Main research areas of TUL (by faculty)

Faculty of Mechanical Engineering

- technology development of changing the surface layer properties by means of heat, thermo-chemical and vacuum techniques, in particular nitriding and carbo-nitriding processes of ferrous, Ti and non-ferrous alloys
- elaboration of nanocrystalline multilayer and composite coatings with particular mechanical, electrical and optical properties
- simulation of residual stress distribution in coatings and substrates for different coatings' systems and substrates with use of FEM methods and investigation of the effect of substrate's form and/or type, of the coating's type and of its thickness as well as of the coating's edge and the experimental verification of the simulations' results
- fabrication, characterization and application possibilities of carbon layers (NCD, DLC)
- examination of influences between physiological fluids and artificial surfaces
- examinations concerning the computerization level of industrial companies on the ERP system implementation and exploitation needs
- automation and robotics in manufacturing
- investigations on medical robots
- process supervision in an Intelligent Grinding System
- machine tools design
- modeling of machining processes
- investigations on surface integrity generated in machining process and on its influence on functional properties of machined parts
- estimation of a trajectory of a vehicle with GPS
- investigations of vehicles with ABS, ASR, AS, 4WD 4WS systems
- research and diagnosis of abrasive materials
- research in the processes of electrodischarge (EDM) and electrochemical (ECM) machining
- strength of materials and structures
- static, stability, postbuckling state and load carrying capacity of thin-walled structures made of isotropic, orthotropic, composite and gradient (FGM) materials
- fracture mechanics of composites
- metrology of energetic values in the flow and automation of research processes
- fluid mechanics - numerical and experimental methods of flow investigations
- improvements in design and operating procedures of turbomachines
- diagnostics and automation and control systems for turbomachines
- optimization of energy consumption in industrial technological processes
- processing and utilization technologies of energy from renewable resources
- medical apparatus, non-invasive diagnostic methods, therapeutic and rehabilitation equipment and investigations devoted to biomedical signal processing
- investigations on active magnetic fluids
- automation of machines, optimisation of control systems, machine drives
- cooling, heating and ventilation
- burning of gas and dust mixtures
- heat transfer
- new high wear resistance aluminium bronze and new aluminium alloys,
- application of thermal-derivative analysis method (TDA) to work out computer system to control of iron and non-iron alloys,
- multi-criterion optimization of production system of machine elements producing

Faculty of Electrical, Electronic, Computer and Control Engineering

- automatic control
- databases systems
- electrical power engineering
- electronic
- electrical engineering
- electroheating
- renewable energy
- computer engineering
- electrical machines
- electricity production
- optoelectronics
- robotics
- biomedical engineering
- image processing and analysis
- expert systems
- computer networks
- electricity markets
- digital systems
- electrical lighting technology
- microprocessor engineering
- high-voltage engineering
- measuring techniques
- computer systems
- internet engineering
- microelectronics technology
- telecommunication
- electric traction
- electronic systems
- electrical apparatus
- waste treatment
- computer aided design
- instrument transformers

Faculty of Chemistry

- characterization of supported metallic and bimetallic catalysts in reactions: dry reforming of methane with carbon dioxide, low temperature CO oxidation (also PROX), HDS and HDA of fuels, selective hydrogenation of α,β – unsaturated aldehydes, carbon transformation,
- preparation and properties of chemical sensors for the detection of reducing gases (CO, CO2, H2)
- crystallographic structure of organic and complex compounds, relationships between the molecular structure and properties, particularly biological activity, QSAR analysis
- analysis and investigations of organic and inorganic contaminations in soil, water and plants
- thermocatalytic treatment of liquid waste
- peptides containing coded and uncoded amino acids, and modified peptide bonds
- application of combinatorial chemistry in studies of artificial receptors and post-translation modification of peptides and proteins
- new methods of synthesis of modified nucleosides, nucleotides and oligonucleotides in order to find new selective inhibitors of pathogenic bacteria translation and inverse transcription of retroviruses
- studies on new methods of synthesis and application in organic synthesis of organophosphorus compounds
- structural studies of modified biomolecules on the basis of nuclear magnetic spectroscopy (NMR) and theoretical methods
- experimental and theoretical (computer modeling) studies on mechanistic aspects of chemical and enzymatic reactions, and radiation induced processes
- research on polymer biomaterials, new therapeutic substances, and development of new medical diagnostic methods
- research in the field of environment protection, radioecology, use of the ionizing radiation in conservation of historical objects and sterilization of medical products
- the crosslinking of the elastomers, the structure of the unconventional networks and its correlation with elastomers properties, technology of the rubber articles thermally resistant with specified tribological properties
- synthesis and properties of nanocomposites, in which the organic matrix phase reveals elastomeric properties. New types of inorganic and organic fillers are synthesized and investigated
- synthesis of components for the cosmetics and polymer processing, the applications of the keratin and collagen
- synthesis of dyes for special applications, synthesis of new components for household chemistry (UV absorbes, optical brightevers, surfactants), synthesis of dye photoinitiators
- investigations of composites and hydrogels based on naturals and synthetic polymers (liquid crystals polymers included)
- polymer nanocomposites with organic conductors and nanotubes
- biosensors based on molecular imprinting technology
- semiconducting polymers for optoelectronics
- field effect transistors, light-emitting diodes and photovoltaic cells based on organic and hybrid (organic-inorganic) materials

Faculty of Textile Engineering and Marketing

- bioactive fibers forming polymers and man made fibers for medical application
- chemistry and technology of synthetic fibers and fibers forming polymers
- imposing of specific properties on natural and synthetic polymers by chemical modification
- modification of textile surfaces by deposition of polyelectrolyte nano-layers
- studies of structure - properties relationships in polymers and copolymers
- architectonical design of textiles
- modelling of woven textiles, their properties, structures, textures, outside forms
- technologies and techniques of mechanical and chemical modifications of textiles as -designer's tools for creating of useful and attractive products
- analysis of functions and costs of textiles
- digital analysis of textile image
- history of architecture of textiles
- methods of documentation and reconstruction of historic textiles
- transposition of artistic vision to engineering, durable and useful textile product
- improving and applications of techniques for creative problem solving
- applications of CAD/CAM in textile design
- measurement of colour and use of it for dispensing of a prescription
- rudiment and optimization of processes for chemical treatment of textiles
- rudiment and optimization of processes for conservation of textiles
- examination of fibre fine-structures and relationship between fine-structure and physical properties of fibres and their dyeability,
- examination of physical-chemical phenomena during modification and chemical finishing processes,
- chemical finishing of textiles and textile care (laundry and dry-cleaning of textiles)
- digital analysis of surface and external form of textile’s structure
- modern techniques of yarn production and new generations of yarn structures
- investigation of spinning and weaving processes
- technological utility of yarns
- destruction and degradation of yarn in textile processes
- interaction between friction barriers and yarns in technological processes
- structure of knitted fabrics and their basic structural parameters with relationship to technological parameters,
- weft and warp knitted technology
- fabric relaxation and thermosetting effects on structural parameters of knitted fabrics
- optimization of clothing processing techniques, testing of cloth properties
- analysis of conditions of exploitation and reliability of textile machinery
- computer aided design of textile structures and technological processes
- measuring, control systems and automation of textile processes
- textronics as compound technology of electronics, informatics and textile engineering
- theoretical and experimental assessment of textile properties and behaviour
- novel application of non-woven materials and their novel manufacturing technologies
- mechanics of textile, textile structures and composites
- computer-oriented analysis, synthesis and optimization of materials and structures
- computer modelling of machines and robots
- vibrations of mechanical systems,
- machine safety

Faculty of Biotechnology and Food Sciences

- bacterial cellulose as a modern biomaterial useful in medicine
- enzymatic synthesis of prebiotic oligosaccharides
- cool adopted enzymes of antarctic microbes origin and their use for synthesis of chiral building blocks
- methagenom of antartic soil as a source of unique lipase/esterase genes
- biosynthesis of lipases and pro-salubrious lipids by fungi of *Mucor* genus
- biodiesel enzymatic synthesis
- production of enzymes of *Aspergillus niger* and their use in textile industry
- chemical synthesis of bioconjugates of nucleosides and oligonucleotides from 1-alpha-methyl-D-mannopyrazyde as a new form of potential pro-drug
- chitozane enzymatic hydrolysis
- isolation, sequentionning and gene expression of microbial enzymes useful in medicine and economy
- apoptosis induction by the vegetable polyphenols selected
- rentgenographic structure analysis of proteins and small molecules (asparaginase, citocines, transcription regulators, lupine protein PR10, monoclonal antybodies)
- bioremediation of biotopes polluted by petroleum Molecular characteristics of bacteria degradating oil-derived substances
- social and legal aspects of biotechnology, especially legislation and intellectual property protection
- participation in the elaboration of methods for the preparation of antibacterial and therapeutic textile articles
- investigation of lactic bacteria role of *Lactobacillus* genus (LAB) in the humans and animal alimentary canal Elaboration of new probiotical vehicles for lactic bacteria based on plant sources
- study of fermentative capability of brewery and amylolitic yeasts immobilized on the surface of solid vehicles and their use possibilities for beer and bioethanol production
- elaboration of methods for manufacture of functional food of pro-salubrious value and dietetic supplements enriched in biologically active organic forms of selenium, polyphenols, cellulose; design of vaccines and starters for the production of fermentative food
- elaboration of new, wasteles technologies for vine and cider production enriched in organic form of selenium or polyphenols
- elaboration of methods of biosynthese process of yeasts for feeding stuff and bioethanol production based on intermediate products of sugar industry
- spore inactivation of *Bacillus stearothermophillus* during sterilization process of plant and animal raw materials
- optimization of purification process of sugar-beet raw juice
- validation of basic methods of white sugar analysis
- use of artificial neuron webs to the description of conductivity changes of sugar-calcium solutions
- initiation of HACCP system in some food works
- new sugar assortment obtaining with the use of food dyes
- elaboration of early warning system against the microbial infection of apple juice
- composition and properties of polyphenol extracts obtained from by-product of food industry
- sugar identification based on polyphenols and saponins present therein
- stability of sugar solutions assigned to beverage production
- influence of cryoprotectants on the freezed meat properties
- physiological and antioxidative activity of vegetables stored under controlled atmosphere
- storage stability and sorption property of lyophilized food articles
- study of antioxidative activity of coca bean extracts and their application to the inhibition of food oxidative processes
- influence of composition and origin of wheaten starch on the physico-chemical properties of enzymatic hydrolysates
- investigation of chocolate articles enriched in living culture of yogurt bacteria
- glutenles bread
- starch digestibility in glutenles food products

Faculty of Civil Engineering, Architecture and Environmental Engineering

- revitalization and conservation of post-industrial historical areas, revalorization problems of the lodz region, protection of cultural landscape
- urban planning, problems of municipal transportation, applications of information technology in urban planning
- ecological problems of towns, modelling and optimisation of wind conditions around urban structures
- architectural design of public, housing, sportive and recreation building objects
- contemporary architecture of museums
- numerical methods in deterministic and stochastic mechanics, finite element method, method of material points, flow of granular media, dynamics of driving pales, numerical modelling of plates and shells, stochastic finite element method
- mechanics of heterogeneous media, dual bounds of effective properties, problems of equilibrium, quasi-static evolution, stability, dynamics and wave propagation, problem of hyperconductive toroidal bobbin, problems of cracking and contact, modelling of structure soil interaction, surface reinforcement of soils
- physics of building materials and structures: modelling and computer simulation of coupled problems of mass and energy transfer, phase transitions, absorption of short and long wave electromagnetic radiation, heat energy accumulators, energy saving building envelope, intelligent elements of building envelope
- modifications of building materials and composites: gypsum, cement and ceramic, problems of utilization of industrial wastes in building industry, technologies of new generation concretes
- concrete elements and structures, ordinary, high strength and selfcompacting concretes, effects of carbon, aramid, and glass fibrous reinforcement, effects of dispersed fibrous reinforcement made of polypropylene and steel, reinforcement of constructions, massive concrete casting
- steel and timber elements and structures, strength and flexibility of mechanical connectors, concrete-timber composed elements
- navigation and thematic environmental cartography, geometric shaping of structures
- strength and exploitation of heating and air conditioning installations and materials
- structural and operation analysis of environmental engineering devices (drives and bearings)
- optimisation of water consumption in industrial technological processes
- reclamation of misused municipal and industrial areas
- numerical modelling and model testing of water and wastewater systems, forecasting of rain water fall flows
- modernization and optimisation of structural designs of water and wastewater systems, methods of purification of water and wastewater, utilization of wastes

Faculty of Technical Physics, Computer Science and Applied Mathematics

- vertical-cavity surface-emitting and edge emitting lasers
- measurements and applications of electrooptic effects, applications of extended matrix calculus to uniaxial crystals in the presence of external fields
- relations between physical structure and electrical properties of diamont-like carbon thin films
- mathematical physics
- properties of liquid crystals
- morphology of crystals
- crystal growth
- applications of laser techniques
- artificial intelligence (computational intelligence, applications of neural, genetic and fuzzy systems to modelling, simulation, technical and medical diagnosis, pattern recognition, knowledge extraction and intelligent internet exploration, expert systems, knowledge acquisition, data mining, application of intelligent systems, optimization, numerical methods, soft computing, artificial intelligence, evolutionary computing, linguistic summary, theory of fuzzy sets, text processing, intelligent Web searching, theory of rough sets, linguistic knowledge representation)
- computer graphics and multimedia (virtual reality, multimedia, human-computer, interaction, computer games, graphic design, typography design and illustration, artistic composition of images and virtual spaces, visualization)
- information systems and databases (software methodology and engineering, data mining and knowledge extraction, information systems, database systems, computer system design, electronic data interchange, electronic commerce, data warehousing, virtual communities, information management, information system analysis and design, relational and object oriented database systems)
- modeling and simulation (computer science, teleinformation, modelling and simulation in engineering, technical and medical diagnosing, electrical engineering, bioelectromagnetism, asymptotic methods, integral equations, inverse scattering and ill-posed problems, numerical methods, operational research, methods of optimization, system theory, parallel programming)
- security of computer systems (operating system security, security problems in local and wide area networks, database access security, access control in information systems)
- signal and image processing (theory of fast adaptive algorithms, technical and medical diagnostics, processing, classification and recognition of structural data, applications of artificial intelligence, universal and uniform computational architectures, data compression)
- financial risk management for pensions plans, insurance companies and other financial institutions, portfolio immunization, immunization inequalities, risk transfers, optimal reinsurance contracts, stochastic control of the insurer's risk process via reinsurance and investments, credibility theory, multiperiod optimization of insurance premiums, bayesian and minimax prediction, information inequalities for prediction risk, optimization of social transfers
- real functions: generalized continuity, algebraic properties, classification of Baire
- measure theory and topology: generalized integral
- complex functions: geomerical theory of one and several variables
- nonlinear analysis: fixed point theory, iterated function systems
- small sets in analysis and topology: Baire category, representations of algebras of sets, statistical and ideal convergence
- connections of Boolean algebras with topology and Banach spaces theory
- connections between Lapunov exponents and Hamiltonian biliards
- periodic solutions to a nonlocal pendulum equation
- invariant measures and Frobenius-Perron operators
- travelling waves in generalizations of Korteweg-deVries equation
- Miranda's theorem for morphisms in the sense of Górniewicz
- geometrical studies of Lie-Rinehart algebra - an algebraic equivalent of Lie algebroid

Faculty of Organisation and Management

- managing staff in the structure of power in companies
- adjustment of organizational structure and strategy in the process of large companies development
- outsourcing in SME sector
- methods of building competition advantage in SME sector
- multidimensional analysis of factors influencing risk management in company
- demand for managerial and engineering staff in Łódź voivodeship in years 2002 – 2015
- analysis of pension funds functioning and of their members' decisions with the use of quantitative methods, etc
- creating the company image
- obtaining the access to new technologies
- avoiding uneconomical investments
- market-oriented transformation
- liberalization of the power and natural gas sectors
- network industries
- regulation, energy policy, structural changes
- regulation for competition
- incentive price regulation
- innovation, economics of innovation
- R&D, R&D management
- high tech industries
- venture capital
- high tech incubators
- economic activity of disabled people
- managerial accounting, cost management
- cost budgeting and controlling
- artificial intelligence, neural networks
- management of long-term contracts
- process costing, product costing
- the potential of regional R & D
- managing the innovation process
- marketing management in small and medium sized enterprises
- financing innovations
- innovativeness of SMEs in the Lodz region in the years 2005-2008
- the influence of Advanced Technology Centers on the innovativeness of textile enterprises
- internet marketing In R & D institutions - concept and application
- innovations in the creation of competitive advantage by hypermarkets in Poland
- managing innovation processes in the sector of industrial biotechnology
- using distance learning in enterprise management
- ultimate load of thin-walled structures
- the theoretical and numerical analysis of stress and strain state of structures, especially denture structures
- insertion loss of sound absorbing screens used during the exploitation of earth moving machines
- the problem of the noise high level of machines working on the open space
- industrial symbiosis and designing of eco-industrial parks
- intellectual property protection, including: modelling the methods of assessing immaterial and legal values, as well as improving the innovation of enterprises by using industrial property

Faculty of Process and Environmental Engineering

- fluid mixing in homogeneous and heterogeneous systems
- microgrinding in mills of different constructions
- disintegration of microorganisms in bead mills
- powder and dust granulation in drum and disc granulators
- separation processes in different types of screens (wet or dry)
- hydrodynamics of multiphase system flow
- construction of new types of rheometres
- two-phase flow in micro-channels
- transport of media of complex rheological properties
- rheology and rheometry of non-Newtonian liquids
- single- and multiphase emergency outflows
- Biotechnology and environmental management
- Improvement of bioproduct separation methods
- designing and improvement of biotechnological equipment
- kinetics, modelling and optimization of biotechnological processes
- biochemical and thermal utilization of solid wastes and sewage sludge
- unit processes and operations in environmental engineering
- atmospheric protection engineering
- thermal and calorimetric analysis
- environmental management
- industrial safety and risk management