Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish Robotyka mobilna
Name in English Mobile robotics
Main field of study (if applicable): Control Engineering and Robotics (AIR)
Specialization (if applicable): Embedded Robotics (ARE)
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: AREA100
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		90		
Form of crediting	crediting with grade		crediting with grade*		
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical (P) classes			3		
including number of ECTS points for direct teacher-student contact (BK) classes	1		2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

K2AIR_W01, K2AIR_W02, K2AIR_W06, K2AIR_W08, K2AIR_U03, K2AIR_U05

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SUBJECT OBJECTIVES

C1 Attaining knowledge on current problems and development in mobile robotics
C2 Attaining knowledge on mathematical models of mobile robots
C3 Attaining knowledge on robot localization methods
C4 Attaining knowledge on methods of robot environment mapping
C5 Developing skills of mobile robot navigation

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEK_W01 – knows and understands standard problems in mobile robotics
PEK_W02 – knows modeling methods of mobile robots
PEK_W03 – knows methods of mobile robot localization
PEK_W04 – understands problems of environment mapping and SLAM

relating to skills:
PEK_U01 – can solve localization problem of mobile robot
PEK_U02 – is able to map environment of a mobile robot
PEK_U03 – is able to use sensory data and maps to navigate mobile robot

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Introduction: applications and problems in mobile robotics	2
Lec 2	Kinematic models of mobile robots	2
Lec 3	Dynamic models of ground mobile robots	2
Lec 4	Dynamic models of non ground mobile robots	2
Lec 5	Mathematical foundations of probabilistic robotics	2
Lec 6	Sensory data filtering and fusion	2
Lec 7	Robot localization: odometry	2
Lec 8	Robot localization: Markov methods, EKF	2
Lec 9	Mapping: Occupancy grid maps	2
Lec 10	Mapping: topological and hybrid maps	2
Lec 11	SLAM: basic idea, off-line methods	2
Lec 12	SLAM: online methods	2
Lec 13	Case study: autonomous car	2
Lec 14	Case study: flying robot	2
Lec 15	Mobile robots: perspectives and open problems	2
	Total hours	30

Form of classes - laboratory		**Number of hours**
Lab 1	Introduction. Fundamentals of laboratory sites operation	3
Lab 2	Odometry	3
Lab 3	Sensor fusion in localization	3
Lab 4	Environment mapping	6
Lab 5	SLAM	6
Lab 6	Reactive controller	3

Lab 7	Hybrid controller	3
Lab 8	Integration of subsystems, summary of results	3
	Total hours	30

TEACHING TOOLS USED
N1. Lecture N2. Laboratory exercises N3. Consultations N4. Study hall – problems and cases study and preparation to tests N5. Study hall – preparation for laboratory exercises

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01 - PEK_U03	Discussion, evaluation of laboratory tasks realization, written reports.
F2	PEK_W01 - PEK_W04	Written test, written assignment on selected subjects (optional)
P=0.5*(F1+F2), passed iff both F1 and F2 passed		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] R.Siegwart. Introduction to Autonomous Mobile Robots. MIT Press, 2011. [2] S.Thrun i in. Probabilistic robotics. MIT Press, 2006. **[3]** A.Kelly. Mobile Robotics: Mathematics, Models, and Methods. Cambridge University Press, 2013 **SECONDARY LITERATURE:** [1] Handbook of robotics. Springer, 2008. [2] H.Choset et al. Principles of Robot Motion: Theory, Algorithms, and Implementations. A Bradford Book, 2005. **[3]** The DARPA Urban Challenge. Springer, 2010.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Janusz Jakubiak, Janusz.Jakubiak@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Mobile robotics
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics (AIR)
AND SPECIALIZATION
Embedded Robotics (ARE)

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARE_W05	C1	Lec1,Lec5,Lec6 , Lec13-Lec15	1,3,4
PEK_W02	S2ARE_W05	C2	Lec2 – Lec4	1,3,4
PEK_W03	S2ARE_W05	C3	Lec7 – Lec 8	1,3,4
PEK_W04	S2ARE_W05	C4	Lec9 - Lec12	1,3,4
PEK_U01	S2ARE_U05	C3	Lab1 – Lab 3	2,3,5
PEK_U02	S2ARE_U05	C4	Lab4 – Lab5	2,3,5
PEK_U03	S2ARE_U05	C5	Lab6 – Lab8	2,3,5

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY of Electronics / DEPARTMENT **K-7**

SUBJECT CARD

Name in Polish Sensory i elementy napędowe 2
Name in English Sensors and Actuators 2
Main field of study (if applicable): Control Engineering and Robotics (AIR)
Specialization (if applicable): Embedded Robotics (ARE)
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: AREA112
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			15		
Number of hours of total student workload (CNPS)			60		
Form of crediting			Crediting with grade*		
For group of courses mark (X) final course					
Number of ECTS points					
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes			1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

S2ARE_W02

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SUBJECT OBJECTIVES

C1. Understanding of physical principles of basic sensors used in robots.
C2. Gain a knowledge of construction of basic sensors used in robots.
C3. Learn about construction of basic circuits in measurements systems.
C4. Learn about data processing obtained from specific sensors.
C5. Learn about basic actuators used in robots.
C6. Gain a knowledge of limitation of sesors application.

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEK_U01 – a student can interpret data obtained from basic sensors used in robots

relating to social competences:
PEK_K01 – understands the need for self-study and develop own skills for independently applying the knowledge and abilities

PROGRAMME CONTENT

Form of classes – laboratory		Number of hours
Lab. 1	Proprioceptive sensors	2
Lab. 2	Force and torque sensors	2
Lab. 3	Inertial sensors – part 1	2
Lab. 4	Inertial sensors – part 2	2
Lab. 5	Advanced ultrasonic range-finder systems	2
Lab. 6	Optical triangulation range-finders	2
Lab. 7	3D optical systems	3
	Total hours	15

TEACHING TOOLS USED

N1. Laboratories
N2. Consultations.
N3. Independent work – preparation for the laboratories

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01	Evaluation of Laboratory tasks
P = F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] B. Siciliano, et. al., Robotics – Modelling, Planning and Control, Springer-Verlag London Limited, 2009
[2] E. Gaura, R. Newman, Smart MEMS and Sensor Systems, Imperial College Press, 2006
[3] J. Fraden, Handbook of Modern Sensors – Physics, Design, and Applications, Springer-Verlag, 2004

SECONDARY LITERATURE:

[1] Internet resources

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Bogdan Kreczmer, bogdan.kreczmer@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Sensors and Actuators 2
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics (AIR)
AND SPECIALIZATION
Embedded Robotics (ARE)

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_U01	S2ARR_ U02	C1÷C7	Lab1÷Lab7	1,2,3
PEK_K01	S2ARR_ U02	C1	Lab1÷Lab7	3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish	**Planowanie zadań i ruchu**
Name in English	**Task and Motion Planning**
Main field of study:	**Control Engineering and Robotics**
Specialization:	**Embedded Robotics**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**AREA113**
Group of courses	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				15
Number of hours of total student workload (CNPS)	60				30
Form of crediting	crediting with grade				crediting with grade
For group of courses mark (X) final course	X				
Number of ECTS points	3				
including number of ECTS points for practical (P) classes					1
including number of ECTS points for direct teacher-student contact (BK) classes	1				0,5

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 to acquire knowledge on factors influencing formulation and solution of motion planning tasks
C2 to learn how to select properly a method to a given task.
C3 to acquire knowledge on selected methods of motion planning for varied environments and types of models
C4 to gain advanced knowledge, from a technical literature, on applications of action and motion planning methods

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Students acquire a knowledge of terminology and mathematical backgrounds of motion planning.

PEK_W02 Students know all ingredients important while defining motion planning tasks.

PEK_W03 Students are familiar with techniques of motion planning for manipulators.

PEK_W04 Students know non-classical motion planning methods.

PEK_W05 Students can apply methods of optimal control to some motion planning tasks.

PEK_W06 Students know selected methods of motion planning for models with a special structure.

relating to skills:

PEK_U01 Students are able to locate motion planning among tasks of robotics.

PEK_U02 Students can propose a motion planning method to a given task exploiting some knowledge of its model and desired properties.

PEK_U03 Students can propose an action planner for antagonistic and non-antagonistic cases.

relating to social competences:

PEK_K01 Students are aware of necessity to search and collect information permanently and to analyze it critically.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Terminology and classification of action and motion planning tasks.	2
Lec 2	Representations of a state, a space and obstacles. Distance measures between objects.	2
Lec 3	Interpolation and approximation methods.	2
Lec 4	Path planning based on the Newton algorithm.	2
Lec 5,6	Applications of the optimal control theory in motion planning.	4
Lec 7	Sampling-based methods.	2
Lec 8	Combinatorial motion planning.	2
Lec 9,10	Selected analytical methods of motion planning under differential constraints.	4
Lec 11,12	Action planning while playing either with a nature or an opponent.	4
Lec 13	Biologically inspired motion planning methods.	2
Lec 14	Motion planning for multi-agent systems.	2
Lec 15	Summary of lectures.	2
	Total hours	30

Form of classes - seminar		**Number of hours**
Sem 1	Presentation of possible subjects of seminars. Students select one among presented subjects or propose their own subject concerning planning issues.	2

Sem 2-7	Seminar presentations on motion planning methods and algorithms or related topics.	12
Sem 8	Evaluation of seminar presentations. Seminar summary.	1
	Total hours	15

TEACHING TOOLS USED
N1. Traditional lecture using video projector. N2. Consultations. N3. Self-study of (robotic) literature to prepare for seminars. N4. Seminar discussions. N5. Independent work – self-study and preparation for the written test.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 ÷ PEK_W06; PEK_U01 ÷ PEK_U03; PEK_K01	Activity at lectures
F2	PEK_W01 ÷ PEK_W06; PEK_U01 ÷ PEK_U03; PEK_K01	Final test results
F3	PEK_W01 ÷ PEK_W06; PEK_U01÷ 03; PEK_K01	seminar preparation and presentation, seminar discussion
P=0.1*F1+0.5*F2+0.4*F3 A pass grade must be obtained in all forms of classes.		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] S. LaValle, Planning Algorithms, Cambridge Univ. Press., 2006. [2] J.C. Latombe "Robot motion planning" Kluwer, Boston, 1993. **SECONDARY LITERATURE:** [1] conference and journal papers on motion and action planning [2] internet resources
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. dr hab. inż. Ignacy Dulęba ignacy.duleba@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Task and motion planning
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARE_W08	C1-3	Lec1	N1,N2,N5
PEK_W02	S2ARE_W08	C1-3	Lec2	N1,N2,N5
PEK_W03	S2ARE_W08	C1-3	Lec3-4	N1,N2,N5
PEK_W04	S2ARE_W08	C1-3	Lec13	N1,N2,N5
PEK_W05	S2ARE_W08	C1-3	Lec5-6	N1,N2,N5
PEK_W06	S2ARE_W08	C1-3	Lec7-12,14	N1,N2,N5
PEK_W01-PEK_W06	S2ARE_W08	C1-3	Lec15	N1,N2
PEK_U01÷PEK_U03	S2ARE_U08	C1-4	Sem1÷Sem8	N3,N4
PEK_K01	S2ARE_W08, S2ARE_U08	C1-4	Lec1÷Lec14, Sem1÷Sem7	N1-N5

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish …… Roboty społeczne …….
Name in English …… Social Robots …….
Main field of study (if applicable): …… AIR …….
Specialization (if applicable): …… ARE ……..
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code … AREA114….
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	3				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	0,5		1,5		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. No.

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SUBJECT OBJECTIVES

C1. Gaining ability to create a common social space of robots and humans.
C2. Gaining basic knowledge on technology of social robots.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Knowledge of the fundamental features of a social robot.
PEK_W02 Knowledge about selected computational models of emotions and about the need of endowing a robot with empathy, current possibilities in this matter
PEK_W03 Knowledge about the concept of an embodiment, constructions of selected humanoid robots and research platforms being used in the field of human - robot interactions as well as about the need of endowing a social robot with the ability to communicate verbally and nonverbally with a man; current possibilities in this matter.

relating to skills:

PEK_U01 The ability of programming of a humanoid robot Nao.
PEK_U02 The ability of design and programming of socially interactive behaviours for Nao

robot as well as implementation of short-term scenarios of multimodal human-robot interactions involving Nao.

relating to social competences:

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Socially Interactive Robot	2
Lec 2	Computational Models of Emotion, Personality	2
Lec 3	User Models, Intentionality	2
Lec 4	Embodiment	2
Lec 5	Human - Robot Communication	3
Lec 6	Human – Robot Interactions: examples of research problems	2
Lec 7	Robotic Companion	2
	Total hours	**15**

Form of classes - laboratory		**Number of hours**
Lab 1	Introduction to Laboratory Classes	2
Lab 2	Basics of Graphical Programming of Nao in Choreographe	4
Lab 3	Perception of Human and Environment by Nao.	4
Lab 4	Motion, Action, Expressive Behavior	4
Lab 5	Voice Communication Between Human and Robot, Dialog System in Nao	4
Lab 6	Programming of Interactive Behaviour of Nao with use of Python	4
Lab 7	Human – Robot Interactions, Animation of Social Behaviours of a Robot	4
Lab 8	Computational Model of Mind, Human – Robot Proxemics	4
	Total hours	30

TEACHING TOOLS USED
N1. traditional lecture N2. laboratory exercises N3. consultations N4. individual work

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01÷PEK_W03	written test (lecture)
F2	PEK_U01, PEK_U02	reports on the completed tasks (laboratory)
C=0.5*F1+ 0.5*F2 Successful completion of all the classes forms (which means that F1, F2 are positive) is the necessary condition for crediting with a positive mark at the semester end for the course.		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Terrence Fong, Illah Nourbakhsh, Kerstin Dautenhahn, A survey of socially interactive robots , Robotics and Autonomous Systems, Volume 42, Issues 3-4, pp.143-166

[2] C. Breazeal, A. Takanishi, T. Kobayashi, Social Robots that Interact with People, chapter in: Springer Handbook of Robotics, pp. 1349-1369, Springer Berlin Heidelberg, 2008

[3] Joscha Bach, Dietrich Dörner, Ronnie Vuine, *Psi and MicroPsi A Novel Approach to Modeling Emotion and Cognition in a Cognitive Architecture*, The 7th International Conference on Cognitive Modeling

[4] Cynthia Breazeal, Emotion and sociable humanoid robots, International Journal of Human-Computer Studies, vol. 59, Issues 1-2, July 2003, pp.119-155

[5] Brian Scassellati, Theory of Mind for a Humanoid Robot, Humanoids 2000

[6] C. Breazeal, Designing Sociable Robots, MIT Press, Cambridge, MA, 2002

[7] Zhihong Zeng, Maja Pantic, Glenn I. Roisman and Thomas S. Huang, *A survey of affect recognition methods: audio, visual and spontaneous expressions*, IEEE Transactions on Pattern Analysis and Machine Intelligence 2009, vol.31, pp.39–58.

[8] M. A. Anusuya, S. K. Katti, Speech recognition by machine: A review, International Journal of Computer Science and Information Security, 2009, vol.6 pp.181–205.

[9] S. Mitra, T. Acharya, Gesture Recognition: A Survey, IEEE Trans. Systems, Man, Cybernet., —Part C: Applications and Reviews, vol. 37, no. 3, pp.311-324, 2007

[10] Riek, L.D. Rabinowitch, T.-C. Bremner, P. Pipe, A.G. Fraser, M. Robinson, P.Cooperative gestures: Effective signaling for humanoid robots, Human-Robot Interaction (HRI), 2010 5th ACM/IEEE International Conference on, page(s)**:** 61 – 68

[11] K. Dautenhahn, Methodology & themes of human-robot interaction: A growing research field. International Journal of Advanced Robotic Systems, 2007, vol.4 (1), s. 103-108.

SECONDARY LITERATURE:

[1] Joao Miguel de Sousa de Assis Dias, FearNot!: Creating Emotional Autonomous Synthetic Characters for Empathic Interactions, UNIVERSIDADE TÉCNICA DE LISBOA, doctoral dissertation

[2] A. Billard et al. Robot Programming by Demonstration, Handbook of Robotics, Ch 59, 2007.

[3] Wickens, Gordon, and Liu, "Chapter 2: Research Methods", W: An Introduction to Human Factors Engineering, 1998.

[4] Nao, http://www.aldebaran-robotics.com/en

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Krzysztof Arent, krzysztof.arent@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
…… Social Robots ……
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY ……**AIR**……..
AND SPECIALIZATION ……**ARE**……..

Subject educational effect	**Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)****	**Subject objectives*****	**Programme content*****	**Teaching tool number*****
PEK_W01	S2ARR_W08	C1	Lec 1, Lec 7	1,3,4
PEK_W02	S2ARR_W08	C1	Lec 1, Lec 2, Lec 3	1,3,4
PEK_W03	S2ARR_W08	C1	Lec 1, Lec 4÷Lec 6	1,3,4
PEK_U01	S2ARR_W08	C2	Lab 1, Lab 2, Lab 6	1,2,3,4
PEK_U02	S2ARR_W08	C2	Lab3 ÷ Lab5, Lab7, Lab8	1,2,3,4

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

WYDZIAŁ ELEKTRONIKI

KARTA PRZEDMIOTU

Nazwa w języku polskim:	**Fizyka**
Nazwa w języku angielskim	**Physics**
Kierunek studiów:	**Informatyka, Elektronika, Telekomunikacja, Teleinformatyka, Automatyka i robotyka**
Stopień studiów i forma:	**II stopień, stacjonarna**
Rodzaj przedmiotu:	**obowiązkowy**
Kod przedmiotu:	**FZP4901**
Grupa kursów:	**NIE**

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15				
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	30				
Forma zaliczenia	Zaliczenie na ocenę				
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	1				
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)	-				
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego kontaktu (BK)	0,5				

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I INNYCH KOMPETENCJI

CELE PRZEDMIOTU

C1 Zdobycie wiedzy w zakresie wybranych, fundamentalnych praw fizyki współczesnej koniecznej do zrozumienia zjawisk fizycznych w obrębie studiowanej dyscypliny naukowej

C2 Zrozumienie potrzeby samokształcenia.

PRZEDMIOTOWE EFEKTY KSZTAŁCENIA

Z zakresu wiedzy:

PEK_W01 zna i rozumie na czym polega dualizm korpuskularno-falowy światła i materii
PEK_W02 zna i rozumie postulaty i podstawowy formalizm mechaniki kwantowej
PEK_W03 zna i rozumie sens fizyczny równania Schrödingera i funkcji falowej
PEK_W04 zna i rozumie sens fizyczny rozwiązania równania Schrödingera dla atomu wodoru i atomów wieloelektronowych
PEK_W05 zna i rozumie idee opisu kwantowego układów wieloatomowych, w szczególności strukturę pasmową kryształów
PEK_W06 zna i rozumie oraz jest świadomy wpływu statystyk kwantowych na właściwości materii
PEK_W07 zna i rozumie jak na gruncie modelu pasmowego ciał stałych można wyjaśnić właściwości elektro-optyczne ciał stałych
PEK_W08 zna i rozumie zasadę działania nowoczesnych wybranych urządzeń półprzewodnikowych

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Dualizm korpuskularno - falowy światła i materii. Prawo Plancka. Postulat de Broglie'a.	2
Wy2	Postulaty i elementy formalizmu mechaniki kwantowej. Funkcja falowa. Zasada nieoznaczoności Heisenberga.	2
Wy3	Równanie Schrödingera i jego zastosowanie (studnia potencjału, układy studni, efekt tunelowy). Skaningowy mikroskop tunelowy.	2
Wy4	Atom wodoru. Liczby kwantowe. Spin. Atom wieloelektronowy. Widmo absorpcji i emisji.	2
Wy5	Układy wieloatomowe, typy wiązań międzyatomowych. Struktura krystaliczna ciał stałych. Model pasmowy ciał stałych.	2
Wy6	Statystyki kwantowe: Fermiego-Diraca i Bose-Einsteina.	2
Wy7	Właściwości elektro-optyczne metali, izolatorów i półprzewodników w obrazie struktury pasmowej	2
Wy8	Wybrane nowoczesne przyrządy półprzewodnikowe (ogniwo słoneczne, fotodioda, laser półprzewodnikowy).	1
	Suma godzin	**15**

STOSOWANE NARZĘDZIA DYDAKTYCZNE

N1 Wykład tradycyjny z prezentacjami multimedialnymi uzupełniony demonstracjami zjawisk fizycznych.
N2 E-materiały do wykładu umieszczone w Internecie.
N3 Konsultacje i kontakt pocztą elektroniczną.
N4 Praca własna – przygotowanie do testu końcowego

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW KSZTAŁCENIA

Oceny (F – formująca (w	Numer efektu	Sposób oceny osiągnięcia efektu kształcenia

trakcie semestru), P – podsumowująca (na koniec semestru)	kształcenia	
F1	PEK_W01,PEK_W02, PEK_W03,PEK_W04, PEK_W05,PEK_W06, PEK_W07,PEK_W08, PEK_K01, PEK_K02	aktywność na wykładzie : odpowiedź ustna oraz testy
F2	PEK_W01,PEK_W02, PEK_W03,PEK_W04, PEK_W05,PEK_W06, PEK_W07,PEK_W08, PEK_K01, PEK_K02	test końcowy
P = F2 z uwzględnieniem F1		

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Materiały do wykładu (pliki PPT), dostępne poprzez internet: www.if.pwr.wroc.pl\~popko
[2] J. Orear, *Fizyka*, tom 2., WNT, Warszawa 2008.
[3] K.Sieranski, J.Szatkowski *Fizyka. Wzory i Prawa z Objaśnieniami* cz.III, Scripta 2008

LITERATURA UZUPEŁNIAJĄCA:

[1] Paul A. Tipler *Fizyka Współczesna*; PWN, Warszawa 2011

[2] R R. A. Serway, *Physics for Scientists and Engineers*, 8th Ed., Brooks/Cole, Belmont 2009; *Physics for Scientists and Engineers with Modern Physics*, 8th Ed., Brooks/Cole, Belmont 2009

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Paweł Scharoch, e-mail: pawel.scharoch@pwr.edu.pl
prof. dr hab. inż. Paweł Machnikowski; Pawel.Machnikowski@pwr.edu.pl

MACIERZ POWIĄZANIA EFEKTÓW KSZTAŁCENIA DLA PRZEDMIOTU
Fizyka
Z EFEKTAMI KSZTAŁCENIA NA KIERUNKU
Informatyka, Elektronika, Telekomunikacja, Teleinformatyka, Automatyka i robotyka

Przedmiotowy efekt kształcenia	Odniesienie przedmiotowego efektu do efektów kształcenia zdefiniowanych dla kierunku studiów i specjalności	Cele przedmiotu	Treści programowe	Numer narzędzia dydaktycznego
PEK_W01	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy1	N1-N4
PEK_W02	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy2	N1-N4
PEK_W03	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy3	N1-N4
PEK_W04	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy4	N1-N4
PEK_W05	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy5	N1-N4
PEK_W06	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy6	N1-N4
PEK_W07	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy7	N1-N4
PEK_W08	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy8	N1-N4

Zał. nr 4 do ZW 33/2012

FACULTY ELECTRONICS

SUBJECTCARD

Name in Polish: **Fizyka**
Name in English **Physics**
Main field of study: **Computer Science, Electronics, Telecommunication, Control Engineering and Robotics**
Levele and form of studies: **2nd level, full time**
Kind of subject: **obligatory**
Subject code: **FZP4901**
Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	30				
Form of crediting	Crediting with				

	grade				
For group of courses mark (X) final course					
Number of ECTS points	1				
Including number of ECTS points for practical (P) classes	-				
Including number of ECTS points for direct teacher-student contact (BK) classes	0,5				

PREREQUISITIES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCIES

SUBJECT OJECTIVES

C1 Acquire a knowledge of selected, fundamental modern physics laws necessary for understanding physical phenomena within studied field

C2 Understanding the need for self-education.

THE SUBJECT EDUCATIONAL EFFECTS

Related to knowledge:

PEK_W01 knows and understands the wave-particle duality of electromagnetic radiation and matter

PEK_W02 knows and understands postulates and basic formalism of quantum mechanics

PEK_W03 knows and understands the meaning of the Schrödinger equation and a wave function

PEK_W04 knows and understands the meaning of the Schrödinger equation solutions for the hydrogen atom and many-electrons atoms.

PEK_W05 knows and understands the ideas of quantum description of polyatomic systems, in particular the band structure of crystals.

PEK_W06 knows and understands the effect of quantum statistics on properties of matter

PEK_W07 knows and understands how it is possible to explain the electro-optical properties of solids on the ground of band structure

PEK_W08 knows and understands the rules of operation of chosen modern electronic devices

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Wy1	Wave-particle duality of electromagnetic radiation and matter. Planc's law. De Broglie postulate.	2
Wy2	Postulates of quantum mechanics. Wave function. Heisenberg uncertainty principle.	2
Wy3	Schrödinger equation and its applications (quantum well, systems of quantum	2

	wells, quantum tunneling). Scanning tunneling microscope.	
Wy4	Hydrogen atom. Quantum numbers. Spin. Many electron atoms. Absorption and emission spectra.	2
Wy5	Many atom systems. Types of ionic bonds. Crystalline structure. Electronic bands of crystals.	2
Wy6	Quantum statistics: Fermi-Dirac and Bose-Einstein.	2
Wy7	Electro-optical properties of dielectrics, semiconductors and metals within the picture of electronic bands.	2
Wy8	Chosen modern semiconductor devices (solar cell, photodiode, light emitting diode, semiconductor laser).	1
	Total hours	**15**

TECHING TOOLS USED
N1 Traditional and multimedia lecture presentations supplemented with the demonstration of physical phenomena N2 E-lecture materials available in internet. N3 Consultations and contact via e-mail. N4 Own work – preparation to final test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENTS

Evaluation of grade (F – forming, during semester, P – concluding, at the end of semester)	Educational effect number	Way of evaluationg the educational effect achievemnt
F1	PEK_W01,PEK_W02, PEK_W03,PEK_W04, PEK_W05,PEK_W06, PEK_W07,PEK_W08, PEK_K01, PEK_K02	activity on the lecture: oral answers and tests
F2	PEK_W01,PEK_W02, PEK_W03,PEK_W04, PEK_W05,PEK_W06, PEK_W07,PEK_W08, PEK_K01, PEK_K02	final test
P = F2 taking into account F1		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Materiały do wykładu (pliki PPT), dostępne poprzez internet: www.if.pwr.wroc.pl\~popko [2] J. Orear, *Fizyka*, tom 2., WNT, Warszawa 2008. [3] K.Sieranski, J.Szatkowski *Fizyka. Wzory i Prawa z Objaśnieniami* cz.III, Scripta 2008 **SECONDARY LITERATURE:** [1] Paul A. Tipler *Fizyka Współczesna*; PWN, Warszawa 2011 [2] R R. A. Serway, *Physics for Scientists and Engineers*, 8th Ed., Brooks/Cole, Belmont 2009; *Physics for Scientists and Engineers with Modern Physics*, 8th Ed., Brooks/Cole, Belmont 2009
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADRESS)
Paweł Scharoch, e-mail: pawel.scharoch@pwr.edu.pl **prof. dr hab. inż. Paweł Machnikowski;** Pawel.Machnikowski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECST OF

Physics

WITH EDUCATIONAL EFFECTS OF

Computer Science, Electronics, Telecommunication, Control Engineering and Robotics

Subject educational effect	Correlation between subject educational effects and educational effects defined for main field of study	Subject objectives	Programme content	Teching tool number
PEK_W01	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy1	N1-N4
PEK_W02	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy2	N1-N4
PEK_W03	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy3	N1-N4
PEK_W04	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy4	N1-N4
PEK_W05	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy5	N1-N4
PEK_W06	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy6	N1-N4
PEK_W07	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy7	N1-N4
PEK_W08	K2AIR_W02, K2EKA_W02, K2INF_W02, K2TEL_W02, K2TIN_W01	C1,C2	Wy8	N1-N4

Zał. nr 4 do ZW 64/2012

FACULTY of Electronics/DEPARTMENT K-7

SUBJECT CARD

Name in Polish: Zastosowania systemów robotyki wbudowanej
Name in English: Embedded Robotic Applications
Main field of study (if applicable): Control Engineering and Robotics
Specialization (if applicable): Embedded Robotics
Level and form of studies: 2nd level, stationary
Kind of subject: obligatory
Subject code: AREA115
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	30				
Form of crediting	crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	1				
including number of ECTS points for practical (P) classes	0				
including number of ECTS points for direct teacher-student contact (BK) classes	0,5				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

S2ARE_W01, S2ARE_W03

SUBJECT OBJECTIVES

C1 – Acquiring knowledge on control system architecture, integration and designing methods.
C2 – Acquiring knowledge on practical application of motor control methods, sensor data acquisition/fusion systems and communication interfaces and protocols.
C3 – Acquiring knowledge on implementation of task-oriented robot functionality.
C4 – Acquiring knowledge on highest layer of robot control methods.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEK_W01 – Ability to summarize designing principles of multi-layer control system architecture.
PEK_W02 – Ability to design task-oriented robot control modules.
PEK_W03 – Ability to propose a set of robot control components based on given example.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Introduction, requirements, bibliography.	2
Lec 2	Control system architecture, integration and designing methods.	2
Lec 3	Motor control, sensor data acquisitions, communication protocols – practical applications.	2
Lec 4	RTOS applications - practical examples.	2
Lec 5	Parallel and event-based programming.	2
Lec 6	Task-oriented robot control layer.	2
Lec 7	Highest level control methods.	2
Lec 8	Repetitions	1
	Total hours	15

TEACHING TOOLS USED

N1 – Traditional lectures using multimedia tools and presentation of application examples.
N2 – Consultation.
N3 – Individual work (preparation for lectures and test).

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01÷03	N1÷3
P=F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Handbook of robotics. Springer, 2008.
[3] E. Gat. On Three-Layer Architectures. Artificial Intelligence and Mobile Robots. MIT Press, 1998.
[4] C. L. Breazeal. Designing Sociable Robots. Intelligent Robots and Autonomous Agents. A Bradford Book, The MIT Press, 2002.
[5] R. A. Brooks. A robust layered control system for a mobile robot. IEEE Journal of Robotics and Automation, 1(1):14–23, 1986.
[6] Russell, J. and Cohn, R., Mqx, 2012.
[7] Linear Circuit Design Handbook, Edited by Hank Zumbahlen, Newnes, February 2008.
[8] Radulov, G., Quinn, P., Hegt, H., van Roermund, A.H.M. Smart and Flexible Digital-to-Analog Converters, 2011, XIV
[9] The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors, 3rd Edition, 28 Nov 2013 Imprint: Newnes
[10] Serial Port Complete Second Edition, Jan Axelson, 2007
[11] Programming in C, Pearson Education, 2005
[12] Thinking in C++, Volume 2: Practical Programming, Prentice Hall; 1 edition (December 27, 2003)
[13] Complete Handbook of Electric Motor Controls, John E. Traister, 2nd Edition, 1994
[14] Beginner's Guide to Embedded C Programming Volume 2
[15] Embedded Systems Hardware for Software Engineers, Eduardo Lipiansky, McGraw-Hill Professional; 1 edition (November 22, 2011)

[16] Embedded Systems Architecture, Second Edition: A Comprehensive Guide for Engineers and Programmers, Tammy Noergaard, Newnes; 2 edition (December 28, 2012)
[17] Practical Electronics for Inventors, Third Edition, Paul Scherz, Simon Monk, McGraw-Hill/TAB Electronics; 3 edition (January 10, 2013)
[18] Arduino Robotics, John-David Warren, Josh Adams, Harald Molle, Apress; 1 edition (July 13, 2011)

SECONDARY LITERATURE:

[1] http://www.freescale.com
[2] http://www.ti.com
[3] http://www.analog.com
[4] http://www.urbiforge.org
[5] http://www.flash.iiar.pwr.edu.pl
[6] http://en.wikibooks.org/wiki/Embedded_Systems

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Jan Kędzierski, 71 320 45 43, jan.kedzierski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Embedded Robotic Applications
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARE_W10	C1, 4	Lec 1,2,7	N1÷3
PEK_W02	S2ARE_W10	C2, 3	Lec 3,5,6	N1÷3
PEK_W03	S2ARE_W10	C1÷4	Lec 2÷8	N1÷3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS

SUBJECT CARD

Name in Polish Przedsiębiorczość
Name in English Entrepreneurship
Main field of study (if applicable): Control Engineering and Robotics, Electronics, Computer Science , Teleinformatics, Telecommunications
Specialization (if applicable): ……..
Level and form of studies: 2nd level, full-time
Kind of subject: optional / university-wide
Subject code ZMZ0387
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**				**15**
Number of hours of total student workload (CNPS)	**90**				
Form of crediting	**crediting with grade**				
For group of courses mark (X) final course					
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	**0,5**				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Obtaining knowledge about strategic entrepreneurship
C2 Knowing instruments (strategies, models and methods), that support strategic entrepreneurship

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:
PEK_W01 Student knows the idea of entrepreneurship and innovativeness
PEK_W02 Student knows types of entrepreneurship and innovations
PEK_W03 Student is familiarity with selected instruments (concepts, methods, models) of estimation an entrepreneurship and innovations

Relating to skills:
PEK_U01 Student is able to seek and interpret the knowledge of entrepreneurship and innovativeness

Relating to social competences:
PEK_K01 Student acquires enthusiastic and entrepreneurial approach for activity and skills in the field of innovation

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Introduction to entrepreneurship	3
Lec 2	Academic entrepreneurship	2
Lec 3	Corporate entrepreneurship and SME entrepreneurship	2
Lec 4	Regional entrepreneurship	2
Lec 5	Social entrepreneurship	2
Lec 6	Intellectual entrepreneurship	2
Lec 7	Test	2
	Total hours	15
Form of classes - class		**Number of hours**
Cl 1		
Cl 2		
Cl 3		
	Total hours	
Form of classes - laboratory		**Number of hours**
Lab 1		
Lab 2		
Lab 3		
	Total hours	
Form of classes - project		**Number of hours**
Proj 1		
Proj 2		
Proj 3		
	Total hours	
Form of classes - seminar		**Number of hours**
Sem 1	Introduction to seminar	1
Sem 2	Characteristic of innovative idea/ product	2
Sem 3	Characteristic of customer client, competitor	2
Sem 4	Innovative idea/ product strategy	2
Sem 5	Success assessment/ Intellectual property	2
Sem 6	Financing innovation	2
Sem7	Business model	2
Sem8	Analyzing results of term work	2
….	Total hours	15

TEACHING TOOLS USED
N1 Laptop N2. Multimedia performance N3. Selected statistical data and reports

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F	Educational effect number	Way of evaluating educational effect achievement

– forming (during semester), P – concluding (at semester end)		
F1	PEK_W01, PEK_W02, PEK_W03, PEK_U01,	Estimation the student activity by checking list of presence (lecture)
F2	PEK_W01, PEK_W02, PEK_W03, PEK_UO1	Estimation the knowledge by preparing term work relating to entrepreneurship
F3	PEK_K01	Assessment of entrepreneurial approach by preparing the innovative idea/ product
C		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] W. Kasprzak, K. Pelc, Innowacje. Strategie techniczne i rozwojowe, Wydawnictwo Politechniki Wrocławskiej, Wrocław, 2012

[2] G. Gierszewska, B. Olszewska, J. Skonieczny, Zarządzanie strategiczne dla inżynierów, PWE, Warszawa 2012

[3] J. Skonieczny (red.), Kształtowanie zachowań innowacyjnych, przedsiębiorczych i twórczych w edukacji inżyniera, Wydawnictwo Indygo Zahir Media, Wrocław, 2011

[4] P. Drucker, Natchnienie i fart czyli innowacja i przedsiębiorczość, Wydawnictwo Studia Emka, Warszawa 2004

[5] A. Dereń, Zarządzanie własnością intelektualną w transferze technologii, Difin, 2014.

SECONDARY LITERATURE:

[1] K. Matusiak (red.), Innowacje i transfer technologii. Słownik pojęć, PARP, Warszawa 2005

[2] A. Sosnowska, S. Łobejko, A. Kłopotek, J. Brdulak, A.Rutkowska-Brdulak, K.Zbikowska, Jak wdrażać innowacje technologiczne w firmie, PARP, Warszawa 2005

[3] J.G. Wissema, Technostarterzy. Dlaczego i jak?, PARP, Warszawa 2005

[4] A. Bąkowski, T. Cichocki, G. Gromada, J. Guliński, S. Kmita, T. Krzyżyński, U. Marchlewicz, K. Matusiak, D. Trzmielak, J. Wajda, K. Zasiadły, Innowacyjna przedsiębiorczość akademicka, PARP, Warszawa 2005

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

PhD Jan Skonieczny (jan.skonieczny@pwr.wroc.pl),

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Entrepreneurship
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics, Electronics, Computer Science , Teleinformatics, Telecommunications
AND SPECIALIZATION ……..

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01 (knowledge)	WM2_1	C1, C2	Lec1-Lec7 Sem1-Sem7	N1,N2,N3
PEK_W02	WM2_1	C1, C2	Lec1-Lec7 Sem1-Sem7	N1,N2,N3
PEK_W03	WM2_1	C1, C2	Lec1-Lec7 Sem1-Sem7	N1,N2,N3
PEK_U01 (skills)	WM2_1	C1, C2	Lec1-Lec7 Sem1-Sem7	N1,N2,N3
PEK_K01 (competences)	WM2_1	C1, C2	Lec1-Lec7 Sem1-Sem7	N1,N2,N3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS

SUBJECT CARD

Name in Polish Metody matematyczne automatyki i robotyki
Name in English Mathematical methods of automation and robotics
Main field of study (if applicable): Control Engineering and Robotics
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code AREA002
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	80	100			
Form of crediting	examination	crediting with grade			
For group of courses mark (X) final course	X				
Number of ECTS points	6				
including number of ECTS points for practical (P) classes		3			
including number of ECTS points for direct teacher-student contact (BK) classes	2	2			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. None

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SUBJECT OBJECTIVES

C1. Gain knowledge of mathematical methods of modern automation and robotics
C2. Peruse the paradigm of transformation and equivalence
C3. Learn of properties and equivalence of functions
C4. Learn of properties and equivalence of dynamical systems
C5. Learn of properties and feedback equivalence of control systems
C6. Learn of synthesis of control algorithms for linearizable, decoupable, and differentially flat systems
C7. Learn of using normal forms in the synthesis of control algorithms

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01- knows pillars of nonlinear analysis: inverse function theorem, theorem of existence and uniqueness of trajectory of dynamic system, Frobenius theorem, and contraction function theorem

PEK_W02 - knows the concept of equivalence of functions and their normal forms

PEK_W03 - knows the concept and properties of dynamic system

PEK_W04 - knows the definition of equivalence of dynamic systems and basic theorems on the equivalence

PEK_W05 - knows the concept and properties of control affine system

PEK_W06 - knows the concept of feedback equivalence of control systems

PEK_W07 - knows methods of synthesis of control algorithms based upon linearization or decoupling by static feedback

PEK_W08 - knows methods of synthesis of control algorithms based upon dynamic feedback linearization

PEK_W09 - knows the concept of differentially flat system and its applicability in synthesis of control algorithms

PEK_W10 - knows applicability of normal forms in synthesis of control algorithms

relating to skills:

PEK_U01- can use the pillar theorems of nonlinear analysis

PEK_U02 - can use the implicit function theorem in the context of robot manipulator kinematics

PEK_U03 - can make use of theorems of immersions, submersions, and Morse functions, understands the concept of kinematic singularities of robotic manipulators

PEK_U04 - can analyze properties of dynamic systems

PEK_U05- can make use of theorems on equivalence of dynamic systems, understands their connection to Lyapunov theorems

PEK_U06 - can make use of Lie brackets as a tool of analysis of nonlinear control systems

PEK_U07 - can use theorems on feedback linearization and decoupling of control systems, understands the role of these methods in synthesis of control algorithms

PEK_U08- can make use of differential flatness in control of mobile robots

PEK_U09 - can make use of normal forms in synthesis of robot control algorithms

PEK_U10 – can apply mathematical methods in synthesis of control algorithms of diverse systems of automation and robotics

relating to social competences:

PEK_K01- understands significance of information retrieval and critical analysis

PEK_K02 - can debate, rationally explain, and justify his/her own standpoint relying on the subject knowledge

PEK_K03 – understands significance of mathematical methods in automation in robotics

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Smooth functions, inverse function theorem, diffeomorphism	2
Lec 2	Newton algorithm	2

Lec 3	Implicit function theorem	2
Lec 4	Equivalence of functions, normal forms	2
Lec 5	Dynamic system, existence and uniqueness theorem, contraction function theorem	2
Lec 6	Stability of dynamic systems	2
Lec 7	Equivalence of dynamic systems, theorems on linearization	2
Lec 8	Vector fields, Lie brackets, distributions, Frobenius theorem	2
Lec 9	Control affine systems, controllability	2
Lec 10	Feedback equivalence	2
Lec 11	Linearization by static feedback	2
Lec 12	Input/output decoupling, zero dynamics	2
Lec 13	Linearization by dynamic feedback	2
Lec 14	Differential flatness	2
Lec 15	Nonlinear normal forms	2
	Total hours	30

Form of classes - class		Number of hours
Cl 1	Feedback equivalence of linear control systems: Brunovsky canonical form	2
Cl 2	Matrix norms	2
Cl 3	Inverse and implicit function theorems	2
Cl 4	Immersions, submersions, Morse functions	2
Cl 5	Equivalence of dynamic systems	2
Cl 6	Stability analysis of dynamic systems	2
Cl 7	Gradient and Hamiltonian systems	2
Cl 8	Control systems: definition and properties of Lie brackets	2
Cl 9	Feedback equivalence and linearization	2
Cl 10-11	Analysis of linearization conditions, equations of equivalence	4
Cl 12	Differential degree, input/output decoupling, zero dynamics	2
Cl 13	Analysis of differential flatness	2
Cl 14	Nonlinear normal forms	2
Cl 15	Test	2
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lecture N2. Classes N3. Consultations N4. Independent work – solving example problems N5. Independent work – literature study

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 ÷ PEK_W10;	examination
F2	PEK_W01 ÷ PEK_W10; PEK_U01 ÷ PEK_U10;	active participation in classes, test
C=0.4*F1+0.6*F2		

Notice: a mark at least 3.0 (passed) within F2 is prerequisite of admission to the exam F1.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. Golubitsky, V. Guillemin: „Stable Mappings and Their Singularities", Springer-Verlag, New York, 1974.
[2] R. Abraham, J. E. Marsden, T. Ratiu: „Manifolds, Tensor Analysis, and Applications", Springer-Verlag, New York, 1988.
[3] V. I. Arnold: „Geometrical Methods in the Theory of Ordinary Differential Equations", Springer-Verlag, New York, 1983.
[4] S. S. Sastry: „Nonlinear Systems", Springer-Verlag, New York, 1999.
[5] A. M. Bloch: „Nonholonomic Mechanics and Control", Springer-Verlag, New York, 2003.
[6] H. Nijmeijer, A. J. van der Schaft: „Nonlinear Dynamical Control Systems", Springer-Verlag, New York, 1990.
[7] H. Sira-Ramirez, S. K. Agrawal: „Differentially Flat Systems", Marcel Dekker, New York, 2004.

SECONDARY LITERATURE:

[1] Ph. Hartman: „Ordinary Differential Equations", J. Wiley, New York, 1964.
[2] H. K. Khalil: „Nonlinear Systems", Prentice-Hall, New Jersey, 2000.
[3] R. Murray, Z. Li, S. S. Sastry: „A Mathematical Introduction to Robotic Manipulation", CRC Press, Boca Raton, 1994.
[4] A. Isidori: „Nonlinear Control Systems", Springer-Verlag, New York, 1995.
[5] V. Jurdjevic: „Geometric Control Theory", Cambridge Univ.Press, Cambrigde, 1997.
[6] J. Levine: „Analysis and Control of Nonlinear Systems: A Flatness-based Approach", Springer-Verlag, Berlin, 2009.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Mathematical methods of automation and robotics
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01 (knowledge)	K2AIR_W08, K2AIR_W01, K2AIR_W05	C1, C7	Lec1-Lec5, Lec9	1,3,4,5
PEK_W02	K2AIR_W08	C2, C3	Lec4	1,3,4,5
PEK_W03	K2AIR_W08	C4	Lec5	1,3,4,5
PEK_W04	K2AIR_W08	C2, C4	Lec6-Lec7	1,3,4,5
PEK_W05	K2AIR_W08	C5	Lec8-Lec9	1,3,4,5
PEK_W06	K2AIR_W08	C2, C5	Lec10	1,3,4,5
PEK_W07	K2AIR_W08,	C6	Lec11-Lec12	1,3,4,5
PEK_W08	K2AIR_W08	C6	Lec13	1,3,4,5
PEK_W09	K2AIR_W08	C6	Lec14	1,3,4,5
PEK_W10	K2AIR_W08, K2AIR_W05	C1, C5-C7	Lec10-Lec15	1,3,4,5
PEK_U01 (skills)	K2AIR_U05	C1	Cl3-Cl4, Cl9	2,3,4
PEK_U02	K2AIR_U05	C1, C3	Cl3	2,3,4
PEK_U03	K2AIR_U05	C2, C3	Cl4	2,3,4
PEK_U04	K2AIR_U05	C4	Cl5-Cl7	2,3,4
PEK_U05	K2AIR_U05	C2, C4	Cl5	2,3,4
PEK_U06	K2AIR_U05	C2, C5	Cl8	2,3,4
PEK_U07	K2AIR_U05	C6	Cl9-Cl12	2,3,4
PEK_U08	K2AIR_U05	C6	Cl13	2,3,4
PEK_U09	K2AIR_U05	C2, C7	Cl14	2,3,4
PEK_U10	K2AIR_U05, K2AIR_U01	C2, C6, C7	Cl9-Cl15	2,3,4
PEK_K01-PEK_K03(competences)	K2AIR_U05 K2AIR_W09	C6, C7	Lec1-Lec15, Cl1-Cl15	1,2,3,5

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS

SUBJECT CARD

Name in English Optimization theory and advanced numerical methods
Name in Polish Teoria i metody optymalizacji
Main field of study (if applicable): Control Engineering and Robotics
Specialization (if applicable) Embedded Robotics
Level and form of studies: 2nd level, part-time
Kind of subject: obligatory
Subject code AREA003
Group of courses YES.

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**30**			**15**	
Number of hours of total student workload (CNPS)	**90**			**90**	
Form of crediting	Crediting with grade			Crediting with grade	
For group of courses mark (X) final course	**X**				
Number of ECTS points	**5**				
including number of ECTS points for practical (P) classes	-				
including number of ECTS points for direct teacher-student contact (BK) classes	**2**			**3**	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

- Ability to apply acquired mathematical skills to the analysis of automation and robotics domains.

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SUBJECT OBJECTIVES

C1 Learning of the basics of optimization theory

C2 Getting the knowledge of analytic methods of optimization and conditions of optimality

C3 Getting the knowledge of methods of linear and nonlinear optimization with and without constraints. Approximate methods

C4 Getting the skills of using accurate and approximate algorithms for the static optimization problems with and without constraints for continuous and discrete decision variables.

C5 Getting the skills of using standard procedures to solve practical optimization problems

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – have the knowledge about analytic methods of multi-variable and knows the conditions of optimality

PEK_W02 – knows numerical procedures of local optimization dedicated for specific static optimization problems with and without constraints

PEK_W03 – have the knowledge of heuristic algorithms, dedicated for specific problems of static optimization

relating to skills:

PEK_U01 – is able to apply accurate and approximate algorithms to solve the tasks of static opimization with or without constraints

PEK_U002 – is able to apply accurate and approximate algorithms to solve continuous and discrete optimization problems

PEK_U03 – can use standard procedures and select suitable parameters for the selected methods

PEK_U04 – can interpret the meaning of the obtained solution for the specific problems of control theory and robotics

PROGRAMME CONTENT

	Form of classes – lecture	**Number of hours**
Lec1	Optimization – mathematical models, classification of problems, basic terms.	2
Lec2	Sample problems is control theory and robotics	2
Lec3	Necessary conditions for the existence of extremum.	2
Lec4	Linear programming problems. Graphical interpretation.	2
Lec5	Generalized simplex algorithm, conditions of admissibility and optimality.	2
Lec6	Two-phase simplex algorithm, dual simplex algorithm. Dual theory for linear programming problem.	2
Lec7	Optimization methods for the problems of integer programming (Branch and Bound method, Cutting Plane method).	2
Lec8	Optimality conditions for nonlinear programming with constraints - Kuhn-Tucker-Karusch conditions.	2
Lec 9	Regularity conditions, Lagrange method. Exmples.	2
Lec10	Algorithms of local optimization without constraints. Simple search methods , non-gradient and gradient methods.	2

Lec11	Optimization algorithms with constraints.	2
Lec12	Algorithms of global optimization – survey of meta-heuristic methods of local and population search	2
Lec13	Practical examples. Standard optimization procedure – review.	2
Lec14	Multi-criteria optimization. Optimality in the Pareto sense.	2
Lec15	Test	2
	Total hours	**30**

Form of classes – project		**Number of hours**
Pr1	Assigning the subject of the project (e.g.. profit optimization with the limitations imposed on stocks with the use of selected method).	2
Pr2	Formulation of mathematical model. Analysis and selection of methods	4
Pr3	Implementation of the selected algorithm. Tunning the parameters.	4
Pr4	Testing, discussion. Verification of the project.	2
Pr5	Presentation of the results, preparation of the final report.	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Traditional lecture
N2. Discussions
N3 Consultations/Office hours
N4. Individual job – literature studies and preparing to final test
N5. Individual job – preparing the final report

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), C – concl. (at sem. end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01, PEK_W02, PEK_W03	**Activity on lectures** **Grade for the written tests** **Consultations during office hours**
F2	PEK_U01, PEK_U02, PEK_U003,	**Grade for the written report**

	PEK_U004	

C = 0,5*F1 + 0,5 *F2 F1>2; F2>2
All forms of subject have to achieve the positive grades at the end of semester.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Minoux M., Mathematical programming – Theory and algorithms, J. Wiley &Sons Ed. 2008.
[2] Nocedal J. and Wright S., Numerical optimization, 2006.
[3] Ruszczyński ., Nonlinear optimization, Princeton University Press, 2006.
[4] Fletcher R., Practical methods of optimization, J. Wiley Ed. 2000.
[5] Boyd S., Vanderberghe L.: Convex optimization, Cambridge University Press, 2004 bv_cvxbook.pdf, 2008.
[6] Eckart Zitzler: *Evolutionary Algorithms for Multiobjective Optimization: Methods and Applications,* Zürich 1999.
[7] Jeffrey Horn, Nicholas Nafpliotis, David E. Goldberg: *A Niche Pareto Genetic Algorithm for Multiobjective Optimalization,* IEEE 1994 , Volume 1, pp. 82-87.

SECONDARY LITERATURE:

[1] Rardin R.L., Optimization in operations research. Prentice Hall Ed. 1998.
[2] Fletcher R., Practical methods of optimization, J. Wiley Ed. 2000.
[3] Thomas Weise, Global optimization algorithms – Theory and Applications (book.pdf)
[4] .http://delta.cs.cinvestav.mx/~ccoello/EMOO/

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Optimization theory and advanced numerical methods
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	K2AIR_W07	C1, C2	Lec1÷Lec4 Lec6	N1, N2,N3, N4
PEK_W02	K2AIR_W07	C3	Lec5, Lec7	N1, N2, N3, N4
PEK_W03	K2AIR_W07	C4	Lec8÷Lec10	N1, N2, N3, N4
PEK_U01	K2AIR_U04	C3	Pr1÷Pr3	N2, N3, N5
PEK_U02	K2AIR_U04	C4, C5	Pr4	N2, N3, N5
PEK_U03	K2AIR_U04	C5	Pr5	N2, N3, N5

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS

SUBJECT CARD

Name in Polish Modelowanie i identyfikacja
Name in English Modeling and identification
Main field of study (if applicable): Control Engineering and Robotics
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code AREA004
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		90		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical (P) classes	-		2		
including number of ECTS points for direct teacher-student contact (BK) classes	1		2		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. Gaining the knowledge about generation of pseudo-random numbers
C2. Gaining the knowledge about foundations of estimation theory and assessment of estimation quality
C3. Learning parametric and nonparametric methods of estimation of the probability density function and the regression function
C4. Learning identification methods of linear dynamic systems excited and disturbed by random signals
C5. Learning the least squares method, its properties, scope of applicability and numerical procedures
C6. Learning the instrumental variables method, and procedures of generation of instruments
C7. Learning selected method of identification of block-oriented (Hammerstein and Wiener) systems
C8. Introduction to ‘System Identification Toolbox’ of Matlab

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEK_W01 – knows the methods of computer modeling of random environment
PEK_W02 – knows parametric and nonparametric algorithms of synthesis of linear and nonlinear systems on the basis of uncertain data
PEK_W03 – knows computer realizations of typical methods of system identification
PEK_W04 – knows the methods of generation of random numbers
PEK_W05 – knows selected methods of identification of block-oriented (Hammerstein and Wiener) systems

relating to skills:
PEK_U01 – can use measurement data for building and testing models of linearand nonlinear plants under various prior knowledge
PEK_U02 – can forecast time series on the basis of collected data
PEK_U03 – can select suitable model for data
PEK_U04 – can conduct experimental analyses using dedicated software

relating to social competences:
PEK_K01 – is aware of the importance of the ability of data searching and analysis,
PEK_K02 – understand the necessity of further self-education and broadening knowledge and skills,

PROGRAMME CONTENT

Form of classes – lecture		**Number of hours**
Lec 1	Random number generation by the inversion method	2
Lec 2	Random number generation by the rejection method	2
Lec 3	Estimation theory, quality of the estimate, limit theorems, types of probabilistic convergence. Parametric and nonparametric approach	2
Lec 4	Nonparametric estimation of the distribution function	2
Lec 5	Nonparametric estimation of the probability density function	2
Lec 6	Regression function estimation – kernel method	2
Lec 7	Regression function estimation – orthogonal expansion method	
Lec 8	Identification of linear dynamic systems. Least squares method - synthesis.	2
Lec 9	Least squares method – properties	2
Lec 10	Least squares method – recursive version	
Lec 11	Linear system excited by random signal. Cross-correlation analysis. Inverse filtering. Gauss-Markov estimate.	2

Lec 12	Instrumental variables method	2
Lec 13	Computational algorithms of the least square s method (spectral analysis, LU and SVD decomposition)	2
Lec 14	Hammerstein and Wiener systems	2
Lec 15	Summary	2
	Total hours	**30**

Form of classes – laboratory		**Number of hours**
Lab 1	Generation of random numbers – inverse method	2
Lab 2	Generation of random numbers – rejection method	2
Lab 3	Estimation, limit theorems, mean and sample median and their properties	2
Lab 4	Nonparametric identification of distribution function	2
Lab 5	Nonparametric identification of probability density function	2
Lab 6	Regression function estimation. Kernel method	2
Lab 7	Regression function estimation. Orthogonal expanssion method	2
Lab 8	Identification of linear systems by the least squares method	2
Lab 9	Recursive least squares method	2
Lab 10	Cross-correlation analysis, inverse filtering. Gauss-Markov estimate	2
Lab 11	Instrumental variables method	2
Lab 12	Computational algorithms of the least squares method (spectra analysis, LU and SVD decomposition)	2
Lab 13	Hammerstein system	2
Lab 14	Wiener system	2
Lab 15	Summary	2
	Total hours	**30**

TEACHING TOOLS USED
1. Traditional lecture with the use of videoprojector 2. Laboratory 3. Consultations 4. Individual job – preparing to laboratory, processing of the results, written reports 5. Individual job – preparing to final test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Educational effect numer	Way of evaluating educational effect achievement
F1	PEK_U01 – PEK_U04 PEK_K01 – PEK_K02	Written tests, Observationn on the laboratory, Written reports,
F2	PEK_W01 – PEK_W05	Final test
C = 0,8*F2 + 0,2 *F1, provided that F1>2.0 and F2>2.0		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Gajek, Kałuszka — ”Wnioskowanie statystyczne dla studentów”
[2] Greblicki, Pawlak – „Nonlinear system identification”, Cambridge 2008.
[3] Kiełbasiński, Schwetlick — ”Numeryczna algebra liniowa — wprowadzenie do obliczeń zautomatyzowanych”
[4] Kincaid, Cheney — ”Analiza numeryczna”, WNT Warszawa, 2006.
[5] Ljung “System Identification - Theory For the User”
[6] Nahorski, Mańczak — ”Komputerowa identyfikacja obiektów dynamicznych”
[7] Söderström, Stoica — ”Identyfikacja systemów”
[8] Niederlinski — ”Systemy komputerowe automatyki przemysłowej”
[9] http://diuna.ict.pwr.wroc.pl

SECONDARY LITERATURE:

[1] Magiera — ”Modele i metody statystyki matematycznej”, wyd. GiS, Wrocław, 2002.
[2] Stanisz — ”Przystępny kurs statystyki w oparciu o pakiet STATISTICA”
[3] Klonecki — ”Statystyka matematyczna dla inżynierów”
[4] Krysicki, Włodarski — ”Statystyka matematyczna”
[5] Jakubowski, Stencel — ”Wstęp do teorii prawdopodobieństwa”, wyd. Script,Warszawa, 2004.
[6] Trybuła — ”Statystyka matematyczna z elementami teorii decyzji”, Ofic. Wyd. PWr., 2002.
[7] Fisz — ”Rachunek prawdopodobieństwa i statystyka matematyczna”
[8] Feller — ”Wstęp do rachunku prawdopodobieństwa”
[9] Chow, Teicher — ”Probability theory”
[10] Strang — ”Introduction to linear algebra”
[11] Hannan, Deistler — ”The statistical theory of linear systems”
[12] Greblicki — ”Podstawy automatyki”
[13] Łysakowska, Mzyk — ”Komputerowa symulacja układów automatycznej regulacji w środowisku Matlab/Simulink”

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Modeling and identification
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01 (knowledge)	K2AIR_W06	C1..C8	Lec1..Lec15	1,3,5
PEK_W02	K2AIR_W06	C2,C3	Lec4..Lec7	1,3,5
PEK_W03	K2AIR_W06	C5,C8	Lec12	1,3,5
PEK_W04	K2AIR_W06	C1	Lec1,Lec2	1,3,5
PEK_W05	K2AIR_W06	C7	Lec13,14	1,3,5
PEK_U01 (skills)	K2AIR_U03	C1..C8	Lab1..Lab15	2,3,4
PEK_U02	K2AIR_U03	C3,C4	Lab8..Lab11	2,3,4
PEK_U03	K2AIR_U03	C2,C3,C5,C6	Lab8,Lab9, Lab13,Lab14	2,3,4
PEK_U04	K2AIR_U03	C5,C8	Lab1..Lab15	2,3,4
PEK_K01, PEK_K02 (competences)	K2AIR_K01 K2AIR_K02		Lec1□Lec15 Lab1□Lab15	1,2,3,4,5

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FACULTY of ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish	**Wprowadzenie do systemów wbudowanych 1**
Name in English	**Introduction to Embedded Systems 1**
Main field of study (if applicable):	**Control Engineering and Robotics**
Specialization (if applicable):	**Embedded Robotics**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**AREA101**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**30**				
Number of hours of total student workload (CNPS)	**60**				
Form of crediting	**Examination**				
For group of courses mark (X) final course					
Number of ECTS points	**2**				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	**1**				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. K2AIR_W02
2. K2AIR_W05

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SUBJECT OBJECTIVES

C1. Acquiring knowledge on functional blocks in microcontrollers

C2. Acquiring knowledge on embedded software design methods

C3. Acquiring knowledge on operating principles and structure of embedded controllers

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – ability to explain microcontroller modules used in embedded controllers

PEK_W02 – ability to summarize the embedded programming and debugging methods PEK_W03 – ability to explain operating principles and structure of embedded controllers

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Embedded systems are everywhere	2
Lec 2	Microcontrollers spectrum	2
Lec 3	Programming tools and environments	2
Lec 4	Debugging techniques for embedded systems	2
Lec 5	MPU selection issues	2
Lec 6	Interface classes in embedded systems	2
Lec 7	Common interfaces for sensors and actuators	2
Lec 8	Human-machine interface support	2
Lec 9	Embedded control algoritm implementation issues	2
Lec 10	Rapid prototyping techniques for embedded controllers	2
Lec 11	Real-time operating systems overview	2
Lec 12	Basic RTOS services 1	2
Lec 13	Basic RTOS services 2	2
Lec 14	Implementation of RTOS-based embedded system	2
Lec 15	Examples of embedded control applications	2
	Total hours	**30**

TEACHING TOOLS USED
1. Traditional lecture 2. Consultations 3. Reading (self-study)

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 ÷ PEK_W03	Examination
C=F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Thomas Braunl, Embedded Robotics, Springer 2003, 2006

[2] Kirk Zurell, C Programming for Embedded Systems, Taylor & Francis 2000

[3] Processor Expert User Guide, Freescale Semiconductor, Inc. 2013

[4] Wnuk M., Slides: „Introduction to Embedded Systems", http://rab.ict.pwr.wroc.pl/~mw

SECONDARY LITERATURE:

[1] Freescale Semiconductor, http://www.freescale.com

[2] STMicroelectronics, http://www.st.com

[3] ARM, http://www.arm.com

[4] http://en.wikibooks.org/wiki/Embedded_Control_Systems_Design

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Introduction to Embedded Systems 1
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARE_W01	C1	Lec2, Lec5-Lec8	1,2,3
PEK_W02	S2ARE_W01	C2	Lec3-Lec4, Lec10, Lec14-Lec15	1,2,3
PEK_W03	S2ARE_W01	C3	Lec9, Lec11-lec15	1,2,3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS

SUBJECT CARD

Name in Polish: Teoria sterowania
Name in English: Control theory
Main field of study: Control Engineering and Robotics
Specialization :
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: AREA005
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15	30		
Number of hours of total student workload (CNPS)	60	60	60		
Form of crediting	Examination	crediting with grade	crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	6				
including number of ECTS points for practical (P) classes	-	2	3		
including number of ECTS points for direct teacher-student contact (BK) classes	2	1	2		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 knowledge acquirement for the modeling of control systems in the state space.
C2 ability acquirement for the control process determination in the state space.
C3 knowledge acquirement for the controllability and observability criteria for control systems.
C4 ability requirement for the design of state observers.
C5 knowledge acquirement for the investigation methods of the stability of nonlinear control systems.
C6 ability acquirement for the design of stable feedback control systems.
C7 knowledge requirements for optimal control methods of dynamic systems.
C7 ability acquirement for the use of effective optimal control algorithms with advanced numerical procedures.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knowledge of the modeling of control systems in the state space.
PEK_W02 – knowledge of the process evaluation methods for control systems in the state space.
PEK_W03 – knowledge of controllability and observability criteria for linear systems.
PEK_W04 – knowledge of the synthesis methods for identity and reduced state observers.
PEK_W05 – knowledge of the investigation methods of the stability of nonlinear control systems.
PEK_W06 – knowledge of the synthesis methods of control systems with required properties.
PEK_W07 – knowledge of optimal control methods for nonlinear systems.
PEK_W08 – knowledge of the synthesis methods for optimal state regulator.
PEK_W09 – knowledge of the modelling and optimization of complex control systems.

relating to skills:

PEK_U01 – ability of the design of stable feedback control systems.
PEK_U02 – ability of the design of identity and reduced state observers.
PEK_U03 -ability of the design of optimal state regulators.
PEK_U04 – ability of the simulation and evaluation of dynamic processes in control systems.
PEK_U05 – ability of the application of local and global optimization methods for control systems.
PEK_U06 – ability of the analysis of complex control systems.

relating to social competences:

PEK_K01 – awareness of the successes of advanced technologies and their ecological danger.
PEK_K02 – awareness of systematic study and creative professional discussions.

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec1	Mathematical description of control systems in the state space. Continuous and discrete systems. Models of control systems.	2
Lec 2,3	Controllability and observability of linear control systems. Structural investigation of control systems. Kalman decomposition.	4
Lec 4	Direct Lyapunov method for the stability investigation of nonlinear control systems. Stabilizability of control systems.	2
Lec 5	Indirect Lyapunov method for the stability of nonlinear control systems. Differential Lyapunov equation.	2
Lec 6	Synthesis of control systems with required properties. Shifting of eigenvalues of the state matrix.	2
Lec7	Deterministic and stochastic state observers.	2
Lec8	Stochastic models of dynamic systems and adaptive control.	2
Lec9	Bellman optimality principle. Dynamic programming method for the synthesis of closed control systems.	2
Lec 10	Pontryagin maximum principle. Canonical equations with mixed boundary conditions.	2

Lec 11	Synthesis of optimal state regulator. Riccati equation.	2
Lec 12	Sequential quadratic programming method for constrained optimal control problems.	2
Lec 13,14	Modeling of distributed parameter control systems. Problems of mass and heat transfer.	4
Lec 15	Modeling of complex control systems. Multilevel control. Parametric decomposition methods.	2
	Total hours	30

Form of classes - class		Number of hours
Cl 1	Examples of models of control systems in the state space.	2
Cl 2	Investigation of controllability and observability of linear control systems.	2
Cl 3	Investigation of the stability of open and closed control systems.	2
Cl 4	Examples of the synthesis of control systems with desired properties.	2
Cl 5	Examples of the synthesis of the state observers.	2
Cl 6	Examples of the synthesis of optimal state regulators.	2
Cl 7	Examples of the determination of optimal controls for lumped and distributed control systems.	3
	Total hours	15

Form of classes - laboratory		Number of hours
Lab 1	Laboratory safety instruction. Introduction to laboratory classes.	2
Lab 2	Modeling of control systems in the state space. Static and dynamic systems.	4
Lab 3	Synthesis of identity and reduced state observers.	4
Lab 4	Investigation of local stability by computer simulation methods.	4
Lab 5	Difference gradient method for optimal cyclic control problems.	4
Lab 6	Simulated annealing method for optimal nonlinear control problems.	4
Lab 7	Shifted penalty function method for constrained optimal control problems.	4
Lab 8	Synthesis of optimal state regulators. Algebraic and differential Riccati equations.	4
	Total hours	

TEACHING TOOLS USED
N1.Classical lectures with the use of multimedia. N2.Laboratory instructions. N3.Self-study. N4 Preparing to the tests. N5.Self-work with laboratory classes.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01 – PEK_U05	Oral answers, observation of classes execution, written tests
F2	PEK_W01 – PEK_W09 PEK_K01 – PEK_K02	Written and oral examination
P=0.4*F1+0.6*F2, but F1>2.0 and F2>2.0 is the necessary condition		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Kaczorek T., Teoria sterowania i systemów, PWN, Warszawa 1996
[2] Górecki H., Optymalizacja systemów dynamicznych, PWN, Warszawa 1993
[3] Pełczewski W., Teoria sterowania, WNT, Warszawa 1980
[4] Ogata K., Metody przestrzeni stanu w teorii sterowania, WNT, Warszawa 197

SECONDARY LITERATURE:

[1] Betts J.T., Practical Methods for Optimal Control and Estimation Using Nonlinear Programming, SIAM, Philadelphia, 2010
[2] Speyer J.L., Primer on Optimal Control Theory, SIAM, Philadelphia 2010
[3] Biegler L.T., Nonlinear Programming, SIAM, Philadelphia 2010

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Control theory
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization	Subject objectives	Programme content	Teaching tool number
PEK_W01	K2AIR_W01, K2AIR_W05	C1	Lec 1, 13, 14	1,2,4,5
PEK_W02	K2AIR_W02, K2AIR_W05	C2	Lec 1, 13, 14	1,2,4,5
PEK_W03	K2AIR_W05	C3	Lec 3	1,4,5
PEK_W04	K2AIR_W01, K2AIR_W05	C4	Lec 4	1,4,5
PEK_W05	K2AIR_W05	C5	Lec 5	1,4,5
PEK_W06	K2AIR_W02, K2AIR_W05	C6	Lec 6, 7	1,2,4,5
PEK_W07	K2AIR_W05	C7	Lec 8	1,2,4,5
PEK_W08	K2AIR_W05	C7	Lec 9 - 12	1,2,4,5
PEK_W09	K2AIR_W08	C8	Lec 13, 14	1,2,3
PEK_U01	K2AIR_U05	C1	Lab 2	2,4
PEK_U02	K2AIR_U01	C6	Lab 3, Lab 8	1,2,3,4
PEK_U03	K2AIR_U01	C4, C7	Lab 8	1,2,4
PEK_U04	K2AIR_U02	C2	Lab 3, Lab 4	1,2,3,4,5
PEK_U05	K2AIR_U04	C7	Lab 4 - 7	1,2,3,4
PEK_U06	K2AIR_U05	C8	Lab 8	1,2,3,4
PEK_K01	K2AIR_K01	C8	Lec 1 - 15	1,2,3,4,5
PEK_K02	K2AIR_K02	C8	Lab 1 - 8	1,2,3,4,5

Zał. nr 4 do ZW 64/2012

FACULTY of Electronics / DEPARTMENT **K-7**

SUBJECT CARD

Name in Polish Sensory i elementy napędowe 1
Name in English Sensors and Actuators 1
Main field of study (if applicable): Control Engineering and Robotics (AIR)
Specialization (if applicable): Embedded Robotics (ARE)
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: AREA102
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	30				
Form of crediting	Crediting with grade*				
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	0,5				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements concerning the second level.

SUBJECT OBJECTIVES

C1. Understanding of physical principles of basic sensors used in robots.
C2. Gain a knowledge of construction of basic sensors used in robots.
C3. Learn about a construction of basic circuits used in measurements systems.
C4. Learn about data processing obtained from specific sensors.
C5. Learn about basic actuators used in robots.
C6. Gain a knowledge of limitation of sensors application.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knows purposes of usage of sensors in specific applications
PEK_W02 – knows physical principles of basic sensors used in robots
PEK_W03 – understands a construction of basic sensors used in robots
PEK_W04 – understands basic circuits used in measurements systems

relating to social competences:

PEK_K01 – understands the need for self-study and develop own skills for independently applying the knowledge and abilities

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec1	Introduction: program, requirements, literature. Basic concepts and issues. Survey of sensor used in robots	2
Lec2	Actuators and proprioceptive sensors – position and velocity transducers, encoder, resolvers and others	2
Lec3	Force and torque sensors	2
Lec4	Inertial sensors	2
Lec5	Algorithms of data fusion and processing. Examples of methods application for inertial sensors	2
Lec6	Advanced ultrasonic range-finders systems	2
Lec7	Optical and laser range-finders	2
Lec8	Vision systems and 3D cameras	1
	Total hours	15

TEACHING TOOLS USED

N1. Traditional lecture using video projector
N2. Consultations.
N3. Independent work – self study and preparation for the written test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 ÷ PEK_W03	The final test
P = F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] B. Siciliano, et. al., Robotics – Modeling, Planning and Control, Springer-Verlag London Limited, 2009
[2] E. Gaura, R. Newman, Smart MEMS and Sensor Systems, Imperial College Press, 2006
[3] J. Fraden, Handbook of Modern Sensors – Physics, Design, and Applications, Springer-Verlag, 2004

SECONDARY LITERATURE:

[1] Lecture notes
[2] Internet resources

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Sensors and Actuators 1
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics (AIR)
AND SPECIALIZATION
Embedded Robotics (ARE)

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARR_ W02	C1	Lec1÷Lec8	1,2,3
PEK_W02	S2ARR_ W02	C4	Lec2÷Lec4, Lec6÷Lec8	1,2,3
PEK_W03	S2ARR_ W02	C1,C2,C4	Lec2÷Lec4, Lec6÷Lec8	1,2,3
PEK_W04	S2ARR_ W02	C1÷C6	Lec3, Lec4,Lec6	1,2,3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish Robotyczne środowiska programistyczne
Name in English Robotic Programming Environments
Main field of study (if applicable): Control Engineering and Robotics (AIR)
Specialization (if applicable): Embedded Robotics (ARE)
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: AREA103
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	4				
including number of ECTS points for practical (P) classes	-		2		
including number of ECTS points for direct teacher-student contact (BK) classes	0,5		1,5		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. No

SUBJECT OBJECTIVES

C1 General understanding of the component oriented programing.
C2. General understanding of the distributed control systems.
C3 General understanding of the communication protocols.
C4 Learn about robotic middleware frameworks.
C5 Learn about robotic simulation frameworks.
C6 Learn about programing libraries and tools supporting implementation of the control system.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knowns the basic of component oriented programming
PEK_W02 – knowns the basic of distributed control system development
PEK_W03 – knowns the basic of communication protocols for distributed systems
PEK_W04 – knowns the robotic programing frameworks
PEK_W05 – knowns the robotic simulation frameworks
PEK_W06 – knowns the programing libraries and tools supporting control system development

relating to skills:

PEK_U01 – can design and implement distributed control system
PEK_U02 – can decompose complex system into set of generic components with well defined interfaces and functionalities.
PEK_U03 – can develop distributed, portable application that operates on more then one physical platform
PEK_U04 – can use well known robotic programming framework to implements complex distributed control system for autonomous robot
PEK_U05 – can use well known robotic simulation framework to model robot and its environment
PEK_U06 – can use well known programing libraries to solve ordinary differential equation, nonlinear optimization problems, nonlinear model predictive control problems and motion planning problems.

relating to social competences:

PEK_K01 – understands the need for self-study and knowledge sharing

PROGRAMME CONTENT		
Form of classes - lecture	**Number of hours**	
Lec 1	Introduction to robotic programming environments	1
Lec 2	Component/agent based approach for distributed control system	1
Lec 3	Communication protocols	1
Lec 4	OROCOS framework	3
Lec 5	ROS framework	4
Lec 6	Simulation environments	2
Lec 7	Mathematical libraries (algebra, ODE)	1
Lec 8	Optimization and model predictive control libraries	1
Lec 9	Motion planning libraries	1
	Total hours	15

Form of classes - laboratory	Number of hours	
Lab 1	Introduction to laboratory classes, setup programming environment	2
Lab 2	Component/agent based modeling	2
Lab 3	Distributed communication	2
Lab 4	Introduction to OROCOS framework	2
Lab 5	OROCOS component design	2
Lab 6	Developing distributed system with OROCOS	2
Lab 7	Introduction to ROS framework	2
Lab 8	ROS node design	2
Lab 9	Developing distributed system with ROS	2
Lab 10	Integration ROS with OROCOS	2
Lab 11	Introduction to simulation environment	2
Lab 12	Integration simulation environment with ROS/OROCOS	2
Lab 13	Solving system of linear, nonlinear and ordinary differential equation using mathematical libraries	2
Lab 14	Introduction to optimization and model predictive control frameworks	2
Lab 15	Introduction to ROS navigation stack	2
	Total hours	30

TEACHING TOOLS USED
N1. traditional lecture N2. laboratory exercises N3. consultations N4. independent work – preparation for the laboratory classes N5. independent work – self study and preparation for the written test N6. individual work – literature studies

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 ÷ PEK_W06; PEK_K01	test
F2	PEK_U01 ÷ PEK_U06; PEK_K02	active participation in classes, test
P = 0,4*F1 + 0,6*F2, Notice: a mark at least 3.0 (passed) within F2 is prerequisites of admission to the test F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] R. Simmons, D. Kortencamp, D. Brugali. Robotics Systems Architectures and Programming, Handbook of Robotics IIed. , Springer 2013

[2] R. Bischoff, T. Guhl, E. Prassler, W. Nowak, G. Kraetzschmar, H. Bruyninckx, P. Soetens, M. Haegele, A. Pott, P. Breedveld, J. Broenink, D. Brugali and N. Tomatis. BRICS − Best practice in robotics. In Proc. of the IFR International Symposium on Robotics (ISR 2010), June 2010, Munich, Germany.

[3] R. Patrick Goebel, „ROS By Example FUERTE - Volume 1”, 2012

[4] R. Patrick Goebel, „ROS By Example GROOVY - Volume 1”, 2013

SECONDARY LITERATURE:

[1] Houska, B., Ferreau, H. J., Diehl, M.: ACADO Toolkit - An Open-Source Framework for Automatic Control and Dynamic Optimization. Optimal Control Methods and Application 32, 298–312 (2011)

[2] D. Brugali and P. Scandurra. Component-based Robotic Engineering. Part I: Reusable building blocks. In IEEE Robotics and Automation Magazine, December 2009.

[3] D. Brugali and A. Shakhimardanov. Component-based Robotic Engineering. Part II: Models and systems. In IEEE Robotics and Automation Magazine, March 2010.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Robotic Programming Environments
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics (AIR)
AND SPECIALIZATION **Embedded Robotics (ARE)**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARE_W03	C1	Lec1,Lec2	N1,N3,N5,N6
PEK_W02	S2ARE_W03	C2	Lec1,Lec2	N1,N3,N5,N6
PEK_W03	S2ARE_W03	C3	Lec1,Lec3	N1,N3,N5,N6
PEK_W04	S2ARE_W03	C4	Lec4,Lec5	N1,N3,N5,N6
PEK_W05	S2ARE_W03	C5	Lec6	N1,N3,N5,N6
PEK_W06	S2ARE_W03	C6	Lec7,Lec8	N1,N3,N5,N6
PEK_U01	S2ARE_U03	C1÷C6	Lab1÷Lab10	N2,N3,N4
PEK_U02	S2ARE_U03	C1	Lab2	N2,N3,N4
PEK_U03	S2ARE_U03	C3÷C4	Lab3÷Lab10	N2,N3,N4
PEK_U04	S2ARE_U03	C4	Lab4÷Lab10	N2,N3,N4
PEK_U05	S2ARE_U03	C5	Lab11	N2,N3,N4
PEK_U06	S2ARE_U03	C6	Lab13÷Lab15	N2,N3,N4
PEK_K01	S2ARE_K01	C1÷C6	Lab1÷Lab15	N4,N5,N6

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS / DEPARTMENT K-7

SUBJECT CARD

Name in Polish: Sterowanie Zdarzeniowe
Name in English: Event-based Control
Main field of study (if applicable): Control Engineering and Robotics
Specialization (if applicable): Embedded Robotics
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: AREA105
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			30	
Number of hours of total student workload (CNPS)	60			60	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course	X				
Number of ECTS points	4				
including number of ECTS points for practical (P) classes	-			2	
including number of ECTS points for direct teacher-student contact (BK) classes	1			1	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements concerning the second level.

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SUBJECT OBJECTIVES

C1. Acquirement of the basic knowledge of the Discrete Event System (DES) theory and its applications, including the concepts of formal languages, finite state automata, and Petri nets.

C2. Acquirement of the ability to apply the theory of DES in the modeling of robotics and automation systems as well as the design and development of the supervisory control.

C3. Consolidation of the team project realization skills.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge

PEK_W01 – understands the concept of discrete event system (DES) and event-based control

PEK_W02 – knows the basic formalisms for modeling discrete event systems: formal languages, finite state automata and Petri nets

PEK_W03 – understands the idea of hybrid representation and control of complex systems

PEK_W04 – understands the RAS (Resource Allocation System) paradigm and the RAS-based approach to the correct-by-construction supervisory control synthesis

W05 - knows DES-based models and control logic for selected types of robotic systems

relating to skills

PEK_U01 – can create DES models of complex systems and develop supervisory control for them

relating to social competences

PEK_K01 – is able to self-study

PEK_K02 - is able to share technical information and work in teams

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec1	Introduction to discrete event systems (DES). Event-based control: a new modeling and control paradigm.	2
Lec2	Formal models of DES behavior: languages and finite state automata.	2
Lec3	Net models of DES: place/transition Petri net systems.	2
Lec4	Algebraic representation of Petri nets.	2
Lec5	High level Petri nets.	2
Lec6	Timed and stochastic Petri nets.	2
Lec7	Resource Allocation Systems (RAS). RAS taxonomy.	2
Lec8 Lec9	Liveness enforcement. Automatic synthesis of formally correct supervisory control for RAS.	4
Lec10	Continuous and hybrid DES models. Hybrid control of complex systems.	2
Lec11	Job flow control in flexible manufacturing cells.	2
Lec12	Supervisory control in AGV systems.	2
Lec13 Lec14	Traffic control in multiagent mobile systems.	4
Lec15	Control synthesis in health care systems: MRS scanner and patient flow system.	2
	Total hours	30

Form of classes - project		Number of hours
Proj1	Presentation of the content and organization of the project class: team work, model construction and computer implementation of supervisory control for a selected DES.	2
Proj2	Partition of the class into project groups, discussion with each group their project assignment and presentation of the requested form of the initial form of the project description (problem, task list, schedule, responsible persons, project management, milestones, deliverables). Sign-in of students to e-portal.	2
Proj3	Discussion with each particular group of their initial project description. Possible modification of the envisioned work.	2
Proj4 - Proj6	Development of the DES model and control algorithms. Documentation in the form of intermediate reports associated with the assumed milestones. Evaluation of the reports by the teacher, discussion with the students, possible modification of further work.	6
Proj7 - Proj12	Computer implementation of the control system. Documentation in the form of intermediate reports associated with the assumed milestones. Evaluation of the reports by the teacher, discussion with the students, possible modification of further work.	12
Proj13 - Proj14	Preparation of the final report. Evaluation of the control system and its documentation developed by each particular group. Realization of possible corrections.	4
Proj15	Dissemination of the results among all the participants of the course. Presentation of the results achieved by each particular group.	2
	Total hours	30

TEACHING TOOLS USED

N1. Lecture with a video projector.

N2. Project class – team work on the project topics under the supervision of the teacher.

N3. E-portal of Politechnika Wrocławska http://eportal.pwr.wroc.pl – repository of the project materials and an additional communication channel among the students and between the students and the teacher.

N4. Consultations.

N5. Self-study – individual work and preparation for the final test.

N6. Self-study – individual realization of partial project tasks.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 ÷ PEK_W05	Test result
F2	PEK_U01 PEK_K01 ÷ PEK_K02	Evaluation of the project proposal (initial description of the project) Evaluation of the project development process Evaluation of the project result
P = 0,5*F1 + 0,5*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] C.G. Cassandras, S. Lafortune, Introduction to Discrete Event Systems, Kluwer Academic Publishers, 1999, selected chapters.
[2] R. David, H. Alla, Petri Nets and Grafcet: tools for modeling discrete event systems, Prentice Hall, 1992, selected chapters.
[3] S.A. Reveliotis, Real-Time Management of Resource Allocation Systems: A Discrete-Event Systems Approach , Springer, NY, 2005, selected chapters.

SECONDARY LITERATURE:

[1] W. Reisig, Sieci Petriego, WNT 1988
[2] J. Błażewicz, Złożoność obliczeniowa problemów kombinatorycznych, WNT, 1988
[4] W.M. Wonham, Supervisory Control of Discrete Event Systems, http://www.control.utoronto.ca/cgi-bin/dldes.cgi
[5] M.C. Zhou, M.P. Fanti (editors), Deadlock Resolution in Computer-Integrated Systems, Marcel Dekker, 2005

Journals:

[1] IEEE Transactions on Automatic Control
[2] IEEE Transactions on Automation Science and Engineering

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Event-Based Control
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARE_W06	C1	Lec1÷Lec2 Lec11÷Lec15	1,3,4,5
PEK_W02	S2ARE_W06	C1	Lec3÷Lec5	1,3,4,5
PEK_W03	S2ARE_W06	C1	Lec3÷Lec4 Proj4÷Proj6	1,3,4,5
PEK_W04	S2ARE_W06	C1	Lec6÷Lec7 Lec10÷Lec15 Proj4÷Proj6	1,2,3,4,5,6
PEK_W05	S2ARE_W06	C1,C2	Lec11÷Lec15	1,3,4,5
PEK_U01	S2ARE_U06	C1,C2	Lec1÷Lec15 Proj1÷Proj15	1,2,3,4,5,6
PEK_K01	S2ARE_K01	C1,C2	Lec1÷Lec15 Proj1÷Proj15	3,5
PEK_K02	K2AIR_K02	C2-C3	Proj1÷Proj15	2,3,6

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY OF ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish: Projekt przejściowy
Name in English: Intermediate project
Main field of study (if applicable): Control Engineering and Robotics
Specialization (if applicable): Embedded Robotics
Level and form of studies: 2nd, full-time
Kind of subject: obligatory
Subject code: AREA107
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				30	
Number of hours of total student workload (CNPS)				60	
Form of crediting				crediting with grade*	
For group of courses mark (X) final course					
Number of ECTS points				2	
including number of ECTS points for practical (P) classes				2	
including number of ECTS points for direct teacher-student contact (BK) classes				1	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. K2AIR_W05, K2AIR_W06, K2AIR_W08
2. K2AIR_U01, K2AIR_U02, K2AIR_U03, K2AIR_U05

SUBJECT OBJECTIVES

C1. Developing skills for researching and constructively analyzing the available literature
C2. Developing skills for formulating the goals, scope, requirements, and time schedule of the project
C3. Developing skills for designing the abstract architecture of the system
C4. Developing skills for implementing the given system structure under the supervision of the instructor, and in cooperation with another student.
C5. Developing skills for writing and presenting the project documentation.

SUBJECT EDUCATIONAL EFFECTS

relating to skills:
PEK_U01 – can research the technical literature for the given problem
PEK_U02 – can state the goals, scope, requirements and time schedule for a project
PEK_U03 – can creatively implement a project in the broad area of embedded robotics
PEK_U04 – can document and present project results

relating to social competences:

PEK_K01 – can work in a team PEK_K02 – is aware of the significance of a reliable task accomplishment

Form of classes - project		**Number of hours**
Proj 1	Propose an individual project in the broad area of embedded robotics systems and applications	4
Proj 2	Development of the project	18
Proj 3	Prepare the project report	4
Proj 4	Presentations of the project outcomes	4
	Total hours	30

TEACHING TOOLS USED
N1. Consultations in class N2. Literature study and research N3. Independent work – project development

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01 ÷ PEK_U04	Evaluation of the project outcome and report
C=F1		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Handbook of robotics, II ed., Springer, 20013 [2] Siciliano, et.al., Robotics – Modeling, Planning and Control, Springer, 2009 [3] Thrun et.al. Probabilistic robotics. MIT, 2006 [4] Bradski, Kaehler: Learning OpenCV, O'Reilly, 2008 [5] Duda, Hart, Stork: Pattern Classification, Second Edition, Wiley 2000 [6] LaValle, Planning Algorithms, Cambridge, 2006 [7] Latombe, Robot motion planning, Kluwer, 1993 [8] Tchoń et.al. Manipulatory i roboty mobilne. OW PLJ, 2000
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS
Witold Paluszyński, Witold.Paluszynski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Intermediate project
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_U01	S2ARE_U11	C1	Proj 1	N1,N2
PEK_U02	S2ARE_U11	C2	Proj 1	N1,N3
PEK_U03	S2ARE_U11	C3,C4	Proj 2	N1,N3
PEK_U04	S2ARE_U11	C5	Proj 3,4	N1,N3
PEK_K01, PEK_K02	S2ARE_K01, S2ARE_K02	C1-C5	Proj 1-4	N1,N2,N3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY of Electronics

SUBJECT CARD

Name in Polish: Sztuczna inteligencja i uczenie się maszyn
Name in English: Artificial Intelligence and Machine Learning
Main field of study (if applicable): Control Engineering and Robotics (AIR)
Specialization (if applicable): Embedded Robotics (ARE)
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: AREA106
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			30	
Number of hours of total student workload (CNPS)	60			90	
Form of crediting	Crediting with grade*			Crediting with grade*	
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical (P) classes				3	
including number of ECTS points for direct teacher-student contact (BK) classes	1			1	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements concerning the second level.

SUBJECT OBJECTIVES

C1. General understanding of the knowledge representation and reasoning issues.
C2. Learn about using heuristics and their use in problem solving.
C3. Learn about using logic and theorem proving in reasoning.
C4. Learn about using probability, the Bayes rule, utilities, and Markov processes algorithms for single and sequential decision making.
C5. Learn about the induction and reinforcement learning methods.
C6. Gain a practical ability to use one of the existing formal paradigms to build abstract representation of practical problems, and solve them.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

EK_W01 – understands the concept of artificial intelligence, knowledge representation, and reasoning

PEK_W02 – knows the search methods for different classes of problems, and the use of heuristics in problem solving

PEK_W03 – understands the application of mathematical logic to problem representation, and the significance of uncertainty

PEK_W04 – understands the application of probability to problem description, the Markov decision processes, and the basic algorithms for solving them

PEK_W05 – knows the basic machine learning methods

relating to skills:

PEK_U01 – can create abstract descriptions of hard practical problems and implement algorithms to solve them

relating to social competences:

PEK_K01 – understands the need for self-study and develop own skills for independently applying the knowledge and abilities

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec1	Introduction: program, requirements, literature. Basic concepts and issues. Definition of artificial intelligence. The Turing test. History of AI. Strong and weak artificial intelligence.	2
Lec2	State space representation. Searching. Hill-climbing strategies. Utilizing heuristic information.	2
Lec3	Graph searching. Breadth-first, depth-first, and best-first strategies. A* algorithm. Properties.	2
Lec4	Constraint satisfaction problems. Arc consistency. Basic algorithms. Searching for games. Minimax algorithm. Alpha-beta cuts.	2
Lec5	Representation in first order logic. Resolution theorem proving. Refutation reasoning.	2
Lec6	Utilizing incomplete and uncertain information. Nonmonotonic logic. Truth maintenance systems.	
Lec7	Classical action planning. STRIPS and ADL representations. Partial order plans. POP algorithm. Planning graphs. The Graphplan algorithm.	2
Lec8	Semantic knowledge representation. The Semantic Web initiative. Introduction to XML.	2
Lec9	Semantic networks. The RDF representation language. The SPARQL query language.	2
Lec10	Probabilistic representation. Conditional probability. Bayes' rule. Probabilistic belief networks.	2
Lec11	Introduction to simple decision making. Utility functions. Influence diagrams. Value of information.	2

Lec12	Sequential decision problems. Markov decision processes. Dynamic programming. Value and policy iteration.	2
Lec13	Introduction to induction machine learning. Building decision trees. Issues arising in induction machine learning.	2
Lec14	Reinforcement learning. Basic algorithms. Exploration. Function approximation.	2
Lec15	Introduction to natural language communication. Parsing and semantic analysis. Statistical methods.	2
	Total hours	30

Form of classes - project		**Number of hours**
Proj1-6	Series of six individual projects concerning the topics covered in lectures: searching using heuristics, programming using logic, semantic knowledge representation and querying/searching, probabilistic knowledge representation and making decisions, induction and reinforcement machine learning.	30
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lecture using video projector N2. Project classes N3. Consultations N4. Independent work – preparation for the project classes N5. Independent work – self study and preparation for the written test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 ÷ PEK_W05	The final examination
F2	PEK_U01	Evaluation of the project assignments
C = 0,4*F1 + 0,6*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S.J.Russell, P.Norvig, Artificial Intelligence A Modern Approach (3rd Ed.), Prentice-Hall, 2010
[2] T.Mitchell, Machine Learning, McGraw Hill, 1997

SECONDARY LITERATURE:

[1] Lecture notes
[2] Internet resources

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Witold Paluszyński, witold.paluszynski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Artificial Intelligence and Machine Learning
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics (AIR)
AND SPECIALIZATION
Embedded Robotics (ARE)

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARE_ W07	C1÷C6	Lec1÷Lec15	1,3,5
PEK_W02	S2ARE_ W07	C1,C2,C6	Lec2, Lec3, Lec4	1,3,5
PEK_W03	S2ARE_ W07	C1,C3,C6	Lec5, Lec6, Lec7, Lec8, Lec9	1,3,5
PEK_W04	S2ARE_ W07	C1,C4,C6	Lec10, Lec11, Lec12	1,3,5
PEK_W05	S2ARE_ W07	C1,C5,C6	Lec13, Lec14	1,3,5
PEK_U01	S2ARE_ U07	C1÷C6	Proj1-6	2,3,4
PEK_K01	S2ARE_ U07	C1,C6	Proj1-6	4,5

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY ELECTRONICS / DEPARTMENT K-7

SUBJECT CARD

Name in Polish **Seminarium specjalnościowe**
Name in English **Specialization seminar**
Main field of study (if applicable): **Control Engineering and Robotics**
Specialization (if applicable): **Embedded Robotics (ARE)**
Level and form of studies: **2nd level, full-time**
Kind of subject: **obligatory**
Subject code **AREA108**
Group of courses **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					30
Number of hours of total student workload (CNPS)					60
Form of crediting					crediting with grade
For group of courses mark (X) final course					
Number of ECTS points					**2**
including number of ECTS points for practical (P) classes					2
including number of ECTS points for direct teacher-student contact (BK) classes					1

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. Acquire the knowledge on recent developments in the specific area of Embedded Robotics as well as in the broader area of Control Engineering and Robotics
C2. Acquire the skills to study technical literature and make a synthesis of collected information
C3. Acquire the skills to prepare and deliver a comprehensible seminar in the field
C4. Acquire the skills to participate constructively in a scientific/technical discussion

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEK_U01 is able to prepare and present a scientific/technical seminar using traditional and electronic resources.
PEK_U02 is able to lead and participate in a scientific/technical discussion.

Form of classes - seminar		Number of hours
Sem1	Presentation of the thematic scope of the seminar, main sources of the material, and principles of preparing and delivering the seminar	2
Sem2	Discussion on the propositions of individual students, acceptance of the seminar topics, and setting the schedule.	2
Sem3 ÷ Sem15	Individual presentations and class discussions on the delivered material	26
	Total hours	**30**

TEACHING TOOLS USED
N1. multimedia presentation N2. class discussion N3. individual work

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_ U01	presentation
F2	PEK_U02	discussion
P= 0.7*F1+0.3*F2 **(in order to pass the course, both F1 and F2 must be positive)**		

Evaluation (F – forming (during semester), P – concluding (at semester end)

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] IEEE Robotics &Automation Magazine [2] IEEE Transactions on Robotics [3] IEEE Embedded System Letters **SECONDARY LITERATURE:** [1] Thomas Braunl, Embedded Robotics, .Springer-Verlag, Berlin Heidelberg, 2008 [2] e-books and e-journals in the field accessible through CWiINT at P.Wr.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Elżbieta Roszkowska, elzbieta.roszkowska@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Specialization seminar
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics (ARE)

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_U01	S2ARE_U12	C2, C3	Sem1 ÷ Sem15	1,2
PEK_U02	S2ARE_U12	C4	Sem1 ÷ Sem15	2

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish	**Seminarium dyplomowe**
Name in English	**Diploma Seminar**
Main field of study (if applicable)	**Control Engineering and Robotics**
Specialization (if applicable):	**Embedded Robotics**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**AREA109**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					30
Number of hours of total student workload (CNPS)					90
Form of crediting					crediting with grade
For group of courses mark (X) final course					
Number of ECTS points					3
including number of ECTS points for practical (P) classes					3
including number of ECTS points for direct teacher-student contact (BK) classes					1,5

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. learn to acquire multi-source knowledge useful and appropriate to propose original contributions
C2. learn to prepare a presentation in a clear manner presenting own ideas, concepts and solutions
C3. acquire knowledge how to discuss and argue for and against, using substantial arguments
C4. gain ability to present own achievements in a written form.

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEK_U01 Students are able to prepare a multi-media presentation illustrating their achievements.
PEK_U02 Students can put forward arguments for their own ideas and solutions.
PEK_U03 Students are able to evaluate critically solutions of the others.

PROGRAMME CONTENT

	Form of classes - seminar	**Number of hours**
Sem1	Principles of preparing and writing diploma work.	2

Sem2	Presentation of contemporary robotic literature related to diploma work pointing out original contributions.	8
Sem3	Discussions on a literature specific to subject of diploma work scope. Assumptions taken and solutions proposed.	6
Sem4	Presentations of diploma work pointing out original contributions. Discussions on the diploma achievements.	14
	Total hours	30

TEACHING TOOLS USED
N1. multimedia presentation N2. discussions N3. individual study

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W02, PEK_U01	presentation
F2	PEK_W01, PEK_U02, PEK_U03	discussions
P= 0.5*F1+0.5*F2		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
Literature specific to diploma work
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Krzysztof Tchoń, krzysztof.tchon@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Diploma Seminar
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_U01	S2ARE_U13	C2	Sem2, Sem4	N1
PEK_U02	S2ARE_U13	C3	Sem3, Sem4	N2, N3
PEK_U03	S2ARE_U13	C1 ,C2, C3, C4	Sem3, Sem4	N2, N3

Zał. nr 4 do ZW 64/2012

FACULTY OF ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish …… Teoria sterowania dla systemów wbudowanych …….
Name in English …… Control Theory for Embedded Systems …….
Main field of study (if applicable): ……AIR……
Specialization (if applicable): ……ARE……..
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code … AREA104….
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15	15		
Number of hours of total student workload (CNPS)	60	45	45		
Form of crediting	Examination	crediting with grade	crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	**5**				
including number of ECTS points for practical (P) classes		1,5	1,5		
including number of ECTS points for direct teacher-student contact (BK) classes	1	1	1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. relating to knowledge:
K2AIR_ W05, 2. K2AIR_ W06, K2AIR_ W08
2. relating to skills:
K2AIR_ U01, K2AIR_ U02, K2AIR_ U03, K2AIR_ U05

SUBJECT OBJECTIVES

C1. Gaining knowledge on classical methods for control systems design.
C2. Gaining knowledge on uncertainty models and robust control systems.
C3. Gaining knowledge on H-infinity control.
C4. Gaining knowledge on design and analysis of adaptive control systems.
C5. Gaining knowledge on computer techniques for analysis, synthesis and deploying to embedded controllers of robust and adaptive control systems.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 He/She knows the fundamentals of the feedback theory: basic feedback configurations and properties, stability, stability robustness, loop shaping; the classical control objectives and performance criteria, classical compensator design methods: lead and lag compensation, root-locus, Guillemin-Truxal design procedure; the concept of parametric uncertainty and methods for parametric robustness analysis, in particular the Kharitonov theorem; the concept of the basic perturbation model, the small gain theorem, and internal stability; the concepts of stability and performance robustness of feedback systems and also with sufficient conditions for occurrence of these system features.

PEK_W02 He/She knows the problem and the solution of state feedback H-infinity control and the underlying mathematical apparatus: the form of the Algebraic Riccati Equation and its basic properties, the concepts of coprime factorization of MIMO systems and Youla parameterization of stabilizing controllers, the concept of J-inner coprime factorisation.

PEK_W03 He/She knows a general structure of adaptive control systems and the mathematical apparatus used for analysis of adaptive systems

PEK_W04 He/She knows design and properties of a simple adaptive law (a gradient estimation algorithm with dead zone), a robust adaptive Luenberger observer, a robust adaptive pole placement controller.

PEK_W05 He/She knows implications induced by real software on deployment of mathematical control laws on a physical hardware, basic stages of deployment of a mathematical control law (according to the V-model) that are supported by the Matlab/Simulink software, in particular: Simulation, Rapid Prototyping, On-Target Rapid Prototyping, Software-in-the-Loop, Processor-in-the-Loop, Hardware-in-the-Loop, is familiar with the following toolboxes of a numerical computing system MATLAB/Simulink: Control System, Robust Control, System Identification, Real-Time Windows Target, Simulink Coder, Embedded Coder, SimMechanics, SimMechanicsLink.

relating to skills:

PEK_U01 He/She is able to loop shaping, determine amplitude and phase margins and use the Doyle's stability robustness criterion, use the Nyquist criterion and a polynomial criterion to investigate stability, design a compensator using classical methods: lead and lag compensation, root-locus, Guillemin-Truxal design procedure (calculations using paper with support dedicated software systems as Matlab).

PEK_U02 He/She knows how to use the the Kharitonov theorem to investigate stability of a system with parametric uncertainty, is able to transform a control system with uncertainty into basic perturbation model (with additive or multplicative perturbation) and to investigate stability robustness using a small gain theorem, analyse performance robustness of a feedback system (calculations using paper with support dedicated software systems as Matlab).

PEK_U03 He/She knows how to design a standard H-infinity state feedback controller, verify existence of the unique, positive semidefinite solution of an Algebrai Riccati Equation, compute the solution and analyze the basic properties of this equation, derive coprime factorization of MIMO systems and Youla parameterization of stabilizing controllers (calculations using paper with support dedicated software systems as Matlab).

PEK_U04 He/She is able to design adaptive control algorithm based on the certainty equivalence principle, knows how to use selected technical lemmas when analyzing stability of adaptive control systems, apply a robust adaptive law (e.g. recursive

estimation algorithm with dead zone or adapt one of available recursive identification algorithms available i Matlab / System Identification Toolbox) when designing adaptive feedback control system, design a robust adaptive pole placement controller for a SISO plant and carry out simulation analysis of such a control system in Matlab/Simulink.

PEK_U05 He/She knows how to use rapid control prototyping technology when designing a control algorithm, how to employ Matlab/Real-Time Windows Target Toolbox integrated with a data acquisition card to control a physical plant from a Simulink level, and for collecting data to carry out identification using Matlab/System Identification Toolbox, automatically generate C code for a specific microcontroller using Simulink / Embedded Coder Toolbox from a block diagram in Simulink that represents a control algorithm, transform 3D CAD model into a Simulink diagram that consists of blocks from SimMechanics Toolbox and employ such a Simulink model for designing and analysis of a control algorithm.

relating to social competences:

PEK_K01 He/She is able to assess arguments, rationally explain and justify own point of view with the use of subject knowledge.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	General Structure of Control Systems	2
Lec 2	Classical Control System Design	2
Lec 3	Software Implications	2
Lec 4	Deploying Designs to Embedded Controllers Through Automatic Code Generation in Matlab/Simulink	2
Lec 5	Parametric Robustness Analysis	2
Lec 6	Signal and System Spaces, Norms of Systems	2
Lec 7	Uncertainty Models and Stability Robustness	2
Lec 8	Robust Stability: the Structured Stability Radius	2
Lec 9	Algebraic Riccati Equation	2
Lec 10	System Algebra	2
Lec 11	H-infinity Control	2
Lec 12	General Structure of Adaptive Control Systems	2
Lec 13	Stability	2

Lec 14	Robust Adaptive Laws	2
Lec 15	Robust Adaptive Pole Assignment	2
Total hours		30

Form of classes - class		Number of hours
Cl 1	Selected Problems in Mathematical Methods in Robotics and Control Engineering	3
Cl 2	Classical Design Methods of Compensators	2
Cl 3	Uncertainty Models and Stability Robustness I	2
Cl 4	Uncertainty Models and Stability Robustness II	2
Cl 5	Algebraic Riccati Equation, H-infinity Control	2
Cl 6	Stability of Simple Adaptive Systems	2
Cl 7	Final Test	2
Total hours		**15**

Form of classes - laboratory		Number of hours
Lab 1	Introduction to Laboratory Classes	1
Lab 2	Introduction to Real-Time Workshop Embedded Coder and Real-Time Windows Target I	2
Lab 3	Introduction to Real-Time Workshop Embedded Coder and Real-Time Windows Target II	2
Lab 4	Physical Modeling	2
Lab 5	DC Motor: Modeling and Identification	2
Lab 6	DC Motor: Model-Based Control	2
Lab 7	Inverted Pendulum on a Cart: Model-Based Control	2
Lab 8	Term for Carrying Out an Overdue Exercise	2
	Total hours	**15**

TEACHING TOOLS USED
N1. traditional lecture N2. computational exercises N3. laboratory exercises N4. consultations N5. individual work – solving exemplary problems N6. individual work – literature studies N7. individual work – solving selected problems using a software environment for numerical computation, as Matlab/Simulink or Octave N8. individual work - solving some tasks in the form of programs in C/C++

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01÷PEK_W05	written test (lecture)
F2	PEK_W01÷PEK_UW5 PEK_U01÷PEK_U05	active participation in classes, written test (classes)
F3	PEK_U01÷PEK_U05	reports on the completed tasks (laboratory)
C=0.33*F1+0.33*F2+0.34*F3 Successful completion of all the classes forms (which means that F1, F2, F3 are positive) is the necessary condition for crediting with a positive mark at the semester end for the course.		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Datta, Biswa Nath, *Numerical Methods for Linear Control Systems - Design and Analysis*, 2004 Elsevier http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=1920

[2] T. Wescott, Applied Control Theory for Embedded Systems, Elsevier, 2006, http://www.knovel.com/web/portal/basic_search/display?_EXT_KNOVEL_DISPLAY_bookid=1927

[3] P. A. Ioannou, J. Sun, Robust Adaptive Control, Prentice-Hall, 1996 http://www-rcf.usc.edu/ ioannou/RobustAdaptiveBook95.pdf

[4] F. W. Fairman, Linear Control Theory. The State Space Approach. John Willey & Sons, 1998

[5] K. Zhou, J. C. Doyle, K. Glover, Robust and Optimal Control, Prentice Hall, 1996

SECONDARY LITERATURE:

[1] R. Marino, P. Tomei, Nonlinear Control Design. Geometric, Adaptive and Robust, Prentice Hall, 1995

[2] R. A. Freeman, P. A. Kokotović, Robust Nonlinear Control Design, State-Space and Lyapunov Techniques, Birkhäuser, 1996

[3] I. D. Landau, R. Lozano, M. M'Saad, Adaptive Control, Springer-Verlag London

[4] G. Tao, Adaptive Control Design and Analysis, John Willey & Sons, 2003

[5] Thomas Bräunl, Embedded Robotics. Mobile Robot Design and Application with Embedded Systems, Springer, 2008.

[6] B. Shahian, M. Hassul, Control System Design Using Matlab, Englewood Cliffs, 1993

[7] The Mathworks. Matlab/Simulink software documentation, http://www.mathworks.com

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
…… Control Theory for Embedded Systems ……
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY ……**AIR**……..
AND SPECIALIZATION ……**ARE**……..

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	S2ARR_W02, K2AIR_W05, K2AIR_W08	C1, C2, C5	Lec 1, Lec 2, Lec 5÷Lec 7, Cl 1÷Cl 3, Lab 1÷Lab 3, Lab 6, Lab 7	1÷7
PEK_W02	S2ARR_W02, K2AIR_W05, K2AIR_W08	C2, C3, C5	Lec 9÷Lec 11, Cl 5, Lab 7	1÷7
PEK_W03	S2ARR_W02, K2AIR_W06, K2AIR_W05, K2AIR_W08	C2	Lec 13, Cl 6	1÷7
PEK_W04	S2ARR_W02, K2AIR_W06, K2AIR_W05, K2AIR_W08	C2, C4, C5	Lec 13÷Lec 15, Cl 6, Lab 5, Lab 6	1÷7
PEK_W05	S2ARR_W02, K2AIR_W05, K2AIR_W08	C5	Lec 3, Lec 4, Lab 1÷Lab 7	3, 4, 6, 7, 8
PEK_U01	S2ARR_U03, S2ARR_U04, K2AIR_U01, K2AIR_U02, K2AIR_U04, K2AIR_U05	C1, C2, C5	Cl 1, Cl 2, Lab 2, Lab 4, Lab 6	2÷7
PEK_U02	S2ARR_U03, S2ARR_U04, K2AIR_U01, K2AIR_U02, K2AIR_U04, K2AIR_U05	C2, C5	Cl 3, Cl 4, Cl 5, Lab 6, Lab 7	2÷7
PEK_U03	S2ARR_U03, S2ARR_U04, K2AIR_U01, K2AIR_U02, K2AIR_U04, K2AIR_U05	C2, C3, C5	Cl 5, Cl 6, Lab 7	2÷7
PEK_U04	S2ARR_U03, S2ARR_U04, K2AIR_U01, K2AIR_U02, K2AIR_U03, K2AIR_U04, K2AIR_U05	C2, C4, C5	Cl 6, Lab 5, Lab 6	2÷7
PEK_U05	S2ARR_U04	C1÷C5	Lab 1÷Lab 7	3÷8
PEK_K01	K2AIR_U05, K2AIR_W09, S2ARR_W08	C1÷C5	Lec, Cl, Lab	

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Zał. nr 4 do ZW 64/2012

FACULTY of ELECTRONICS/DEPARTMENT K-7

SUBJECT CARD

Name in Polish	**Wprowadzenie do systemów wbudowanych 2**
Name in English	**Introduction to Embedded Systems 2**
Main field of study (if applicable):	**Control Engineering and Robotics**
Specialization (if applicable):	**Embedded Robotics**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**AREA111**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			**30**		
Number of hours of total student workload (CNPS)			**90**		
Form of crediting			**crediting with grade**		
For group of courses mark (X) final course					
Number of ECTS points			**3**		
including number of ECTS points for practical (P) classes			**3**		
including number of ECTS points for direct teacher-student contact (BK) classes			**1,5**		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. K2AIR_W02
2. K2AIR_W05
3. S2ARE_W01

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SUBJECT OBJECTIVES

C1. Acquiring skill in using software development tools for embedded systems

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEK_U01 – ability to use microcontroller development tools for embedded controllers

Form of classes - laboratory		Number of hours
Lab 1	Introduction	2
Lab 2	Software development tools for embedded systems	4
Lab 3	I/O programming with Processor Expert tool	4
Lab 4	Human-machine interfaces	4
Lab 5	Communication interfaces (CAN, RS485, etc.)	4
Lab 6	Rapid prototyping example	4
Lab 7	RTOS implementation – a simple example	4
Lab 8	Embedded controller implementation and testing	4
	Total hours	**30**

TEACHING TOOLS USED
1. Laboratory exercises 2. Consultations 3. Reading (self-study)

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01	Laboratory exercises grading
C=F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Thomas Braunl, Embedded Robotics, Springer 2003, 2006

[2] Kirk Zurell, C Programming for Embedded Systems, Taylor & Francis 2000

[3] Processor Expert User Guide, Freescale Semiconductor, Inc. 2013

[4] Wnuk M., Slides: „Introduction to Embedded Systems", http://rab.ict.pwr.wroc.pl/~mw

SECONDARY LITERATURE:

[1] Freescale Semiconductor, http://www.freescale.com

[2] STMicroelectronics, http://www.st.com

[3] ARM, http://www.arm.com

[4] http://en.wikibooks.org/wiki/Embedded_Control_Systems_Design

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Introduction to Embedded Systems 2
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION
Embedded Robotics

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_U01	S2ARE_U01	C1	Lab1-Lab8	1,2,3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above