd semester	6	75 h		105 h	•
1	Modu	ule structu	re						
	No.	Element	t / Course			LSF no.	Туре	LP	SWS
	1	Design o	of Sustainable Pr	roducts & Serv. Lectu	re	08 0035	V	3	2
	2	Design o	of Sustainable Pr	roducts & Serv. Exerci	se	08 0036	Ü	1	1
	3	Design o	of Sustainable Pr	roducts & Serv. Practi	cal Training	08 0037	Р	2	4
2	Cours	se languag	ge:			•			1
	Englis	sh							
3	Teacl	ning conte	nt of elements	1 and 2					
	1. De	sign proce	esses for produc	ts and services taking	into account :	sustainabili [.]	ty criteria		
				on and operation of pr					
	3. Ca	lculation a	nd Optimizing c	of CO2 footprints of pr	oducts and se	ervices			
	4. Pro	ofitability	evaluations (net	present value calcula	tion, investme	ent decision	s)		
	5. Su	stainability	y as part of the r	marketing of products	(incl. product	t life cycle,	pricing)		
	6. Or	ganization	of companies a	ind projects					
	7. Bu	siness star	t-up as an optio	n for implementing su	stainable proc	luct ideas			
	Teac	ning conte	nt of element 3						
	 Co 	mputer-ba			ted practical	course			
		•	ased business si	mulation as an integra	-		roduct or s	ervice off	fering
	• Cre	eation of a	ased business si		-		roduct or s	ervice off	fering
	• Cre Litera	eation of a nture	ased business sin business plan f	mulation as an integra or a self-selected, inn	ovative and su	ustainable p			C
	• Cre Litera Walk	eation of a iture er, Julia, A	ased business sin business plan f Ima Pekmezovio	mulation as an integra or a self-selected, inn c, and Gordon Walker	ovative and su Sustainable o	ustainable p developmer	nt goals: ha	arnessing	C
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Mo	dule N	I-2: Energy	Economics and	Technologies			S	ES-102
An	nester	n winter I le structu i	Duration 1 Semester	Study section 3. Semester	LP 5	Attendance rate 35 h	Self-st 115 h	udy
1	Nr.	Element	-			LSF no.	Тур	sws
	1			echnologies Lecture		08 xxxx	V	2
	2			echnologies Presentat	ions	08 xxxx	Ü	1
2		e language				00 /////	0	-
-	Englis		-					
	techn becor of te	ological, e ne familiar chnologies	conomic, social, with the conce	content of the cour and environmental c pts and tools of energ nents and strategies uitability.	hallenges re y economics	elated to energy tra and policy analysis.	nsitions. Th It covers a	ne studen diverse se
		k: Introduc	tion to Energy <i>I</i> II: Energy Efficie					
	instru	iments driv	ing the deployn	e course, students are nent of sustainable en al impacts of such pol	ergy solutio			
5	Exam	S						
	Modu	ıle Exam:						
	•		sentations (dat	te to be confirmed)				
	1		noint clides as "	dfinduding to be se	nt to tha in	structor a wook ab	and of the	
			point slides as p ation at the lat	odf including to be se est *	nt to the in	structor a week ah	ead of the	
	h IIA*	present	ation at the lat	est *				
6		present ates will be	ation at the lat	est * weeks after the start				
6		present ates will be	ation at the lat e published two nation and perf	est * weeks after the start	of the lectu			
	Form:	present ates will be s of examin Module E cipation ree	ation at the lat e published two nation and perf	est * weeks after the start ormance	of the lectu	re at the very latest		
6 7 8	Form Partic None Modu	present ates will be s of examin Module E cipation ree ale type an	ation at the lat <u>e published two</u> nation and perform xam quirements d usability of th	est * weeks after the start ormance	of the lectu Partial a	re at the very latest. chievements		
7	Form Partic None Modu Mand Modu	present ates will be s of examin Module E cipation red ule type an latory mod latory mod stefan Palz	ation at the lat e published two nation and perform xam quirements d usability of th ule in the Maste sor	est * weeks after the start ormance e module er's degree program S Faculty in	of the lectu Partial a ustainable E charge	re at the very latest. chievements		hnology

	rnus		Duration	Study section	LP	A++ 0	ndance rate	Self-stu	a)
	nually	at WS	1 Semester	1. Semester	8	70 h	inualice rate	170 h	uy
1		ule structu		1. Semester	0	7011		1/011	
	Nr.	Element					LSF no.	Тур	SWS
	1		•	and Stability Lecture			08 0146	V	4
	2	-		and Stability Exercise			08 0147	Ü	2
2		se languag					00011	U	-
;	-		nt of elements	1 and 2					
	1. Po 1.1. I 1.2 S 1.3 A 1.4 S 1.5 P 1 Fu 2. Po 2.1 S 2.2 C 2.3 S 2.4 F 2.5 V 2.6 N Litera	wer Syster ntroductio ystem arch lgorithms ubstation a ower syster uture trend tability in e oynamic po mall signal requency s oltage stat Aeasures to ature	m Supervision, in into electrical nitecture of pow for power syste automation and em protection fu ls in control cen m Stability, Dyn electrical power wer system mo and transient r stability pility and voltag p improve stabil	amics and Control systems delling and simulation otor angle stability e control ity	s operational t ters sion and opera re is for short circ	ation	d fault calculat	ion	
		•	•	ntrol by Kundur	_				
		•	•	sign by Overbye, Glove	er, Sarma				
ŀ		er System (petencies	Operations by C	onejo, Baringo					
	syste	m supervis	sion, control and	the module, the stude					•
5	analy Furth oper dyna Exan	vse the intenermore, the intenermore, the second seco	eraction of the s ney have knowle are able to cho iour and stabilit	grids from a security an upervision, control an edge about all kinds of pose the appropriate n y can be calculated an	nd economic p d protection c power system nodels for stab d analysed.	erspec ompor n stabil pility as	tive. The stude nents. ity necessary f sessment. Bas	or plannir ed on the	ole to ng and se, the
5	analy Furth oper- dyna Exan <i>Mod</i>	vse the intension nermore, the ation. They <u>mic behavi</u> ns ule examin	eraction of the s ney have knowle are able to cho iour and stabilit ation: oral exam	grids from a security an upervision, control an edge about all kinds of pose the appropriate n	nd economic p d protection c power system nodels for stab d analysed. utes) or written	n exam	tive. The stude nents. ity necessary f ssessment. Bas nination (max.	or plannir ed on the	ole to ng and se, the
5	analy Furth oper dyna Exan <i>Mod</i> *The Prüfu	vse the inter- nermore, the ation. They mic behavions ule examin exact exam ungsforme Module I	eraction of the s ney have knowle are able to cho iour and stabilit ation: oral exan mination modal n und -leistung Exam	grids from a security an supervision, control an edge about all kinds of pose the appropriate n y can be calculated an nination (max. 40 minu ities will be announced	nd economic p d protection c power system nodels for stab d analysed. utes) or written d by the 2nd co	erspec ompor n stabil ility as n exam	tive. The stude nents. ity necessary f ssessment. Bas nination (max.	or plannir ed on the	ole to ng and se, the
5	analy Furth oper dyna Exan Mod *The Prüfu X Parti None	vse the inter- nermore, the ation. They <u>mic behavi</u> ns ule examin exact exam ungsforme Module for cipation re	eraction of the s ney have knowle are able to cho iour and stabilit ation: oral exan mination modal n und -leistung Exam equirements	grids from a security an oupervision, control an edge about all kinds of pose the appropriate n y can be calculated an nination (max. 40 minu ities will be announced en	nd economic p d protection c power system nodels for stab d analysed. utes) or written d by the 2nd co	erspec ompor n stabil ility as n exam	tive. The stude nents. ity necessary f sessment. Bas nination (max. at the latest.	or plannir ed on the	ole to ng and se, the
5	analy Furth oper dyna Exan Mod *The Prüfu X Parti None Mod	vse the inter- nermore, the ation. They mic behavions ule examine exact examine exact examine module for cipation re- e ule type an	eraction of the s ney have knowle are able to cho iour and stabilit ation: oral exan mination modal n und -leistung Exam equirements nd usability of t	grids from a security an upervision, control an edge about all kinds of pose the appropriate n y can be calculated an nination (max. 40 minu ities will be announced en	nd economic p d protection c power system nodels for stab d analysed. utes) or written d by the 2nd co D Parti	erspec ompor n stabil vility as n exam <u>ourse a</u> al achi	tive. The stude nents. ity necessary f sessment. Bas nination (max. at the latest. evements	or plannir ed on the	ole to ng and se, the
5 6 7 8	analy Furth oper dyna Exan Mod *The Prüf u X Parti None Mod	vse the inter- nermore, the ation. They mic behavions ule examine exact examine exact examine module for cipation re- e ule type an	eraction of the s ney have knowle vare able to cho iour and stabilit ation: oral exan mination modal n und -leistung Exam equirements nd usability of t dule in the Mas	grids from a security an oupervision, control an edge about all kinds of pose the appropriate n y can be calculated an nination (max. 40 minu ities will be announced en	nd economic p d protection c power system nodels for stab d analysed. utes) or written d by the 2nd co D Parti	erspec ompor n stabil ility as n exam <u>ourse a</u> al achi ergy Sy	tive. The stude nents. ity necessary f sessment. Bas nination (max. at the latest. evements	or plannir ed on the	ole to ng and se, the

				n of Distributed Energ		Attandence		SES-104
	nus	at \//C	Duration	Study section	LP	Attendance	Self-st	uay
٩M	nually	at WS	1 Semester	3. Semester	5	rate 35 h	115 h	
L	Mod	ule structu	re			5511		
-	Nr.	Element				LSF no.	Тур	SWS
	1			Distributed Energy So		08 XXXX	V	2
	2	-		<u>.</u> .			Ü	
			•	Distributed Energy So	urces	08 XXXX	U	1
		se languag	e					
	Engli		-+					
}		hing conte				an tauranda CO		-l: f
				ndergoing a massive				
			-	cale power plants ar	-		•	-
		•		n new requirements for	•		•	••
		-		grids. Within this lect equirements for syste		-		
				ure is structured into				operatio
				entation of distribute				
			•	energy conversion ar	• • •			
				and protection of dist		gy conversion system	ns in low a	nd mediu
		oltage grid	-		induced energy	gy conversion system		nu meulu
				control strategies of co	nverter-bas	ed energy conversio	n	
				e economic efficiency				
		Jesign and			or ansembate		rsystems	
	Liter	ature						
			gv conversion s	ystems - 1st Edition, I	/uhammad	Kamran & Muhamm	ad Fazal. IS	BN:
		128235980						
l	Com	petencies						
	After	successful	completion of t	he module, the stude	nts know the	e process and the eff	ects of the	change
	from	a centralis	ed to a decentra	alised energy supply. ⁻	hey can clas	sify the associated e	ffects and	know a
	selec	tion of (teo	hnical control) r	measures to increase	the integration	on capability of dece	entralised e	energy
	conv	ersion plan	ts in the electric	cal distribution grids. I	urthermore,	, they are familiar wi	th the diffe	erent plar
	techi	nologies foi	r decentralised a	and regenerative elect	rical energy	conversion. They kn	ow the diff	erent
		•	•	otection concepts acc	-	••		•
		•	•	tralised energy conve	rsion plants s	afely, taking into ac	count the e	economic
	and t	echnical bo	oundary condition	ons.				
5	Exan							
	Mod	ule exam: c	oral exam (max.	30 minutes) or writte	n exam (max	. 90 minutes) *		
	*The			ties will be announced	by the 2nd	course at the latest.		
	_	ns ot exami	nation and perf	_	- ·			
;					Partial ad	chievements		
5	Form	Module E	xam	_				
	\mathbf{X}		axam quirements					
	区 Parti	cipation re	quirements	nowledge of the fund	amentals of	power engineering a	nd electric	al power
6 7	Parti Reco	cipation re mmended	quirements		amentals of	power engineering a	nd electric	al power
7	Parti Reco syste	cipation re mmended ms.	quirements prerequisites: K	nowledge of the fund	amentals of	power engineering a	nd electric	al power
7	Parti Reco syste	cipation re mmended ms. ule type ar	quirements prerequisites: K I d usability of th	nowledge of the fund			nd electric	al power
	Parti Reco syste Mod Man	cipation re mmended ms. ule type ar	quirements prerequisites: K I d usability of th Jule in the Mast	nowledge of the fund	ustainable E		nd electric	al power

	odul M	-5: Princip	les of Sustainabi	lity			SES	-105
Ro An ter	ually su	ummer	Duration 1 Semester	Semester 2nd Semester	Credits 5	Attendance 35 h	Self-stu 115 h	dy
1	Mod	ule structu	ire		•		•	
	Nr.	Courses				LSF no.	Туре	SWS
	1	Principle	es of Sustainabilit	Ξγ		08 XXXX	V	2
	2	Principle	es of Sustainabilit	Ξ γ		08 XXXX	Ü	1
2	Lang Engli	-				·		
	2. Le 3. Re 4. Ou 5. Cii 6. Cli 7. Su 8. So	ur CO2 foo rcular Ecor imate neut istainable s icial Respon ie Year 204	vork d Monitoring tprint omy in the conto- ral energy supply colutions for ener nsibility	ext of energy supply y and demand rgy systems (2 lecture	s)			
		petencies						
_	After susta fram level can c	iinability. T ework and s of sustair lerive the i	hey can put sust develop approp nability and their	, students have the ne ainable approaches a riate reporting and m necessary interactior chnology and process	nd solutions in onitoring meth is conveyed b	nto the context of t hods. The handling based on energy sy	he current of the diffe	erent
	After susta fram level can c Exam <i>Mod</i> <i>Exam</i>	inability. T ework and s of sustair derive the i hination ule exam: o hination pro	hey can put sust develop approp hability and their mpact of new te pral exam (max. erequisites: tbd	ainable approaches a riate reporting and m necessary interactior chnology and process 40 minutes) or writte	nd solutions in onitoring meth is conveyed b es on the path n exam (max. §	nto the context of t hods. The handling pased on energy sy n of sustainability. 90 minutes) *	he current of the diffe stems. The	erent
5	After susta fram level can c Exam <i>Mod</i> <i>Exan</i> * Th	inability. T ework and s of sustair derive the i hination ule exam: o hination pro- be exact ex	they can put sust develop approp hability and their <u>mpact of new te</u> pral exam (max. derequisites: tbd amination moda	ainable approaches a riate reporting and m necessary interactior chnology and process 40 minutes) or writte lities will be announce	nd solutions in onitoring meth is conveyed b es on the path n exam (max. §	nto the context of t hods. The handling pased on energy sy n of sustainability. 90 minutes) *	he current of the diffe stems. The	erent
5	After susta fram level can c Exam <i>Mod</i> <i>Exan</i> * Th	inability. T ework and s of sustair derive the i hination ule exam: o hination pro- be exact ex	hey can put sust develop approp hability and their <u>mpact of new te</u> oral exam (max. <i>erequisites:</i> tbd amination moda rmance of Exam	ainable approaches a riate reporting and m necessary interactior chnology and process 40 minutes) or writte lities will be announce	nd solutions in onitoring meth is conveyed b es on the path n exam (max. s ed at the latest	nto the context of t hods. The handling based on energy sy n of sustainability. 90 minutes) * t for the 2nd event	he current of the diffe stems. The	erent
5	After susta fram level can c Exan <i>Mod</i> <i>Exan</i> * Th Type	inability. T ework and s of sustair derive the i nination ule exam: o nination pro- e exact exa and Perfo	hey can put sust develop approp hability and their <u>mpact of new te</u> oral exam (max. <i>erequisites:</i> tbd <u>amination moda</u> rmance of Exam Exam	ainable approaches a riate reporting and m necessary interactior chnology and process 40 minutes) or writte lities will be announce ination	nd solutions in onitoring meth is conveyed b es on the path n exam (max. s ed at the latest	nto the context of t hods. The handling based on energy sy n of sustainability. 90 minutes) * t for the 2nd event	he current of the diffe stems. The	erent
5	After susta fram level can c Exan <i>Mod</i> <i>Exan</i> * Th Type X	inability. T ework and s of sustair derive the i nination ule exam: o nination pro- e exact exa and Perfo Module I ule prereq	hey can put sust develop approp hability and their <u>mpact of new te</u> oral exam (max. <i>erequisites:</i> tbd <u>amination modal</u> rmance of Exam Exam uisites	ainable approaches a riate reporting and m necessary interactior chnology and process 40 minutes) or writte lities will be announce ination	nd solutions in onitoring meth is conveyed b es on the path n exam (max. s ed at the latest Accumulat	ato the context of the hods. The handling based on energy sy a of sustainability. 90 minutes) * the for the 2nd event red grade	he current of the diffe stems. The	erent
4 5 6 7 8	After susta fram level can c Exam <i>Mod</i> <i>Exan</i> * Th Type X Mod Reco	inability. T ework and s of sustair derive the i nination ule exam: o nination pro- e exact exa and Perfo Module I ule prereq mmended	hey can put sust develop approp hability and their <u>mpact of new te</u> oral exam (max. <i>erequisites:</i> tbd <u>amination modal</u> rmance of Exam Exam uisites	ainable approaches a riate reporting and m necessary interactior chnology and process 40 minutes) or writter lities will be announce ination	nd solutions in onitoring meth is conveyed b es on the path n exam (max. s ed at the latest Accumulat	ato the context of the hods. The handling based on energy sy a of sustainability. 90 minutes) * the for the 2nd event red grade	he current of the diffe stems. The	erent
5 6 7	After susta fram level can c Exam <i>Mod</i> <i>Exan</i> * Th Type X Mod Reco Mod	inability. T ework and s of sustair derive the i nination ule exam: o nination pro- e exact exa and Perfo Module I ule prereq mmended ule type an datory mod	hey can put sust develop approp hability and their <u>mpact of new te</u> oral exam (max. <i>erequisites:</i> tbd <u>amination modal</u> rmance of Exam Exam uisites preconditions: K nd usability of th dule in the Maste	ainable approaches a riate reporting and m necessary interactior chnology and process 40 minutes) or writte lities will be announce ination	nd solutions in onitoring meth is conveyed b es on the path n exam (max. s ed at the latest Accumulat ciples of energ ustainable Ene	ato the context of t hods. The handling based on energy sy <u>a of sustainability.</u> 90 minutes) * t for the 2nd event red grade	he current of the diffe stems. The	erent
5 6 7	After susta fram level can c Exam Mod Exam * Th Type X Mod Reco Mod Mane	inability. T ework and s of sustair derive the i hination ule exam: o hination pro- e exact exa and Perfo Module I ule prereq mmended ule type an datory mod ule Superv	hey can put sust develop approp hability and their <u>mpact of new te</u> oral exam (max. <i>erequisites:</i> tbd <u>amination modal</u> rmance of Exam Exam uisites preconditions: K nd usability of th dule in the Maste	ainable approaches a riate reporting and m necessary interaction chnology and process 40 minutes) or writte lities will be announce ination	nd solutions in onitoring meth is conveyed b es on the path n exam (max. 9 ed at the latest d Accumulat ciples of energ ustainable Ene charge	ato the context of t hods. The handling based on energy sy <u>a of sustainability.</u> 90 minutes) * t for the 2nd event red grade	he current of the diffe stems. The	erent student

IVIC	dul M-6	: Smart G	rids					SES-106
An	nus nually at		Duration 1 Semester	Study section 2nd Semester	LP 6	Attendance rate 55 h	Self-st 125 h	udy
1		e structur				155 mg	Turn	CIN/C
		Element	ds Lecture			LSF no. 08 0102	Typ V	SWS
			ds Lecture ds Practical wo	rko		08 0102	P	3
<u> </u>				IKS		08 0103	P	
2	Englisc	e language h	1					
3	This co	 Energ New Election Convoltation State Congo Prote Times 	nandle the follo ay transition Distribution Gri ro-mobility. entional Distribu Estimation	ution Grid and their Tr nent (Voltage CM and ol functions nning	ransformatio	on	k:	
4	The stu • unde • comp • deve	rstand the prehend tl lop new se	e challenges in t ne multiple area	ng the course should codays and future elect as of research done in thes for energy system	trical energ the distribu	tion grids	ed knowle	dge
	Exams			701 K3				
5								
5	<i>Prereq</i> prereq	<i>uesites:</i> A uisite to p	ctive participati articipate in the	30 minutes) oder writ on in practical works (e examination	laboratory t	asks, presentations,		
5	Prerequ prereq * The r	<i>uesites:</i> A uisite to p	ctive participati articipate in the e lecturer will a	on in practical works (laboratory t	asks, presentations,		
	Prerequered prerequered * The r lecture Forms	uesites: Au uisite to p esponsibl at the ve of examir	ctive participati articipate in the e lecturer will a ry latest. nation and perfe	on in practical works (e examination nnounce the mode of ormance	laboratory t	asks, presentations, ation two weeks afte		
6	Prerequered prerequered * The r lecture Forms X Partici	uesites: Ad uisite to p esponsibl at the ve of examir Module E: pation rec	ctive participati articipate in the e lecturer will a ry latest. hation and perfe kam guirements	on in practical works (e examination nnounce the mode of	laboratory t	asks, presentations,		
5 6 7 8	Prerequered prerequered * The r lecture Forms X Particin Basic k Modul	uesites: A uisite to p esponsibl at the ve of examir Module E pation rec nowledge e type an	ctive participati articipate in the e lecturer will a ry latest. nation and perf kam juirements in Electrical En d usability of th	on in practical works (e examination nnounce the mode of ormance	laboratory t the examin Partial a	asks, presentations, ation two weeks afte chievements		

	odul M	-7: Power S	ystem Economi	cs				ETIT-224
	r nus nually a	at SS	Duration 1 Semester	Study section 2. Semester	LP 5	Attendance rate 35 h	Self-st 115 h	udy
1	Mod	ule structu	re					
	Nr.	Element	/ Course			LSF no.	Тур	SWS
	1	Power Sy	stem Economics	s Lecture		08 0227	V	2
	2	Power Sy	stem Economics	s Exercise		08 0228	Ü	1
2	Cours Deuts	se language	9					·
	3. Op 4. Un 5. Gri 6. Ma 7. Cra 8. Ne 9.Por 10. Ir	otimization iit Commitm id charges a odeling and oss-border twork cong tfolio optin	methods in the nent and transmission simulation of el electrical energy	lectricity markets and / trading capacities nent and redispatch of management	-			
	D. Kir		damentals of Po	ower System Economi	cs, Wiley			
	D. Kir Comp After strate grids syste the e Exam	rschen: Fun petencies successful egies in gric to energy s m economi lectricity in ns	completion, stu l-based energy s supply in econor ics to further dev dustry in genera	ower System Economi dents have a sound k supply. They are able nic and business cont velopments in the tec al, the special focus of 40 minutes) or writter	nowledge of to discuss th exts. They a hnical, mark this lecture	e technical constrain re able to apply thein ket and regulatory co is on the electrical n	nts from th knowledg ntext. In a	e power ge in powe ddition to
	D. Kir Comp After strate grids syste the e Exam Mode	rschen: Fun petencies successful egies in gric to energy s m economi lectricity in Is ule Exam: o	completion, stu d-based energy s supply in econor ics to further dev dustry in genera ral exam (max. 4	dents have a sound k supply. They are able nic and business cont velopments in the tec al, the special focus of 40 minutes) or writter	nowledge of to discuss th exts. They a hnical, mark this lecture n exam (max	e technical constrain re able to apply thein ket and regulatory co is on the electrical n k. 180 minutes) *	nts from th knowledg ntext. In a	e power ge in powe ddition to
5	D. Kir Comj After strate grids syste the e Exam Modu *The	rschen: Fun petencies successful egies in gric to energy s m economi lectricity in ns ule Exam: o exact exam	completion, stu d-based energy s supply in econor ics to further dev dustry in genera tral exam (max. 4 nination modalit	dents have a sound k supply. They are able nic and business cont velopments in the tec al, the special focus of 40 minutes) or written ies will be announcec	nowledge of to discuss th exts. They a hnical, mark this lecture n exam (max	e technical constrain re able to apply thein ket and regulatory co is on the electrical n k. 180 minutes) *	nts from th knowledg ntext. In a	e power ge in powe ddition to
5	D. Kir Comj After strate grids syste the e Exam Modu *The	rschen: Fun petencies successful egies in gric to energy s m economi lectricity in ns ule Exam: o exact exam	completion, stu d-based energy s supply in econor ics to further dev dustry in genera ral exam (max. 4 nination modalit nation and perfe	dents have a sound k supply. They are able nic and business cont velopments in the tec al, the special focus of 40 minutes) or written ies will be announcec	nowledge of to discuss th exts. They a hnical, mark this lecture n exam (max l by the 2nd	e technical constrain re able to apply thein ket and regulatory co is on the electrical n k. 180 minutes) *	nts from th knowledg ntext. In a	e power ge in powe ddition to
5	D. Kir Comp After strate grids syste the e Exam Modu *The Form	rschen: Fun petencies successful egies in gric to energy s m economi lectricity in is ule Exam: o exact exam s of examin Module E	completion, stu d-based energy s supply in econor ics to further dev dustry in genera ral exam (max. 4 nination modalit nation and perfo xam quirements	dents have a sound k supply. They are able nic and business cont velopments in the tec al, the special focus of 40 minutes) or writter ies will be announcec ormance	nowledge of to discuss th exts. They a hnical, mark this lecture n exam (max l by the 2nd Partial a	te technical constrain re able to apply their act and regulatory co is on the electrical n and the electrical n an	nts from th knowledg ntext. In a	e power ge in powe ddition to
5 6 7	D. Kir Comp After strate grids syste the e Exam Modu *The Form X Partic Reco	rschen: Fun petencies successful egies in gric to energy s m economi lectricity in is ule Exam: o exact exam s of exami Module E cipation ree mmended p ule type an	completion, stu d-based energy s supply in econor ics to further dev dustry in genera ral exam (max. 4 <u>nination modalit</u> nation and perfo xam quirements prerequisites: Kr d usability of th	dents have a sound k supply. They are able nic and business cont velopments in the tec al, the special focus of 40 minutes) or writter ies will be announced ormance	nowledge of to discuss th exts. They a hnical, mark this lecture n exam (max l by the 2nd Partial a s of power e	e technical constrain re able to apply their set and regulatory co is on the electrical n a 180 minutes) * course at the latest. chievements engineering	nts from th knowledg ntext. In a	e power ge in powe ddition to
4 5 6 7 8 9	D. Kir Comp After strate grids syste the e Exam Mode *The Form X Partic Reco Mode	rschen: Fun petencies successful egies in gric to energy s m economi lectricity in is ule Exam: o exact exam s of exami Module E cipation ree mmended p ule type an	completion, stu d-based energy s supply in econor ics to further dev dustry in genera ral exam (max. 4 nination modalit nation and perfor xam quirements prerequisites: Kr d usability of th lule in the Maste	dents have a sound k supply. They are able nic and business cont velopments in the tec al, the special focus of 40 minutes) or writter ies will be announced ormance	nowledge of to discuss th exts. They a hnical, mark this lecture n exam (max l by the 2nd Partial a s of power e ustainable E	e technical constrain re able to apply their set and regulatory co is on the electrical n a 180 minutes) * course at the latest. chievements engineering	nts from th knowledg ntext. In a	e power ge in powe ddition to

Elective Classes – Cataloque Energy Systems

Elective Classes

A total of 25 credit points must be successfully acquired in the compulsory elective modules (according to the study plan for semesters 1, 2 and 3).

15 of the 25 credit points are to be selected from the Energy Systems catalogue.

10 credit points are freely selectable.

Mo	dul 2-3	5: Selecte	d Chapters in Hi	gh Voltage Technolo	gy			ETIT-288
	r nus nually a	t SS	Duration 1 Semester	Study section 2nd Semester	LP 5	Attendance rate 35 h	Self-st 115 h	udy
1	Modu	le structu	re					
	Nr.	Element				LSF no.	Тур	SWS
	1			NVoltage Technology	(lecture)	08 0203	V	2
	2			N Voltage Technology		08 0204	Ü	1
2		e languag			(caconal)	00 020 1		-
2	Deuts							
3		ing conter	nt					
•		-	ts for high-volta	ge equipment				
			structure and d					
			stems for DC					
			nethods and tec	hnology trends				
		-	nd applications					
	Litera	•		·				
			age Engineering	Fundamentals,				
		•		ng - Fundamentals - 1	echnology - A	Applications		
4	Comp	etencies:						
	Stude	nts acquir	e detailed knowl	edge of selected ope	erating equipr	ment of power trans	mission sy	stems.
	They	are familia	r with the consti	ructive structure and	electrical de	sign and know the te	echnologica	al
				-voltage devices. The		•		
				ity assurance reasons				kamples
	and a	pplications	deepen the kno	owledge and establis	h the referen	ce to the operationa	al practice.	
5	Exam							
	Modi	ile Exam: o	oral exam (max. 4	10 minutes) or writte	n exam (max	. 180 minutes) *		
	***			:	ماله، بالمام			
6			nation modalit	ies will be announce	a by the 2nd	course at the latest.		
0		Module E	•		Dartial ar	chievements		
7			quirements	L				
'		•	•	ıfficient knowledge iı	n anarou tach	nology as can be ac	auirod o a	through
				e "Field and Network			quireu e.g.	tinough
8		•	d usability of th					
0				gree program Sustair	hable Energy	Systems. Energy Sys	tems Catal	loaue.
9		ile Supervi		Faculty ir		-,,, g, by		- 1
5		DrIng. Fra		•	-	igineering and Inforr	nation Tec	hnology
	FIUI.	unenng, rio		racuity 0				noiogy

Мо	dul 2-3	6: Automo	otive Systems					ETIT-291
Tur	nus		Duration	Study section	LP	Attendance	Self-stu	dv
	nually a	t SS	1 Semester	2nd Semester	5	rate	115 h	- 1
	,					35 h		
1	Modu	ile structui	re	·	·			
	Nr.	Element	/ Course			LSF no.	Тур	SWS
	1	Automot	ive Systems (lectu	ıre)		08 0008	V	2
	2	Automot	ive Systems (tuto	rial)		08 0009	Ü	1
2	Cours	e language	9			I		1
	Englis	ch						
3	Lehrin	nhalte						
	1	. Vehicle	dynamics (tires, l	ongitudinal and late	eral dynamics)		
	2	. Actuato	rs in the mechatr	onic vehicle (steeri	ng, braking, a	nd powertrain syste	ms)	
	3	. (Kinema	atic) vehicle mode	els				
	4	. Sensors	measuring vehic	e internal quantitie	s (acceleratio	on, yaw rate, steering	g angle, stee	ering
		torque,	wheel speed, ser	sor data processing	g)			
	5		•	s (braking and drivi		l systems)		
	6			ns and light enginee		, ,		
		ajamani: Ve	•	nd Control (Springe ve Control Systems	-			
4		etencies	Neisen. Automoti	ve control systems	(Springer)			
•	The st vehicl	tudents aco e dynamic	s quantities, actu	-	lation, contro	systems (dynamics, s bl, and optimization) ropriate methods.		-
5		le Exam: o) minutes) or writte	·	. 180 minutes) * course at the latest.		
6			und -leistungen		u by the zhu	course at the latest.		
0		Module E	-	Г	Dartial ar	chievements		
7			quirements	L				
,		-	-	ic knowledge of me	chatronics ar	nd mechanics		
8			d usability of the	•				
-			-		nable Energy	Systems, Energy Sys	tems Catalo	que.
9		-	sor of. h.c. Dr. h.c. To	rsten Faculty o	-	gineering and Inforr	nation Tech	nology

Mo	dul 3-2	28: Machin	e Learning in Ro	obotics				ETIT-27
Tu	nus		Duration	Study section	LP	Attendance rate	Self-s	tudy
An	nually	at SS	1 Semester	2nd Semester	5	35 h	115 h	-
1	Mod	ule structu	re					
	Nr.	Element	/ Course			LSF no.	Тур	SWS
	1	Machine	Learning in Rob	otics (lecture)		08 0808	V	2
	2	Machine	Learning in Rob	otics (tutorial)		08 0809	Ü	1
2	Cours	se language	e					
	Engli							
3		hing conter						
			s of Machine Lea	arning				
		onlinear Reg	•					
		eural Netwo						
		ep Learning						
	E Do	inforcemen	nt Learning					
			0					
	Litera	ature:	-					
	Litera Ian G	ature: oodfellow,	Yoshua Bengio,	Aaron Courville, Dee				
	Litera Ian G Richa	ature: oodfellow, ard Sutton, .	Yoshua Bengio, Andrew G. Barto	on, Reinforcement Le	arning an In	troduction, 2nd editior	i, MIT Pr	ess, 2018
	Litera Ian G Richa	ature: oodfellow, ard Sutton, .	Yoshua Bengio, Andrew G. Barto		arning an In	troduction, 2nd editior	i, MIT Pr	ess, 2018
4	Litera Ian G Richa ausge	ature: oodfellow, ard Sutton, .	Yoshua Bengio, Andrew G. Barto	on, Reinforcement Le	arning an In	troduction, 2nd editior	ı, MIT Pr	ess, 2018
4	Litera lan G Richa ausge	ature: oodfellow, ord Sutton, ewählte Ver petencies	Yoshua Bengio, Andrew G. Barto röffentlichunger	on, Reinforcement Le n aus Zeitschriften un	arning an In d Konferenz	troduction, 2nd editior		
4	Litera lan G Richa ausge Comj The s	ature: oodfellow, ard Sutton, s ewählte Ver petencies tudents acc	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor	arning an In d Konferenz etical conce	troduction, 2nd editior en	ations o	f machine
4	Litera lan G Richa ausge Comp The s learn	ature: oodfellow, ard Sutton, ewählte Ver petencies itudents acc ing in robot	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor	arning an In d Konferenz etical conce ine learning	troduction, 2nd edition en pts and practical applic	ations o	f machine
	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam	ature: oodfellow, ard Sutton, a ewählte Ver petencies atudents acc ing in robot ing with me is	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab	arning an In d Konferenz etical conce ine learning and ROS.	troduction, 2nd edition en pts and practical applic tasks for supervised a	ations o	f machine
	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam	ature: oodfellow, ard Sutton, a ewählte Ver petencies atudents acc ing in robot ing with me is	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach	arning an In d Konferenz etical conce ine learning and ROS.	troduction, 2nd edition en pts and practical applic tasks for supervised a	ations o	f machine
	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam Mode	ature: oodfellow, ard Sutton, a ewählte Ver petencies itudents acc ing in robot ing with me ing with me is ule Exam: o	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a <u>ethods and algo</u> ral exam (max. 4	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach <u>rithms within Matlab</u> 40 minutes) or writte	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma:	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) *	ations o	f machine
5	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam Modu *The	ature: oodfellow, ard Sutton, a ewählte Ver oetencies atudents acc ing in robot ing with me is ule Exam: o exact exam	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a <u>ethods and algo</u> ral exam (max <u>hination modalit</u>	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma:	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) *	ations o	f machine
5	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam Mode *The Prüfu	ature: loodfellow, ard Sutton, sewählte Ver petencies itudents acc ing in robot ing with me ule Exam: o exact exam ingsformer	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo ral exam (max <u>hination modalit</u> n und -leistunge	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced n	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma: d by the 2nd	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) * course at the latest.	ations o	f machine
5	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam Modu *The	ature: oodfellow, ard Sutton, a ewählte Ver oetencies atudents acc ing in robot ing with me is ule Exam: o exact exam	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo ral exam (max <u>hination modalit</u> n und -leistunge	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma: d by the 2nd	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) *	ations o	f machine
5	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam Modu *The Prüfu	ature: oodfellow, ard Sutton, s ewählte Ver petencies itudents acc ing in robot ing with me ing with me ule Exam: o exact exam ungsformer Module E	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo ral exam (max <u>hination modalit</u> n und -leistunge	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced n	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma: d by the 2nd	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) * course at the latest.	ations o	f machine
5	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam Modu *The Prüfu	ature: oodfellow, ard Sutton, a ewählte Ver petencies itudents acc ing in robot ing with me ing with me s ule Exam: o exact exam ingsformer Module E cipation ree	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo ral exam (max <u>nination modalit</u> n und -leistunge xam	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced n	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma: d by the 2nd	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) * course at the latest.	ations o	f machine
5 6 7	Litera Ian G Richa ausge Comp The s Iearn Iearn Exam Mode *The Prüfu X Partie None	ature: oodfellow, ard Sutton, a ewählte Ver petencies itudents acc ing in robot ing with me ing with me s ule Exam: o exact exam ingsformer Module E cipation ree	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo ral exam (max <u>nination modalit</u> n und -leistunge xam	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced n	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma: d by the 2nd	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) * course at the latest.	ations o	f machine
5 6 7	Litera lan G Richa ausge Comp The s learn learn Exam Modu *The Prüfu X Partie None	ature: oodfellow, ard Sutton, s ewählte Ver petencies itudents acc ing in robot ing with me ing with me s ule Exam: o exact exam ungsformer Module E cipation rece ule type an	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a ethods and algo ral exam (max. 4 <u>nination modalit</u> n und -leistunge xam quirements d usability of th	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced n	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma: d by the 2nd Partial a	troduction, 2nd edition en pts and practical applic tasks for supervised an x. 180 minutes) * course at the latest.	ations o nd reinfo	f machine rcment
4 5 6 7 8 9	Litera lan G Richa ausge Comp The s learn learn Exam Mode *The Prüfu X Partie None Elect	ature: oodfellow, ard Sutton, s ewählte Ver petencies itudents acc ing in robot ing with me ing with me s ule Exam: o exact exam ungsformer Module E cipation rece ule type an	Yoshua Bengio, Andrew G. Barto röffentlichunger quire a profound tics. Students a <u>ethods and algo</u> aral exam (max. 4 <u>hination modalit</u> n und -leistunge xam quirements d usability of th the Master's de	on, Reinforcement Le n aus Zeitschriften un d knowledge of theor re able to solve mach rithms within Matlab 40 minutes) or writte ties will be announced n	arning an In d Konferenz etical conce ine learning and ROS. n exam (ma: d by the 2nd D Partial a	troduction, 2nd edition en pts and practical applio tasks for supervised an x. 180 minutes) * course at the latest.	ations o nd reinfo	f machine rcment

Mo	dul 2-4	0 Distrib	uted and Networ	ked Control				ETIT-40			
Tur	nus		Duration	Study section	LP	Attendance	Self-st	udy			
Anı	nually a	at SoSe	1 Semester	2nd Semester	5	rate	115 h				
	1					35 h					
1		ule struct									
	Nr.		t / Course			LSF no.	Тур	SWS			
	1			ed Control (lecture)		08 0092	V	2			
	2	Distribu	ited and Network	ed Control (tutorial)	08 0093	Ü	1				
	3	Distributed and Networked Control (lab course) 08 0094 P									
2		se langua	ge								
	Englis										
3	Teach	ning conte	ent Element 1								
	Intro	duction to	a distributed cont	rol and networked sy	stoms						
	•		-physical systems	•	5101113						
		•	ation domains								
		oraic grap									
	•		•	eir description							
	•	 Directed graphs and their description Matrix representation of graphs 									
	 Analysis tools for graphs 										
	Conse	Consensus in multi-agent control									
	•	Control design for consensus									
	•	Convergence analysis									
		Leader-follower networks									
	Synch	nronisatio	n								
	•			tation of coupling stru	uctures						
	•	Linear and nonlinear settings									
	•		noto oscillators								
	•	Power-swing equations									
	Resea	arch outlo	ook and case stud	ies							
	Toac	ning cont	ont Flomonto 2 u	nd 3							
	Teaci	 Black board exercises, in class computer exercises 									
		Didek	50010 CACICISES, 1		CIGCG						
	Litera	Literature									
	Jan Li	unze, Net	worked Control o	f Multi-Agent System	s, Bookmun	do Direct, 2019, ISBN	: 9789463	867139			
	Franc	esco Bull	o, Lectures on Ne	twork Systems, 2Kind	le Direct Pul	blishing, 2019, ISBN:	978-19864	25643			
4	Comp	petencies									
				ate and to solve prob							
	-			. The students are abl		•	•	•			
	-			and system-theoreti	•	• •					
		•		ecentralized control s		•					
			nyze consensus p	henomena and synch	ronization m	nechanisms arising in	coupled sy	ystems.			
5	Exam	-	oral ovan (may	10 minutos) or writte	n ovan Ima	v = 180 minutes *					
	iviodi	ле Ехат:	orai exam (max.	40 minutes) or writte	n exam (ma	x. 180 minutes) *					
	*The	exact exa	mination modali	ties will be announced	by the 2nd	course at the latest					
6			en und -leistunge								
1	\mathbf{X}	Module	-	 Г	Partial a	chievements					

7	Participation requirements	
	Required prerequisites:	
	Basics of control engineering (sta	te space description, LQR control, Lyapunov functions)
	Basics of ordinary differential equ	uations
8	Module type and usability of the module	
	Elective Class in the Master's degree prog	ram Sustainable Energy Systems, Energy Systems Cataloque.
9	Module Supervisor	Faculty in charge
	Prof. DrIng. Timm Faulwasser	Faculty of Electrical Engineering and Information Technology

Мо	dul 2-	47: Practic	al Distrobuted C	ptimization in JULIA				ETIT-40
	nus Iually	at SoSe	Duration 1 Semester oder Block	Study section 2nd Semester	LP 5	Attendance rate 35 h	Self-study 115 h	
L	Mod	ule structu	ure					
	Nr. Element / Course					LSF no.	Тур	SWS
	1 Practical Distributed Optimization in julia (lecture)				08 0328	V	1	
	2	Practical	Distributed Opti	mization in julia (tuto	rial)	08 0329	Ü	2
	Cour	se languag	ge					
	Engli	sch						
	•	control an distribute problems implemen classroom Algorithm O Deco O Augu O Augu O Augu Applicatio hing conte Introduct	d optimisation d and decentrali tation of the op) s covered includ imposition of Sec mposition mented Lagrang nented Directior mented Lagrang n examples fron ent part 2 cion to JULIA	quential Quadratic P ian of Multipliers Meth ian Inexact Newton (n control and autom isation algorithms in	olving conve es in the pro rogramming ods (ADMIV ALADIN) ation	ex and non-convex c ogramming language g and Interior Point	optimisatio e julia (flip	on ped
	Boyd Statis Macl Berts	stical Learı hine Learn	ning via the Alter ing 3, Nr. 1 (2011 itri P., und John N	Chu, Borja Peleato, u nating Direction Meth): 1–122. N. Tsitsiklis. Parallel ar	od of Multip	oliers". Foundations a	and Trends	s® in
ŀ	Com	petencies						
	Stude with prob suita Stude in it. prob	ents are al the help o lems and t ble multi-a ents maste They have lems using	f mathematical n to transcribe ther agent approaches or the basics of th an overview of e	ntly solve problems o nethods. In particular n into abstract optim s, i.e. distributed and ne programming langu established methods t roaches for distribute	, they are ab sation probl decentralise lage julia and or solving co	le to analyse applica ems and solve them d optimisation meth d are able to solve op onvex and non-conve	tion-relate with the h ods. otimisatior ex optimisa	d elp of problem ition
5		ule Exam:	oral exam (max. <i>ments:</i> project w	30 minutes) * ork accompanying th	e lecture **			
	** Tł	ne course v	work is a prerequ	ies will be announced isite for participation				
5	Form	ns of exam Module	ination and perf ection	ormance	Partial a	chievements		

7	Participation requirements Recommended prerequisites: Prior knowledge of numerical optimisation				
8	Module type and usability of the mo Elective Class in the Master's degree	dule program Sustainable Energy Systems, <i>Energy Systems Cataloque</i> .			
9	Module Supervisor Prof. DrIng. Timm Faulwasser Lecturer DrIng. Alexander Engelmann	Faculty in charge Faculty of Electrical Engineering and Information Technology			

No	dul 2-4	18: Optim	al Power Flow P	roblems				ETIT-40	
	nus ually a	at SoSe	Duration 1 Semester	Study section 2nd Semester	LP 5	Attendance rate 35 h	Self-stu 115 h	ıdy	
L	Mod	ule struct	lire			5511			
•	Nr.		/ Course			LSF no.	Тур	SWS	
-	1			hlems (lecturer)		08 XXXX	V	2	
-	1Optimal Power Flow Problems (lecturer)08 XXXXV22Optimal Power Flow Problems (tutorial)08 XXXXÜ1								
2		se langua				00 ////	0	1	
<u>-</u>	Engli		se						
3		nhalte							
			f Optimal Power	Flow (OPF) in powers	vstems occu	rs in various formula	tions and v	variants i	
	•		•	ext, the lecture offers	•				
	The f	ollowing t	opics are covere	d:					
	•	Formul	ation of the OPF	⁼ problem in AC					
	•	Convex	approximation	s of the OPF problem					
	•	Stocha	stic formulation	s of the AC OPF prob	em				
	•			of the OPF problem f		sion and distribution	networks	:	
	-	•	ering storage dy	•					
	•			ns of the OPF problem					
	 Outlook on approaches for the coupling of electric grids and gas grids 								
	Literature Frank, Stephen, Ingrida Steponavice, and Steffen Rebennack. "Optimal power flow: a bibliographic survey I." Energy systems 3.3 (2012): 221-258. Frank, Stephen, Ingrida Steponavice, and Steffen Rebennack. "Optimal power flow: a bibliographic survey II." Energy systems 3.3 (2012): 259-289. Capitanescu, Florin. "Critical review of recent advances and further developments needed in AC optimal								
	•			tems Research 136 (2				spennar	
	•		,	ngelmann, Tillmann M	,	nd Veit Hagenmeyer	. "Optimal	power	
				ive, distributed and st	ochastic con	trol challenges." at-			
	Automatisierungstechnik 66, no. 7 (2018): 573-589.								
1		petencies	La sult to statist						
			• •	the module, the stud ey are able to recognis		-	-		
				help of suitable softwa		in types of OPP prot	10111	וטומנפ	
				udents have also gair		t into the diverse ap	plication po	ssibilitie	
			blem in energy te		- 0		- 1		
5	Exam								
	Parti	al achieve							
	•			ites) or oral exam (ma					
	_	Projec	6	nying the lecture with	written repo	ort *			
	•	-	t work accompar	lying the lettere with					
	* The moda	e overall g alities will	rade is formed fr be announced b	om the arithmetic me y the 2nd course at th	•	rtial grades. The exa	ct examina	tion	
5	* The moda	e overall g alities will	rade is formed fr be announced b ination and perf	om the arithmetic me y the 2nd course at th	e latest.	rtial grades. The exa	ct examina	tion	

7	Participation requirementsRecommended prerequisites: Prior knowledge of the fundamentals of electrical power engineering			
8	Module type and usability of the module Elective Class in the Master's degree prog	e gram Sustainable Energy Systems, Energy Systems Cataloque.		
9				

-	aul 3-3	3: Electric	Drive Systems					ETIT-28		
Annually at WS 1 Semester 3rd Se		it WS	Duration 1 Semester	Study section 3rd Semester	LP 5	Attendance rate 35 h	Self-study 115 h			
1	Modu	Module structure								
	Nr.	Element	/ Course			LSF no.	Тур	SWS		
	1 Electric Drive Systems (lecture)		cture)		08 0132	V	2			
	2		Drive Systems (tu			08 0133	Ü	1		
	3		Drive Systems (co	· · · · · · · · · · · · · · · · · · ·		08 0134	Р			
2	Cours	e languag		,						
_	Deuts		-							
3	Teaching content									
		-	re of electric driv	ve systems						
	2	. Principl	es and modeling	of electrical machine	es					
	3	. Variable	e speed operatio	on and position sensi	ng methods.					
	4	. Drive in	verters and mod	dulation techniques	-					
	Competencies After successful completion, students will be familiar with the essential properties of the electrical machines used in electric drive systems today and with their application in traction and industry. They are able to mathematically describe and design drive control systems consisting of electrical machines and drive inverters. They successfully apply the common methods for speed control including sensorless									
	mach able t drive	ines used i o mathem inverters.	in electric drive s atically describe	systems today and wi and design drive cor	th their appl trol systems	lication in traction an consisting of electric	d industry. cal machine	. They are es and		
5	mach able t drive opera Exam <i>Modu</i>	ines used i to mathem inverters. ition. s ile Exam: c	in electric drive s latically describe They successfull pral exam (max. 4	systems today and wi and design drive cor	th their appl trol systems methods for n exam (max	lication in traction an s consisting of electric speed control includ x. 180 minutes) *	d industry. cal machine	. They are es and		
5	mach able t drive opera Exam <i>Modu</i> <i>Cours</i> * The	ines used i to mathem inverters. <u>ation.</u> s <i>le Exam: c</i> <i>e achiever</i> exact exat	in electric drive s latically describe They successfull oral exam (max. 4 nents: Successful mination modali	systems today and wi and design drive cor y apply the common 40 minutes) or writte I completion of the la ties will be announce	th their appl trol systems methods for n exam (max b course atte d by the 2nc	lication in traction an s consisting of electric speed control includ k. 180 minutes) * empt in part 3.	d industry. cal machine ling sensor	. They are es and		
	mach able t drive opera Exam <i>Modu</i> <i>Cours</i> * The The c	ines used i to mathem inverters. Ition. s <i>ile Exam: c</i> <i>e achiever</i> exact exan ourse worl	in electric drive s hatically describe They successfull oral exam (max. 4 ments: Successful mination modali k is a prerequisit	systems today and wi and design drive cor y apply the common 40 minutes) or writte <i>I completion of the la</i> ties will be announce <u>e for participation in</u>	th their appl trol systems methods for n exam (max b course atte d by the 2nc	lication in traction an s consisting of electric speed control includ k. 180 minutes) * empt in part 3.	d industry. cal machine ling sensor	. They are es and		
	mach able t drive opera Exam <i>Modu</i> <i>Cours</i> * The The c	ines used i to mathem inverters. Ition. s <i>ile Exam: c</i> <i>e achiever</i> exact exan ourse worl	in electric drive s latically describe They successfull oral exam (max. 4 ments: Successful mination modali k is a prerequisit nation and perfe	systems today and wi and design drive cor y apply the common 40 minutes) or writte <i>I completion of the la</i> ties will be announce <u>e for participation in</u>	th their appl trol systems methods for n exam (max b course att d by the 2nd the Module	lication in traction an s consisting of electric speed control includ k. 180 minutes) * empt in part 3.	d industry. cal machine ling sensor	. They are es and		
6	mach able t drive opera Exam Modu Cours * The The c Form X Partic	ines used i to mathem inverters. <u>ation.</u> s <i>ile Exam: c</i> <i>e achiever</i> exact exam exact exam <u>ourse worl</u> s of exami Module E	in electric drive s latically describe They successfull oral exam (max. 4 ments: Successful mination modali k is a prerequisit nation and perfect xam quirements	systems today and wi and design drive cor y apply the common 40 minutes) or writte <i>I completion of the la</i> ties will be announce <u>e for participation in</u>	th their appl trol systems methods for n exam (max b course atto d by the 2nc the Module Partial a	lication in traction an s consisting of electric speed control includ k. 180 minutes) * empt in part 3. d course at the latest. Exam. chievements	d industry. cal machine ling sensor	. They are es and		
5 6 7 8	mach able t drive opera Exam Modu Cours * The The c Form X Partic Recoil	ines used i to mathem inverters. Intion. s <i>ule Exam: c</i> <i>e achiever</i> exact exan ourse worl s of exami Module E cipation re mmended ule type an	in electric drive s natically describe They successfull oral exam (max. 4 ments: Successful mination modali k is a prerequisit nation and perfe exam quirements prerequisites: Fund usability of th	systems today and wi and design drive cor y apply the common 40 minutes) or writte <i>I completion of the la</i> ties will be announce <u>e for participation in</u> prmance	th their appl trol systems methods for n exam (max b course atta d by the 2nd d by the 2nd the Module Partial a ical machine	lication in traction an s consisting of electric speed control includ k. 180 minutes) * empt in part 3. d course at the latest. Exam. chievements	d industry. cal machine ling sensor	. They are es and less		

Mo	odul 3-3	89: Nonlir	near Model Predi	ctive Control – Theor	y and Applic	ations		ETIT-297
	r nus nually a	at WS	Duration 1 Semester	Study section 3rd Semester	LP 10	Attendance rate 75 h	Self-st 225 h	udy
1	Mod	ule struct	ure			7511		
-	Nr.		t / Course			LSF no.	Тур	SWS
	1			ive Control – Theory a	and	08 0271	V	4
	-		tions (lecture)			00 02/1		
	2		ear Model Predict tions (tutorial)	ive Control – Theory a	and	08 0272	Ü	1
	3		ear Model Predict tions (lab course)	ive Control – Theory a	and	08 0273	Р	1
2	Cour Engli:	se langua	ge				1	L
	Mode	Gatea Pontry Indire Effiizie nced aspe Existe Dual v Singul Dissip ell predict Basics Suffici Econo Differe Desigr pok Stocha Stocha studies	ux derivative yagin Maximum P ct and direct solu ente derivative co ects of optimal co nce of optimal so ariables ar problems ativity and turnpi ive control of sar of MPC ent stability cond mic cost function ences of continuc n and implementa astic and robust N of MPC	tion methods imputation ntrol lutions ke properties npled-data systems litions with and witho is bus time and discrete ation aspects	time formula	ations		
	Teacl •	-	ent Elemente 2 u board and progra	nd 3 mming sessions (ca 2	0h at home a	and ca 10h in course))	
	Litera Chac	ature						PFL
4	Chachuat, Benoit. Nonlinear and dynamic optimization: From theory to practice. Lecture Notes EPFL Competencies The students are able to formulate and to solve problems of operation and control of technical systems of their own. The students are able to understand and to analyze the interplay of problem formulation and efficiency aspects of numerical solutions and to deduce problem-specific formulations. They know how to apply and to implement optimization methods to practical problems. Furthermore, the students can tack complex problems of predictive control by means of abstraction, they are able to document their results written form. The students are able to design predictive controllers for nonlinear systems and to validate them by mean						tion and w how to can tackle r results in	

5	Exams <i>Module Exam:</i> oral exam (max. 40 minutes) ** <i>Course achievements:</i> Elaboration of a project (simulation and optimisation, effort approx. 50h) and documentation of the results in report form (approx. 20 pages DIN A4).*
	** The exact examination modalities will be announced by the 2nd course at the latest.
6	Prüfungsformen und -leistungen
	Module Exam Partial achievements
7	 Participation requirements Necessary requirements: Basics of control engineering (state space description, LQR control, Lyapunov functions) Basics of ordinary differential equations Recommended prerequisites: Basic of optimization, Multivariate Control and Optimal Control
8	Module type and usability of the module
	Elective Class in the Master's degree program Sustainable Energy Systems, Energy Systems Cataloque.
9	Module Supervisor Faculty in charge
	Prof. DrIng. Timm Faulwasser Faculty of Electrical Engineering and Information Technology

	dul 3-	41: Machiı	ne Learning and	optimal Control				ETIT-50
-	r nus nually a	at WS	Duration 1 Semester oder Block	Study section 3rd Semester	LP 5	Attendance rate 35 h	Self-stu 115 h	udy
1	Module structure							
	Nr. Element / Course					LSF no.	Тур	SWS
	1 Machine Learning and optimal Control Vorlesung					08 XXXX	V	2
	2	Machine	Learning and op	otimal Control Übung		08 XXXX	Ü	1
2	Cour Engli	se languag sh	je					
	syste Learr learn Reinf (insb mode The a	m-theoret ning. Based ing, the fo forcement esondere / ell-prädikti Reinfo Hamilt contro Formu The fo Data-d application	ically and contro d on the fundam llowing topics ar Learning (dt. sel Ansätze der Ham ven Regelung rcement learnir on-Jacobi-Bellm l. lation on discre rmulation of sup lriven approach	bstverstärkendes Lerr nilton-Jacobi-Bellman- ng and its connection nan equation and dyr te and continuous st pervised deep learnir es to model-predictiv proaches is formally a	ed introduction een unsuper Gleichung un to optimal of amic progra ate spaces ng as an option re control fo	on to different aspectivised, supervised an ne Verbindung zur op nd des Dynamic Prog control (especially a amming) and to mo mal control problem r linear systems	ets of Mach d self-reinf otimalen Re gramming) o pproaches del-predict	ine forcing egelung und zur s of the tive
	Bishc	•	-	on and machine learn gestellte Forschungsa		, 2006.		
4	After meth the d softw They learn	nods and th lifferent ty vare tools. are able to ing. They a	neir use in contro pes of learning p o explain the fun	the module, the stud ol engineering applica problems, formulate tl udamental relationship	tion contexts nem and solv os between c	. In particular, they we them with the hel optimal control and s	are able to p of suitabl self-reinfore	recognise le cing
	proce engir	edures so t	the numerical sc hat they can int amples, the stud	ormulate problems of olution, the students a erpret and evaluate so ents have also gained	re familiar w olutions from	rith basic algorithmic software tools. Usin	structures ng control	and
5	proce engir mach Exam Parti	edures so t neering exa nine learnin ns al achieven Written	the numerical so that they can intra mples, the stud ng. ments: n exam (90 minu	olution, the students a erpret and evaluate so ents have also gained utes) or oral exam (ma	re familiar w olutions from an insight in x. 30 minute	vith basic algorithmic n software tools. Usin to the diverse applic	structures ng control ation possi	and
5	proce engir mach Exam Parti * The	edures so t neering exa nine learnin ns al achieven Written e exact exa	the numerical so that they can intra mples, the stud ng. ments: n exam (90 minu	olution, the students a erpret and evaluate so ents have also gained ites) or oral exam (ma ities will be announce	re familiar w olutions from an insight in x. 30 minute	vith basic algorithmic n software tools. Usin to the diverse applic	structures ng control ation possi	and

7	Participation requirements			
	Recommended prerequisites: Previous knowledge of Fundamentals of Optimal Control (LQR) or numerical			
	optimisation; state space representation and difference equations.			
8	Module type and usability of the module			
	Elective Class in the Master's degree prog	ram Sustainable Energy Systems, Energy Systems Cataloque.		
9	Module Supervisor	Faculty in charge		
	Prof. DrIng. Timm Faulwasser	Faculty of Electrical Engineering and Information Technology		

Elective Classes

Elective Classes

A total of 25 credit points must be successfully acquired in the compulsory elective modules (according to the study plan for semesters 1, 2 and 3).

15 of the 25 credit points are to be selected from the Energy Systems catalogue.

10 credit points are freely selectable.

Mo	dul 2-1	L4: 3D Compu	ter Vision					ETIT-233		
-	mus nually a		Duration Semester	Study section 2nd Semester	LP 5	Attendance rate 35 h	Self-st 115 h	udy		
1	Mod	odule structure								
-	Nr.	Element / C	ourse		LSF no.			SWS		
	1	-	er Vision (lecti	ure)			Typ V	2		
	2		er Vision (tuto			08 0260	Ü	1		
2	Course language									
	Englis									
	3. de 4. int 5. me 6. pra Litera	termination of roduction to 3 ethods for 3D f actical applicat ature	f point corresp D reconstruct reconstructior tion examples	veral camera images condences cion methods based o n of surfaces based o from current resear erman: Multiple View	on projective n their reflec ch	e geometry ctive properties				
4	After proce stude	essing, photog ents can classif	rammetry and y tasks for sys	e module, the stude d the linear and non- stems for 3D scene re ndependently selecte	inear optimi constructio	isation methods req	uired for th			
5	solve them independently with independently selected methods. Exams Module Exam: oral exam (max. 40 minutes) or written exam (max. 180 minutes) *									
<u> </u>	* The exact examination modalities will be announced by the 2nd course at the latest. Forms of examination and performance									
6			•		Partial a	chievements				
	Image: Module Exam Image: Partial achievements Participation requirements Recommended prerequisites: Good knowledge of linear algebra as well as linear and non-linear optimisation.									
7	Reco optin	nisation.		-	ar algebra a	is well as linear and i	non-linear			
7 8	Reco optin Mod	nisation. ule type and u	isability of the	-			non-linear			

	dul 2-1	L6: Schedul	ling Problems an	d Solutions				ETIT-235	
	nus nually a	at SS	Duration 1 Semester	Study section 2nd Semester	LP 10	Attendance rate 80 h	Self-st 220 h	udy	
1	Module structure								
	Nr.	Element	/ Course			LSF no.	Тур	SWS	
	1	Schedulir	ng Problems and	Solutions (lecture)		08 0385	V	4	
	2	Schedulir	ng Problems and	Solutions (tutorial)		08 0386	Ü	2	
	3	Schedulir	ng Problems and	Solutions (lab course)	08 0387	Р	1	
2		se language	e						
3	Englis		nt part 1 und 2						
	tot 4. On 5. Pai pro 6. Flo	al tardines lline proble rallel mach oblems wwshop, jol	is and a non-regu ems in single mac ine environment b shop, and oper		, a simple bi	criterial problem			
4	461-4 Comp	CPLEX ature ael Pinedo: 1986-0, 20 Detencies	: Scheduling - The 012	eory, Algorithms and	Systems, 4th		erlag, ISBN	l: 978-1-	
4	Litera Micha 461-4 Comp After their	CPLEX ature ael Pinedo: 1986-0, 20 Detencies successful processing	Scheduling - The 12 completion, the . They are able to		Systems, 4th scheduling p ethods with	edition, Springer Vor roblems and apply s regard to their effic	erlag, ISBN suitable m iency and	l: 978-1- ethods for	
4	Litera Micha 461-4 Comp After their new s Exam Modu Study	Ature ael Pinedo: 1986-0, 20 Detencies successful processing solution me solution me ule Exam: o v achieveme	Scheduling - The 212 completion, the . They are able to ethods for compl oral exam (max. 4 ents: Successful o	eory, Algorithms and students can classify o evaluate solution m ex scheduling problem	Systems, 4th scheduling p ethods with ns on the ba rse lab in pa	edition, Springer Vo roblems and apply regard to their effic sis of classical meth rt 3.	erlag, ISBN suitable m iency and	l: 978-1- ethods for	
	Litera Micha 461-4 Comp After their new s Exam Modu Study The c	Ature ael Pinedo: 1986-0, 20 Detencies successful processing solution me solution me ule Exam: o v achieveme ourse work	completion, the completion, the They are able to ethods for compl oral exam (max. 4 ents: Successful of sis a prerequisite nation and perfo	eory, Algorithms and s students can classify o evaluate solution m ex scheduling problem 0 minutes) * completion of the cou e for participation in t	Systems, 4th scheduling p ethods with ns on the ba rse lab in pa he Module E	edition, Springer Vo roblems and apply regard to their effic sis of classical meth rt 3.	erlag, ISBN suitable m iency and	l: 978-1- ethods for	
5	Litera Micha 461-4 Comp After their new s Exam Modu Study The c Form X Partic Recon funda	Ature ael Pinedo: 1986-0, 20 Detencies successful processing solution me solution me achieveme ourse work s of examin Module E Cipation ree amended parentals of	Scheduling - The 212 completion, the They are able to ethods for compl oral exam (max. 4 ents: Successful of c is a prerequisite nation and perfor xam quirements prerequisites: Go f algorithms.	eory, Algorithms and s students can classify o evaluate solution m ex scheduling probler 0 minutes) * completion of the cou e for participation in t ormance	Systems, 4th scheduling p ethods with ns on the ba rse lab in pa he Module E Partial ac	edition, Springer Vo roblems and apply s regard to their effic sis of classical meth rt 3. xam. hievements	erlag, ISBN suitable m iency and iods.	l: 978-1- ethods for	
5	Litera Micha 461-4 Comp After their news Exam Modu Study The c Form X Partic Recon funda Modu	Ature ael Pinedo: 1986-0, 20 Detencies successful processing solution me solution me solution me de Exam: of achieveme ourse work s of examin Module E cipation ree mmended pamentals of ule type an	completion, the completion, the They are able to ethods for completion oral exam (max. 4 ents: Successful of cis a prerequisite nation and perfor ixam quirements prerequisites: Go f algorithms. Id usability of the	eory, Algorithms and s students can classify o evaluate solution m ex scheduling probler 0 minutes) * completion of the cou e for participation in t ormance	Systems, 4th scheduling p ethods with ns on the ba rse lab in pa he Module E Partial ac damentals o	edition, Springer Ve roblems and apply s regard to their effic sis of classical meth rt 3. xam. hievements f discrete mathema	erlag, ISBN suitable m iency and iods.	l: 978-1- ethods for	

Mo	odul 2-1	L9: Local N	etworks – Comn	nunication and Contr	ol			ETIT-23			
-	r nus nually a	at SS	Duration 1 Semester	Study section 2nd Semester	LP 5	Attendance rate 35 h	Self-stu 115 h	ıdy			
1	Mod	ule structu	re			5511					
-	Nr.	Element				LSF no.	Тур	SWS			
	1		-	inication and Control	(lecture)	08 0802	V	2			
	2			inication and Control	. ,	08 0803	Ü	1			
2	Cours Englis	se language sch	e		<u> </u>						
	2. sys 3. sys	 basics of networks: technical concepts and applications system examples of wired networks: CAN bus, Ethernet, USB system examples of wireless networks: WLAN, Bluetooth, Zigbee 									
	Literature										
			- 1								
	Surge	eon: Ethern									
	Surge Rech Mille	eon: Ethern : Wireless L r, Bisdikian		ealed							
4	Surge Rech Mille Comp After with	eon: Ethern : Wireless L r, Bisdikian Detencies successful regard to tl	ANs : Bluetooth Reve completion, the heir performanc	ealed students are able to e, understand existin f the technology.		•					
	Surge Rech Mille Comp After with curre Exam Mode	eon: Ethern : Wireless L r, Bisdikian oetencies successful regard to th nt further o successful regard to th nt further o	ANs : Bluetooth Reve completion, the heir performanc developments or oral exam (max. 4	e students are able to e, understand existin f the technology. 40 minutes) or writte	g standards a n exam (max.	nd build systems as 180 minutes) *	well as ass				
5	Surge Rech Mille Comp After with curre Exam Modu * The	eon: Ethern : Wireless L r, Bisdikian Detencies successful regard to th nt further of s ule Exam: o e exact exar	ANs : Bluetooth Reve completion, the heir performanc developments or oral exam (max. 4	e students are able to e, understand existin f the technology. 40 minutes) or writte ties will be announce	g standards a n exam (max.	nd build systems as 180 minutes) *	well as ass				
5	Surge Rech Mille Comp After with curre Exam Modu * The	eon: Ethern : Wireless L r, Bisdikian Detencies successful regard to th nt further of s ule Exam: o e exact exar	ANs : Bluetooth Reve completion, the heir performanc developments o vral exam (max. 4 mination modali nation and perfo	e students are able to e, understand existin f the technology. 40 minutes) or writte ties will be announce	g standards a n exam (max. d by the 2nd	nd build systems as 180 minutes) *	well as ass				
5	Surge Rech Mille Com After with curre Exam Modu * The Form	eon: Ethern eon: Ethern Wireless L r, Bisdikian betencies successful regard to th nt further of s ule Exam: of e exact exar s of examin Module E cipation re	ANs : Bluetooth Reve completion, the heir performanc developments o vral exam (max. 4 mination modali nation and perfo	e students are able to e, understand existin f the technology. 40 minutes) or writte ties will be announce ormance	g standards a n exam (max. d by the 2nd	nd build systems as 180 minutes) * course at the latest	well as ass				
5 6 7	Surge Rech Mille Comp After with curre Exam Modu * The Form X Partic None	eon: Ethern Wireless L r, Bisdikian Detencies successful regard to the nt further of ule Exam: of e exact exar s of examine Module E cipation reference	ANS Bluetooth Reve completion, the heir performanc developments or oral exam (max. 4 <u>mination modali</u> nation and perfor xam quirements	e students are able to e, understand existin f the technology. 40 minutes) or writte ties will be announce ormance	g standards a n exam (max. d by the 2nd Partial ac	nd build systems as 180 minutes) * course at the latest hievements	well as ass				
4 5 6 7 8 9	Surge Rech Mille Comp After with curre Exam Modu * The Form X Partie None Electi	eon: Ethern Wireless L r, Bisdikian Detencies successful regard to the nt further of ule Exam: of e exact exar s of examine Module E cipation reference	ANS : Bluetooth Reve completion, the heir performanc developments or oral exam (max. 4 mination modali nation and performant xam quirements id usability of th the Master's de	e students are able to e, understand existin f the technology. 40 minutes) or writte ties will be announce ormance	g standards a n exam (max. d by the 2nd Partial ac able Energy S	nd build systems as 180 minutes) * course at the latest hievements	well as ass				

Мо	dul 3-2	0: Mobile	Roboter					ETIT-269
Tur Anr	nus nually a	t SoSe	Duration 1 Semester	Study section 2nd Semester	LP 5	Attendance rate 50 h	Self-st 100 h	udy
1	Modu	le structu	re					
	Nr.	Element	/ Course	LSF no.	Тур	SWS		
	1	Mobile R	oboter (lecture)			08 0154	V	2
	2	Mobile R	oboter (tutorial)			08 0155	Ü	2
2	Cours Englis	e languag o ch	9					
3		ing conter	nt					
	2. 3. 4. 5. 6. 7. 8. 9.	Robotic Sensors Homing Obstacl Localisa Path pla Navigat Online	g and trajectory f le avoidance (Ve ation anning (Rapidly)	x Matlab kinematics of mobile ollowing ector Field Histogram Exploring Random Tr t, ROS Navigation Sta	is) ees, Proba	abilistic Roadmap)		
4	- Sicili - ausg Comp The st	ano, Khati ewählte A etencies cudents acc	quire a profound	book of Robotics Robotik aus Konfere knowledge of fundam mobile robotic tasks	ental conc	epts and practical ex	•	
	localiz	ation in a	self-dependent m	anner with selected i	nethods ar	nd algorithms in ROS	/Matlab.	
5	Study • The co	le Exam: o achievemo Success mobile ourse work	ents: ful completion of robots. < is a prerequisite) minutes) or written at least 75% of the p for participation in th	actical exe	ercises in ROS/Matlal Exam.		amming
				es will be announced	by the 2nd	course at the latest		
6	Forms	of exami Module E	nation and perfor xam	mance	Partial a	chievements		
7	Partic None	ipation re	quirements					
8			d usability of the the Master's deg	module ree program Sustaina	ble Energy	Systems.		
9		l le Supervi rof. Dr. rer	i sor . nat. Frank Hoffn	Faculty in c nann Faculty of E	-	ngineering and Inform	nation Tecl	hnology

_	odul 2-34: Re	mote Sensing						ETIT-2								
ſu	rnus	Duration	Study section	LP	Att	endance ra	te	Self-study								
٩n	nually at SS	1 Semester	2nd Semester	5	35	h		115 h								
L	Module st	Module structure														
	Nr. Element / Cour				LSF no.	Т	ур	sws								
	1	Remote Sensing (lea	cture)		08 0243	V	1	2								
	2	Remote Sensing (tu	torial)		08 0244	Ü	j	1								
2	Course lan	guage English				•										
3	Lehrinhalt	e														
	1. sensor	systems for taking a	erial and satellite imaged	ges												
	2. proper	ties of aerial and sat	ellite images in differe	nt spectral r	anges											
			nospheric and topogra	•												
		•	image data in remote													
		•	spectral data in remo	-												
		-	encing and coregistra			llite imager	·у									
			nulti- and hyperspectr	• •	ata											
	-	cal application examp	les from current resea	ircn												
	Literature	ordt PA·PomotoSo	nsing: Models and Mo	thods for In	and Proc	occing 2rd	Editi	ion Acadomic								
	-		insing. Models and Me		lage Ploc	essing. Siu	Schowengerdt, R.A.: Remote Sensing: Models and Methods for Image Processing. 3rd Edition, Academic									
a	Press, 2007.															
4	Competencies After successful completion of the module, the students master the essential basics of remote sensing as															
+	•		he module, the stude	nts master t	he essent	ial basics of	frem	note sensing as								
4	After succe	essful completion of t	he module, the stude pressing methods requ					-								
4	After succe well as the	essful completion of t signal and image pro		ired for this	. The stud	dents can cl	assif	y tasks for								
4	After succe well as the remote ser	essful completion of t signal and image pro	pcessing methods required ifferent application are	ired for this	. The stud	dents can cl	assif	y tasks for								
	After succe well as the remote ser	essful completion of t signal and image pro nsing systems from d	pcessing methods required ifferent application are	ired for this	. The stud	dents can cl	assif	y tasks for								
4 5	After succe well as the remote ser independe Exams	essful completion of t signal and image pro nsing systems from d ntly selected methoo	ocessing methods required ifferent application are	iired for this eas and solv	. The stud e them in	dents can cl dependent	assif	y tasks for								
	After succe well as the remote ser independe Exams Module Ex	essful completion of t signal and image pro- nsing systems from d ntly selected methoc am: oral exam (max.	ocessing methods requ ifferent application and ds. 40 minutes) or writter	ired for this eas and solv n exam (max	. The stud e them in . 180 min	dents can cl dependent utes)*	assif ly wi	y tasks for								
	After succe well as the remote ser independe Exams <i>Module Ex</i> * The exa	essful completion of t signal and image pro nsing systems from d ntly selected method am: oral exam (max. ct examination mo	ocessing methods requ ifferent application ard ds. 40 minutes) or writter odalities will be ann	ired for this eas and solv n exam (max	. The stud e them in . 180 min	dents can cl dependent utes)*	assif ly wi	y tasks for								
	After succe well as the remote ser independe Exams <i>Module Ex</i> * The exa Forms of e	essful completion of t signal and image pro- nsing systems from d ntly selected method am: oral exam (max. ct examination mo xamination and perf	ocessing methods requ ifferent application ard ds. 40 minutes) or writter odalities will be ann	ired for this eas and solv n exam (max	. The stud e them in . 180 min	dents can cl dependent utes)*	assif ly wi	y tasks for								
5	After succe well as the remote ser independe Exams <i>Module Ex</i> * The exa Forms of e	essful completion of t signal and image pro nsing systems from d ntly selected method am: oral exam (max. ct examination mo	ocessing methods requ ifferent application ard ds. 40 minutes) or writter odalities will be ann	ired for this eas and solv n exam (max ounced by	. The stud e them in . 180 min	dents can cl dependent utes)* course at	assif ly wi	y tasks for								
5	After succe well as the remote ser independe Exams Module Ex * The exa Forms of e X Moo Participati	essful completion of t signal and image pro- nsing systems from d ntly selected method am: oral exam (max. ct examination mo xamination and perf dule Exam on requirements	ocessing methods requ ifferent application and ds. 40 minutes) or writter odalities will be ann formance	ired for this eas and solv n exam (max ounced by Partial a	. The stud e them in . 180 min the 2nd chieveme	dents can cl dependent utes)* course at nts	assif ly wi	y tasks for the second se								
5	After succe well as the remote ser independe Exams <i>Module Ex</i> * The exa Forms of e X Moo Participati Recommen	essful completion of t signal and image pro- nsing systems from d ntly selected method am: oral exam (max. ct examination mo xamination and perf dule Exam on requirements nded knowledge: Suff	ocessing methods requ ifferent application ard ds. 40 minutes) or writter odalities will be ann	ired for this eas and solv n exam (max ounced by Partial a	. The stud e them in . 180 min the 2nd chieveme	dents can cl dependent utes)* course at nts	assif ly wi	y tasks for the second se								
5 6 7	After succe well as the remote ser independe Exams <i>Module Ex</i> * The exa Forms of e X Moo Participati Recomment image proof	essful completion of t signal and image pro- nsing systems from d ntly selected method am: oral exam (max. ct examination mo xamination and perf dule Exam on requirements nded knowledge: Suff cessing	ocessing methods requ ifferent application and ds. 40 minutes) or writter odalities will be ann formance	ired for this eas and solv n exam (max ounced by Partial a	. The stud e them in . 180 min the 2nd chieveme	dents can cl dependent utes)* course at nts	assif ly wi	y tasks for the second se								
5	After succe well as the remote set independe Exams <i>Module Ex</i> * The exa Forms of e X Mod Participati Recommen image proo	essful completion of t signal and image pro- nsing systems from d ntly selected method am: oral exam (max. ct examination mod xamination and perf dule Exam on requirements nded knowledge: Suff cessing pe and usability of th	ocessing methods requisifferent application and states application and states are specified or writter odalities will be ann formance ficient knowledge in base module	ired for this eas and solv n exam (max ounced by Partial a asics of elect	. The stud e them in . 180 min the 2nd chieveme trical engi	dents can cl dependent utes)* <u>course at</u> nts neering, sig	assif ly wi	y tasks for the second se								
5 6 7	After succe well as the remote set independe Exams <i>Module Ex</i> * The exa Forms of e X Mod Participati Recommen image proo	essful completion of t signal and image pro- nsing systems from d ntly selected method am: oral exam (max. ct examination mod xamination and perf dule Exam on requirements nded knowledge: Suff cessing pe and usability of th	ocessing methods requ ifferent application and ds. 40 minutes) or writter odalities will be ann formance	ired for this eas and solv n exam (max ounced by Partial a asics of elect	. The stud e them in . 180 min the 2nd chieveme trical engi	dents can cl dependent utes)* <u>course at</u> nts neering, sig	assif ly wi	y tasks for the second se								
5 6 7	After succe well as the remote ser independe Exams <i>Module Ex</i> * The exa Forms of e X Mod Participati Recommen image proof Module ty Elective Cla	essful completion of t signal and image pro- nsing systems from d ntly selected method am: oral exam (max. ct examination mo xamination and perf dule Exam on requirements nded knowledge: Suff cessing pe and usability of th ass in the Master's de	ocessing methods requirifferent application and states application and states are special or writter odalities will be ann formance ficient knowledge in base of the module appression program Sustain Faculty in Faculty in the species of the specie	ired for this eas and solv n exam (max ounced by Partial a asics of elect able Energy charge	. The stud e them in . 180 min the 2nd chieveme trical engi Systems.	dents can cl dependent utes)* <u>course at</u> nts neering, sig	assif ly wi the	y tasks for the second se								

M	odul 2-4	42: Hardv	ware Software C	odesign				ETIT-40			
Tu	rnus		Duration	Study section	LP	Attendance rate	Self-st	udy			
An	nually a	at SS	1 Semester	2nd Semester	10	70 h	230 h	•			
1	Modu	le struct	ure								
	Nr.	Elemen	t / Course			LSF no.	Тур	SWS			
	1	Hardwa	are Software Coo	design (Lecture)		08 0316	V	3			
	2	Hardwa	are Software Coo	design (Tutorial)		08 0317	Ü	1			
	3	Hardwa	are Software Coo	design (Practical Exerc	ise)	08 XXXX	Р	2			
2	Cours	e langua									
	Englis	-	-								
3	Teach	ning cont	ent								
	1.	Desigr	n of mixed Hadry	ware/Software solution	ns for embe	edded systems,					
	2.	Under	standing of desi	gn components							
	3.			em-level design parac	ligms,						
	4.		W partitioning								
	5.	•	ization methods								
	6.		mance analysis	measures							
	7.		tion methods								
	8.	Mode	ling and Perform	nance analysis of safet	y-critical an	d real-time embedded sy	vstems.				
	1:10.00	.									
	Litera		on and Docign o	f Embedded Systems'	' D. Gaicki I	Prontico Hall 1001					
		0-13-150	-	i Embedded Systems	, D. Gajski, i	Frendle Hall 1994,					
	-		-	re Systeme – Synthes	o und Ontim	vierung" I Teich					
			g 1997, ISBN 3-5		e unu optim	nerung , J. Telch,					
	97		5 10077 10011 0 0								
4	Comp	etencies									
	-			ents will learn the desi	ign of compl	ex electronic systems at	high level	of			
	abstra	actions. T	his includes the	optimized partitionin	g, schedulin	g and evaluation of mixe	d hardwar	e and			
	softw	are desig	n solutions dedi	cated to embedded s	ystems. Duri	ing the Tutorials the stud	ents acqu	ire			
	know	ledge abo	out advanced rel	lated topics in HW/SV	V codesign a	nd performance analysis	for safety	-critical an			
			edded systems.								
		• ·			•	ply the theoretical knowl	•				
						o the methods explained					
	-				partitioning,	optimization and perforr	nance ana	lysis to			
_	synthesize the hardware/software system.										
5	Exam		. ,		,						
		Module Exam: oral exam (max. 40 minutes) or written exam (max. 180 minutes)*									
	Study	achiever			andata 2 aut	of A consist assignments	in ordor 1	a ha			
	•		•	•	npiete 2 out	of 4 special assignments	in order t	.o be			
			ted to the final e		anlata tha l	ah taalka					
	• * Tho			red to successfully cor		id course at the latest.					
					ed by the Zh	iu course at the fatest.					
5		-	en und -leistung	en							
7		Module			Partial	achievements					
7		•	equirements								
			d knowledge:	avabita atuwaa daasta lu	auddes of C						
	Basic				iowidge of C	C programming language.					
	B.4!	110 TV/00 7	and some letters of the								
8			nd usability of t		nahla France	n Suctome					
8	Electi	ve Class i	n the Master's d	legree program Sustai		y Systems .					
8	Electi Modu	ve Class i Ile Super	n the Master's d	legree program Sustai Faculty in c	harge	y Systems . gineering and Informatior	Toshusz				

Ro		49: Mobile	e Radio Networl	ks 1: Fundamental	s and Design Asp	ects		ETIT-40		
	ta		Duration	Semester	Credits	Presence	Self-Stu	udy Load		
anı	ually So	Se	1 Semester	2nd	5	35 h	115 h			
1	Modu	le Structu	re							
	No.	Element	t / Course			LSF-No.	Туре	SWS		
	1	Mobile	Radio Networks	1: Fundamentals a	nd Design	08 0104	V	2		
		Aspects	: Lecture							
	2	Mobile	Radio Networks	1: Fundamentals a	nd Design	08 0105	Р	1		
			: Lab Course							
2	Langu	-								
3	Englis									
	Conte									
				rical development						
	2.			ristics of propagation	on, subscriber mo	obility, resource d	emand and s	spectrum		
			, network plann							
				cellular networks (SPA)			
	4.	System ar	chitecture of OF	DMA-based cellula	ar networks (4G L	TE)				
			C							
				ntent is compleme		demonstrations a	ind by case s	tudies of		
	ongoi	ng researc	h and business a	aspects of mobile r	adio networks.					
	Literature (respective latest version) Walke, B.: Mobile Radio Networks, Wiley Rappaport, Theodore S. Wireless communications: principles and practice. Prentice Hall.									
	Walke	e, B.: Mobi	le Radio Networ	ks, Wiley	principles and p	ractice. Prentice H	lall.			
	Walke Rappa	e, B.: Mobi port, Theo	le Radio Networ odore S. Wireles	ks, Wiley				s		
ł	Walke Rappa Dahlm	e, B.: Mobi port, Theo	le Radio Networ odore S. Wireles	ks, Wiley s communications				S		
ł	Walke Rappa Dahlm Comp After	e, B.: Mobi aport, Theo nann, E.; Pa etencies successful	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of tl	ks, Wiley s communications , J.: 4G: LTE/LTE-Ad he module, studen	lvanced for Mobi	le Broadband, Act	ademic Press tures, protoc	cols,		
1	Walke Rappa Dahlm Comp After dimer	e, B.: Mobil port, Theo nann, E.; Pa etencies successful nsioning ar	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r	ks, Wiley s communications , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo	ts understand th orks. Students are	le Broadband, Ac e system architect e able to evaluate	ademic Press tures, protoc the possibili	cols, ities and		
ł	Walke Rappa Dahlm Comp After dimer challe	e, B.: Mobi aport, Theo <u>nann, E.; Pa</u> etencies successful nsioning an nges of us	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of t ad operation of r ing wireless netw	ks, Wiley s communications , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different o	ts understand the orks. Students are deployment envir	le Broadband, Aca e system architect able to evaluate conments and field	ademic Press tures, protoc the possibili ds of applica	cols, ities and tion, and		
1	Walke Rappa Dahlm Comp After dimer challe to ma	e, B.: Mobi port, Theo nann, E.; Pa etencies successful nsioning an nges of us ke a techn	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the ing wireless netwically sound sele	ks, Wiley s communications , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different o ection. In this way,	ts understand the orks. Students are deployment envir they acquire the	le Broadband, Aca e system architect able to evaluate conments and field	ademic Press tures, protoc the possibili ds of applica	cols, ities and tion, and		
	Walke Rappa Dahlm Comp After dimer challe to ma course	e, B.: Mobi aport, Theo nann, E.; Pa etencies successful nsioning ar nges of us ke a techn es or to stu	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the ing wireless netwically sound sele	ks, Wiley s communications , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different o	ts understand the orks. Students are deployment envir they acquire the	le Broadband, Aca e system architect able to evaluate conments and field	ademic Press tures, protoc the possibili ds of applica	cols, ities and tion, and		
	Walke Rappa Dahlm Comp After dimer challe to ma course Exam	e, B.: Mobi aport, Theo <u>nann, E.; Pa</u> etencies successful nsioning ar nges of us ke a techn es or to stu ination	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless netwically sound sele udy more advance	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different o ection. In this way, ced topics for then	ts understand the orks. Students are deployment envir they acquire the nselves.	le Broadband, Aca e system architect e able to evaluate ronments and field competence to at	ademic Press tures, protoc the possibili ds of applica	cols, ities and tion, and		
	Walke Rappa Dahlm After dimer challe to ma course Exam <i>Modu</i>	e, B.: Mobi aport, Theo <u>nann, E.; Pa</u> etencies successful nsioning an nges of us ke a techn es or to stu ination le exam: o	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless netwically sound sele udy more advance ral exam (max.	ks, Wiley s communications , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different o ection. In this way, ced topics for then 40 minutes) or writ	ts understand the orks. Students are deployment envir they acquire the nselves.	le Broadband, Aca e system architect e able to evaluate ronments and field competence to at	ademic Press tures, protoc the possibili ds of applica	cols, ities and tion, and		
	Walke Rappa Dahlm Comp After dimer challe to ma course Exam <i>Modu</i> <i>Cours</i>	e, B.: Mobil aport, Theo ann, E.; Pa etencies successful asioning an nges of us ke a techn es or to stu ination le exam: o e work: sue	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless netwically sound sele udy more advance ral exam (max. 4 ccessful complet	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different o ection. In this way, ced topics for then 40 minutes) or writ	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2	le Broadband, Aca e system architect a able to evaluate conments and fiele competence to at 180 minutes)*	ademic Press tures, protoc the possibili ds of applica	cols, ities and tion, and		
5	Walke Rappa Dahlm After dimer challe to ma course Exam <i>Modu</i> <i>Course</i> *The	e, B.: Mobil aport, Theo nann, E.; Pa etencies successful asioning an nges of us ke a techn es or to stu ination le exam: o e work: suc exact exam	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless netwically sound sele udy more advance ral exam (max. A ccessful completed nination modality	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or writ tion of lab tasks ties will be announ	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2	le Broadband, Aca e system architect a able to evaluate conments and fiele competence to at 180 minutes)*	ademic Press tures, protoc the possibili ds of applica	cols, ities and tion, and		
5	Walke Rappa Dahlm Comp After dimer challe to ma course Exam Modu Cours *The Form	e, B.: Mobil aport, Theo ann, E.; Pa etencies successful nsioning an nges of us ke a techn es or to stu ination le exam: o e work: suc exact exam	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the doperation of r ing wireless netwically sound sele udy more advand ral exam (max. A ccessful complet nination modality	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or writ tion of lab tasks ties will be announ	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2 ced by the 2nd ev	le Broadband, Act e system architect e able to evaluate comments and field competence to at 180 minutes)*	ademic Press tures, protoc the possibili ds of applica ttend more a	cols, ities and tion, and		
5	Walke Rappa Dahlm After dimer challe to ma course Exam <i>Modu</i> <i>Cours</i> *The Form	e, B.: Mobil aport, Theo nann, E.; Pa etencies successful asioning an nges of us ke a techn es or to stu ination le exam: o e work: suc exact exam ns of exam	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the doperation of r ing wireless netwically sound sele udy more advance ral exam (max. A ccessful completed nination modality ination and per exam	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or writ tion of lab tasks ties will be announ	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2 ced by the 2nd ev	le Broadband, Aca e system architect a able to evaluate conments and fiele competence to at 180 minutes)*	ademic Press tures, protoc the possibili ds of applica ttend more a	cols, ities and tion, and		
5	Walke Rappa Dahlm After dimer challe to ma course Exam Modu Course *The Form	e, B.: Mobil aport, Theo nann, E.; Pa etencies successful asioning an nges of usi ke a techn es or to stu ination le exam: o e work: suc exact exam s of exam Module e ipation rec	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless netwically sound sele udy more advance ral exam (max. A ccessful complete nination modalite ination and per exam quirements	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or write tion of lab tasks ties will be announ formance	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2 ced by the 2nd ex Pa	le Broadband, Act e system architect e able to evaluate competence to at 180 minutes)* vent at the latest. art of modular exa	ademic Press tures, protoc the possibili ds of applica ttend more a	cols, ities and tion, and advanced		
4 5 6 7	Walke Rappa Dahln Comp After dimer challe to ma course Exam Modu Course *The Forn X Partic None.	e, B.: Mobil aport, Theo ann, E.; Pa etencies successful asioning an nges of us ke a techn es or to stu ination le exam: o e work: suc exact exam Module e ipation ree Basic know	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless network ically sound sele udy more advand ral exam (max. A ccessful complet nination modalit nination and per exam quirements wledge of digita	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or write tion of lab tasks ties will be announ formance	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2 ced by the 2nd ev Pa	le Broadband, Act e system architect e able to evaluate competence to at 180 minutes)* vent at the latest. art of modular exa	ademic Press tures, protoc the possibili ds of applica ttend more a	cols, ities and tion, and advanced		
5	Walke Rappa Dahlm Comp After dimer challe to ma course Exam Modu Course *The S Partic None.	e, B.: Mobil port, Theo nann, E.; Pa etencies successful nsioning an nges of us ke a techn es or to stu ination le exam: o e work: suc exact exam Module e ipation ree Basic know	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless netwically sound sele udy more advand ral exam (max. 4 cccessful complete nination modalite ination and per exam quirements wledge of digita d usability of the	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or write tion of lab tasks ties will be announ formance	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2 ced by the 2nd ev Pa and electromagne	le Broadband, Aca e system architect e able to evaluate competence to an 180 minutes)* vent at the latest. art of modular exa etic wave propaga	ademic Press tures, protoc the possibili ds of applica ttend more a	cols, ities and tion, and advanced		
5 6 7	Walke Rappa Dahlm Comp After dimer challe to ma course Exam Modu Course *The S Partic None.	e, B.: Mobil port, Theo nann, E.; Pa etencies successful nsioning an nges of us ke a techn es or to stu ination le exam: o e work: suc exact exam Module e ipation ree Basic know	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the od operation of r ing wireless netwically sound sele udy more advand ral exam (max. 4 cccessful complete nination modalite ination and per exam quirements wledge of digita d usability of the	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or write tion of lab tasks ties will be announ formance	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2 ced by the 2nd ev Pa and electromagne	le Broadband, Aca e system architect e able to evaluate competence to an 180 minutes)* vent at the latest. art of modular exa etic wave propaga	ademic Press tures, protoc the possibili ds of applica ttend more a	cols, ities and tion, and advanced		
5	Walke Rappa Dahln Comp After dimer challe to ma course Exam Modu Course *The S Partic None. Modu Electiv	e, B.: Mobil port, Theo nann, E.; Pa etencies successful nsioning an nges of us ke a techn es or to stu ination le exam: o e work: suc exact exam Module e ipation ree Basic know	le Radio Networ odore S. Wireles arkvall, S.; Sköld completion of the doperation of r ing wireless netwically sound sele udy more advand ral exam (max. A ccessful complet nination modalit ination and per exam quirements wledge of digita d usability of the the Master's de	ks, Wiley s communications: , J.: 4G: LTE/LTE-Ad he module, studen mobile radio netwo works in different of ection. In this way, ced topics for then 40 minutes) or write tion of lab tasks ties will be announ formance	ts understand the orks. Students are deployment envir they acquire the nselves. ten exam (max. 2 ced by the 2nd ev Pa and electromagne	le Broadband, Aca e system architect e able to evaluate competence to an 180 minutes)* vent at the latest. art of modular exa etic wave propaga	ademic Press tures, protoc the possibili ds of applica ttend more a	cols, ities and tion, anc advancec		

Rot	dule 2-50 Mc	bile Radio Network	s 2: Advanced Net	work Concepts			ETIT-40	
	ta	Duration	Semester	Credits	Presence	Self-Stu	idy Load	
ลทเ	ually SoSe	1 Semester	2nd	5	35 h	115 h	-	
L	Module Stru	ucture						
	No. Eler	nent / Course			LSF-No.	Туре	SWS	
	1 Mol Lect	bile Radio Networks ture	2: Advanced Netw	ork Concepts:	XXX	V	2	
	2 Mol Cou	bile Radio Networks rse	2: Advanced Netw	ork Concepts: Lab	XXX	Р	1	
2	Language English					·		
3	Content							
	 4. Satelli 5. Future Intelli The discussi ongoing reso Literature (r Liberg, Olof, Academic Pri 	forming, Ultra Relial ite networks, Aerial e mobile network co gent Surfaces, Integr on of theoretical cor earch and business a respective latest versio , et al. Cellular Interr ress, 2019. E.; Parkvall, S.; Sköld	Wireless Networks oncepts for 5G-Adva ration of Artificial In ntent is complement aspects of mobile ration on) net of Things: From	anced and 6G (e.g. ntelligence) nted by practical de adio networks. Massive Deployme	mmWave/THz s emonstrations a ents to Critical 5	and by case s GG Applicatic	tudies or ons.	
	P. Marsch, A	A. Osseiran, J.F. Mon						
	 P. Marsch, A. Osseiran, J.F. Monserrat, 5G Mobile and Wireless Communications Technology, Cambridge University Press Competencies Upon successful completion of the module, students understand advanced and upcoming mobile radio network concepts and terminology which enables them to characterize research-related challenges of integrating the considered features, assess the feasibility, and to develop design solutions according to design goals. Students further deepen their knowledge base on specific network designs for particular 							
1	Upon succes network cor integrating t design goals	ies ssful completion of t ncepts and terminolo the considered featu s. Students further d	ogy which enables ires, assess the feas eepen their knowle	them to characterizes is bility, and to deve adge base on specifies of the second se	ze research-rela lop design solu	ated challeng	radio es of ing to	
5	Upon succes network cor integrating t design goals fields of app Examination <i>Module exa</i> <i>Course work</i>	ies ssful completion of t ncepts and terminolo the considered featu S. Students further d plication, and to mak	bgy which enables for ares, assess the fease eepen their knowle te a technically sou 40 minutes) or writ tion of lab tasks	them to characteriz sibility, and to deve edge base on specif <u>nd selection.</u> ten exam (max. 18	ze research-rela elop design solu fic network desi 0 minutes)*	ated challeng	radio es of ing to	
;	Upon succes network cor integrating f design goals fields of app Examination <i>Module exa</i> <i>Course work</i> *The exact of Forms of e	ies ssful completion of t ncepts and terminolo the considered featu s. Students further d lication, and to mak n m: oral exam (max. 4 c: successful complet	ogy which enables f ires, assess the feat eepen their knowle te a technically sou 40 minutes) or writ tion of lab tasks ties will be annound	them to characteriz sibility, and to deve edge base on specif nd selection. ten exam (max. 18 ced by the 2nd even	ze research-rela elop design solu fic network desi 0 minutes)*	ated challeng tions accord gns for parti	radio es of ing to	
5	Upon succes network cor integrating to design goals fields of app Examination <i>Module exa</i> <i>Course work</i> *The exact of Forms of e X <i>Mod</i> Participatio	ies ssful completion of t ncepts and terminolo the considered featu 5. Students further d olication, and to mak m: oral exam (max. 4 c: successful complet examination modalit examination and per	ogy which enables t ires, assess the feat eepen their knowle te a technically sou 40 minutes) or writ tion of lab tasks ties will be annound formance	them to characteriz sibility, and to deve edge base on specif nd selection. ten exam (max. 18 ced by the 2nd even □ Part	ze research-rela elop design solu fic network desi 0 minutes)* nt at the latest.	ated challeng tions accord gns for parti	radio es of ing to	
	Upon succes network cor integrating to design goals fields of app Examination <i>Module exa</i> <i>Course work</i> *The exact of Forms of e S <i>Mod</i> Participatio None. Basic Module typ	ies ssful completion of t neepts and terminolo the considered featu s. Students further do lication, and to mak n m: oral exam (max. 4 c: successful complet examination modalit examination and per ule exam n requirements	bgy which enables for ares, assess the fea- eepen their knowle te a technically sou 40 minutes) or writ tion of lab tasks ties will be annound formance e radio networks is te module	them to characteriz sibility, and to deve edge base on specif nd selection. ten exam (max. 18 ced by the 2nd even	ze research-related elop design solu fic network desi 0 minutes)* nt at the latest. of modular exa	ated challeng tions accord gns for parti	radio es of ing to	

Turn	ıl 2-51: I	Embedded	Autonomy					ETIT-409
anua	ius ally SoSe		Duration 1 Semester	Study section 2nd Semester	LP 10	Attendance rate 70 h	Self-st 230 h	udy
1	Mod	ule struct	ure					
	Nr.	Element	t / Course			LSF no.	Тур	SWS
	1	Embedd	led Autonomy (lecture)		08 XXXX	V	3
	2	Embedd	led Autonomy (tutorial)		08 XXXX	Ü	1
	3	Embedd	led Autonomy (lab course)		08 XXXX	Р	2
2	Cou Engl	se langua ish	ge					
	Chris Oper Verla Sam Syste Defe Augu Selm	System Verifica ature stopher Ro rations and ag, Berlin, uel Kounev ems". Sprin nse Advan ust 2017 na Saidi, Di	Architectures a tion of Autonom d Exploration Sy Heidelberg, 200 v, Jeffrey O. Kep nger Publishing nced Research F	ous and Autonomic S ystems" (NASA Mond D7. phart, Aleksandar Mi Company, Incorpora Projects Agency (DAF	Systems: V Systems: V Jegraphs in lenkoski, a lenkoski, a lenkoski, Broa	Systems Vith Applications t Systems and Softw and Xiaoyun Zhu. " dition, 2017. d Agency Announc	vare Engii Self-Awai ement - A	neering). Springer- re Computing Assured Autonomy
		•	ne", IEEE Desigr	and Test Magazine		mst Autonomo	us system	is Design: Charting
4	With in au cons Duri syste to in bala	petencies the succe idering fur ng the pra ms tasks (nplement t nce the pe	essful participat s systems as we nctional and no ctical exercises Sensor fusion a the Percieve - D	ion in the module, st ell as very recent field n-functional aspects to the lecture the st and Al computation v Decide - Act loop) on tations of the platfor	2021. cudents wi ds required (e.g., safe udents wi which pose embedde	ill gain basic knowl d to the design of s ety, reliability). Il learn to impleme e special demands d platforms. The st	edge in th safe autor ent simple on the ar	ne platforms used nomous systems autonomous chitectures in orde ill be able to
5	With in au cons Duri syste to in bala optin Exar Part 1 2 3 * Th perfe	petencies the succe idering fur ng the pra- ems tasks (nplement t nce the pe mal utilizat ns al achieve Oral exa project Success e overall g prmance 1	essful participat s systems as we nctional and no ctical exercises Sensor fusion a the Percieve - D rformance limition of the reso ments: am (30 minutes work with writi ful participatio rade is formed and 2.	ion in the module, st ion in the module, st ell as very recent field n-functional aspects to the lecture the st and AI computation v becide - Act loop) on tations of the platfor urces.) or written exam (90 ten report * n part 3 from the arithmetic	2021. cudents wi ds required (e.g., safe udents wi which pose embedded m against D minutes mean of t	ill gain basic knowl d to the design of s ety, reliability). Il learn to impleme e special demands d platforms. The st the complexity of and he sub-grades of s	edge in th safe autor ent simple on the an udents w tasks and	ne platforms used nomous systems autonomous chitectures in orde ill be able to
	With in au cons Duri syste to in bala optin Exar Part 1 2 3 * Th perfe	petencies the succes idering fur ng the pra- ems tasks (nplement t nce the pe mal utilizat fal achieve Oral exa project Success e overall g ormance 1 exact exan	essful participat s systems as we nctional and no ctical exercises Sensor fusion a the Percieve - D rformance limition of the reso ments: am (30 minutes work with writi ful participatio rade is formed and 2.	ion in the module, step ion in the module, step ill as very recent field in-functional aspects to the lecture the st and AI computation wo becide - Act loop) on tations of the platfor urces.) or written exam (90 ten report * n part 3 from the arithmetic <u>ities will be announc</u>	2021. cudents wi ds required (e.g., safe udents wi which pose embedded m against D minutes mean of t	ill gain basic knowl d to the design of s ety, reliability). Il learn to impleme e special demands d platforms. The st the complexity of and he sub-grades of s	edge in th safe autor ent simple on the an udents w tasks and	ne platforms used nomous systems autonomous chitectures in orde ill be able to

7	Participation requirements None	
8	Module type and usability of the module Elective Class in the Master's degree progra	m Sustainable Energy Systems.
9	Module Supervisor Prof. DrIng. Selma Saidi	Faculty in charge Faculty of Electrical Engineering and Information Technology

Mo	odul 3-3	5: Online F	Problems					ETIT-292
	r nus nually a	it WS	Duration 1 Semester	Study section 3rd Semester	LP 5	Attendance rate 35 h	Self-st 115h	udy
1	Modu	le structu	re			35 11		
-	Nr.	Element				LSF no.	Тур	SWS
	1		oblems (lecture)		08 0142	V	2
	2		oblems (tutorial			08 0143	Ü	1
2	Cours Englis	e language		,			I	
	3. De 4. Ga	me-Theore	Algorithms tic Foundations					
	Litera	ture	ver Games an El-Yaniv, ONL	INE COMPUTATION /	AND COMPE	TITIVE ANALYSIS. Car	mbridge Ur	niversity
4	Litera Allan Press Comp After their	ture Borodin, R petencies successful processing.	an El-Yaniv, ONL completion, the . They are able to	INE COMPUTATION A students can recogn o evaluate solution n thods for online prob	ise online pr nethods with	oblems and apply su regard to their effic	itable proc	edures fo
	Litera Allan Press Comp After their and to Exam	ture Borodin, R petencies successful processing o develop r s	an El-Yaniv, ONL completion, the . They are able to	students can recogn o evaluate solution n thods for online prot	ise online pr nethods with	oblems and apply su regard to their effic	itable proc	edures fo
5	Litera Allan Press Comp After their and to Exam Modu	etencies successful processing. o develop r s ile Exam: o	an El-Yaniv, ONL completion, the . They are able to new solution me ral exam (max. 4	students can recogn o evaluate solution n thods for online prot 10 minutes)	ise online pr nethods with nlems on the	oblems and apply su regard to their effic	itable proc	edures fo
5	Litera Allan Press Comp After their and to Exam Modu Form	etencies successful processing o develop r s ile Exam: o s of examin Module E cipation rec mmended p	an El-Yaniv, ONL completion, the . They are able to new solution me ral exam (max. 4 nation and perfor xam quirements prerequisites: Go	students can recogn o evaluate solution n thods for online prob 10 minutes) ormance	ise online pr hethods with lems on the	oblems and apply su regard to their effic basis of the method chievements	itable proc iency and d ls they have	edures fo
4 5 6 7 8	Litera Allan Press Comp After their and to Exam Modu Form S Partic Recor funda	etencies successful processing o develop r s ule Exam: o s of examin Module E cipation rea mmended p imentals of ule type an	an El-Yaniv, ONL completion, the . They are able to new solution me ral exam (max. 4 nation and perfor xam quirements prerequisites: Go algorithms. d usability of th	students can recogn o evaluate solution m thods for online prob 0 minutes) ormance	ise online pr nethods with plems on the Partial a ndamentals o	oblems and apply su regard to their effic basis of the method chievements of discrete mathemat	itable proc iency and d ls they have	edures for

	dul 2-2	25: Modeli	ng and Control	of Robotic Manipula	tors			ETIT-244
An	r nus nually a		Duration 1 Semester	Study section 3. Semester	LP 5	Attendance rate 35 h	Self-stu 115 h	udy
1		ule structu				1		
	Nr.	Element				LSF no.	Тур	SWS
	1	-		Robotic Manipulator		08 0125	V	2
	2	Modeling	g and Control of	Robotic Manipulator	s (tutorial)	08 0126	Ü	1
2		se languag	e					
3	Engli	sch nhalte						
	2 3 4 5 6 7 8	 Direct K Differer Dynami Actuato Motion Interact Robotic 	ors and Sensors	x and ROS				
4	Sicilia and C Sicilia	Control of F ano, Khatib	Robot Manipulat	odelling, Planning an cors) book of Robotics	d Control (alt	ernativ: Sciavicco, Si	ciliano: Mo	delling
4	Sicilia and C Sicilia Com This c robot The s	ano, Sciavic Control of F ano, Khatib Detencies course prov tic manipul	Robot Manipulat : Springer Hand vides the studen lators.	tors)	ackground of	modelling, planning	and contro	ol of
4	Sicilia and C Sicilia This o robot The s ROS/ Exam Mode	ano, Sciavic Control of F ano, Khatib oetencies course prov tic manipul tudents ac Matlab. Is ule Exam: c	Robot Manipulat : Springer Hand vides the studen lators. quire practical e pral exam (max.	tors) book of Robotics ts with a profound b experience in robot ki 40 minutes) or writte	ackground of inematics, dyr en exam (max	modelling, planning namics and motion c . 180 minutes)*	and contro	ol of
5	Sicilia and C Sicilia This of The s ROS/ Exam Mode * The	ano, Sciavic Control of F ano, Khatib Detencies course prov tic manipul tudents ac Matlab. Is ule Exam: c	Robot Manipulat : Springer Hand vides the studen lators. quire practical e pral exam (max.	tors) book of Robotics ts with a profound b experience in robot king 40 minutes) or writte ities will be announce	ackground of inematics, dyr en exam (max	modelling, planning namics and motion c . 180 minutes)*	and contro	ol of
5	Sicilia and C Sicilia This of The s ROS/ Exam Mode * The	ano, Sciavic Control of F ano, Khatib Detencies course prov tic manipul tudents ac Matlab. Is ule Exam: c	Robot Manipulat :: Springer Hand vides the studen lators. quire practical e pral exam (max. mination modal mation and perf	tors) book of Robotics ts with a profound b experience in robot ki 40 minutes) or writte ities will be announce formance	ackground of inematics, dyr en exam (max ed by the 2nd	modelling, planning namics and motion c . 180 minutes)*	and contro	ol of
5	Sicilia and C Sicilia This c robot The s ROS/ Exam Mode * The Form	ano, Sciavic Control of F ano, Khatib Detencies course prov tic manipul tudents ac Matlab. Is ule Exam: co e exact exan s of exami Module E cipation re	Robot Manipulat :: Springer Hand vides the studen lators. quire practical e pral exam (max. mination modal mation and perf	tors) book of Robotics ts with a profound b experience in robot ki 40 minutes) or writte ities will be announce formance	ackground of inematics, dyr en exam (max ed by the 2nd	modelling, planning namics and motion c . 180 minutes)* event at the latest.	and contro	ol of
	Sicilia and C Sicilia Comp This of robot The s ROS/ Exam Mode * The Form X Partic Keine	ano, Sciavic Control of F ano, Khatib Detencies course provi tic manipul tudents ac Matlab. Is ule Exam: co e exact exam s of exami Module E cipation re e ule type ar	Robot Manipulat Springer Hand vides the studen lators. quire practical e oral exam (max. <u>mination modal</u> mation and perf Exam quirements nd usability of th	tors) book of Robotics ts with a profound b experience in robot king 40 minutes) or writte ities will be announce formance	ackground of inematics, dyr en exam (max ed by the 2nd D Partial ac	modelling, planning namics and motion c . 180 minutes)* event at the latest. chievements	and contro	ol of

Mo	dul 3-4	3: Automa	ated Driving					ETIT-50
Γur	nus		Duration	Study section	LP	Attendance	Self-stu	dy
۹nı	nually a	t WS	1 Semester	3rd Semester	5	rate 35 h	115 h	
L	Modu	le structu	re		•			
	Nr.	Element	/ Course			LSF no.	Тур	SWS
	1	Automat	ed Driving (lectu	ıre)		08 0215	V	2
	2	Automate	ed Driving (tuto	rial)		08 0216	Ü	1
2	Cours	e language						
	Englis							
3	1	nhalte						
	1	. Exteroc	eptive sensors (camera, radar, lidar, ι	Iltrasonic, se	nsor fusion)		
	2		•	fully automated drivi		,		
		a.		vsis and interaction-av	-	bry prediction		
		b.	Trajectory plan	ning and coupled pre	diction and	planning		
			•	ts to follow a planned	l trajectory			
	3	. Machine	e learning in aut	omated driving				
	5							
	4		nonitoring and h	and-over models				
	4 Litera	ture:	-					
	4 Litera I. Goo	ture: dfellow, Y.	. Bengio, A. Cour	ville: Deep Learning (
	4 Litera I. Goo D. For	ture: dfellow, Y. syth, J. Po	. Bengio, A. Cour nce (Ed.): Comp	ville: Deep Learning (uter Vision: A Moderr	Approach (
1	4 Litera I. Goc D. For select	ture: odfellow, Y. ^r syth, J. Por ed papers	. Bengio, A. Cour nce (Ed.): Comp	ville: Deep Learning (Approach (
4	4 Litera I. Goo D. For select Comp	ture: odfellow, Y. syth, J. Pol ed papers otencies	. Bengio, A. Cour nce (Ed.): Comp on automated d	ville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o	h Approach (Jeep learnin	g	hle to unde	rstand
4	4 Litera I. Goo D. For select Comp The st	ture: odfellow, Y. syth, J. Por ed papers etencies tudents acc	. Bengio, A. Cour nce (Ed.): Comp on automated d quire a profound	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom	a Approach (deep learnin nated driving	g systems. They are a		
Ŧ	4 Litera I. Goo D. For select Comp The st	ture: odfellow, Y. rsyth, J. Por red papers retencies tudents acc olve tasks o	. Bengio, A. Cour nce (Ed.): Comp on automated d quire a profound	ville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o	a Approach (deep learnin nated driving	g systems. They are a		
	4 Litera I. Goc D. For select Comp The st and so metho	ture: odfellow, Y. rsyth, J. Por red papers retencies tudents acc olve tasks o ods.	. Bengio, A. Cour nce (Ed.): Comp on automated d quire a profound	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom	a Approach (deep learnin nated driving	g systems. They are a		
	4 Litera I. Goc D. For select Comp The st and so metho Exam	ture: odfellow, Y. syth, J. Pol ed papers otetencies cudents acc olve tasks o ods. s	Bengio, A. Cournce (Ed.): Composition on automated d quire a profound on perception, p	ville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c	Approach (deep learnin nated driving ontrol, and d	g systems. They are a driver modelling with		
	4 Litera I. Goc D. For select Comp The st and so metho Exam	ture: odfellow, Y. syth, J. Pol ed papers otetencies cudents acc olve tasks o ods. s	Bengio, A. Cournce (Ed.): Composition on automated d quire a profound on perception, p	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom	Approach (deep learnin nated driving ontrol, and d	g systems. They are a driver modelling with		
	4 Litera I. Goc D. For select Comp The st and so metho Exam <i>Modu</i>	ture: odfellow, Y. rsyth, J. Pol red papers retencies tudents acc olve tasks o ods. s <i>s</i>	Bengio, A. Cournce (Ed.): Composite on automated of on automated of on perception, perception, paral exam (max. 4	ville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or writter	Approach (deep learnin nated driving ontrol, and o	g systems. They are a driver modelling with . 180 minutes)*		
4	4 Litera I. Goc D. For select Comp The si and si metho Exam <i>Modu</i> * The	ture: dfellow, Y. rsyth, J. Por- red papers retencies tudents acc olve tasks of ods. s <i>s</i> <i>exact exar</i>	Bengio, A. Cour nce (Ed.): Comp on automated d quire a profound on perception, p ral exam (max. 4 <u>mination modali</u>	ville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o knowledge of autom rediction, planning, c 40 minutes) or writter ties will be announce	Approach (deep learnin nated driving ontrol, and o	g systems. They are a driver modelling with . 180 minutes)*		
5	4 Litera I. Goo D. For select Comp The si and so metho Exam Modu * The Prüfu	ture: dfellow, Y. syth, J. Por- red papers retencies tudents acc olve tasks of ods. s le Exam: of exact exar ngsformer	Bengio, A. Cour nce (Ed.): Comp on automated d quire a profound on perception, p ral exam (max. 4 <u>mination modali</u> n und -leistunge	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or writter ties will be announcer n	Approach (deep learnin nated driving ontrol, and o n exam (max d by the 2nd	g systems. They are a driver modelling with . 180 minutes)* event at the latest.		
5	4 Litera I. Goc D. For select Comp The si and so metho Exam <i>Modu</i> * The Prüfu X	ture: dfellow, Y. syth, J. Pol ed papers betencies tudents acc olve tasks of ods. s exact exar: o exact exar mgsformer Module E	Bengio, A. Cour nce (Ed.): Compo on automated of quire a profound on perception, p ral exam (max. 4 <u>mination modali</u> n und -leistunge xam	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or writter ties will be announcer n	Approach (deep learnin nated driving ontrol, and o n exam (max d by the 2nd	g systems. They are a driver modelling with . 180 minutes)*		
5	4 Litera I. Goc D. For select Comp The st and so metho Exam <i>Modu</i> * The Prüfu X Partic	ture: dfellow, Y. syth, J. Por- red papers tudents acc olve tasks of ods. s exact exar: ngsformer Module E ipation red	Bengio, A. Cour nce (Ed.): Compo on automated d quire a profound on perception, p ral exam (max. 4 <u>mination modali</u> n und -leistunge xam quirements	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or writter ties will be announcer n	Approach (deep learnin nated driving ontrol, and o n exam (max d by the 2nd Partial a	g systems. They are a driver modelling with . 180 minutes)* event at the latest. chievements		
5	4 Litera I. Goo D. For select Comp The si and so metho Exam Modu * The Prüfu X Partic Recor	ture: dfellow, Y. syth, J. Por- red papers retencies tudents acc olve tasks of ods. s le Exam: of exact exar ngsformer Module E ipation red nmended p	. Bengio, A. Cour nce (Ed.): Compo on automated d quire a profound on perception, p ral exam (max. 4 <u>mination modali</u> n und -leistunge xam quirements prerequisites: Ba	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or writter ties will be announcer n	Approach (deep learnin nated driving ontrol, and o n exam (max d by the 2nd Partial a	g systems. They are a driver modelling with . 180 minutes)* event at the latest. chievements		
5 6 7	4 Litera I. Goc D. For select Comp The si and so metho Exam Modu * The Prüfu X Partic Recor Modu	ture: dfellow, Y. syth, J. Por- red papers betencies tudents acc olve tasks of olve tasks of ods. s le Exam: of exact exar ngsformer Module E ipation red nmended p ile type an	Bengio, A. Cour nce (Ed.): Compo on automated d quire a profound on perception, p ral exam (max. 4 <u>mination modali</u> n und -leistunge <u>xam</u> quirements prerequisites: Ba d usability of th	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or writter ties will be announcer n	Approach (deep learnin hated driving ontrol, and o n exam (max d by the 2nd Partial ac chatronics, r	g systems. They are a driver modelling with . 180 minutes)* event at the latest. chievements nechanics		
	4 Litera I. Goo D. For select Comp The si and so metho Exam Modu * The Prüfu X Partic Recor Modu Electi	ture: dfellow, Y. syth, J. Por- red papers betencies tudents acc olve tasks of olve tasks of ods. s le Exam: of exact exar ngsformer Module E ipation red nmended p ile type an	Bengio, A. Cour nce (Ed.): Compo- on automated d quire a profound on perception, p ral exam (max. 4 <u>mination modali</u> n und -leistunge xam quirements prerequisites: Ba d usability of th the Master's de	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or written ties will be announced n asic knowledge of mer e module	Approach (deep learnin hated driving ontrol, and o h exam (max d by the 2nd Partial a chatronics, r able Energy	g systems. They are a driver modelling with . 180 minutes)* event at the latest. chievements nechanics		
5 6 7 8	4 Litera I. Goc D. For select Comp The si and so metho Exam Modu * The Prüfu X Partic Recor Modu Electi Modu	ture: dfellow, Y. syth, J. Por- red papers retencies tudents acc obve tasks of ods. s le Exam: of exact exar ngsformer Module E ipation red nmended p ile type an ve Class in ile Supervi	Bengio, A. Cour nce (Ed.): Compo- on automated d quire a profound on perception, p ral exam (max. 4 <u>mination modali</u> n und -leistunge xam quirements prerequisites: Ba d usability of th the Master's de	rville: Deep Learning (uter Vision: A Moderr Iriving, robotics, and o I knowledge of autom rediction, planning, c 40 minutes) or written ties will be announced n asic knowledge of me e module gree program Sustain Faculty in	Approach (deep learnin hated driving ontrol, and o h exam (max d by the 2nd Partial a chatronics, r able Energy charge	g systems. They are a driver modelling with . 180 minutes)* event at the latest. chievements nechanics	appropriat	e

Mo	dul 3-4	5: Mobile	and Pervasive C	omputing				ETIT-50
٩n	rnus nually ir nester	n winter	Duration 1 Semester	Study section 3rd Semester	LP 6	Attendance rate 50 h	Self-stu 130 h	udy
		le structu	re			5011		
-	Nr.	Element				LSF no.	Тур	SWS
	1		nd Pervasive Cor	nnuting Lecture		08 xxxx		2
	2				•	08 xxxx	Ü	
				mputing Presentation	5	08 XXXX	0	2
	Cours Englis	e languag ch	e					
	Teach	ing contei	nt					
	comp These source sensir and p • W lo a • V lo • V lo • Ee fo	uting techn services p es in senso ag and com ervasive co /ireless pe ocalization, oplications isual & acc ocalization, lobile sens echniques dge compu- or low-late	nologies have be provide new insig pr-rich environme opputing technique computing technique rception and correct wireless-based based on wireles based on wirel	and computing tech on, and mobility anal ng: mobile crowdsou es, multi-modal data re-defined computing e services, service-ori	tion to enable l and uncertair ces. The lecture n in practical s ludes the follo assive wireless reless-based ac nologies: Visua ytics based on urcing in smart fusion techniques framework: c	intelligent services information from covers theoretica ystems, and design wing topics: sensing technique ctivity recognition, I-based and acoust visual and acousti cities, privacy-pre- ues based on smar omputation task o	s in our dai a variety o al fundame n principles es, wireless and tic-based c informat serving ser t devices. ffloading t	ly life. of data intals in s in mobi s-based ion. nsing echnique
	netwo ACM/	Minyi G Techno Moham Networ Sherali Networ rch papers orking e.g. IEEE IPSN.	logies and Applic mad S. Obaidat, king", published Zeadally (Editor) king Technologie s published in are IEEE Percom, IEE	, Nafaâ Jabeur (Editor es", IET Press in Londo eas of mobile comput E trans. on Mobile Co	CRC Press, 20 aac Woungang), "Cyber-Phys on, England, 20 ing, pervasive	20. , "Pervasive Comp ical System Desigr 15. computing, and co	uting and with Sens	ion
ŀ		etencies						
•	The go perva perva comp	oal of the l sive comp sive comp utation mo	uting. After comp uting systems on odules and softw	blish knowledge of th oleting the lecture, st mobile and smart pla are required by appli omputing systems.	udents can ind atforms, decor	ependently desigr	n innovativ y between	
5	Exam	s –						
		achievem		an oral exam (30 min s need to successfully		ssignments to be a	admitted to	o the fina
			e nublished two	weeks after the start	of the lecture	at the very latest		
5						מו נווב אבו א ומנפצו.		
	Forms	orexami	nation and perfo	mance				
,	X	Module E			Partial achi	o o ma o ± -		

7	Participation requirements Recommendations (helpful but not manda communications.	atory): knowledge in foundations of algorithms and wireless
8	Module type and usability of the module Elective Class in the Master's degree progr	
9	Module Supervisor JunProf. DrFang-Jing Wu	Faculty in charge Faculty of Electrical Engineering and Information Technology

3rd Semester

	lustrial I	nternship				ETIT-282
Tu noi 1		Duration 12 weeks e structure	Study section 3rd Semester	LP 14		Aufwand 12 weeks
-	Nr.	Element / Course		Тур	Credits	Time hours
	1	Industrial Internship		P	14	420
2	Cours Englise	e language				
3	The in Re Pr Ol M The In studer and su compa intern	ng Content dustrial internship takes place in search and development, oject planning, design, manufact peration and maintenance, arketing, sales, operational organ ternship Office of the Department to n the selection of an internsh pport includes, in particular, the iny with the student's chosen main ship is carried out for each stude etencies	ure, assembly, testing and consistion, management and transferring are of Electrical Engineering are ip company and the implement curricular fit of the internshiption. The professional assessmit	raining nd Infor entation ip area nent ar	mation Tech n of the inter offered by th nd evaluation	rnship. The advice ne internship
	After s proces	uccessful completion of the indu ses and organisation in industry	-		-	-
	Finally	now typical engineering tasks in , they have knowledge of practic	research and development a al procedures in industrial pr	nd/or i	n production	and operation.
5	Finally techno Exams A repo	now typical engineering tasks in , they have knowledge of practic plogies in electrical power engine rt book must be prepared on the	research and development a al procedures in industrial pr ering. e internship. The evaluation o	nd/or in roduction	n production on and/or th ess and perfo	and operation. e use of modern ormance is based or
	Finally techno Exams A repo the su Forms	now typical engineering tasks in , they have knowledge of practic plogies in electrical power engine	research and development a al procedures in industrial pr ering. e internship. The evaluation o ronically as PDF) and the inte	nd/or in oduction of succe ernship	n production on and/or th ess and perfo certificate o	and operation. e use of modern ormance is based or
6	Finally techno Exams A repo the su Forms Partic	now typical engineering tasks in , they have knowledge of practic ologies in electrical power engine rt book must be prepared on the pmitted reports (submitted elect of examination and performance	research and development a al procedures in industrial pr ering. e internship. The evaluation of ronically as PDF) and the inte ce D Partial ach	nd/or in roduction of succe ernship ieveme	n production on and/or the ess and perfo certificate o	and operation. e use of modern ormance is based or
5 6 7 8	Finally techno Exams A repo the su Forms Partic Recom	now typical engineering tasks in , they have knowledge of practic ologies in electrical power engine rt book must be prepared on the omitted reports (submitted elect of examination and performance Module Exam pation requirements	research and development a al procedures in industrial pr ering. e internship. The evaluation of ronically as PDF) and the inter ce D Partial ach to perform engineering rela ule	nd/or in roduction of succe ernship ieveme ted act	n production on and/or the ess and perfo certificate o ents ivities	and operation. e use of modern ormance is based or

Lak	o Cours	е							ETIT-20P
	nus f-yearly	,	Duration 1 Semester each	Study section 4th / 5th Semester	LP 6	At 90	tendanco	e rate	Self-study 90 h
1		le stru		4th / Still Selliestel	0	90			5011
-	Nr.		ent / Course			LSF no.	Тур	СР	Time hours
	1		ourse 1			201 1101	P	3	45
	2		ourse 2				P	3	45
2		e langu					Г	5	45
2	Englis		lage						
3		halte							
-	-		complete 2 compuls	ory elective internships	from th	ne range	of course	s offere	ed by the faculty.
			• •	re available, only one ir		-			
	The e	xact de	scriptions and inform	ation on the internship	can be	found ir	the follo	owing in	nternship
		•	1-18 or on the Interne	et.					
4	•	etencie							
			•	course, students are a					
			• •	in engineering problem	•				
		•		e students are able to s		-			• •
			• .	ckages. Furthermore, the context of scientific we					•
		ent pro	•	Context of Scientific wo	n k ill ei	Igineenn	g anu ca	n appiy	liese to
5	Exam								
-	The e	- xamina	tion requirements are	e deposited in the respe	ctive in	iternship	descripti	ons.	
6			mination and perform			•	•		
		Modul	e Exam	X	Partial a	achieven	ients		
7	Partic	ipation	n requirements						
	The p	articipa	ation requirements are	e listed in the respectiv	e intern	ship deso	riptions.		
			• •	ed. Admission to partic	ipation	is in acco	ordance v	vith § 9	of the
			regulations.						
8		ile type	e and usability of the	module					
	С								
9		ile Supe		Faculty in cha	-				
	Dean	of the I	Faculty of Electrical						
			and Information Tech	-	ctrical E	ngineerir	ng and In	formation	on Technology

LA	3 1: Fie	d theoretica	l simulation					ETIT-211
Tu	nus		Duration	Study section	LP	Attend	lance rate	Self-study
An	nually a	t WS	2 Weeks	3rd Semester	3	60 h		30 h
	1		(Block event)					
1	Modu	le structure						
	Nr.	Element / 0	Course		LSF no.		Тур	Zeitstunden
	1	Lab			08 0023		Р	90
2	Cours	e language						
	Englis	h						
3	Teach	ing Content						
	1			ning and procedure			• •	
	2	•		ethods of field calcul				based
	3			neering problems int				
	4			operties, special feat			Iculation ac	curacy/
	_	-	••	ry conditions and de	-			
	5			of selected problem	•	ional, rota	ationally syn	nmetrical) for
	6	•	•	endent fields, respe	•		المعامما مماميا	
	6	possible)	verification and	comparison of nume	erical solution	s with ana	iytical calcul	ation results (If
	7	• •	obtained simulat	ion results for furthe	r numorical a	ad graphic	al procossin	
	Litera	•			er mumericara	iu graphic	ai processii	
			Methoden in der	Berechnung elektro	magnetischer	Foldor		
4	1	etencies	Wethough in der	Dereennung elektro	magnetisener	reluci		
-	-		mpletion of the	practical course, the	students have	acquired	basic knowl	edge about the
			•	calculation program		•		-
				ment. They also have	•			
	-		-	, level through suital	-			
	simul	ation result c	btained in this w	ay.				
5	Exam	s						
	Succe	ssful comple	tion of 70% of th	e internship tasks				
6	Form	s of examina	tion and perform	nance				
		Module Exar	n	X	Partial achie	evements		
	Partic	ipation requ	irements					
7	i ai ulu			vledge of the basics of	of			
7				-		alculation		
7	Recor	•	ing Basic Mathe			alcalation		
7	Recor Electr	ical Engineer	ing, Basic Mathe ticinants is limite		ticination is in	accordanc		of the
7	Recor Electr The n	ical Engineer umber of par	rticipants is limite	ed. Admission to part	ticipation is in	accordanc		of the
7	Recor Electr The n exam	ical Engineer umber of par ination regul	rticipants is limite ations.	ed. Admission to part	ticipation is in	accordanc		of the
	Recor Electr The n exam Modu	ical Engineer umber of par ination regul	rticipants is limite ations. usability of the n	ed. Admission to part	- 			of the
	Recor Electr The n exam Modu Electi	ical Engineer umber of par ination regul	ticipants is limite ations. usability of the n Master's degree	ed. Admission to part	e Energy Syste			of the

LAE	3 2: Sin	nulative	performance eval	uation of communi	cation netw	orks		ETIT-214
-	mus nually a	at WS	Duration 2 weeks (block event)	Study section 3rd Semester	СР 3	Attendance rate 48 h	Self-st 42 h	udy
1	Mod	ule struc				_		
	Nr.	Eleme	nt / Course		LSF r	10.	Тур	Zeitstunden
	1	Lab			08 02	138	P	90
2	Cours Englis	se langu a sh	age					
3	Teac	hing Con	tent					
	2 3 Litera	a. b. c. d. b. c. d. d. s. evalu a. b. c. ature	Simulation setu Module and sir Simulation of s elling of system pro Modelling of co Consideration of Modelling and Implementatio ation and optimiss Simulation of d Tools for statist Validation of ol	nulation definition/ imple communication operties ommunication protocontraction of mobility aspects of consideration of contraction n of complete systen ation of complex contraction ynamic communicatical analysis	on networks ocols (ISO/O on OMNeT+ mmunicatio m scenarios mmunicatio	SI) + n channel properti n systems	es	
A	Sincla		lation of Compute	r Systems and Com	outer Netwo	rks		
	perfo simul the ir comr netw the re	ormance lation. In mplemen nunicatio orking so esults ob	evaluation and dir addition to the ac station and highly on systems. The gr cenarios and map tained in this way	he practical course, nensioning of comn tual functions of the accurate simulative aduates of this prac them realistically in can be processed a relevant to commun	nunication s e OMNeT++ realisation o tical course the OMNeT ccordingly a	ystems by means o simulation enviror of protocol-based p will be able to abs ++ simulation envi nd used for perfor	of event-d nment, thi processes tract even ronment.	riven is also includes in complex Furthermore,
5	Exam Succe	-	npletion of at leas	t 80% of the tasks s	et.			
6	Form	s of exar Module	mination and perf Exam	ormance	🗵 Partia	al achievements		
7	The r exam	number c ination r	egulations.	nited. Admission to	participatio	n is in accordance	with § 9 c	of the
8			and usability of the the Master's deg	ie module ree program Sustair	hable Energy	y Systems.		
9		ule Supe	rvisor Christian Wietfeld	-	in charge	Engineering and li	oformatio	Tashralasi

	B 3: Sin	nulation a	nd control of rob	oot systems			I	ETIT-216
-	rnus	+ \\\C	Duration	Study section	LP	Attendance	Self-stu	udy
AN	nually a	IL VVS	1 Semester	3rd Semester	3	rate 48 h	42 h	
1	Modu	ule structu	ire					
	Nr.	Element	: / Course		LSF no.		Тур	SWS
	1	Lab			08 0022		Р	4
2	Cours Englis	se languag sh	e					
3	1. bas 2. att 3. exp 4. exp Litera Bode Angel Sicilia	empt: Mo periment: periment: n ture : Systeme rmann, Be no, Sciavio	tence: Matlab, Si delling, kinemati path planning ar image-based cor der Regelungste uschel, Rau, Wo		d Simulink; ulink – Stateflo	w: Grundlagen, To	olboxen, B	eispiele;
4	After meth and s	ods for mo olve them	odelling and sime	he practical course, t ulating robotic systen they have in-depth ki application.	is. The student	s are able to classi	fy tasks in i	robotics
	After meth and s manij	successful ods for mo olve them oulators th s	odelling and simu independently; prough practical	ulating robotic system they have in-depth ki	is. The student nowledge of th	s are able to classi e control and regu	fy tasks in I lation of rc	robotics
5	After meth and s manij Exam The s	successful ods for mo olve them oulators th s upervisor	odelling and simu independently; nrough practical checks the comp ination and perf	ulating robotic system they have in-depth k application.	as. The student howledge of the and the protoc	s are able to classi e control and regu	fy tasks in I lation of rc	robotics
5	After meth and s manip Exam The s Form Partic The n	successful ods for mo olve them oulators th s upervisor s of exam i Module E cipation re	odelling and simulation independently; nrough practical checks the comp ination and perf xam equirements participants is lir	ulating robotic system they have in-depth kn application. Iletion of all subtasks ormance	and the protoc	s are able to classi e control and regu ol during the even ievements	fy tasks in I lation of rc	robotics
4 5 6 7 8	After meth and s manij Exam The s Form Partio The n exam Modu	successful ods for mo olve them oulators th s upervisor s of exami Module E cipation re umber of ination re uber of	odelling and simulation independently; nrough practical checks the comp ination and perfect xam equirements participants is ling gulations. nd usability of the	ulating robotic system they have in-depth kin application. Iletion of all subtasks ormance	is. The student howledge of the and the protoc Partial ach articipation is i	s are able to classi e control and regu ol during the even ievements n accordance with	fy tasks in I lation of rc	robotics

LA	B 4: Pro	gramming Re	econfigurable	Hardware			E	TIT-350
	-			Study section 3rd Semester	LP 3	Attendance rate 45 h	Self-study 45 h	
1	Mod	le structure	·					
	Nr.	Element / C	Course		LSF no.		Тур	SWS
	1	Lab			080333		Р	4
2 Course language							•	
	Englis							
3	Teac	ning Content						
	-	-		uit and Logics on FPG	GAs			
	-		Design and EDA					
	-	VHDL Prog		GA Plattforms				
		VIIDE PIOg	anning					
	Litera	iture						
			nics with DIGII	ENT BASYS 2 & 3 FF	GA Boards ",	, Andrzej J. Gapinski,	Lap Lambe	ert
[1] " Digital Electronics with DIGILENT BASYS 2 & 3 FPGA Boards ", Andrzej J. Gapinski, Lap L Academic Publishing, 2018, ISBN 9786139929764							•	
	Acad	emic Publishir	ng, 2018, ISBN	9786139929764				
4		emic Publishir Detencies	ng, 2018, ISBN	9786139929764				
4	Com	oetencies	<u> </u>		vork with cur	rent FPGA Architect	ures and Bc	oards. The
4	Comp By at funda	betencies tending this c imentals in th	ourse, student ie usage of too	s will learn how to v Is and programming	VHDL will be	e shown.		
4	Comp By at funda In mu	Detencies tending this co mentals in th Iltiple practica	ourse, student ie usage of too al lessons, VHD	s will learn how to v ls and programming L and Xilinx Vivado	VHDL will be will be used t	e shown. to implement hardwa	are designs	for
4	Comp By at funda In mu differ	betencies tending this c imentals in th iltiple practica ent tasks. The	ourse, student ie usage of too al lessons, VHD	s will learn how to v ls and programming L and Xilinx Vivado	VHDL will be will be used t	e shown.	are designs	for
	Comp By at funda In mu differ Artix	Detencies tending this c imentals in th iltiple practica ent tasks. The 7 FPGA.	ourse, student ie usage of too al lessons, VHD	s will learn how to v ls and programming L and Xilinx Vivado	VHDL will be will be used t	e shown. to implement hardwa	are designs	for
	Comp By at funda In mu differ Artix Exam	Detencies tending this c imentals in th iltiple practica ent tasks. The 7 FPGA. s	ourse, student le usage of too al lessons, VHD e students will	s will learn how to v ls and programming L and Xilinx Vivado implement practica	VHDL will be will be used t	e shown. to implement hardwa	are designs	for
-	Comp By at funda In mu differ Artix Exam	Detencies tending this c imentals in th iltiple practica ent tasks. The 7 FPGA. s	ourse, student le usage of too al lessons, VHD e students will	s will learn how to v ls and programming L and Xilinx Vivado	VHDL will be will be used t	e shown. to implement hardwa	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe	petencies tending this commentals in the altiple practica ent tasks. The 7 FPGA. s ssful complet	ourse, student le usage of too al lessons, VHD e students will tion of 70% of	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks	VHDL will be will be used t	e shown. to implement hardwa	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe	petencies tending this commentals in the altiple practica ent tasks. The 7 FPGA. s ssful complet	ourse, student le usage of too al lessons, VHD e students will tion of 70% of t tion and perfo	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks	VHDL will be will be used t exercises or	e shown. to implement hardwa	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe	petencies tending this c imentals in th iltiple practica ent tasks. The 7 FPGA. s ssful complet s of examinat Module Exan	ourse, student le usage of too al lessons, VHD e students will tion of 70% of f tion and perfo n	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe Form	betencies tending this c imentals in the litiple practica ent tasks. The 7 FPGA. s ssful complet s of examinat Module Exam	ourse, student le usage of too al lessons, VHD e students will tion of 70% of t tion and perfo n irements	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe Form Partic Reco	etencies tending this commentals in the litiple practicate ent tasks. The 7 FPGA. sessful complete s of examinate Module Examinate cipation require	ourse, student le usage of too al lessons, VHD e students will tion of 70% of f tion and perfo n irements erequisite:	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe Form Partic Reco Basic	etencies tending this commentals in the altiple practicate ent tasks. The 7 FPGA. s ssful complet s of examinate Module Examinate ipation require knowledge of	ourse, student le usage of too al lessons, VHD e students will tion of 70% of f tion and perfo n irements erequisite: f computer arc	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe Form Partic Reco Basic	etencies tending this commentals in the altiple practicate ent tasks. The 7 FPGA. s ssful complet s of examinate Module Examinate ipation require knowledge of	ourse, student le usage of too al lessons, VHD e students will tion of 70% of f tion and perfo n irements erequisite:	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm	are designs	for
5	Comp By at funda In mu differ Artix Exam Succe Form Partia Reco Basic Basic	betencies tending this c imentals in the litiple practica ent tasks. The 7 FPGA. s essful complet s of examinat Module Exam cipation requi mmended pre- knowledge of knowledge of	ourse, student le usage of too al lessons, VHD e students will tion of 70% of f tion and perfo n irements erequisite: f computer arc f VHDL program	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm	are designs ent Board v	for
5	Comp By at funda In mu differ Artix Exam Succe Form Partie Reco Basic Basic The r	betencies tending this c imentals in the litiple practica ent tasks. The 7 FPGA. s essful complet s of examinat Module Exam cipation requi mmended pre- knowledge of knowledge of	ourse, student le usage of too al lessons, VHD e students will tion of 70% of t tion and perfo n irements erequisite: f computer arc f VHDL program ticipants is lim	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm achievements	are designs ent Board v	for
5	Comp By at funda In mu differ Artix Exam Succe Form Partie Reco Basic Basic Basic	betencies tending this commentals in the altiple practication ent tasks. The 7 FPGA. s ssful complete s of examinate Module Examinate inpation requires knowledge of knowledge of umber of par- ination regulation	ourse, student le usage of too al lessons, VHD e students will tion of 70% of t tion and perfo n irements erequisite: f computer arc f VHDL program ticipants is lim	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or	e shown. to implement hardwa n a Basys3 Developm achievements	are designs ent Board v	for
5 6 7	Comp By at funda In mu differ Artix Exam Succe Form Partie Reco Basic Basic Basic The r exam	betencies tending this commentals in the altiple practica ent tasks. The 7 FPGA. s ssful complet s of examinat Module Exam cipation requires knowledge of knowledge of knowledge of knowledge of knowledge of knowledge of knowledge of knowled	ourse, student le usage of too al lessons, VHD e students will tion of 70% of f tion and perfo n irements erequisite: f computer arc f VHDL program ticipants is lim ations. usability of the	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or Partial a articipation i	e shown. to implement hardwa n a Basys3 Developm achievements	are designs ent Board v	for
4 5 6 7 8 9	Comp By at funda In mu differ Artix Exam Succe Form Partie Reco Basic Basic The r exam Electi	betencies tending this commentals in the altiple practica ent tasks. The 7 FPGA. s ssful complet s of examinat Module Exam cipation requires knowledge of knowledge of knowledge of knowledge of knowledge of knowledge of knowledge of knowled	ourse, student le usage of too al lessons, VHD e students will tion of 70% of t tion and perfo n irements erequisite: f computer arc f VHDL program ticipants is lim ations. usability of the Master's degree	s will learn how to v ls and programming L and Xilinx Vivado implement practica the internship tasks rmance	VHDL will be will be used t exercises or Partial a articipation i ble Energy Sy	e shown. to implement hardwa n a Basys3 Developm achievements	are designs ent Board v	for

LA	B 5: Co	ntrol system	operation for e	electrical power gric	ls		E	TIT-351			
-		Study section 3rd Semester			ance Self-study 45 h						
1	Mod	ule structure									
	Nr.	Element / C	Course		LSF no.		Тур	SWS			
	1 Lab				08XXXX		Р	4			
2		se language									
	Engli										
3				chine interface betw							
		•	• •	tem stable and safe	-	•	-				
			-	as well as disturband	es in the grid	and generation mu	ist be monit	ored and			
	hand	led appropria	tely.								
		hing Content									
				ol centre operation	of electrical t	ransmission netwo	rks				
		•	of a realistic co	•							
	3		•	eration managemen	t for regular o	operating situations	on the cont	rol			
		centre sim									
			ut network ope	erations for disturbe	d operating s	ituations on the col	ntrol centre	simulato			
	Litera										
			tem Stability a	nd Control							
4		petencies	manlation of th	a prostical source th	ha atu danta h	ava agguirad basial	way ladaa k	footro			
				e practical course, the practical course, the practical course, the price of the precedent		•	-				
	-	•	•	is on the control cer	-		-				
		•	stem in practic			. This creates a uee	p understan	ung or			
		•	•	e. uring the practical co	ourse using a	realistic control sys	tom with wh	hich the			
			-	onnel are also traine	-	•					
	situa	•	lagement pers			e and theu out using	goperating				
5											
2		Exams									
	Completion of all subtasks and preparation of a protocol.										
6	Form	s of examinat	tion and perfo	rmance							
•	Forms of examination and performance Module Exam Module Exam										
7	Participation requirements										
		Recommended prerequisites: Knowledge of the basics of electrical power engineering, knowledge of									
	infor	information systems for grid operation management.									
	-	The number of participants is limited. Admission to participation is in accordance with § 9 of the									
		•		ited. Admission to p	articipation is	in accordance with	1 § 9 of the				
	I exam	ination regula	ations.								
		-	Module type and usability of the module								
8	Mod	ule type and	-								
	Mod Elect	ule type and in the	Master's degre	ee program Sustaina		stems.					
8	Mode Elect Mode	ule type and	Master's degre	ee program Sustaina Faculty ir	charge	stems. gineering and Infori					

LA	3 6: Hig	h Perform	ance Computing	in Python				ETIT-354
Turnus annually WiSe			Duration 2 weeks (block event)	Study section 1st semester	LP 3			Self-study 42 h
1	Modu	le structu	re .					·
	Nr.	Element	/ Course		LSF no.		Тур	Zeitstunden
	1	Lab			08 XXXX	,	Р	90
2	Course language English							
4	 Concepts for evaluating the performance of implemented algorithms (Profiling) Computational efficient algorithms and application of multiprocessing for speed improvement Distributed programming for clusters or networked computers utilizing Pyro Connection of existing system via the application of Numba, PyPy, f2py NumPy for fast computations Cython for speed improvements Speeding up an existing loop using OpenMP by building modules for parallelization Examplary implementation and evaluation of an algorithm for the design of quantum devices Literature Gorelick, Ozswald: High Performance Python 							ım devices
	Students gain practical knowledge of developing procedures for the implementation of high performance computing algorithms. They learn about the practical behavior and how the performance characteristics of high performance computing systems can be evaluated as well as what the limits of a hardware-oriented simulation are. Furthermore, students will have gained the essentials of the open-source software framework Python for the realization of high performance computing in engineering applications. They will be able to speed up algorithms for fast computation.							
5	Exams The Supervisor checks the completion and the reports of all subtasks during the course.						ie.	
6	Forms of examination and performance Module Exam Module Exam							
7	Basic The r	knowledge	• •	limited. Admission	to participat	ion is in a	ccordan	ce with § 9 of the
8		••	d usability of the ne Master's degre	e module ee program Sustaina	ble Energy Sy	stems.		
9	Module Supervisor Faculty in charge apl. Prof. DrIng. Dirk Schulz Faculty of Electrical Engineering and Information Technology							

Sei	ninar S	Scientific Work					ETIT-281
Tu	Turnus Duration Study see		Study section	LP	Attendance rat	e Self-st	udy
На	lf-yearl		25 h	65 h			
1		ule structure					
	Nr.	Element / Course		LSF no.	Тур	SWS	
	1	Course Scientific Wo	rk: Paper reading			S	2
	2	Seminar Scientific W	ork			S	2
2	Course language Englisch						
	2. cla 3. su Teac 1. ela 2. pr 3. dis	search and selection assification and elabora mmary of contents hing content Abschnitt aboration of the conter esentation of scientific scussion of scientific th subject from which the	2 It of scientific paper work to an expert a eses and results wit	audience h an expert au	dience on the subject area of t	he upper s	seminar.
	Competencies Students can familiarise themselves with a scientific publication and are able to place the publication in the overall context of the respective field. They can present the content of the publication to an expert audience, answer questions about the content of this publication and discuss the conclusions from this publication with an expert audience. To this end, they are proficient in the presentation techniques customary in scientific lectures. In addition, they can participate in the discussion about the contents of a scientific lecture from their subject area.						expert om this ues
5	Exam The s	15	tion is the Module		on, the student must ac	tively parti	cipate in at
6	Forms of examination and performance Image: Module Exam Image: Partial achievements						
7		cipation requirements mmended prerequisite		nowledge in th	e respective field of the	upper sem	ninar.
8		ule type and usability of the course in the Master of the course in the Master of the course in the Master of the course in the course of the		sustainable Er	nergy Systems.		
9	Dean	ule Supervisor of the Faculty of Elect neering and Information	rical Fac	ulty in charge ulty of Electrica	al Engineering and Inform	nation Tec	hnology

Master Thesis

With the Master's thesis, 30 credit points must be successfully acquired.

Mo	odul 4-1	L: Master Thesis					ETIT-29			
Turnus Duration Study sec			Study section	LP	Attendance rate	Self-st	udy			
На	lf-yearl	y 1 Semester	4th Semester	30	-	900 h	•			
1	Module structure									
	Nr.	Element / Course			LSF no.	Тур	SWS			
	1	Master Thesis				Р	-			
2	Cours	se language								
	Englis									
3	Teac	hing Content								
	1. far	niliarisation with the s	cientific problem of t	he task using	guidelines.					
		alysis of the relevant p		rk						
		velopment of solution	••							
		rification and evaluation								
		ection and realisation	• •							
	6. sci	entific description of t	he methodology and	the solution in	n written form.					
	-									
				•	ssed and presented to an	expert a	udience.			
			place no later than e	b weeks after s	submission of the thesis.					
4		petencies tudopt is able to work	indopondontly on a r	arrowly dofin	ned technical-scientific pro	ablom fro	m his or			
					evaluate relevant prelimi					
					aluate these and finally im					
					g in a structured way so th					
					le to present the results to					
	-	ence and discuss them			p					
5	Exam	Exams								
	The N	Aaster's thesis counts a	as a Module Exam.							
6	Forms of examination and performance									
	X	Module Exam		🗌 Partia	al achievements					
_	Parti	Participation requirements								
7	Recommended prerequisites: Good scientific knowledge in the respective field of the master thesis									
7	Reco	mmended prerequisite	s: Good scientific kno	owledge in the	e respective field of the m	laster the	sis			
7				-	•	laster the	sis			
7	Requ	ired prerequisites: Acq	uisition of 80 credit p	-	•	laster the	esis			
	Requ Mod		uisition of 80 credit p of the module	points in the N	Aaster's programme.	laster the	esis			
	Requ Mode Elect	ired prerequisites: Acq ule type and usability	uisition of 80 credit p of the module ter's degree program	ooints in the N Sustainable E	Aaster's programme.	laster the	esis			
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Version information

V 1.0: Vom Fakultätsrat der Fakultät für Elektrotechnik und Informationstechnik am 19.05.2010 beschlossene Version des Modulhandbuchs

Information on the elective modules

Two subject-related modules of 3 SWS each (usually corresponds to 5 LP) can be completed by a joint module examination. In this way, 10 credit points are acquired. There are a number of sensible combinations for this, which can be requested from the respective professors in individual cases.