Study plan

Name of study plan: Cybernetics and Robotics - Senzors and Instrumention

Faculty/Institute/Others: Faculty of Electrical Engineering Department: Branch of study guaranteed by the department: Welcome page Garantor of the study branch: Program of study: Cybernetics and Robotics Type of study: Follow-up master full-time Required credits: 98 Elective courses credits: 22 Sum of credits in the plan: 120 Note on the plan:

Name of the block: Compulsory courses in the program Minimal number of credits of the block: 66 The role of the block: P

Code of the group: 2015_MKYRDIP Name of the group: Diploma Thesis Requirement credits in the group: In this group you have to gain 30 credits Requirement courses in the group: In this group you have to complete 1 course Credits in the group: 30 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
BDIP30	Diploma Thesis	Z	30	22s	L	Р

Characteristics of the courses of this group of Study Plan: Code=2015_MKYRDIP Name=Diploma Thesis

 BDIP30
 Diploma Thesis
 Z
 30

 Independent final comprehensive work for the Master's degree study programme. A student will choose a topic from a range of topics related to his or her branch of study, which will be specified by branch department or branch departments. The diploma thesis will be defended in front of the board of examiners for the comprehensive final examination.

Code of the group: 2015_MKYRP

Name of the group: Compulsory subjects of the programme Requirement credits in the group: In this group you have to gain 36 credits Requirement courses in the group: In this group you have to complete 5 courses Credits in the group: 36 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
B3M33ARO	Autonomous Robotics	Z,ZK	7	3P+2L	L	Р
B3M38DIT	Diagnostics and Testing	Z,ZK	7	3P+2L	L	Р
B3MPVT	Pavel Mužák, Tomáš Drábek, Martin Hlinovský, Ond ej Drbohlav Tomáš Drábek Tomáš Drábek (Gar.)	KZ	6	0P+4S	L	Ρ
B3MPROJ8	Project Martin Hlinovský, Petr Pošík, Drahomíra Hejtmanová, Jaroslava Mat jková, Tomáš Svoboda, Martin Šipoš, Jana Zichová	z	8	0p+6s	z	Р

Characteristics of the courses of this group of Study Plan: Code=2015_MKYRP Name=Compulsory subjects of the programme

 B3M33ARO
 Autonomous Robotics
 Z,ZK
 7

 The Autonomous robotics course will explain the principles needed to develop algorithms for intelligent mobile robots such as algorithms for: (1) Mapping and localization (SLAM) sensors calibration (lidar or camera). (2) Planning the path in the existing map or planning the exploration in a partially unknown map and performing the plan in the world. IMPORTANT: It is assumed that students of this course have a working knowledge of optimization (Gauss-Newton method, Levenberg Marquardt method, full Newton method), mathematical analysis (gradient, Jacobian, Hessian), linear algebra (least-squares method), probability theory (multivariate gaussian probability), statistics (maximum likelihood and maximum aposteriori estimate), python programming and machine learning algorithms.

B3M38DIT	Diagnostics and Testing	Z,ZK	7					
B3MPVT		KZ	6					
Teamwork is the basis of	Teamwork is the basis of most of the activities that people perform in companies and their personal lives. In this course, students can try how to solve a technical task in a team, how							
to cooperate, how to co	to cooperate, how to communicate together and how to solve problems such as project delays, how to include external influences in the plan, etc.							
B3MPROJ8	Project	Z	8					

Name of the block: Compulsory courses of the specialization Minimal number of credits of the block: 26 The role of the block: PO

Code of the group: 2015_MKYRPO2 Name of the group: Compulsory subjects of the branch Requirement credits in the group: In this group you have to gain 26 credits Requirement courses in the group: In this group you have to complete 5 courses Credits in the group: 26 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
B3M38MSE	Modern Sensors	Z,ZK	6	2P+2L	Z	PO
B3M38SPD	Data Acquisition and Transfer	Z,ZK	6	2P+2L	Z	PO
B3M38VBM	Videometry and Contactless Measurement	Z,ZK	6	2P+2L	Z	PO
B3M38VIN	Virtual Instrumentation	Z,ZK	6	2P+2L	L	PO
B3M38ZDS	Analog Signal Processing and Digitalization	Z,ZK	6	2P+2L	Z	PO

Characteristics of the courses of this group of Study Plan: Code=2015_MKYRPO2 Name=Compulsory subjects of the branch

B3M38MSE	Modern Sensors	Z,ZK	6
An overview of sensors	of physical quantities used in industry and in research and methods of signal processing.		
B3M38SPD	Data Acquisition and Transfer	Z,ZK	6
The aim of the course is	to acquaint students with principles and limits of data transmission from sensors and similar sources of information for IoT a	nd M2M, wireless	sensor networks
and specific algorithms,	respecting the limiting conditions of their function. The basic algorithms of distributed information processing in sensor netw	orks, as well as te	echnology for
energy harvesting for pe	owering the wireless nodes of the network, will be studied.		
B3M38VBM	Videometry and Contactless Measurement	Z,ZK	6
This course focuses on	CCD and CMOS video sensors, and optoelectronic sensors in general and their use in contactless videometric measurement	systems. Further	optical radiation,
its features, behavior ar	d its use for acquiring object parameters, optical projection system, design of measurement cameras and processing of their	signal will be pres	sented. Students
will design, realize and	debug an independent project - 'Optoelectronic reflective sensor', during labs.		
B3M38VIN	Virtual Instrumentation	Z,ZK	6
B3M38ZDS	Analog Signal Processing and Digitalization	Z,ZK	6

Name of the block: Compulsory elective courses Minimal number of credits of the block: 6 The role of the block: PV

Code of the group: 2015_MKYRPV2

Name of the group: Compulsory subjects of the programme Requirement credits in the group: In this group you have to gain at least 6 credits (at most 90) Requirement courses in the group: In this group you have to complete at least 1 course (at most 15) Credits in the group: 6

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
B3M35DRS	Dynamics and Control Networks Kristian Hengster-Movric Kristian Hengster-Movric	Z,ZK	6	2P+2C	Z	PV
B3M38INA	Integrated Avionics <i>Martin Šipo</i> š	Z,ZK	6	2P+2L	L	PV
B3M37KIN	Space Engineering Kristian Hengster-Movric, Václav Navrátil, René Hudec, Martin Hrom ík, Martin Urban, Petr Ondrá ek René Hudec René Hudec (Gar.)	Z,ZK	6	2P+2L	Z	PV
B3M37LRS	Aeronautical radio systems Pavel Ková Pavel Ková Pavel Ková (Gar.)	Z,ZK	6	2P+2L	Z	PV

B3M35NES Nonlinear Systems and Chaos Kristian Hengster-Movric, Sergej elikovský Sergej elikovský Sergej Z,ZK 6 2P+2C Z PV B3M35NES Estimation, filtering and detection Vladimír Havlena Vladimír Havlena (Gar.) Z,ZK 6 2P+2C Z PV B3M35ORD Estimation, filtering and detection Vladimír Havlena Vladimír Havlena (Gar.) Z,ZK 6 2P+2C L PV B3M35ORR Optimal and Robust Control Zden k Hurák Zden k Hurák Zden k Hurák (Gar.) Z,ZK 6 2P+2C L PV B3M35PRO Advanced robotics Z,ZK 6 2P+2C Z PV B3M35PSR Real -Time Systems Programming Michal Sojka Michal Sojka (Gar.) Z,ZK 6 2P+2C Z PV B3M33PIS Industrial Information Systems Z,ZK 6 2P+2L Z PV B3M35SRL Flight Control Systems Martin Hrom ik Martin Hrom ik (Gar.) Z,ZK 6 2P+2L Z PV B3M35SRL Flight Control Systems Martin Hrom ik Martin Hrom ik (Gar.) Z,ZK 6 2P+2L Z PV B3M33UI Artificial Intelligence Petr Pošik Z,ZK 6 2P+2C<	B3M33MKR	Mobile and Collective Robotics	Z,ZK	6	2P+2L	Z	PV
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B3M38PSL Arcraft Avionics Z.ZK 6 2P+2L Z PV B3M3SSRL Flight Control Systems Z.ZK 6 2P+2L Z PV B3M3SUL Artificial Melligence Z.ZK 6 2P+2L L PV Characteristics of the courses of this group of Study Plan: Code=2015_MKYRPV2 Name=Computory subjects of the programme B3M3SURS Z.ZK 6 2P+2L L PV Characteristics of the courses of this group of Study Plan: Code=2015_MKYRPV2 Name=Computory subjects of the programme B3M3SURS Z.ZK 6 2P+2L L PV Characteristics of the courses of this group of Study Plan: Code=2015_MKYRPV2 Name=Computory subjects of the programme EdM3SURS EdM3SURS Foreadmark the programme	B3M35PSR		Z,ZK	6	2P+2C	Z	PV
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E3M3GDRS [Dynamics and Control Networks [Z,Z] 6 This course responses in a environment is an experimental similaries between diverse areas such as e.g. treasaing the spread of global pandemics, public open dynamics communits through a contential on manipulation of communities through a contential is inflating a treasaing operation and distribution power gists, etc. Understanding such comments and distribution power gists, etc. Understanding such communities through a comparison of any single physical, technologial or scientific domains. Therefore, we will another the outwer introduces through the through networks and the comute introduces through the through networks and the comparison technologian networks. The such expective displation and the detailed intercommedia and bastics on comparison and event with a special any single physical, technologial or scientific domains. The socient global pandemics and through the course introduces through the through the special on the special or a displacing right theory, network reasure, the first part of the course site displation graph theory, network measure and method to a displation control theory. E3M3BIN Integrated Avionics Z.ZK 6 East and the displation of the course site science in the second of a displation (model) through theory, networks and an application technologies and antisplation of the science in the second of a displation control theory and the course site science in the second of a displation control theory and the course introduces and the course introduces and the displation of the second of a displation control theory and the course introduces and the course introduces and the displation of the second of a displation of the second of a displation of the second of a displation (the course intocourse) introduces and the	Characteristics of the		ame=Compu	lsorv sub	iects of	the pro	gramme
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option dynamics and manipulation of communities through social meeting, formation controls for unmanned whiches, mergy generatives, and distribution in power grids, etc. Understranding such compelling takes grows for hyport the boundrates of any single physical celencial enteriors. The social set data of the interactivistics of the individual components and distribution in power grids, etc. Understranding social according to the state of a processing photony. Interactivistics of the individual components and distribution in power interactivistics of the individual components and distributed HW systems is SW blocks. They use high-speed connections to exchange data in approximation, fault distributed HW systems is SW blocks. They use high-speed connections to exchange data in approximate, fault distributed HW systems is SW blocks. They use high-speed connections to exchange data in approxime, fault of distributed HW systems, fault distributed HW systems is SW blocks of physics of the space and protein time of space systems and imprace or portal and increases. SMMXTKIN Space Engineering Z/X 6 Shadd acquaints with the basics of physics of the space and increase in the event of a failure. In course, statement of statement of space systems and imprace or the accurace, understrained in space systems, sensor used, their modeling and description. It discusses the principles of underlying calculations and their processing. SMMXTKIN S			x systems compo	sed of many		· .	-
such compaling issues goes for beyond the boundaries of any single physical, technological or sientific domain. Therefore, we will analyze phenomena across different domains, involving colleal, economic and biologian tervork. For such network algoests controlled to detailed intervortence to physical or biological retervices. For such network algoests controlled to detailed intervortence to physical or biological for the involving collection of an other second and metrics and metrics and truth encourse intoduces hundren that the records in algoestical (MA) focuses on a precise way those components are intercommeted the detailed intervortence to physical or biological for the involving detailed theoretical in addition of advances (Control Heory). E3X453INA Infograted Avionices (MA) focuses on a noders concept of the approach to the development and design of aincrit electrocity (viscus), where the transition from details about the requirements for two control Heory). The excitaing regulatory basis and alignacy basis analys and balignacy basis an	interconnected into a single of	distributed entity. Herein, we will consider fundamental similarities between diverse are	as such as e.g. fo	precasting the	e spread of	global par	demics, public
involving societal, economic and biological networks. For such networked systems, the resulting behavior dependent or only on the haracteristics of their individual components and details of their (provingencial or logical interactions, but also to a precises wey those components and interconnection the dealed meterconnection. The design and abstract computational networks analysis concepts; in particulas, the algebraic applications (see that on the excent part of the course subsequently views networks as dynamical systems, studies their properties and ways in which these are controlled, using mainly methods of automatic control theory:	opinion dynamics and manipu	ulation of communities through social media, formation controls for unmanned vehicles,	energy generatior	and distribut	ion in powe	er grids, etc	Understanding
details of heir physical or togical interactions, but also on a procise way those components are interconnected the detailed interconnection topology. For that reason, the first part of the course introduces fundamental heavershally and successful in the detailed interconnection topology. For that reason, the first part of the course introduces fundamental heavershally and successful interconnection topology. For that reason, the first part of the course introduces fundamental methods and unmatice control theory. E3M3BIN Integrated Avionics Z,ZK 6 He course introduces (MM) focuses on a modern concept of the approach to the development and design of alternet tectoria (avionics), where the transition from distributed HW systems to SN blocks. They use high-speed connection to exchange data in applications related to paid at intract electoria (avionics), where the transition from distributed HW systems to SN blocks. They use high-speed conception of the inspine work in the event of a failure. In the occurs, includes and support data inspine work in the event of a failure. In the occurs, includes and support and control systems, studies within the basics of physics of the space environment and the technologies used in space systems, statelites and spaceorafis and sunches and methods are detailed description of the inspine. Subject systems and methods are detailed description of the inspine systems, statelites and spaceorafis and systems or tappec and the spine systems. Subject matter includes a detailed description of the inspine system, sensora way is a spine systems, and the inspination of the estimation and their processing. E3M37LW Space Canging Mark Systems Z,ZK 6 E3M37LW Apromatitical radio systems, sensora was detailed and pract							
the course introduces fundimental theoretical and abatratic computational network marylysis concepts: in particular, the algorited graph theory, network measures and metrica and undimating control theory. The second part of the course subsequently views networks as dynamical systems, studies their properties and ways in which these are controlled, using mainly methods of automatic control theory. The second part of the course subsequently views networks as dynamical systems, studies their properties and ways in which these are controlled. The course integrated Modular Advincis (MA) focuses on a modern concept of the approach to the development and design of alcraft electronics (alvincins), where the transition from distributed HW systems to SW bocks. They use high-speed councils or development and particular in the course, students will enclose a subset on the accurse, visibality, and functionality of electronic systems is neared to paid at integrate methods. Subject on the accurse visibality, and hendicos al teaching detain in applications related to paid at integrations. The course integratements for so-called salwy-oritical multi-sensor systems, and modular of transmite integratements. BIMSININ Space Engineering A subset subset on the social systems and markets of integratements. BIMSININ Space Engineering A course also covers optice/ectronics in space environment and the technologies used in space systems, satellites, spacecrafts and list resistance to wetrant infuences of the sace anvironment, and analysis of intruments and systems and methods of hubit restings. It provides a basic coveries of pote trajectories of space relations. The course integrates is a space systems, sensors used, their modeling and description. It discusses the principles of underlying calculations, and analysis of intruments and systems and methods of their prevention. It discusses the principles of underlying calculations, environmental methods and practical multis and practical multipation and consistem including statements ar	-		-				-
Indiamental network algorithms. The second part of the course subsequently views networks as dynamical systems, studies their properties and ways in which these are controlled, using maining methods of automated and use and control theory. B3M38INA Integrated Autonics (MA) locues on a modern concept of the approach to the development and design of alrcraft electronics (aviolucis), where the transition from distributed HW systems to SW blocks. They use high-speed connections to exchange data in applications related to paid air transport. The existing regulatory basis and airspace sharing define the requirements for the accuracy, reliability, and functionality of electronic systems even in the even of a failure. The existing regulatory basis and airspace systems, shall be course, students will learn details about the course, students will learn details about the accuracy reliability, and nucleonality of electronic systems, sentiled systems, statellites, spacecrafts and faunchers and methods and the integrituations. The course induces a detailed description of the instrumentation of statellites and spaceerstras and methods and their applications. The course induces is used in the development and description of the instrumentation of statellites and spaceerstras and methods and their applications. The course indice covers opticelectronics in space systems, sensors used, their modeling and description. It discusses the principies of underlying calculators, simulations and their processing. ZZK 6 for the course introduces students to the aeronautical radio explanement. The course infoduces a total and their processing. CZK 6 for the accurate or the accurate systems and systems and systems for students to the aeronautical radio explanement. The course infoduces automatical and be systems and systems and systems and systems and processing. CZK 6 for the course infoduces automatical mode engineering, aeronautical and practical knowledge of the coperation of the acarchate systems and their inforgation to the acronautical					0,	,	
using analy methods of automatic control theory. Z,ZK 6 SMM3BINA Integrated Modular Avionics (MAA) bocuses on a modern concept of the approach to the development and design of aircraft electronics (avionics), where the transition from design of aircraft electronics (avionics), where the transition from design of aircraft electronics (avionics), where the transition from design and aircraft electronics) experiments for so-called stately-critical multi-sensor systems, methods of data processing from prodetermined systems, fault detection methods, selection of primary computer and oranol system in the avent of a failure. In the course, students will learn details about the requirements for so-called stately-critical multi-sensor systems, methods of data processing from prodetermined systems, fault detection methods, selection of primary computer and noral contributions. The source atoquinits students with the basics of hysics of the space environment and the technologies used in space systems, satellites, spacecrafts and launchers and methods for the design and preparation of space missions. Subject matter includes a detailed description of their testing functional solutions and launchers and launchers and methods for their applications. The course intermediates and space-critical multicons and the aeronautical instruments and systems for space-critical multi-sensor the trajectories of the trajectories of appendix including statellites navigation, primary scondary and passive radiolocitism, earonautical analogue, digital and satellite communication systems, aeronautical radio navigation including statellites navigation, primary scondary and passive radiolocitism, earonautical analyse, digital and satellite communication systems, aeronautical radio systems and their integration the aeronautical pressive metal course states in presented base of the aeronautical application. The course site integrate analyse							
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The goal of this course is to introduce basics of the modern approaches to the theory and applications of nonlinear control. Fundamental difference when dealing with nonlinear systems control compared with linear case is that the state space approach prevails. Indeed, the frequency response approach is almost useless in nonlinear control. State space models are based mainly on ordinary differential equations, therefore, an introduction to solving these equations is part of the course. More importantly, the qualitative methods for ordinary differential equations will be presented, among them Lyapunov stability theory is crucial. More specifically, the focus will be on Lyapunov function method enabling to analyse stability of nonlinear systems, not only that of linear ones. Furthemore, stabilization desing methods will be studied in detail, among them the so-called control Lyapunov function concept and related backstepping method. Special stress will be, nevertheless, given by this course to introduce and study methods how to transform complex nonlinear models to simpler forms where more standard linear methods would be applicable. Such an approach is usually refered to as the so-called exact nonlinearity compensation. Contrary to the well-known approximate linearization this method does not ignore nonlinearities but compensates them up to the best possible extent. The course introduces some interesting case studies as well, e.g. the planar vertical take off and landing plane ("planar VTOL"), or a simple 2-dimensional model of the walking robot. B3M350FD Estimation, filtering and detection Z,ZK 6 This course will cover description of the uncertainty of hidden variables (parameters and state of a dynamic system) using the probability language and methods for their estimation. Based on bayesian problem formulation principles of rational behavior under uncertainty will be analyzed and used to develop algorit	on real data.				-	-	
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and how it can be used to identify its kinematic parameters. Theory will be demonstrated on simulated tasks and verified on a real industrial robot.							
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1	al -Time Systems Programming	ntoma for overnale i	in control on		Z,ZK	6 The feature
-	provide students with basic knowledge about software development for real-time syster uipped with a real-time operating system (RTOS). Lectures will cover real-time syster	-				
	lectures will introduce methods and techniques used for development of safety-crit			-		
e	t solve a few simple tasks to familiarize themselves with basic components of $VxWo$				•	
· · ·	ent the typical criteria for assessing the suitability of a given platform for the given a		•			plex task of
	oplication which will require full utilization of RTOS features. All the tasks at the labs	will be implemented	a in C (or C-			6
	ustrial Information Systems rovide students with the necessary set of skills essential for the design and manage	ment of modern pro	duction svs		Z,ZK	6 course the
	hods of modeling and simulation of discrete production systems. Students will then		-		-	
as well as into methods for p	rocess mining. The final part of the course deals with methods of data and knowled	ge modeling, which	are necessa	ary for expli	cit capture and	machine
	knowledge about production.					
	craft Avionics				Z,ZK	6
-	field of aircraft avionics including principles, sensors, measurement and evaluation			-	-	-
-	e. engine and aircraft monitoring systems, power systems, pressure-based systems innology and methodology on aircraft and thus serves to understand fundamentals		-	-		-
-	ns and sensors. The course focuses on both small and large aircraft as well as on U			,		
B3M35SRL Flig	ght Control Systems			Z	Z,ZK	6
	ssical and modern control design techniques for autopilots and flight control system			-		
angle stabilizers, to guidance are discussed.	and navigation systems. Next to the design itself, important aspects of aircraft moc	delling, both as a rig	id body and	considering	g flexibility of th	e structure,
B3M33UI Art	ificial Intelligence			2	Z,ZK	6
	iches knowledge of Al gained in the bachelor course Cybernetics and Artificial Intell	•	0			
	ce with some of them. They will master other required abilities to build intelligent age			-		
	s to evaluate models, and methods for overfitting prevention. They will learn about p nted with the basics of probabilistic graphical models, Bayesian networks and Mark	-	-			
	a of again populat neural networks, with an emphasis to new methods for deep lear					
Requirement crea Requirement cou	p: Humanities subjects dits in the group: rses in the group:					
Credits in the gro	•					
Note on the group					· · · · ·	
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
B0M16FI2	Philosophy 2	Z,ZK	4	2P+2S	L	V
B0M16HT2	History of science and technology 2	Z,ZK	4	2P+2S	L	V
B0M16HSD	History of economy and social studies	Z,ZK	4	2P+2S	L	v
BOM16MPS		Z,ZK	4	2P+2S	Z,L	V
	Psychology Physical Education					
A003TV	Ji í Drnek	Z	2	0+2	L,Z	V
B0M16TE1	Theology	Z,ZK	4	2P+2S	L	V
Characteristics of the	courses of this group of Study Plan: Code=2015_MKYRH Na	ame-Humaniti	es subie	rte		
	losophy 2		co oubje		Z,ZK	4
	e transdisciplinar aspects of philosophy, informatics, physics, mathematics and biolo	ogy.		2	-,	7
	tory of science and technology 2			2	Z,ZK	4
	developments in electrical engineering branches in the world and in the Czech Lan	ds. Its ultimate goal	is to stimula	1	<i>'</i>	history and
traditions of the subject, while	e highlighting the developments in technical education and professional organization	ns, the process of s	haping scier	ntific life and	the influence	of technical

engineers							
B0M16HSD	History of economy and social studies	Z,ZK	4				
This subject deals with	the history of the European and Czech society in the 19th - 21th centuries. It follows the forming of the European and Czech	political represen	tation, its aims				
and achieved results as	well as the social, economical, technical and cultural development and coexistence of the various ethnical groups.						
B0M16MPS	Psychology	Z,ZK	4				
A003TV	Physical Education	Z	2				
B0M16TE1	Theology	Z,ZK	4				
This subject provides to	students the basic orientation in christian theology and requires no special previous education. After short philosophic lectu	re the basic theolo	ogic disciplines				
are gone through. The subject is determined not only to believer students who want to know the reliable theologic grounding but also above all to ones who want to get know Christianity							
- religion from which gra	aws our civilization up.						

Code of the group: MTV Name of the group: Physical education Requirement credits in the group: Requirement courses in the group: Credits in the group: 0 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
TVV	Physical education	Z	0	0+2	Z,L	V
TV-V1	Physical education	Z	1	0+2	Z,L	V
TVV0	Physical education	Z	0	0+2	Z,L	V
TVKZV	Physical Education Course	Z	0	7dní	Z	V
TVKLV	Physical Education Course	Z	0	7dní	L	V

Characteristics of the courses of this group of Study Plan: Code=MTV Name=Physical education

TVV	Physical education	Z	0
TV-V1	Physical education	Z	1
TVV0	Physical education	Z	0
TVKZV	Physical Education Course	Z	0
TVKLV	Physical Education Course	Z	0

Code of the group: 2015_MKYRVOL Name of the group: Elective subjects Requirement credits in the group: Requirement courses in the group: Credits in the group: 0 Note on the group: ~Nabíd

~Nabídku volitelných předmětů uspořádaných podle kateder najdete na webových stránkách http://www.fel.cvut.cz/cz/education/volitelne-predmety.html\\

List of courses of this pass:

Code	Name of the course	Completion	Credits
A003TV	Physical Education	Z	2
B0M16FI2	Philosophy 2	Z,ZK	4
·	The course is oriented on the transdisciplinar aspects of philosophy, informatics, physics, mathematics and biology.		
B0M16HSD	History of economy and social studies	Z,ZK	4
This subject deals	with the history of the European and Czech society in the 19th - 21th centuries. It follows the forming of the European and Czech po	litical representation	on, its aims
	and achieved results as well as the social, economical, technical and cultural development and coexistence of the various ethnica	l groups.	
B0M16HT2	History of science and technology 2	Z,ZK	4
This subject traces	historical developments in electrical engineering branches in the world and in the Czech Lands. Its ultimate goal is to stimulate stude	ents' interest in the	history and
traditions of the sub	pject, while highlighting the developments in technical education and professional organizations, the process of shaping scientific life	and the influence	of technical
	engineers		
B0M16MPS	Psychology	Z,ZK	4
B0M16TE1	Theology	Z,ZK	4
This subject provid	es to students the basic orientation in christian theology and requires no special previous education. After short philosophic lecture i	he basic theologic	disciplines
are gone through. T	he subject is determined not only to believer students who want to know the reliable theologic grounding but also above all to ones wh	o want to get know	Christianity
	- religion from which graws our civilization up.		
B3M33ARO	Autonomous Robotics	Z,ZK	7
The Autonomous	robotics course will explain the principles needed to develop algorithms for intelligent mobile robots such as algorithms for: (1) Mapping and the principle of	, bing and localization	n (SLAM)
sensors calibration	(lidar or camera). (2) Planning the path in the existing map or planning the exploration in a partially unknown map and performing the p	plan in the world. IN	PORTANT:
It is assumed that st	udents of this course have a working knowledge of optimization (Gauss-Newton method, Levenberg Marquardt method, full Newton m	nethod), mathemat	ical analysis
(gradient, Jacobia	n, Hessian), linear algebra (least-squares method), probability theory (multivariate gaussian probability), statistics (maximum likeliho	od and maximum	aposteriori
	estimate), python programming and machine learning algorithms.		
B3M33MKR	Mobile and Collective Robotics	Z,ZK	6
The course introdu	ces a basic mobile robot structure design together with control methods aimed to achieve autonomous and collective behaviors for i	obots. Methods ar	nd tool s for
	and processing are presented herein with the overall goal to resolve the task of autonomous navigation for mobile robots comprising		
environmental mod	eling including Simultaneous Localization And Mapping (SLAM) approaches. Besides sensor-processing related tasks, methods for r	obot trajectory plan	nning will be

introduced. The central topic of the course stands in specific usage of the afore methods capable of execution with groups of robots and taking the advantage of their cooperation and coordination in groups. Labs and seminars are organized in a form of an Open Laboratory whereas the students will implement some fundamental algorithms and study their properties

j	on real data.	· · · · · · · · · · · · · · · · · ·	1 1		
B3M33PIS	Industrial Information Systems	Z,ZK	6		
	rse is to provide students with the necessary set of skills essential for the design and management of modern production systems. In				
students will learn about methods of modeling and simulation of discrete production systems. Students will then gain insight into methods for data analysis to optimize the production as well as into methods for process mining. The final part of the course deals with methods of data and knowledge modeling, which are necessary for explicit capture and machine					
	utilization of information and knowledge about production.	explicit capture and			
B3M33PRO	Advanced robotics	Z,ZK	6		
	demonstrate techniques for modelling, analyzing and identifying robot kinematics. We will explain more advanced principles of the rep		ion in space		
and the robot descriptions suitable for identification of kinematic parameters from measured data. We will explain how to solve the inverse kinematic task of 6DOF serial manipulators					
and how it can be used to identify its kinematic parameters. Theory will be demonstrated on simulated tasks and verified on a real industrial robot.					
B3M33UI	Artificial Intelligence	Z,ZK	6		
	is and enriches knowledge of AI gained in the bachelor course Cybernetics and Artificial Intelligence. Students will get an overview of experience with some of them. They will master other required abilities to build intelligent agents. By applying new models, they will r				
machine learning, techniques to evaluate models, and methods for overfitting prevention. They will learn about planning and scheduling tasks, and about methods used to solve them.					
-	get ackquainted with the basics of probabilistic graphical models, Bayesian networks and Markov models, and will learn their applica				
	introduce students to the area of again populat neural networks, with an emphasis to new methods for deep learning.				
B3M35DRS	Dynamics and Control Networks	Z,ZK	6		
	ponds to an ever-increasing demand for understanding contemporary networks large-scale complex systems composed of many cor	-	-		
	b a single distributed entity. Herein, we will consider fundamental similarities between diverse areas such as e.g. forecasting the sprea	0 1	· •		
	nd manipulation of communities through social media, formation controls for unmanned vehicles, energy generation and distribution in p issues goes far beyond the boundaries of any single physical, technological or scientific domain. Therefore, we will analyze phenome	-	-		
	economic and biological networks. For such networked systems, the resulting behavior depends not only on the characteristics of the				
-	visical or logical interactions, but also on a precise way those components are interconnected the detailed interconnection topology. For	-			
the course introd	uces fundamental theoretical and abstract computational network analysis concepts; in particular, the algebraic graph theory, network	k measures and m	etrics and		
fundamental netwo	ork algorithms. The second part of the course subsequently views networks as dynamical systems, studies their properties and ways	in which these are	controlled,		
Dallashisa	using mainly methods of automatic control theory.		•		
B3M35NES	Nonlinear Systems and Chaos	Z,ZK	6		
•	irse is to introduce basics of the modern approaches to the theory and applications of nonlinear control. Fundamental difference when a with linear case is that the state space approach prevails. Indeed, the frequency response approach is almost useless in nonlinear co	•			
	dinary differential equations, therefore, an introduction to solving these equations is part of the course. More importantly, the qualitative n				
equations will be pr	resented, among them Lyapunov stability theory is crucial. More specifically, the focus will be on Lyapunov function method enabling to	o analyse stability	of nonlinear		
systems, not onl	y that of linear ones. Furthemore, stabilization desing methods will be studied in detail, among them the so-called control Lyapunov fu	unction concept an	d related		
	hod. Special stress will be, nevertheless, given by this course to introduce and study methods how to transform complex nonlinear m	-			
	ar methods would be applicable. Such an approach is usually refered to as the so-called exact nonlinearity compensation. Contrary to method does not ignore nonlinearities but compensates them up to the best possible extent. The course introduces some interesting of the source of t				
ineanzaion ins i	planar vertical take off and landing plane ("planar VTOL"), or a simple 2-dimensional model of the walking robot.	Lase studies as we	ii, e.y. iie		
B3M35OFD	Estimation, filtering and detection	Z,ZK	6		
	ver description of the uncertainty of hidden variables (parameters and state of a dynamic system) using the probability language and	I ' I	-		
Based on bayesia	an problem formulation principles of rational behavior under uncertainty will be analyzed and used to develop algorithms for parameter	er estimations (AR)	X models,		
Gaussian process	s regression), filtering (Kalman filter) and detection (likelihood ratio theory). We will demonstrate numerically robust implementation o	f the algorithms ap	plicable in		
D014050DD	real life problems for the areas of industrial process control, robotics and avionics.		-		
B3M35ORR	Optimal and Robust Control	Z,ZK	6		
B3M35PSR	Real -Time Systems Programming	Z,ZK	6 The feeture		
-	ourse is to provide students with basic knowledge about software development for real-time systems, for example in control and embe rstems equipped with a real-time operating system (RTOS). Lectures will cover real-time systems theory, which can be used to forma				
-	nother set of lectures will introduce methods and techniques used for development of safety-critical systems, whose failure may have				
During labs, studer	nts will first solve a few simple tasks to familiarize themselves with basic components of VxWorks RTOS and to benchmark the used C)S and hardware ()	Kilinx Zynq).		
The obtained metrics represent the typical criteria for assessing the suitability of a given platform for the given application. After the simple tasks, students will solve a complex task of					
	ritical motion control application which will require full utilization of RTOS features. All the tasks at the labs will be implemented in C (c	, , , , , , , , , , , , , , , , , , , ,	•		
B3M35SRL	Flight Control Systems	Z,ZK	6		
	oted to classical and modern control design techniques for autopilots and flight control systems. Particular levels are discussed, start o guidance and navigation systems. Next to the design itself, important aspects of aircraft modelling, both as a rigid body and conside				
	are discussed.	and the second s	e structure,		
B3M37KIN	Space Engineering	Z,ZK	6		
	ints students with the basics of physics of the space environment and the technologies used in space systems, satellites, spacecrafts				
used for the design	and preparation of space missions. Subject matter includes a detailed description of the instrumentation of satellites and spacecrafts	s and its resistance	e to external		
	ace environment, and analysis of instruments and systems for spacecratfts and methods of their testing. It provides a basic overview of		•		
and their application	ons. The course also covers optoelectronics in space systems, sensors used, their modeling and description. It discusses the principl	es of underlying ca	alculations,		
	simulations and their processing.	774	6		
B3M37LRS	Aeronautical radio systems duces students to the aeronautical radio engineering, aeronautical analogue, digital and satellite communication systems, aeronautic	Z,ZK	6 including		
	n, primary secondary and passive radiolocation. The course gets students theoretical and practical knowledge of the operation of the a	-	-		
their integration to the aircraft systems.					
B3M38DIT	Diagnostics and Testing	Z,ZK	7		
B3M38INA	Integrated Avionics	Z,ZK	6		
The course Integra	ted Modular Avionics (IMA) focuses on a modern concept of the approach to the development and design of aircraft electronics (avior		nsition from		
	ystems to SW blocks. They use high-speed connections to exchange data in applications related to paid air transport. The existing re		-		
sharing define the requirements for the accuracy, reliability, and functionality of electronic systems even in the event of a failure. In the course, students will learn details about the					
requirements for so-called safety-critical multi-sensor systems, methods of data processing from predetermined systems, fault detection methods, selection of primary computer and control system in parallel architectures, bus technology, and methods of testing/certification of aircraft instruments.					

B3M38MSE	Modern Sensors	Z,ZK	6
	An overview of sensors of physical quantities used in industry and in research and methods of signal processing.		1
B3M38PSL	Aircraft Avionics	Z,ZK	6
The subject is focu	sed into a field of aircraft avionics including principles, sensors, measurement and evaluation systems and signal/data processing m	nethods. The subje	ct goes into
	systems, i.e. engine and aircraft monitoring systems, power systems, pressure-based systems, low-frequency navigation means, and	•	
introduces currentl	y used technology and methodology on aircraft and thus serves to understand fundamentals of avionics. Inertial navigation systems		more details
	as well as their aiding systems and sensors. The course focuses on both small and large aircraft as well as on UAV suited avid	1	1
B3M38SPD	Data Acquisition and Transfer	Z,ZK	6
	se is to acquaint students with principles and limits of data transmission from sensors and similar sources of information for IoT and N		
and specific algor	ithms, respecting the limiting conditions of their function. The basic algorithms of distributed information processing in sensor networ	rks, as well as tech	nnology for
	energy harvesting for powering the wireless nodes of the network, will be studied.	7 71/	0
B3M38VBM	Videometry and Contactless Measurement	Z,ZK	6
	s on CCD and CMOS video sensors, and optoelectronic sensors in general and their use in contactless videometric measurement sys or and its use for acquiring object parameters, optical projection system, design of measurement cameras and processing of their sig		
its leatures, benavit	will design, realize and debug an independent project - 'Optoelectronic reflective sensor', during labs.	nai wiii be present	eu. Siudenis
B3M38VIN		Z,ZK	6
B3M38ZDS		-	-
	Analog Signal Processing and Digitalization	Z,ZK	6
B3MPROJ8	Project	Z	8
B3MPVT		KZ	6
	isis of most of the activities that people perform in companies and their personal lives. In this course, students can try how to solve a		a team, how
	o cooperate, how to communicate together and how to solve problems such as project delays, how to include external influences in t	ne plan, etc.	
BDIP30	Diploma Thesis	Z	30
•	comprehensive work for the Master's degree study programme. A student will choose a topic from a range of topics related to his or l		
	y branch department or branch departments. The diploma thesis will be defended in front of the board of examiners for the compreh	1	1
·	Dhuried education		
TV-V1	Physical education	Z	1
TV-V1 TVKLV	Physical Education Course	Z	0
TV-V1		Z Z	· ·
TV-V1 TVKLV	Physical Education Course	Z	0

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