ANNUAL REPORT

1. 1. 2011 - 31. 12. 2011

ESTABLISHED IN 1707

Department of Microelectronics

Faculty of Electrical Engineering
Czech Technical University in Prague
Czech Republic

CONTENTS:

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Edited by Pavel Kulha (February 2012)

FOREWORD

The Department of Microelectronics belongs to The Faculty of Electrical Engineering (FEE) that is one of the six faculties forming the Czech Technical University in Prague (CTU in Prague). The roots of CTU in Prague can be followed as far back as the year 1705, when Christian Josef Willenberg (1655 - 1731) wrote a letter to Emperor Leopold I. in Vienna seeking permission to begin public teaching of engineering sciences. This was granted by a decree of Emperor Josef I (successor to Leopold I.) on 18 January 1707. For these reasons, the priority of CTU to be the first technical school at university level in the world is usually claimed for.

The Department of Microelectronics has been established in January 1977. During the past 28 years more than 1000 students graduated in the branch of Microelectronics and nearly 50 Ph.D and 5 DrSc. degrees have been awarded. Five persons from the Department staff became professors and 14 Associate Professors. The Department offers the B.Sc., M.Sc. and Ph.D. degrees in Electronics.

The Department maintains international co-operation with many universities, research laboratories, and institutes in the Europe. This is in connection with the LEONARDO and SOCRATES Programmes, EUROPRACTICE projects, the NATO Science for Peace programme, and the Framework Programmes of the European Community.

The Department gives a high priority to collaborative research with industry. The donation from Cadence is being used to continue the education of IC design at industrial level. Several domestic electronic factories were supported by R&D works from the Department this year.

This brochure is the 22st annual review of our Department. The content of this report emphasises our effort for continuing the close association of teaching, research and co-operation with external subjects at both national and international levels.

Prague
February 2012

Pavel Kulha
Editor

STAFF OF THE DEPARTMENT

Head of the Department:	M. Husák, M.Sc., Ph.D.
Deputy:	J. Foit, M.Sc., Ph.D.
Professors:	M. Husák, M.Sc., Ph.D. J. Kodeš, M.Sc., Ph.D., DrSc. (Emeritus Professor) J. Vobecký, M.Sc., Ph.D., DrSc.
Associate Professors:	Z. Burian, M.Sc., Ph.D. J. Foit, M.Sc., Ph.D. P. Hazdra, MSc., Ph.D. J. Voves, M.Sc., Ph.D.
Assistant Professors:	A. Bouřa, M.Sc. J. Jakovenko, M.Sc., Ph.D. V. Janíček, M.Sc. V. Jeřábek, M.Sc., PhD. L. Jirásek, M.Sc., Ph.D. A. Krejčiřík, M.Sc., Ph.D. J. Kroutil, M.Sc. P. Kulha, M.Sc. PhD. A. Laposa, M.Sc. J. Novák, M.Sc. Ph.D V. Prajzler, M.Sc., Ph.D. T. Teplý, M.Sc. T. Vítek, M.Sc. V. Záhlava, M.Sc., Ph.D.
Ph.D. students:	J. Frolec, M.Sc. O. Harwot, M.Sc. M. Janoušek, M.Sc. J. Kroutil, M.Sc. M. Kubař, M.Sc. M. Majer, M.Sc. M. Mašek, M.Sc. J. Scheirich, M.Sc. Z. Šobáň, M.Sc.

SUPPORT STAFF

Department Secretary and Administration:	R. Burianová
Technical Service:	M. Horník

ABOUT THE STAFF

Miroslav Husák was born in Kladno in 1953. He graduated in Radioengineering from FEE-CTU in Prague in 1978. Ph.D. in 1985, Assoc. Professor in 1997, Full Professor in 2000. Manager of Microsystems Group. Author or co-author 6 lecture notes and more than 200 scientific and technical papers. Research in the field of microsytems and integrated sensor systems. Teaching the courses Sensor systems, Power Suppliers in Electronics, Electronic Security Systems and Microsystems. Supervisor of Electronics branch (Master and Ph.D. study).

Jiří Kodeš was born in 1932. He received MSc., Ph.D., and D.Sc. degrees in electronics, semiconductor physics and microelectronics from the CTU in Prague in 1956, 1963 and 1990, resp. At present, he is Full Professor at the Department. His area of research includes electronic transport in semiconductors and quantum electronics devices. He is the author or co-author of numerous technical papers in journals and conference proceedings. He has written several textbooks for students.

Jan Vobecký - MSc. 1981, Ph.D. 1988, Assoc. Professor 1992, DrSc. 1999, Full Professor 2000 – all from FEE-CTU in Prague. Visiting fellow: University of Uppsala (1988, 1989-90), MOTOROLA Toulouse (1993). Research: High-power devices - design & technology. Author and reviewer of numerous scientific papers, H-index = 8, 37 SCI papers, 161 SCI citations, 2 patents granted, 12 patent applications, 1 textbook, 9 printed lectures. Member of Scientific Board FEE-CTU in Prague and Academy of Sciences Czech Rep. Senior Member IEEE, Adcom member SRC EDS IEEE. 2007- now with ABB Switzerland Ltd. Semiconductors, Lenzburg, Product Management & Technology Group.

Zdeněk Burian was born in 1944. He graduated from the FEE-CTU in 1966. In 1975 he received PhD. degree. He is the author of 35 technical papers, 10 printed lectures and he owns 7 technical inventions. He is Assoc. Professor and gives lectures on optoelectronics. He is working in the field of integrated optics and planar optical waveguides. He researched the optical waveguides in silica in University of York, U.K.. Member of EOS and Czech Society of Photonics.

Julius Foit was born in 1932. He received MSc., PhD. and Ass. Prof. degrees in Radar Engineering, Colour TV Eng. and Multiphase Signal Processing from the CTU in Prague in 1954, 1961 and 1978, resp.. Dean of the Faculty in the University of Maiduguri, Nigeria in 1987-1989 and B. Tech. Programme Coordinator in the University of Zimbabwe, Harare, in 1990-1993. Currently, he is Associate Professor in the Dept. He is the author of many papers, several monographs and textbooks for students. He is a Fellow of ZIE and Past-President of Rotary Int.

Pavel Hazdra was born in 1960. M.Sc. and Ph.D. in Microelectronics from FEE-CTU (1984, 1991), Assistant (1987), Associate (1996) and Full Professor (2010), Vice-Dean of the FEE-CTU (2006-7). In 1988, 1992, and 1993-4 visiting fellow at the University of Surrey, Hull, and Lund, resp. Research on defects in semiconductors, quantum structures and their characterization. Manager of the Electron Device Group. More than 200 scientific and technical papers. H-index = 12, 48 SCI papers, 217 SCI citations, 2 patents granted. SM IEEE and vice-chairman of the IEEE MTT/AP/ED/EMC Chapter in the Czech Republic.

Jan Voves was born in Prague in 1960. MSc. and RNDr. degree in Physical Electronics and Optics from the Charles' University in Prague in 1984. Since 1984, Research Assistant in the Department (characterisation of ion implanted doping profiles in semiconductors). From 1987 and 1996, Assistant and Assoc. Professor, resp. Ph.D in 1993. Research in the device physical modelling (Monte Carlo Method). Author of about 30 technical papers and 3 printed lectures. Member of the IEEE.

Adam Bouřa Adam Bouřa was born in Ostrava in 1980. He graduated in Microelectronics from the FEE-CTU in Prague in 2004. Since 2004 he is a PhD student at the Department of Microelectronic and member of the Microsystems group. His work is concentrated on wireless sensor systems. Since January 2005 to February 2006 he was part-time research fellow and since February 2006 he is an assistant professor at the Department. He is teaching Electronics, Electronic Devices and Structures, Sensors for Electronic and Sensors for Medicine.

Jan Formánek was born in Most in 1985. He graduated in Microelectronics from the FEE-CTU in Prague in 2010. Since September 2010 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group. Since November 2010 he is part-time research fellow in the Department. His work is focused on analog integrated circuit design and thermoelectrical simulations of electronic components.

Jiří Jakovenko born 1972, Prague. He graduated in Microelectronics from FEE-CTU, Ph.D. from FEE-CTU in 2004. Member of Microsystems group. Research: MEMS design and modeling. In 1998 he spent 4 months in Hogeschool Gent in the frame of TEMPUS programme. Author of many scientific and technical papers. Since 1999 Assistant Professor at the Dept. Education: Microelectronics, IC Design, Design of VLSI, Practice of IC design, Electronics.

Vladimír Janíček was born in 1974 in Most. He graduated in Microelectronics from the FEE-CTU in Prague and he belongs to the Microsystems group. His Ph.D. research is focused on self-powered microsystems and microsystems power sources. He teaches Smart Electronics, IC Design, Electron Devices. At present, he is IT manager of the Department.

Vítězslav Jeřábek born 1951. 1975: MSc. from FEE-CTU in Prague. 1987: PhD. in Optoelectronics. 1976–91: TESLA Research Institute, Prague. 1981: Optoelectronics Division, dynamics and modelling of optoelectronics devices & broad band optoelectronic modules. 1991–98: Head R&D lab. Dattel Ltd. - integr. optoelectronics modules and systems. Since 1999: teaching technology of optics and optoelectronics components and systems for transmission and processing of information. Author of 35 technical papers, 2 printed lectures and 3 patents, Member IEEE, Committee member of IEE in the Czech Republic.

Lubor Jirásek was born in Prague in 1953. He graduated from the FEE CTU in Prague, in 1978. He received PhD. degree in Electronics in 1983. From 1978 to 1983 he was working as a Research Fellow in the area of high-power devices. He is author of 7 technical papers and 3 printed lectures. He is teaching in the area of semiconductor devices and solid-state physics. Presently, he is responsible for the curriculum of the Department.

Alexandr Krejčiřík was born in 1947. He graduated in Electrotechnology from the Faculty of Electrical Engineering, CTU in Prague, in 1971. He received PhD. degree in Mathematics and Physics – branch Semiconductors. He is the author of 10 technical papers, 21 printed lectures and 12 textbooks. He is teaching courses on Electronics, Power supplies in Electronics and Design of Power Supplies.

Jiří Kroutil was born in Tábor in 1980. He graduated in Microelectronics from the CTU-FEE in Prague in 2005. Since 2005 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group. His work is focused on inteligent microsystem structures.

Pavel Kulha was born in Písek in 1978. He graduated in Microelectronic from the FEE-CTU in 2002. He received Ph.D. degree in Electronics from FEE-CTU in 2009. He is working as assistant professor since September 2004. His work is concentrated on microsensors and microsystems for high temperature applications.

Alexandr Laposa was born in Pardubice in 1978. He graduated in Automation and Computer Science from Faculty of Mechanical Engineering from Brno University of Technology. He is working towards his Ph.D. in Microsystems Group. His work is concentrated on inteligent microsystem structures.

Jan Novák was born in Prague in 1973. He graduated in Microelectronics from FEE-CTU, Ph.D. from FEE-CTU in 2006. Member of Microsystems group. Research: Electromagnetic compatibility of integrated circuits and microsystems. Since 2001 he is an Assistant Professor at the Department. He is teaching Electronics, PCB Design and IC Design. He is finance manager of the Department

Václav Prajzler was born in Prague, the Czech Republic in April 10th 1976. In 2001 he graduated from the Faculty of Electrical Engineering at the Czech Technical University in Prague at Department of Microelectronics. Since 2005 he has been working at the Czech Technical University in Prague, Faculty of Electrical Engineering, Department of Microelectronics as a research fellow. In 2007 he obtained the PhD degree from the same university. His current research is focused on design of the new photonics structures such as optical microring resonators and passive photonics devices. Research is also focused to investigation properties of the polymer materials doped with rare earth ions.

Tomáš Teplý was born in Chrudim in 1979. He graduated in Microelectronics from the FEE-CTU in Prague in 2005. He is working towards his PhD in the Microsystems group. His work is concentrated on simulation and optimization of microsystems. Since October 2005 he is part-time research fellow at the Department.

Tomáš Vítek was born in Opava in 1980. He graduated in Microelectronics from the FEE-CTU in Prague in 2005. Since March 2005 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group. His work is focused on microsystems and security systems. Since October 2005 he is part-time research fellow in the Department.

Vít Záhlava was born in Prague in 1965. He graduated in Microelectronics from the FEE-CTU in 1988. Ph.D. degree in 1994. He is teaching Electronics and PCB design. Active in EMC on PCB, design, application and testing. He is a member of the Academic Senate of the Faculty. He is the author of 4 textbooks, several printed lectures for students, and technical papers on power devices.

Ondřej Barkman

Frolec Jakub

Ondřej Harwot was born in Prague in the Czech Republic on September 23, 1985. He received the diploma in electrical engineering from Czech Technical University in Prague, in 2010. Currently, he is a Ph.D. student at the Faculty of Electrical Engineering, Czech Technical University in Prague. His research interests include electromagnetic compatibility of integrated circuits and digital circuits design in conjunction with field gate programmable arrays.

Michal Janoušek

Miloslav Kubař was born in 1981. He gets his MSc. degree in electronics from Czech Technical University (CTU), Prague, in 2007. He worked with STMicroelectronics in 2006 as analog IC designer. He is currently working toward Ph.D. in microsensor signal processing at CTU. Topic of his thesis is Design and optimization of the linear low-power regulators for integrated circuits. He also works with Asicentrum s.r.o from 2007 as analog IC designer.

Michal Majer

Petr Mašek was born in Mariánské Lázně in 1986. He graduated in Microelectronics from the CTU-FEE in Prague in 2010. Since 2010 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group. His work is focused on detection of ionization radiation and development of the new detector systems.

Josef Náhlík was born in Mělník, CZ, in 1987. He graduated in Electronics from the FEE-CTU in 2011. He is currently working as PhD student in the Electron Devices Group. His work is concentrated on graphene.

Jan Scheirich

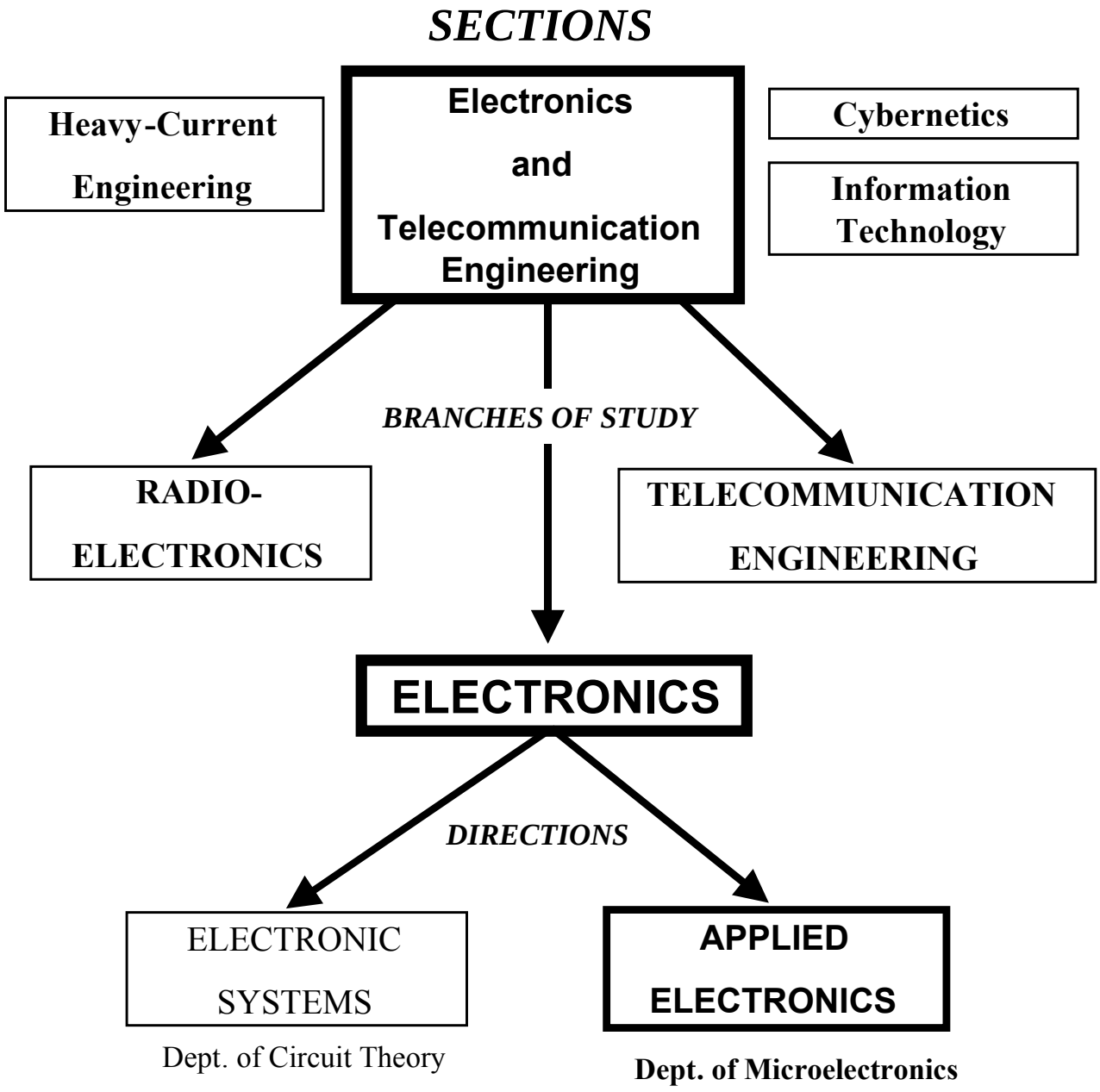
Šobáň Zbyněk

Renáta Burianová was born in Prague in 1960. She graduated from grammar school in 1979 and Secondary school for librarians in 1981. She joined the Department of Microelectronics in September, 1981. From that time she has been in charge of administrative work of the Department.

Miroslav Horník was born in Prague in 1946. He graduated in 1966 at a Secondary school specialized in Machinery engineering in Prague. He joined CTU Prague, then the Institute of Physics, Czechoslovak Academy of Science and, nowadays, he is working in the Department as a technician. He provides repair and service of miscellaneous tools and equipments.

UNDERGRADUATE TEACHING

Organization of study at the Faculty of Electrical Engineering



BRANCH OF STUDY ELECTRONICS

The objective of the electronic branch of study is to educate electrical engineers competent to solve problems concerning the wide spectrum of the structure of electrical industry and also extending to the field of information and computing technology, ecology, health care, mechanical engineering, robotics, etc.

The study involves the necessary theoretical introduction into subjects that provide general education for an electrical engineer which is followed by specialized courses. As to specialized orientation, the stress is laid on electronic components, semiconductor structures, digital and analog electronic circuits, microelectronics, application specific integrated circuit design, microcomputers, signals and electronic systems, sensors, sensor systems, design of electronic equipment, integrated and coherent optics, radiation sources and detectors, applications of optoelectronics and telecommunication systems. The study of the applied electronics and electronic systems aims to prepare engineers who are able to solve problems of the applications of integrated circuits and of the special electronic structures and systems, as well as the electronic instrumentation design. The students master the digital signal processing methods and the implementation of algorithms in the special processor systems.

The optional subjects in the higher terms provide the students an opportunity of individual choice of their further specialization emphasizing the applications of electronics and optoelectronics.

The topics of lectures, laboratory and seminar exercises have been selected so that a student can master the reported stuff perfectly also in practice. The Department of Microelectronics endeavors to give the students, especially those with excellent results, the possibility of satisfying their professional ambition home, as well as abroad. The graduates are also offered a possibility of further postgraduate (Ph.D) studies. We believe that the graduates of our specialization will find good jobs in the industry of developed countries.

COURSES DELIVERED BY THE DEPARTMENT
In summer semester 2010/2011

Courses in Czech – Bachelor Study Program

Course Code	Course Name	Lectures and exercises in hours per week
New curriculum		
A0B34PPN	Principles and Rules of Electronic Design	2+2
A2B34ELP	Electron Devices	2+2
A2B34SEI	Sensors in Electronics and Informatics	2+2
Old curriculum		
X34ELE	Electronics	2+2
X34ESS	Electronic Devices and Structures	2+2
X34FOT	Photonics	2+2
X34NZE	Design of Power Supplies for Electronics	2+2
X34SEE	Sensors in Electronics	2+2

Course in Czech – Master Study Program

Course Code	Course Name	Lectures and exercises in hours per week
New curriculum		
A0M34EZS	Electronic Security Systems	2+2
A0M34NFO	Design of Photonic Circuits	2+2
A0M34NNZ	Design of Power Supplies	2+2
A0M34NSV	VLSI System Design	2+2
A2M34MIM	Microsystems in Multimedia	2+2
A2M34MST	Microsystems	2+2
A2M34NAN	Nanoelectronics and Nanotechnology	2+2
A2M34NIS	Design of Integrated Systems	2+2
A4M34ISC	Integrated System on Chip	2+2
A5M34ELE	Electronics	2+2
Old curriculum		
X348MS	Microsensors and Microsystems	2+2
X34NSE	New Trends in Electronics	2+2
X34PPN	Principles and Rules of Electronic Design	2+2

Courses in English

Course Code	Course Name	Lectures and exercises in hours per week
New curriculum		
AE2B34ELP	Electron Devices	2+2
AE2B34SEI	Sensors in Electronics and Informatics	2+2
AE2M34NAN	Nanoelectronics and Nanotechnology	2+2
AE2M34NIS	Integrated Systems Design	2+2
AE4M34ISC	Systems on Chip	2+2

Courses for vocational students

Course Code	Course Name	Lectures and exercises in hours per week
New curriculum		
AD2B34ELP	Electron Devices	2+2
AD2M34MST	Microsystems	2+2
AD2M34NAN	Nanoelectronics and Nanotechnology	2+2
AD2M34NIS	Design of Integrated Systems	2+2
Old curriculum		
XD34BAP	Bachelor Project	0+15
XD34ELE	Electronics	14+6
XD34ESS	Electronic Devices and Structures	14+6
XD34FOT	Photonics	14+6

COURSES GIVEN BY THE DEPARTMENT
In winter semester 2011/2012

Courses in Czech – Bachelor Study Program

Course Code	Course Name	Lectures and exercises in hours per week
New curriculum		
A0B34PPN	Principles and Rules of Electronic Design	2+2
A2B34IAE	Intelligent Applied Electronics	
A2B34IN	Individual Project	2+2
A2B34MIK	Microcontrollers	
A2B34OFT	Optoelectronics and Photonics	
A4B34EM	Electronics and Microelectronics	2+2
Old curriculum		
X34BPJ	Semester Project	2+2
X34BAP	Bachelor Project	0+5
X34MPC	Microcontrollers	1+2
X34SES	Sensor Systems	
X34NZE	Design of Power Supplies for Electronics	2+2

Courses in Czech – Master Study Program

Course Code	Course Name	Lectures and exercises in hours per week
New curriculum		
A0M34EZS	Electronic Security Systems	2+2
A0M34NFO	Design of Photonic Circuits	2+2
A0M34NNZ	Design of Power Supplies for Electronics	2+2
A2M34BP3	Safety in Electronics	2+2
A2M34IND	Individual Project	0+4
A2M34SIS	Integrated System Structures	2+2
A5M34EZS	Electronic Security Systems	3+1
A6M34BMS	Sensors in Biomedicine	
Old curriculum		
X34NII	Design of Integrated Circuits for Informatics	2+2
X34NNZ	Design of Power Supplies for Electronics	2+2
X34POP	Practice of Optoelectronics	2+2
X34BMS	Biomedical Sensors	2+2
X34PMI	Individual Project	2+2
X34PPN	Principles and Rules of Electronic Design	2+2

Courses in English

Course Code	Course Name	Lectures and exercises in hours per week
New curriculum		
AE2M34SIS	Integrated System Structures	2+2
AE4B34EM	Electronics and Microelectronics	2+2

A BRIEF DESCRIPTION OF COURSES DELIVERED BY THE DEPARTMENT

Electron Devices, BSc

Lectures given by P. Hazdra

This course introduces the basic theory, principles of operation and properties of electron devices. Physical principles of operation, device structures and characteristics are explained together with adequate models for small- and large-signal. Basic applications in analogue and digital electronics are examined. In seminars and labs, students are introduced to basic principles of device simulation, measurement of device characteristics and extraction of device parameters. Operation of electron devices in electronic devices is then analyzed using the PSpice simulator.

Photonics, BSc

Lectures given by Z. Burian

The major aim of these lectures is to explain the principles and using of the main parts of modern optical systems, both from the theoretical and application point of view. Measurement methods for optoelectronics are presented. The part of lectures is devoted to optical display structures, optical processors and to the image processing.

Power Supplies in Electronics, BSc

Lectures given by M. Husák

Rectifiers. Stabilisers - parametric, with continuous control. IC voltage regulators. Fly-back converter. Forward converter. Push-pull converter, double forward converter. Monolithic regulators. EMC. Over current protection. Over voltage, under voltage, output reverse voltage protection. Overload and thermal protection. Batteries, solar battery, accumulator, chargers. References.

Microcontrollers, BSc

Lectures given by T. Teplý

Microchip PIC18F252 family. I/O tasks, programmable peripheral ICs. Development and debugging tools. Design and programming of instruments and systems based on single-chip computers. Individual students' projects.

Optoelectronics and Photonics, BSc

Lectures given by V. Jeřábek

Basic principles of optoelectronics. Planar and fiber optical waveguides. Semiconductor lasers and LEDs. Semiconductor light detectors. Structures for distribution and harnessing of optical radiation. Optoelectronic processors. Optical communication systems. Optical amplifiers. Display devices. Optical memories. Optical fiber sensors. Integrated optical and photonic structures.

Sensor in Electronics and Informatics, BSc

Lectures given by M. Husák

Sensor - classification, materials, production. General characteristics - static and dynamic parameters, errors, noise, linearisation, calibration. Microelectronic sensors materials, physical principles, design, integration. Temperature sensors, pressure sensors, SAW sensors, optoelectronic sensors, fibre optic sensors. Radiation sensors. Magnetosensors. Chemical sensors, biosensors. Humidity sensors. Flow meters. Level sensors. Sensor signals processing. Smart sensors. Application of sensors.

Smart Electronics. BSc.

Lectures given by V. Janíček

The aim of the course is to show and present to the students the modern trends used in electronics design. It will practically show the usage of electronic devices, circuits and functional blocks. Typical methods, errors and mistakes during the design process flow will be shown.During the exercises students will design a concept and select appropriate electronic components for circuit realization. Simulation software will help to compare the designed circuit with the realized one. Evalution boards with complete software support from STMicroelectronics will help the students to understand the basic function of presented integrated circuits.

Principles and Rules of Electronic Design, BSc.,MSc.

Lectures given by V. Záhlava

Computer design of printed circuit boards (PCB). System OrCAD. Design rules for PCB according to EMC in analog, digital and power applications. Supply and grounding techniques. Technological processes and fabrication of PCB, classes of accuracy. Surface mount technology and devices, circuit layout process and soldering. Technological and design trends. Design of student PCB by use of PC in departments computer room.

Electronics, BSc, MSc.

Lectures given by V. Záhlava

Semiconductors. PN junction, diodes, Schottky diode. Rectifiers. Bipolar transistors, biasing circuits. JFET and MOSFET, biasing circuits. Small signal amplifier, power amplifier. Switching circuits. Power amplifier classes. Thyristor, latch-up. Operational Amplifiers – negative and positive feedback, basic circuits. Optoelectronics – LED, laser, photodiode, phototransistor, photoresistor. Introduction to digital technique – CMOS, LSTTL.

Microsystems, MSc.

Lectures given by M. Husák

The subject solves systems working in interdisciplinary areas, the most frequently in the energy interface - optical, thermal, mechanical, electrical). There are explained physical principles of any sensors, especially of optical and mechanical quantities, principle of biometric pick-up information, principle of tactile display, etc. There re solved the basic methods of the signal pre-processing. Basic principles of actuators are described, ones are using for the control in instruments and systems of multimedia applications. The attention is focused on MEMS elements and systems and their applicability in modern instrument technology.

VLSI system design, MSc

Lectures given by P. Hazdra

Course introduces students to basic principles of design, synthesis and verification of very large scale integration (VLSI) systems and systems on chip. Students become acquainted with basic building blocks, architectures and design principles, which are used for realization of complex integrated systems, design methodology and system synthesis. Students will also learn verification strategy, test design and analysis. In seminars and labs, the hardware description languages (VHDL, Verilog) will be explained and used for practical design, synthesis and testing of a system on chip.

Structures of Integrated Systems, MSc

Lectures given by J. Jakovenko

Design methodologies of analog, digital and optoelectronics integrated systems. Description of integrated circuits fabrication process; CMOS technologies and its modern sub-micron trends; design rules and layout design. Design and fabrication process of micro-electro-mechanical systems (MEMS); polymer based technologies; optical and optoelectronical integrated circuits, fabrication process and technologies, matherials, design and testing.

Integrated System on Chip, MSc

Lectures given by J. Jakovenko

Importance of ICs. Economic aspects of IC. Design methodologies: gate arrays, standard cells and functional blocks, full custom design. Design hierarchy: behavioural description, logic and electric design, simulation, layout capture and verification. CAD tools for IC design: HDL, front end tools, simulators, layout editors, structural synthesis, silicon compilers. IC testing.

Electronics and Microelectronics

Lectures given by J. Jakovenko

Semiconductors fundamentals, PN junction. Bipolar transistor, MOSFET structure. Fundamentals of Integrated systems processing technologies. CMOS technology, layout design, design rules. Analogue CMOS integrated circuits blocks, AD and DA convertors. Memory structures. Micro-electro-mechanical systems. Optoelectronics devices.

Sensors in Security Systems, MSc

Lectures given by M. Husák

Security, safety and multi-channel systems. Dynamic analysis and optimisation. Signal interference and system internal noise. Input quantities. Analog and digital signal processing, conversions. Signal representation and sensor signal code. System calibration. Communication in system, interface. Output unit - communication, indication, registration, protection, switch, local and remote control, actuators.

Nanoelectronics and Nanotechnology, MSc

Lectures given by J. Voves

The subject is oriented on the present nanotechnologies in the connection with their electronic, photonic and spintronic applications. Quantum theory basics are used to explain the effects observed in nanostructures. Basic nanoelectronic structures are described with their possible applications. Modern computer methods and models, which are able to simulate the operation of nanoelectronic structures and which are the important tools for their design and optimisation, are studied.

Desigh of Photonic Structures, MSc.

Lectures given by V. Jeřábek

Students will obtain practical skills with design of photonic devices and their applications in photonic systems. Students acquaint with BMP, FULL WAVE and TCAD programs. These software allowed design of optical structures and devices used for control and distribution of optical signals. Software TCAD is used for design of injection optical sources. Optoelectronic integrated circuits will be designed by ORCAD and WINMIDE software.

Design of Power Supplies, MSc.

Lectures given by A. Krejčiřík

This represents extension of the subject “Power Supplies in Electronics”. The main field comprises Integrated circuits for SMPS (principles, design, verification.) Coils, transformers, regulators, synchronous rectifiers, resonance power supplies. Switcher CAD. Magnetic design Tool. Filter CAD. MicroPower Switcher CAD.

COURSES FOR PhD. STUDENTS (IN CZECH)

Crystaloptics and Non-linear Optics

Lectures given by J. Čtyroký

Optical medium type classification. Single- and double-axis optical anisotropy. Chiral media. Propagation of planar waves, polarisation, phase and group velocity vectors. Energy balance and reciprocity. Reflection and refraction. Electro-optical and piezoelectric tensors. Theory and design of beam handling devices.

Integrated Optics

Lectures given by V. Jeřábek

Theoretical and technological principles of IO. Light propagation in dielectric waveguide structures. Methods of waveguide structures solution. Basic physical effects and interactions used for IO structures. Fabrication of dielectric waveguides and IO structures. Passive and dynamic waveguide devices. Non-linear devices. Semiconductor integrated optoelectronics.

Optical Radiation Detection and Detectors

Lectures given by Z. Burian

Electromagnetic radiation spectrum. Radiometric and photometric units. Detection of optical radiation. Ideal detector, internal and external photo-effect. Optical receivers, design principles, properties. Noise. Detectors based on external or internal photo-effect, on thermal phenomena and others. Solar cells, properties.

Semiconductor Radiation Sources

Lectures given by Z. Burian

Stimulated emission in semiconductors, Homogeneous junction and heterojunction. Double heterostructure lasers. Waveguide resonators, DFB structures. Types and properties of lasers. Bistable and memory devices, switches. Non-coherent LEDs. Super-LEDs. Laser injection amplifiers. Applications and measurement of various types.

Technology of Optoelectronic Structures

Lectures given by V. Jeřábek

Preparation of optoelectronic materials and structures, diagnostic and testing methods. Fabrication of semiconductor waveguides, LEDs, lasers, photodetectors and QW structures. Design and fabrication of planar dielectric

waveguide structures for distribution and harnessing of optical radiation. Measuring and testing methods. Properties of various structures, practical examples.

VLSI Structures and Technologies

Lectures given by J. Jakovenko

Functional structures of integrated circuits, unipolar and BiMOS structures. 3D structures, submicron technologies. Problems associated with dimensional reduction. Memory cells. Test structures. VLSI processes. New technologies. IC design, layout, design rules. Reliability and yield. Limitations in ICs.

Electrical Transport in Semiconductors

Lectures given by J. Voves

Electrons and holes in semiconductor crystals. Boltzmann transport equation, scattering. High field transport. Quantum transport, resonant tunneling. Single electron transport, Coulomb blockade. Ballistic transport. Transport in magnetic field, quantum Hall effect.

RESEARCH ACTIVITIES

The Department has continued in research activities through grants and contracts from the Ministry of Education of the Czech Republic, Grant Agency of the Czech Republic, and CTU in Prague. A significant part of research activities was supported by the Programmes of the Ministry of Education in the following fields in alphabetical order:

- Development, Reliability and Safety of Electro-Energetic Systems,
- Information and Communication Technology,
- Methods and Systems for Measurement of Physical Quantities and Data Processing,
- Trans-Disciplinary Biomedical Engineering Research.

The international projects were those of the Framework Programmes of the European Community.

In the field of research contracts the co-operation with Robert Bosch and Magneton took place.

The research activities of the Department are focused on Electron Devices, Optoelectronics and Microsystems as listed below in the order of their date of origin. These three directions constitute the organization scheme of research in our Department and are schematically shown below. This scheme is supplemented by a brief summary of activities of individual research groups and list of their members. This is followed by the description of relevant research projects of individual research groups. The list of contracts is given as well.

MICROSYSTEMS GROUP

Head of the Research Group: M. Husák

Members: J. Foit, J. Jakovenko, V. Janíček, L. Jirásek, P. Kulha, J. Novák, A. Bouřa, T. Vítek, T. Teplý, A. Laposa, J. Kroutil, M. Kubař, J. Scheirich, M. Majer, L. Farský, J. Formánek

Research Activities:

- Modeling of Temperature and Mechan. Behaviour of Microsystem Structures
- Design of Strain Gauge Sensors for High-Temperature
- Semiconductor Microsystem Structures
- Sensor Signals Processing and Wireless Transmission
- Sensor Control Systems
- Integrated Circuit Design

ELECTRON DEVICE GROUP

Head of the Research Group: P. Hazdra

Members: J. Vobecký, J. Voves, V. Záhlava, J. Kodeš,v J. Janoušek, Z. Šobáň, O. Harwot, J. Náhlík.

Research Activities:

- Quantum Devices, Nanostructures, Spintronics
- Device and Process Simulation
- Lifetime and Defect Engineering, Ion Irradiation
- Power Devices and Integrated Circuits
- Current Injection Capability of Microcontroller Units
- Programmable Logic Devices
- PCB Design and EMC of integrated structures

OPTOELECTRONICS GROUP

Head of the Research Group: V. Jeřábek

Members: Z. Burian, V. Prajzler, K. Bušek, J. A. Arciniega

Research Activities:

- Preparation and Testing of Planar Waveguides
- Analysis, Preparation and Testing of Novel Planar Electro-Optic Structures
- Modeling of Electro-Optic Structures
- Research toward the Integrated Optic Circuits for Measurement and Sensor Applications

RESEARCH PROJECTS

MICROSYSTEMS GROUP

MORGAN
Project leader: M. Husák
Project No. VG20102015015

MORGaN is an FP7 project which will address the need for new materials for electronic devices and sensors that operate in extreme conditions, especially high temperatures and high electric fields. It will take advantage of the excellent physical properties of diamond and gallium nitride (GaN) based heterostructures. The association of these two materials will give rise to the best materials and devices for ultimate performance in extreme environments.

INTELLIGENT MICRO AND NANO STRUCTURES FOR MICROSENSORS REALIZED WITH SUPPORT OF NANOTECHNOLOGY
Project leader: M. Husák
Grant No. GA102/09/1601

The project is targeted on research in the field of new types of microstructures with carbon diamond layers and promising materials from AIIIBV group, for using in industry, living environment protection, biomedicine and measurement systems. Nanocrystalline diamond layer are determined for integrated intelligent strain gauges capable work under very high temperatures. Entire part of the aims is to verify technological processes leads to successful realisation of such structures ideally on silicon substrates, mainly selective growth of diamond layers and doping. Research in the field of micro and nanostructures and their preparation for sensors is aimed to deposition of carbon composites, e.g. nanotubes and nanofibres. Research of piezoelectric AlGaN/GaN structures is determined for intelligent gas sensor based on SAW principle. Operating range of such sensor is up to 500 °C - 1000 °C.

INTEGRATED MICROSYTEM FOR ANALYSIS OF TOXIC GASES CONCENTRATION (MAK)
Project leader: M. Husák
Project No. VG20102015015

The goal of the project is to develop an intelligent miniaturised system for gas concentration analysis with variable multisensor matix.

ENIAC CSSL - CONSUMERIZING SOLID STATE LIGHTING
Project leader: M. Husák
Project No. 120219

LED (Light-emitting diodes) lamps are a fast emerging technology and many commercial products are now available for professional application, however there is rarely any LED retrofit products which meets all the expectations of consumers in terms of price, light output and other functionalities at the same time. The cosumerizing Solid State Lighting (CSSL) project aims to demonstrate affordable smart SSL light-sources for consumers via both technology and application routes. The proposed CSSL project works vertically across the entire value chain from LED die, lightsource, consumer luminaires, controls and dimmer to partnerships with utility companies in order to bring SSL retrofit product to European consumers with a substantial cost reduction.

DEVELOPMENT OF SMART DEVICES AND SYSTEMS IN THE FIELD OF MICROELECTRONICS, NANOELECTRONICS AND OPTOELECTRONICS.
Project leader: M. Husák
Project No. SGS11/156/OHK3/3T/13

The project supports selected expert activities sold by doctoral and master students in the field of micro and nanostructures, microsystems and microsensors, chip integration, the use of new materials, including optoelectronic integrated systems. These are mainly three approaches to areas of expertise. Development of optimization tools for designing analog integrated circuits in CMOS technology in Cadence design environment. Activities are focused on design of the voltage comparator with very low-power consumption, design capacitor-less DC-DC converters, design of intelligent sensor chip for wireless sensor data transfer and linearization, design of MEMS structures for autonomous power supply for microsystems and further optimized design of analog integrated circuits.

MEASUREMENT OF INTRINSIC PARAMETERS OF THE DEPFET PARTICLE DETECTOR
Project leader: J. Scheirich
Project No. SGS11/066/OHK3/1T/13
A goal of this project is to realize complex measurements on new types of DEPFET particle detector prototypes and to extract intrinsic parameters of these detectors. It is planned than to upgrade and optimize a measuring system, which was designed with the support of the CTU Student Grant Competition in 2010. The project is within the frame of an international cooperation for development of new detector for the accelerator physics on the world BELLE II Experiment.

ELECTRON DEVICE GROUP

LIGHT EMITTING DIODES WITH InAs/GaAsSb QUANTUM DOT LAYER EMBEDDED IN GaAs

P. Hazdra, J. Oswald*, K. Kuldová*, A. Hospodková*, E. Hulicius* and J. Pangrác*

*Institute of Physics of the AS CR, v. v. i.

Project support: the grant No. 202/09/0676 of the Grant Agency of the Czech Republic, Research Programme MSM 6840770014 - Ministry of Education, Youth and Sports of the Czech Republic

The aim of the project is to develop light emitting diodes (LEDs) with active layer formed by InAs QDs covered by different $GaAs_{1-y}Sb_y$ strain reducing layers (SRLs) which will be suitable for 1.3 and 1.55 μm bands.
LEDs were prepared by metalorganic vapor phase epitaxy (MOVPE) in AIXTRON 200 reactor on Si doped GaAs substrate using Stranski–Krastanow growth mode. TMGa, TEGa, TMIn, AsH_3, TBA and TESb were used as precursors. The first GaAs buffer layer was grown at 650°C then the temperature was decreased to 510°C for the growth of the second GaAs buffer, InAs QD layer (growth interruption 15s), undoped thin $GaAs_{1-y}$ Sb_y SRL and the GaAs cap. The rest of the structure (undoped GaAs, p-type and p^+-type C doped GaAs top anode layer) was grown at 650°C. Structures were characterized by atomic force microscopy (AFM) and X-ray diffraction. Optical properties of QD LEDs were measured between 10 – 320 K by photo-, electroluminescence (EL) and photocurrent spectroscopy.
Results show that MOVPE grown LEDs with QDs (AFM shows 4-6 nm high InAs lenses) covered by $GaAs_{1-y}Sb_y$. SRL exhibit strong EL which is red shifted from 1.2 to 1.4 μm with increasing Sb content. In all cases, the strong ground state emission is given by recombination of electrons and holes confined in the QDs while the emission from excited states, which dominates at lower temperatures, origins from states located in the SRL and the wetting layer. Fast thermal quenching of EL from excited states is then given by the escape electrons from the wetting layer and holes from SRL.

HYDROGENATED RADIATION DEFECTS IN SILICON: ISOTOPIC EFFECT OF HYDROGEN AND DEUTERIUM

P. Hazdra and V. Komarnitskyy

Project support: Research Centre LC06041 and Research Programme MSM 6840770014 - Ministry of Education, Youth and Sports of the Czech Republic

Within this project, the isotopic effect of hydrogen and deuterium on hydrogenation of radiation defects introduced in *n*-type float zone and Czochralski silicon by irradiation with high-energy alphas was investigated.

Silicon diodes were first irradiated with 2.4 MeV alphas to a fluence of $1x10^{10}$ cm^{-2} and then hydrogen or deuterium was introduced by rf plasma treatment at 250°C. Reactions of hydrogen and deuterium with radiation defects were monitored by deep-level transient spectroscopy during subsequent isochronal annealing at temperatures ranging from 100 to 400ºC. Results show that hydrogen rf plasma effectively neutralizes majority of vacancy related radiation defects created by alphas in both materials. In contrast with it, neutralization by deuterium plasma is substantially weaker. Disappearing of vacancy-related defect levels due to hydrogen (deuterium) treatment is accompanied by introduction of two dominant deep levels at E_C-0.309 eV and E_C-0.365 eV. While hydrogenation significantly accelerates annealing of radiation defects especially in Czochralski material, deuteration has weaker effect and gives rise to new defect levels during annealing.

GROWTH AND PROCESSING OF GRAPHENE LAYERS ON SILICON CARBIDE

Project leader: P. Macháč, VŠCHT
Project leader at CTU: Jan Voves
Project support: Grant of Grant Agency, Czech Republic No. P108/11/0894 - 2011-2014

The project is targeted to the growth of thin graphene layers on SiC monocrystaline substrates and to the study of processes which lead to the conversion of Ni-type contact structures on SiC from Schottky to ohmic behaviour. The Ni/SiC structure connects both proposed fields of study into one. The structure serves for the contact metallization and it can be the source of graphene layer as well. We plan to study the processes of grephene growth by means of the low temperature annealing of the mentioned Ni/SiC structure and by the graphitization of SiC in an argon atmosphere at high temperature. The graphene layers will be analyzed by Raman spectroscopy, AFM microscopy and XPS analysis. We will analyze the possibilities of graphene nanopatterning by means of scanning probe methods and by electron beam lithography. The other part of research will be oriented to the study of VLS epitaxial growth of silicon carbide and to the application of the growth in the preparation of ohmic contact structures.

SEMICONDUCTOR NANOSTRUCTURES PREPARED BY MEANS OF AFM LITHOGRAPHY

Project leader: M. Janoušek

Project No. SGS10/281/OHK3/3T/13

Preparation of nanostructures based on ferromagnetic semiconductors, strained layers and graphene by means of AFM lithography. Namely the method of local anodic oxidation and the method of tip force action on the material surface will be used. Nanostructures will be characterized by electrical transport methods. Simulation of these structures by means of suitable computer models, including quantum-mechanical calculations, will be done simultaneously.

OPTOELECTRONICS GROUP

NEW POLYMER OPTICAL COMPONENTS FOR PHOTONICS APPLICATIONS

Project Manager: V.Prajzler
Grant no. GACR 102/09/P104, Grant Agency of the Czech Republic

Goal of this project is to fabricate photonics structures as optical Y-branches and microresonators using easy fabrication process and low cost materials. Photonics structures will be designed by using RSoft software. I chose new type polymer Su-8 for my research due to its unique optical and mechanical properties (Low optical losses 0.08 - 1.5 dB/cm at wavelength 632.8 do 1550 nm, suitable refractive indices).

RESEARCH GRANTS AND CONTRACTS

Impact of Capping Layers on Electronic States in Quantum Dots
Grant no. GACR 202/09/0676, Grant Agency of the Czech Republic
Project Manager: **P. Hazdra**

Electrical characterization of power diodes
ABB Switzerland Ltd, Semiconductors
Project Manager: **P. Hazdra**

Characterization of power diodes
ABB s.r.o.
Project Manager: **P. Hazdra**

EDUCATIONAL GRANTS AND CONTRACTS

ELECTRON DEVICES: ESTABLISHMENT OF NEW SUBJECT
Grant FRVŠ 1781/2011, Development Fund of Higher Education Institutions
Project Manager: **P. Hazdra**

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