MAIN AREAS OF RESEARCH

FACULTY OF ARCHITECTURE

Healthcare Facilities

- design of Healthcare Facilities ranging from small outpatient clinics to multi-functional hospitals
- design for elderly and disabled people (architecture & interior design)
- the aim: improving the quality of life and well-being, supporting process of rehabilitation

Archi-technology

- eco-friendly shaping of public space and architecture
- building energy-efficiency – prefabrication and structure of nearly zero-energy building

Protection & Preservation of historical buildings

- applying vernacular patterns to residential environment
- new forms of regional architecture
- contemporary architecture and urban heritage protection
- protection and preservation of modernistic buildings
- reconstruction and renovation of monuments and urban structures

Architecture and design:

- new meaning of piece of art (design with industry and for industry)
- applied arts
- design for innovation
- kids education through design

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

- Damage and fracture mechanics for building materials
- Steel-concrete composite structures
- Extreme engineering
- Optimisation
- Modern structural materials
- Thin walled structures
- Innovative material testing
- Dynamics of structures
- Fermentation technologies
- Waste management
- Bioprocess development
- Environmental Biotechnology
- Pilot-scale research
- Advanced molecular and analytical methods
- Full-scale research
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FACULTY OF ENGINEERING MANAGEMENT

1. **Production Management and Logistics, specifically:**

research and shaping organization and management systems; research and improvement of design methods of organizational structures of production systems; organization and adaptive management of ventures; management of development of production enterprises; entrepreneurship management; methodology of region development; venture management;

2. **Ergonomics and Quality Management, specifically:**

methodology of research and practical applications of macroergonomics; ergonomic diagnosis and (corrective and concept) design of production processes in technological manufacturing systems; ergonomic diagnosis and (corrective and concept) design of machinery and technological devices; safety engineering; methods of estimation and occupational risk assessment at workstands; methodology of shaping work and product quality level in machinery industry in the context of EN and ISO standards and TQM concept; realization of exploitation processes of pro-quality systems in industry and service; reengineering methods of business and production processes in enterprise; qualitology and quality economics;

3. **Modern concepts of management, including information support systems, knowledge-based economy, specifically:**

enterprises strategy; business planning; budget systems; organizational structures including process structures; management information systems; computing systems supporting management; lean management; agile enterprise; virtual enterprise;

4. **Economic sciences, economic engineering and marketing, specifically:**

marketing theory and engineering; financial and managerial accounting and controlling; methodology of pro-qualitive and marketing enterprise management; value management and intellectual capital management; economic efficiency account; price management; acceleration of technical knowledge; problems of world economy; transformation of system economy, region development and politics; direct foreign investments; financial markets, funding of business and financial management; banking; competitiveness in micro, macro and meso aspects; partnership marketing; risk management; public procurements; role of infrastructure in market economy; public-private partnership; applied econometrics;

5. **Entrepreneurship and Business Communication, specifically:**

small and medium enterprises; clusters and network structures of firms; Modernization of the management of public services; Regulatory modernization in the EU and Poland; The European Social Model; Instruments supporting the development of Small and Medium Enterprises; Public support for entrepreneurs; Management of tourist services; Improving the public procurement system.

FACULTY OF COMPUTING

1. **Computer Science and Bioinformatics**
   - data science (machine learning, data mining)
   - big data (databases, business intelligence)
   - operational research
   - artificial and computational intelligence
   - distributed systems and computer networks
   - software engineering
   - algorithms, scheduling and combinatorics

2. **Automatic Control and Robotics**
   - computer design in electronics
   - digital and analog circuit design
   - technical cybernetics and specialized digital systems
   - nonholonomic control systems
   - robots control
   - medical robotics

FACULTY OF ELECTRONICS AND TELECOMMUNICATIONS

1. **Communication and Computer Networks**

2. **Switching and Routing group**
   - Architectures and control of switching fabrics
   - Packet switch architectures and scheduling algorithms
   - Technologies of the Future Internet
   - OpenFlow and Software Defined Networks

3. **Traffic and routing team**
   - Optimization and dimensioning of 2G/3G/4G cellular networks
   - Traffic management mechanisms for multi-service 3G/4G mobile networks
   - Multicast routing algorithms and protocols in wired and wireless networks
   - Modeling of multiservice switching networks
   - Modeling of systems with limited availability (Video on Demand, Overflow systems)
   - Multiservice queuing systems

4. . **Multimedia Communications and Microelectronics**
   - Video compression – several coding methods: AVC, SVC, MVC, HEVC, 3D.
   - 3D video creation and processing: depth estimation, view synthesis, free-viewpoint video.
   - Video processing: surveillance applications.
   - Video watermarking.
   - Audio compression and processing
   - Video and audio codec implementations - software and hardware (FPGA etc.).

- Digital television, interactive television, free-view TV.
- IP cores' development, FPGA programming, design for FPGA.

5. …International standardization activities in multimedia:

- Active participation in activities aimed at new international (ISO and ITU) standards: 3D extension of MVC and 3D Video Coding HEVC-based

6. Communication Systems and Optoelectronics

- Synchronization of communication systems, time and frequency quality assessment, construction of several devices (e.g. time and frequency signal source, distributing amplifier of synchronization signals, etc.)
- fiber optics and photonics (sound experimental achievements (EDFA amplifiers, discretely tuned optical filter, optical sources, SAW elements…), ultra-dense WDMA
- Cryogenic electronics, quantum metrology, distributed computer measurement systems, properties of op amps and FETs in very low temperatures, conductance in nanowires/nanostructures
- Advanced digital signal processing with emphasis on medical applications

7. Wireless Communications

8. Software defined radio (SRD) and cognitive radio group

- Techniques of flexible multitone transmission: OFDM, non-contiguous OFDM (NC-OFDM), Filter-Bank Based Multicarrier (FBMC), generalized multitone modulations, out-of-band power reduction
- Link adaptation techniques, reconfigurable transceivers, spectral sensing,
- Transmission in TV White Spaces, implementation of Software Defined Radio,
- Spectrally and energy-effective techniques of radio transmission (Green Communications)
- Interference management in cognitive radio systems and
- application of game theory in cognitive radio

9. Wireless systems group

- Physical (PHY) and MAC layer issues of wireless systems and networks (2G/3G/4G/5G), frequency and timing synchronization in OFDM systems, adaptive equalizers
- Radio resource management in cellular networks (e.g. CoMP)
- PAPR reduction techniques, HPA linearization techniques
- Application of MIMO and relay techniques and network coding in cellular systems
- Modelling of radio channels for 4G/5G systems
- Methodology of computer link and system level simulation of cellular systems/networks – strong abilities of computer simulations (computer cluster of our own design – more than 200 simulatiom runs in parallel)
- New reliable transmission methods in ITS systems
- Ultra reliable communications and short error correction codes
- Wireless LANS and their improvement,
- Iterative receivers,

- Continuous phase modulations

FACULTY OF ELECTRICAL ENGINEERING

-mathematical modelling in engineer sciences and the theoretical investigations in the area of analysis
-simultaneous localization, mapping drives and power converters
-analysis, design, optimization of electrical and electromagnetic systems
- generation, transmission, distribution of electricity and innovative technologies applications in power system operation, diagnostics and security of supply

FACULTY OF MACHINES AND TRANSPORTATION

- Experimental and simulation research on road vehicle dynamics and design of control
- Examinations in field of basics of durability regarding tribometrics, materials science and surface layer
- Non-destructive tests – application and development
- Transportation systems
- Research on comestible machines and food transportation
- Logistics
- Combustion engines investigations
- Rehabilitation engineering
- Rail vehicles investigations
- Modal analysis of flows,
- Global analysis of stability,
- Low-dimensional modelling for flow control,
- Numerical calculations of aeroelasticity, aerodynamics and materials strength,
  Biomechanics
- Research on energy conversion processes,
- Research on fluid-flow compression machines,
- Examination of solid, liquid and gas fuels combustion processes,
- Research on transport of momentum and heat,
- Heat turbines components assessment,
- Training and preparation for examinations for aircraft licenses,
- Perfecting trainings of pilot skills on Fregata motoglider simulator.
- Modelling of non-classical construction materials,
- Theory of machines design,
- Design of machines for non-conventional technological processes,
- Machines assemblies and components analysis,
- Design of mechatronical assemblies, evaluation of its' construction properties,
- Design, research and numerical analysis of mechanical, hydraulic and pneumatic drives dynamics,
- Modelling and computer analysis of construction utilizing FEM,
- Rapid Prototyping.

FACULTY OF MECHANICAL ENGINEERING AND MANAGEMENT

- Modern problems in mechanics of non-Newtonian fluids
- Stability and optimization of thin-walled shell structures
- Application of information technologies and experimental data in vibroacoustics of biomechanical systems
- Mechanics of smart materials and structures
- Construction, technology and testing of technological machines, production and control mechatronic equipment
- Automation of production stands and processes
- Human-machine communication by voice, haptic joystics, vision systems, wireless control, RFID elements etc.
- Contact and optical coordinate measurement, including dynamic measurement of deformations by optical scanner
- Thermovision measurement of various objects thermal state
- Roughness and topograhy measurement, including nano scale
- Measurement of form errors with nanometric resolution by interferometric, holographic and shearographic methods
- Examination of materials mechanical and tribological properties
- Testing of chemical composition, thickness and adhesion of wear resistant coatings
- Diffraction studies and solid materials using powder X-ray: phase analysis, qualitative, quantitative measurement of the crystallite size and parameters of the network and the low angle diffraction SAXS
- Accelerated corrosion tests based on the polarization curves
- Kinetics and mechanisms of electrochemical corrosion of mechanical materials with regard to general corrosion and pitting, passivation processes, anodic dissolution
- Early detection of the sharkskin instability during processing
- DSC testing of polymeric materials and composites
- Determination of thermal effects of changes i.e. exothermic or endothermic. Chemical reactions, phase transitions, enthalpy, specific heat and temperatures of phase transitions of first and second order

FACULTY OF CHEMICAL TECHNOLOGY

- Application of inverse gas chromatography and inverse liquid chromatography in characterization of various materials used in abrasive industry, biomaterials and pharmaceutical industry.
- Polymeric materials with special properties (for medicine, pharmacy, electrochemical devices, nanocomposites, UV-curable), their preparation and mechanism of formation; characterization (thermal, mechanical and physical properties, morphology), processing and rheology.
- Kinetics and thermodynamics of energy storage devices. Ionic liquids as electrolytes. Safe Li-ion batteries.
- Lignosulfonate-stabilized nanoparticles for colorimetric sensing and electrochemistry. Nanostructured materials for energy storing and electrochemical sensing.

- Functional fillers and polymer composites; activators of rubber compounds, (bio)additives and eco-friendly fillers.
- Biomineralization – inspired syntheses and Extreme Biomimetics; biocomposites and biomaterials
- Sample preparation; metals determination at trace and ultratrace level; hyphenated analytical techniques; plasma and microplasmas excitation sources.
- Development of nanotextured materials (especially carbons and their composites), their electrochemical characterization, as well as in their practical applications for chemical and electrochemical systems (e.g. supercapacitors, Li-ion accumulators, hydrogen storage, fuel cells, sensors and pollutants reversible trapping).
- Drying processes (conventional & hybrid).
- Reactive separations (reactive distillation, reactive extraction, membrane-based separations techniques).
- Advanced functional materials: synthesis, functionalization and applications
- Wastewater pollutants removing: adsorption, photocatalysis, membrane processes

FACULTY OF TECHNICAL PHYSICS

- Formation and characterization of surfaces & nanostructures, Ultra High Vacuum (UHV) techniques, scanning probe methods and spectroscopy, magnetic field sensors
- Elastic and transparent electrodes for application in organic photovoltaics
- Computational modeling of nanoscale processes and materials
- Investigations and analysis of the surface structure, adhesion and friction at nano-scale
- Sensing nanomaterials -characterization of carbon materials: nanotubes, nano- and microdiamonds, graphen and graphen-like materials.
- Biological materials (human bone tissue, teeth, collagen, etc.- the use of Raman spectroscopy as a diagnostic tool
- Laser materials doped with rare earth ions
- design, construction and operation of the equipment and apparatus in scientific research
- application of laser techniques for metrological systems
- complete systems for spectroscopic analysis, spectroscopic standards and gas detectors
- atomic time and frequency standards for modern engineering
- arrangement of ultra high vacuum systems

Contact persons:

1/ prof. Tomasz Łodygowski
Rector
tomasz.lodygowski@put.poznan.pl

2/ prof. Joanna Józefowska
Prorektor ds. nauki
Prorektor.nauka@put.poznan.pl

3/ prof. Teofil Jesionowski
Prorektor for LLL and International Education
teofil.jesionowski@put.poznan.pl