

Part II - CAETS Energy Report 2022

Chapter 0. To set the scene¹

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1. Context, scope and methodology of the report

The reports of the Intergovernmental Panel on Climate Change (IPCC) issued during the 2021-2022 period show that it is becoming ever more urgent to act in order to contain climate change and other related global issues. Despite the COP26 conference, numerous announcements from governments, trillions of investments in efficiency and renewable sources, the major greenhouse gases (GHGs), especially CO₂, CH₄, N₂O, and SF₆, keep increasing as shown in Fig. 0.1. (in this figure, data for 2020 is only available for fossil CO₂ and Land Use, Land Use Change and Forestry (LULUCF), but not for Fluorinated Gases (F-gases), CH₄ or N₂O). The result is that in 2019, the annual average concentration of CO₂ in the atmosphere reach 410 ppm, compared to 280 before the industrial age (See IPCC - Climate change 2021 - The physical science basis - Summary for policymakers).

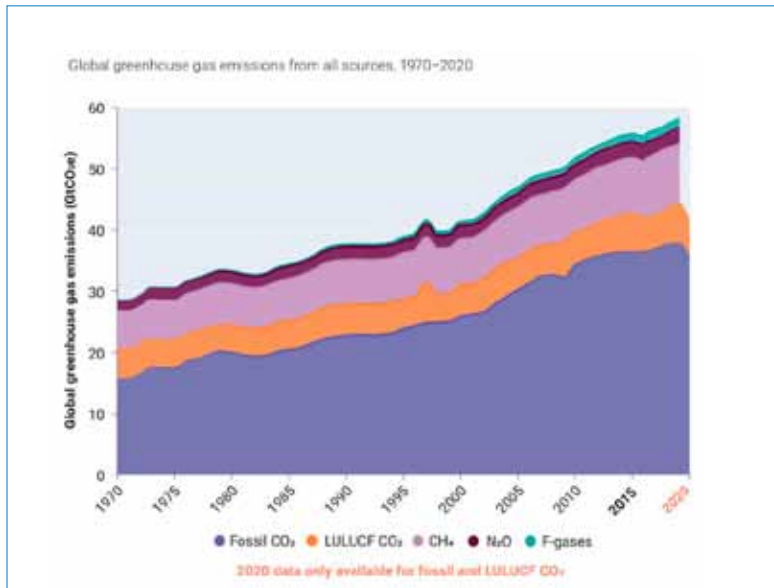


Fig. 0.1. Global GHG emissions from all sources

Source: Emissions Gap Report 2021: The Heat Is On, page XVII
<https://www.unep.org/resources/emissions-gap-report-2021>

The CAETS¹ are committed to addressing these highly complex and systemic issues, to which technology is only one of the key elements, although an essential one. This is why we have endeavoured to write this report. The reader will see that many of the technologies that can mitigate present global climate change are already available and affordable, or could be made so, and may be deployed immediately as soon as the political, economic, and societal contexts are sufficiently aligned and stable.

For this reason, our report is focused on the time period 2020-2040 to illustrate what may be possible right now.

However, some considerations in our report extend to beyond 2040 and some even extrapolate beyond existing technologies since the development and implementation of new technologies will open new possibilities to help the world meet the net-zero goals. Continuous support and funding for Research and Development (R&D) are thus critical.

The Council of Academies of Engineering and Technological Sciences (CAETS) provides its more than 30 worldwide Member Academies and their individual Fellows with the opportunity to enrich their approaches

¹ <https://www.newcaets.org/>

beyond their respective national contexts. CAETS enables comparing solutions, sharing best practices and making suggestions to the respective public authorities of the Member Academies. The Academies do not lobby for any specific technology or special interest but aim to make recommendations based on evidence rather than self-interest, ideology, or philosophical motivations. The composition of the Academies and the diversity of their Members, some coming from the Industry, some other from the academic world or other sectors, help us elaborate evidence-based reports, which is of utmost importance for policy-makers, industrial leaders, and the general public in an area where ‘wishful thinking’ and ‘fake news’ are often present.

In its past reports², the CAETS Energy committee first analysed aspects of energy generation (2018), then the integration of intermittent sources (2020). As the other side of the energy equation: how is it used, had not been addressed so far, this topic has been chosen for this 2022 report.

Many international reports produce ‘scenarios’ or present ‘roadmaps’³ to net-zero GHG emissions by 2030, 2050 or 2060, for example, one reference being the well-known 2021 Net-Zero IEA Roadmap . International sectorial associations are also describing how their respective sector will reduce GHG emissions. At the national level, in particular in connection with the Paris Agreement, many countries have also presented national ‘roadmaps’.

We have chosen to highlight some of the most GHG-intensive sectors of the global economy in this report and to explore feasible approaches to GHG emissions reduction. Our report is not strictly limited to the technical dimensions of the issue since other dimensions as well as holistic approaches are required to move on from discussing to acting.

We have opted to focus on sectors that are energy and capital intensive, with presently high GHG emissions, and for which the diversity of member Academies is an asset to provide relevant answers, comments and recommendations.

We did not include some important sectors in this study, as we had to choose those in which our limited resources could be put to the best use. Therefore, we decided not to consider the sectors of transport, aluminium and paper. Along these lines, the chapters included in this report are the following:

- Chapter 0.* To set the scene
- Chapter 1.* Food and agriculture
- Chapter 2.* Buildings and Smart Cities
- Chapter 3.* Oil and gas industry
- Chapter 4.* Chemical industry
- Chapter 5.* Cement industry
- Chapter 6.* Iron and Steel industry
- Chapter 7.* Information and Communications Technologies
- Chapter 8.* Conclusions
- Annexes* Country analysis questionnaires

² <https://www.newcaets.org/statements-reports/caets-reports>

³ <https://www.iea.org>

Fig. 0.2. below shows the 2019 GHG emissions produced by the major sectors, in particular by the sectors covered in this report (McKinsey Sustainability Insights 2021).

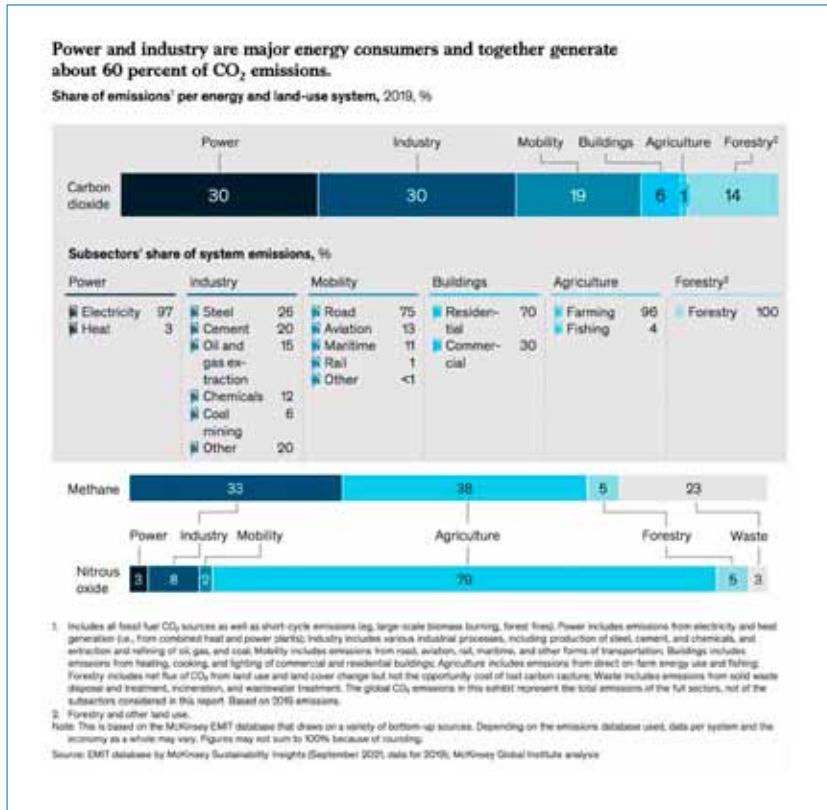


Fig. 0.2. Percentage of CO₂ emissions by sector, 2019

Exhibit from "The net-zero transition. What it would cost, what it could bring", January 2022, McKinsey & Company, www.mckinsey.com.

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<https://www.mckinsey.com/-/media/mckinsey/business%20functions/sustainability/our%20insights/the%20net%20zero%20transition%20what%20it%20would%20cost%20what%20it%20could%20bring/the-net-zero-transition-what-it-would-cost-and-what-it-could-bring-final.pdf>

The report is organised as indicated below.

- This introductory chapter (*Chapter 0.*) is focused on the increasing role of electricity and provides common comments concerning most sectors to facilitate decisions and actions by policy-makers, industrial and academic leaders.
- Each of the seven chapters in this report describes one sector. The chapters are not exhaustive monographs on their subject. They do not examine the potential for growth or contraction of their sector. Their focus is on scope 1 and scope 2⁴, as defined in the studies on Climate Change⁵. They highlight the main elements on the potential pathways to reduce GHG emissions as seen by the Members of our Committee, using *currently available* technologies and existing ‘low-hanging fruit’ for ‘non-regret’ strategies, some lessons learned or case studies and, where appropriate, potentially disruptive technologies.
- Finally, *Chapter 8.* draws conclusions and summarises our key findings.
- The annexes contain country specific data on energy use, GHG emissions, information on decarbonisation strategies, and further elements for some selected sectors.

How was this report prepared?

After the validation of a scoping paper and a working process suggested by the Committee Chairman, the CAETS Member Academies were invited to propose participants to the Committee and to its Working Groups. The list of the more than 60 authors from 20 countries is given at the end of the report.

The working process was organised along the following two parallel lines.

1. Seven Working Groups, generally led by two co-chairs from different continents, were organised and responsible for the drafting of one chapter each. Sometimes they have invited external experts (the list of these experts can be found at the end of the report). The Working Groups also presented the progress of their work in seminars organised by the Energy Committee.
2. In total, the chairman organised such Energy Committee Seminars from February 2021 to June 2022, where transversal issues were presented, proposals by the Working Groups discussed and suggestions for achieving further progress made. All members of the Working Groups were invited to the seminars, held in two-hour sessions, twice a day (morning and afternoon, Central European Time) to facilitate the participation of members in different time zones, on two consecutive days.

A complete version of each chapter was produced by the end of May 2022 and then sent to internal reviewers (members from one Working Group (WG) reviewing the chapter of another WG) and external reviewers (list at the end). The reviewers’ comments and suggestions were discussed and taken into account by the WGs from 20 June to 10 July 2022, under the leadership of the WG’s Co-chairs, before validation by the participants. The revised version of the whole text was sent for editing to ensure as much consistency as possible for a text written by many hands! The text was then sent to the Academies for endorsement.

The process was supported by NATF’s team lead by the Committee Chairman Pr. Yves Bamberger (Academician) supported by Dr. Wolf Gehrisch and Dr. Gaël-Georges Moullec.

⁴ Scope 1, Scope 2, emissions: Emissions responsibility as defined by the GHG Protocol, a private sector initiative. ‘Scope 1’ indicates direct greenhouse gas (GHG) emissions that are from sources owned or controlled by the reporting entity. ‘Scope 2’ indicates indirect GHG emissions associated with the production of electricity, heat, or steam purchased by the reporting entity.

⁵ See for example: https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-i.pdf and <https://ghgprotocol.org/standards>

2. The central role of low-carbon electrification

The focus of the report is the reduction, as soon as feasible, of GHG emissions from energy uses in the seven sectors it covers. This includes all types of energy uses in the sectors including: heating, cooling, manufacturing, processing, data handling, etc.

Today, fossil energy sources are largely used in industry and remain the main source for electricity generation: thus, *energy efficiency improvements*, i.e. the use of technologies that contribute to lowering energy/electricity consumption, directly reduce GHG emissions. When electricity has a low-carbon content, i.e. is quite entirely produced via renewable energy or nuclear power, increasing or decreasing its consumption will have less impact on CO₂ emissions. This is likely to happen at a different pace in each country.

What is low-carbon electricity?

The CO₂ content of electricity, also known as the CO₂ intensity of electricity, is usually characterised by the number of grams of CO₂ produced to obtain 1 kWh of electricity. See for example <https://www.iea.org/data-and-statistics/data-product/emissions-factors-2021>.

With electricity produced through hydropower, wind, solar or nuclear energy, CO₂ content is equal to zero if only emissions for operation are considered, and not the complete cycle for the plant and the fuel: (a) upstream (e.g., material acquisition and plant construction), (b) combustion (where applicable), (c) operation and maintenance, (d) plant decommissioning and fuel disposal/recycling. Taking these phases into consideration, CO₂ content is generally estimated to be between 10 gCO₂/kW and 50 gCO₂/kWh. See for example analysis by the US National Renewable Energy Laboratory (NREL) [<https://www.nrel.gov/analysis/life-cycle-assessment>].

According to IEA, <https://www.iea.org/data-and-statistics/data-product/emissions-factors-2021>, the average CO₂ content of electricity worldwide was:

- 950 gCO₂/kWh for coal, with plants below 900 gCO₂/kW and others at 1 100 gCO₂/kWh,
- 430 gCO₂/kWh for natural gas, with plants around 350 gCO₂/kW and others at 550 gCO₂/kWh.

Taking into account the complete cycle, some 10 g have to be added for natural gas plant, some 20 g for coal plants.

In this report, the term low-carbon energy implies emitting less than 50 gCO₂/kWh for electricity as well as for heat.

While energy efficiency is often among the ‘low-hanging fruit’, it does not lead to “zero emissions”. Comparing the decrease of GHG emissions resulting from the introduction of specific energy-efficient technology (with its associated cost) with other available solutions, such as replacing the energy vector (gas with electricity for example), reveals key variables for each outcome.

Four principal options, which may possibly be combined, are currently available to achieve as soon as practicable low GHG emissions:

1. When feasible, replace fossil sources by *directly* using low-carbon sources: direct use of solar energy to heat water for example;
2. If 1 is not feasible, replace fossil sources with low-carbon heat or low-carbon electricity (hydropower, solar and other renewable energy, or nuclear energy);
3. If 1 or 2 are not feasible, use low-carbon (‘green’) hydrogen (see *Annex to Chapter 0*, below, second section), which often means indirectly using (even more) electricity;
4. In hard-to-abate industries, emissions arise from the process itself (in the cement industry for example) and cannot be simply reduced by the use of low carbon electricity or hydrogen. If the process itself cannot be decarbonised, carbon capture and storage (CCS) may be the solution, if it is proven to be cost-effective and practical in a specific location.

Passing from one of the above options to the next usually entails increasing costs to avoid emissions: the 'low-hanging fruit' are often associated with electrification (option 2). They are consistent with the new uses or extensions of uses of electricity, while at the same time advancing the decarbonisation of electricity (which is not the subject of this report).

Even if the energy efficiency of equipment and systems improves, the increasing level of electrification of a growing number of activities, the improvement of the quality of life in poorer countries and regions, and further demographic growth in some parts of the world will generate an increased need for the production of electricity. Such production thus needs to be increasingly decarbonised to sustain the emissions reduction.

For these reasons, the IEA and most other international and national institutions increasingly foresee and promote a higher level of electrification in energy systems and, at the same time, an increase in electricity consumption⁶: at the global scale, the share of electricity in final energy consumption could increase from 19.3% in 2020 to 50% in 2050. As a result, electricity consumption would more than double, from 22 300 TWh in 2020 to around 50 000 TWh in 2050.

At the same time, the related CO₂ emissions from electricity production must decrease. Per kilowatt-hour, indeed, this has been achieved since 1990, as shows *Fig. 0.3*⁷ below, dropping from 533 gCO₂/kWh to 485 gCO₂/kWh. This decrease is, however, counterbalanced by an expansion in consumption, resulting in an increase in the total emissions from electricity production from 1990 to 2019.

The global decarbonisation of electricity must therefore proceed, as rapidly as possible especially through increasing the share of renewable and nuclear energy, as previously seen.

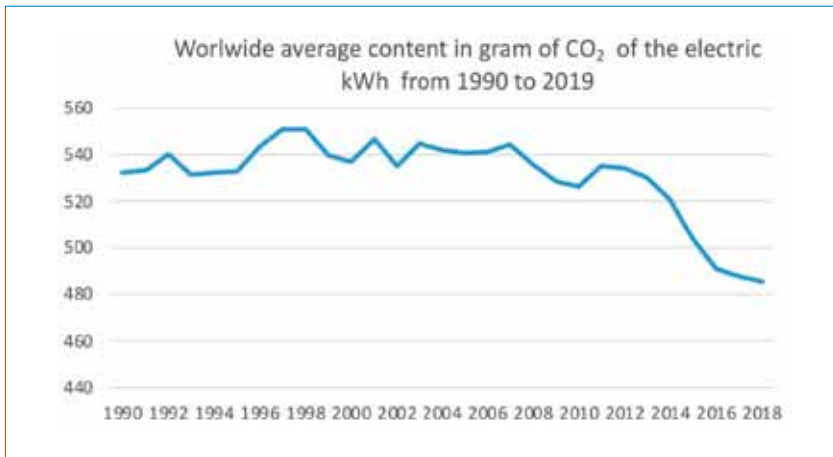


Fig. 0.3. Worldwide average CO₂ content of electricity 1990 to 2019 [CO₂/kWh]

Source: IEA. Reproduced with permission

<https://www.iea.org/data-and-statistics/data-product/emissions-factors-2021>

For the last two options above, technologies are available but still need incentives, such as new regulations imposing higher prices for CO₂ emissions, or new business models to be deployed extensively. The number of demonstration projects, pilot projects, and first industrial projects in different countries is increasing. Some of them are described in the chapters of the report.

⁶ The potential level of electrification sector by sector of the European countries has been studied in the extremOS project realised by a consortium of academic and industrial German partners: <https://extremos.ffe.de/>

⁷ See for reference: <https://www.iea.org/data-and-statistics/data-product/emissions-factors-2021>

3. Fifteen general comments

The following general comments apply to most, if not all, of the sectors studied in this report and generally to other sectors it does not cover. Some are more oriented on technical aspects, other more on regulatory or industrial policy choices. These comments are evidence-based, and while some may seem 'simple', many obstacles beyond technical aspects are still standing in the way of their implementation.

Unfortunately, it is not very difficult to find examples in many countries of feasible choices or solutions that do not seem to be implemented at a sufficient scale, or at all. There are nevertheless a large number of examples in which best practices and solutions have been properly taken into consideration and implemented. Some are listed below; others can be found in the various chapters and the annex of the report.

Low-carbon available technologies

The urgency of climate mitigation implies deploying as soon as practicable the best available and most cost-effective lower-carbon intensive technologies. Fortunately, a number of such technologies are already commercially available and at an affordable cost; moreover, many of them offer co-benefits such as reduced energy bills, improved comfort and health, improved industrial processes and/or increased demand flexibility. This is especially true for the first and second options listed above.

The heat pumps family

While the use of heat pumps is increasing worldwide, it is worth further promoting this family of technologies as it has an increasing range of applications, from residential and tertiary sectors to many industrial processes. Furthermore, the reuse of waste heat might have more applicability in the future. By "pumping" heat, heat pumps bring heat (or cold) where it is needed while using less electricity than would otherwise be needed to heat (cool) a space or equipment, and this by a factor which may be frequently higher than 3. Heat pumps are a key lever for reducing CO₂ emissions. They are described in the first section of the annex to this chapter.

Local adaptation of some technologies

Many existing technologies are available globally, but some have been developed and will be used in highly developed countries, also known as the 'Global North'. These technologies may require adaptation to different climates and local contexts. In some cases, further developments are needed. In particular, some equipment is climate sensitive. For example, air-air heat pumps and solar water heaters are sensitive to temperature and humidity.

Energy efficiency and the rebound effect

Energy efficiency is always useful: technologies that are improving equipment efficiency and system insulation save energy. So does adding a modern command-control into an industrial process or into a heating system at a home: replacing a thermomechanical thermostat with an electronic one reduces the energy consumption by 5% to 10%, as it avoids overheating. Command-control with a learning capacity, using AI, may be increasingly useful.

Frequently, these improvements rapidly pay for themselves and become profitable if the outdated equipment is replaced at the right time with a more efficient one, at the end of its life, for example.

Increased energy efficiency may improve the quality of life in a home, especially for the less affluent for whom energy costs tend to be a large portion of their disposable income. However, improvements in energy efficiency may often be subject to the well-known rebound effect (also known as the 'Jevons paradox') when consumption is no longer limited by cost. Higher efficiency may indeed lead to an increased, often wasteful, use of resources as their prices decrease and their availability increase. This trend may limit or cancel the expected reduction in energy consumption and emissions. This is often the case for heating at home: people now tend to maintain their homes at higher temperature than before the improvement of the equipment, to feel more comfortable. Other well-documented indirect rebound effects occur when the cost reduction due to an increase in efficiency lets the consumer spend more energy on other activities.

Life Cycle Assessment

Life Cycle Assessment (LCA, also known as Life Cycle Analysis) is useful for assessing not only the impact of a process, equipment or system, but also its proposed replacement by another process, equipment or system to produce a more effective and sustainable decrease in GHG emissions. The goal is not necessarily to obtain a highly precise LCA figure but to evaluate the externalities of an initial choice or of a potential replacement that could be useful for reducing GHG emissions. The different types of LCAs are presented in the third section of the annex of this chapter.

Recycling, circular economy and the reduction of GHG emissions

The development of long-life products, recycling and a circular economy generally leads to reductions in GHG emission, pollution, and use of materials. Recycling requires energy (both to recover what is to be recycled and for recycling itself). For some important materials such as steel and aluminium, the emissions produced by recycling are indeed lower than for the initial production, but this is not always the case. Recycling is not necessarily easy to organise, implement and finance, but it is often desirable.

Example: the recycling of steel

The recycling of steel generally requires less than one fourth of the energy needed for its production from iron ore; furthermore, recycling scrap uses mainly electricity, thus allowing less CO₂ emissions, if the electricity is produced from lower carbon intensive sources. This approach may be especially useful during the next 30 years or more until hydrogen reduction processes are available and applied on a large commercial scale. With increased recycling, the average energy use for 1 tonne of steel could be reduced by 30% to 40% and the average CO₂ emissions per tonne by about 70% (see *Chapter 6. on the Iron and Steel industry: Fig. 6.10. in Section 2.4., Footnote 15. in Section 2.3., Table 6.1. in Section 2.5.2.*).

Importance of holistic approaches

Holistic approaches are essential for an effective and affordable transition to a lower carbon intensive economy to be achieved because there are many interconnections between sectors, political choices, regulations and industrial developments or decline. This implies that public and local services should work across and between administrations and governmental agencies without forgetting interaction with industry. Collaborations are also needed at the national and international levels. It is important to specify the varying timing of the different transformations: roadmaps or planning based on solid and transparent simulations are the basic tools needed to gain acceptance and support. Many IPCC reports are examples of such a holistic approach.

Different impacts of ICT

The increasingly ubiquitous digitalisation of our world and daily lives is transforming the world's value chains, offering numerous possibilities for measures, analysis, optimisation, etc., which may contribute to reducing energy consumption and GHG emissions. On the other hand, information and communications technology (ICT) induces GHG emissions as it requires important amounts of energy in operation, principally in the form of electricity, and also other energy vectors in manufacturing. This report is principally devoted to the energy use on the operation side (see *Chapter 7.*).

Stability and predictability of regulatory changes

Public policies (regulations, mandates, incentives, etc.) usually concern many stakeholders (from citizens to industrial companies but also cities and national governments). To be accepted and sustainable in many countries, these policies need to be transparent, adequate and, if possible, stable. As far as possible, the evolutions of these policies and their rationale should be announced well in advance so that key stakeholders to adapt and to gain confidence and create acceptance of the general public. Setting a clear path for coming policy

changes, and making it known to the stakeholders, will help predicting with some certainty their evolution and acceptance.

Importance of metrics and data sources

It is necessary to choose the right metrics and reliable and reproducible data when selecting or defining objectives and monitoring the implementation of any GHG reduction programme. We recommend using metrics for emissions and final consumption rather than primary consumption, because reducing primary energy consumption and reducing emissions are not necessarily synonymous: replacing coal or gas with electricity may increase primary energy consumption and yet decrease CO₂ emissions: see for example *Chapter 6*. on the steel industry, and below.

Low primary energy and low CO₂ emissions are not necessarily synonymous

Let's suppose a country has the following electricity mix⁸:

50% renewables (hydro, solar, wind), 25% nuclear, 25% gas (with 50% efficiency, thus 400 gCO₂/kWh)

In that case, following the IAE coefficients (3 for nuclear), the ratio primary energy to final energy is given by $E_p / E_f = [(50\% \times 1) + (25\% \times 3) + (25\% / 0,5)] / 100\% = 1.75$

The CO₂ content of electricity is: 25% x 400 = 100 gCO₂/kWh.

Considering two identical houses with a yearly heating need of 4 MWh.

- One house is heated by a gas furnace of efficiency 100% (to simplify).
Its primary energy consumption is thus 4 MWh and its emissions are 400 kgCO₂.
- The other house is heated by a heat pump with a Seasonal Coefficient of Performance (SCOP) of 3.
Its primary energy consumption is 7 MWh (4 x 1.75) and its emissions are (4 MWh/3) x 100 kg/MWh = 133 kgCO₂.

With this electricity mix, it is thus better to take directly CO₂ emissions as indicators than to take the primary energy.

Impact of size on the transition in capital-intensive sectors

The urgent need to reduce GHG emissions and the externalities of the required changes call for an exploration of scale issues, such as the size of the facilities under consideration.

In most capital-intensive industries, generally heavy industries, facilities have become increasingly bigger due to the benefits of economy-of-scale, and more and more have been operating continuously with fewer shut-downs for repair and maintenance. These large complex facilities have been highly optimised to increase in efficiency and consequently profitability, which makes it all the more complicated to modify them. Many of these existing facilities have long remaining life spans, which decreases incentives for replacing them.

As a result, changing today's large facilities, in order to reduce GHG emissions or integrate with other processes, requires comprehensive planning, clear regulatory environments, and large investments: such changes indeed typically take several years to implement. If their production needs to be curtailed to modify the process, the whole local industrial ecosystem might suffer from it and so might numerous customers.

⁸ Producing 1 kWh by combustion of gas produces some 200 g of CO₂. We take into account the standard ratio from the International Energy Agency of primary energy over final energy for nuclear electricity (coefficient 3).

Benchmarking

Benchmarking, particularly in industry, is a way to promote dynamics for emission reductions: comparing for example how much kgCO₂/tonne of production different companies from the same sector emit may help these companies and public authorities pursue emission reduction goals.

Japanese benchmarking system for industries

To improve energy efficiency in industrial sectors, Japan introduced a benchmark system in 2009 combining regulation and incentives. 70% of industrial and commercial sectors are currently covered by this system. In each area, a simple and easy-to-understand measurable benchmark performance indicator is defined; a benchmark target level is then set, representing the best available technology, already achieved by 10% to 20% of top performers from that sector and also high-ranking in the international EU Emissions Trading System (EU ETS) for the year 2030. This target may be revised if a majority of companies have achieved it. The benchmarking system includes: (a) Inspections by the Ministry of Economy, Trade and Industry (METI) of businesses whose efforts in energy efficiency are unsatisfactory; and (b) Energy efficiency subsidies when a benchmark target is achieved (See: <https://iea.blob.core.windows.net/assets/2867cfa4-5184-4d4e-801b-c545de7e8900/2.Mr.MasanaEZAWA%2CMETI17-03BenchmarkingWorkshop.pdf>).

With this system, the government may compare energy intensities among companies and discern each industry's energy efficiency potential; conversely, each of the industries and companies can recognise its own energy efficiency potential. The whole process is based on a strong existing relationship between METI and Japanese industrial associations.

Synergies between uses and resiliency

Developing synergies can be an effective way to reduce energy needs and associated emissions. For example, waste heat from data centres may provide heat to office buildings or swimming pools, and waste heat from industrial sites may supply heat networks.

This coupling between systems is beneficial in normal operations and should be developed where possible. However, to avoid unacceptable disruptions or at least limit them, in case one of the systems fails, the resiliency of each system should be studied and adapted if necessary; if necessary, adapted backup systems may indeed have to be installed. More generally, resiliency at the strategic level as well as for everyday operation will be studied before the transformations for GHG emissions reduction are chosen.

RD&D

RD&D efforts are essential in all areas to provide new opportunities for the needed energy transition as well as to mitigate and adapt to the currently occurring climate change and all other resulting global changes.

RD&D efforts are not only required in the areas of technology, engineering, systems modelling and simulation but also in the complementary areas of humanities and social sciences - in particular but not only how technologies are perceived with their known and unknown benefits, advantages and disadvantages, and consequences. These key issues, however, mostly lie beyond the scope of this report.

Skills and competencies

All the members of the Committee and its Working Groups are convinced that training / professional development is a key issue: many jobs will disappear in the transition driven by GHG reductions while, others will change, and new ones are likely to appear. Therefore, some skills will no longer be needed while others will have to change/adapt, and new ones will be needed.

This issue concerns all educational systems in the world, starting from elementary school. It also involves updating skills and developing new ones during one's working life, in particular in engineering and technologies. This is a concern for large and small companies, and for society as a whole. A large effort is needed to rethink teachers'

training and provide more opportunities for lifelong learning both in educational institutions and in the internal training organisations of industrial and service companies.

Leadership, collaboration, networking and social issues

The urgency of the transformation that must be accomplished, the necessity for choices and agendas to be consistent with one another in different sectors, and the need for arbitration between multiple conflicting interests, call for effective leadership is and very high level in the different sectors. Collaboration and networking contribute to the development of confidence and sharing of best practices. Such is the role, for example, of city networks. Effective cooperation also lies in the different networks that link Academies in the world with one another, as CAETS does. Social issues are ubiquitous and essential but beyond the scope of this report, as already mentioned.

Annex

Three transversal levers for the transitions: heat pumps, hydrogen, LCA

Three different and important elements or tools may be applied to almost all sectors and are described below.

- Heat pumps form a family of systems mobilising local renewable heat from the air, the water or the ground. They are not yet as widely deployed as they could be.
- Hydrogen as an energy vector: the use of hydrogen and hydrogen-based molecules (synthetic fuels) may be regarded as a stimulating way to decarbonise several industrial processes that cannot be directly electrified.
- Life Cycle Assessment methods (LCA) help understand the global impact of processes and changes to such processes.

This annex briefly describes these three technologies, which are technical levers for the transition.

1. Heat pumps: a key technology family for the transition

In nature, heat flows from a warm body to a colder one. Heat pumps work the other way around: they transfer residual heat from cold places (making them even colder) to warm or warmer ones. Refrigerators and air-conditioning systems, well-known to many, are examples of common heat pumps.

- The refrigerator ‘pumps’ heat from the inside to keep it cool or cool it even more and expels it outside, generally in the kitchen, where the temperature is about 20 °C or more. It is thus at the same time slightly heating its environment.
- The air-conditioning system extracts heat from the inside of a house or any built structure, thus transferring it to the warmer area outside. At the same time it is thus also slightly heating the outside air.

Heat pumps, which are the reverse of air conditioning, are increasingly used for heating in northern countries in winter and reduce CO₂ emissions and lower energy consumption: in such a case, the heat pump extracts residual heat from the outside, where it is cold, transferring it to the inside, where it is already warmer. This application of heat pumps for heating is generally simply referred to as ‘heat pump’.

Heat pumps demystified

The heat pump operating principle is based on the three main ideas that rule the phase shift of a heat transfer fluid from liquid to gas and conversely.

1. To vaporise a liquid into gas, heat must be transferred to the liquid (as for example when water is boiled). Conversely, liquefying a gas releases heat.
2. The higher the pressure, the more heat is needed to vaporise a liquid since the generated gas has to overcome the external pressure. In other words, the temperature needed for the vaporisation of the liquid increases with the external pressure. Likewise, the liquefaction temperature of a gas thus increases with the pressure.
3. When you rapidly compress a gas, its temperature increases (as does for example the air in a bicycle pump).

The principle of the heat pump is to find a fluid that will, under certain pressure, vaporise at the outside temperature, and under higher pressure liquefy at the inside temperature, thus releasing heat inside: this requires low outside pressure (for vaporisation to capture heat) and high inside pressure (for liquefaction to release heat).

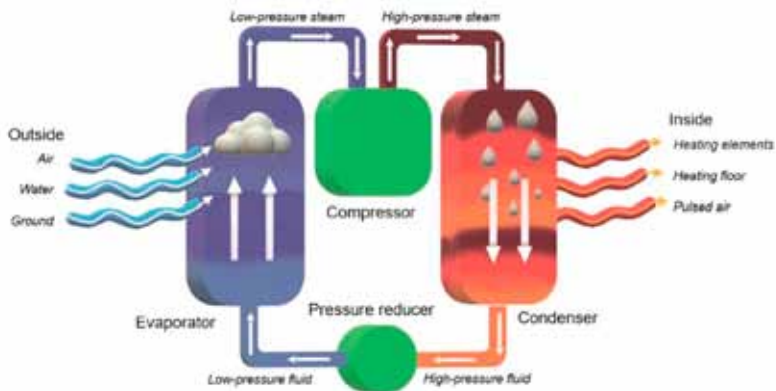


Fig. 0.4. Heat pump operating principle (© Püttgen-Bamberger) Reproduced with permission

A heat pump is thus composed of a fluid in a closed loop and:

- outside the home, a *low-pressure evaporator*, where the fluid arrives liquid and adsorbs the residual heat to vaporise;
- inside the home, a *compressor* ensuring the circulation and compression of the gas, where the temperature increases with increasing pressure;
- inside the home a *condenser*, where the gas releases heat;
- a *pressure reducer*, where the cooled gas returns to liquid before being pumped again to the outside evaporator to be vaporised again.

The key advantage of a heat pump is that it provides more heat than the energy consumed by the compressor. The ratio referred to as the Coefficient of Performance (COP) is regularly higher than 3. A COP equal to 3 means that the heat pump produces 3 kWh when only 1 kWh of electricity is consumed.

Gaining 2 kWh from the outside is generally considered as renewable energy even if a (very) little decrease of the outside temperature results from it. The COP depends on the inside and the outside temperature. It is higher when the temperature difference is lower. In addition, when the outside temperature decreases,

it becomes more difficult to recover heat and the COP decreases, which is clearly contrary to the desired output. This often imposes a limit to the temperature range in which heat pumps can work efficiently. This range is usually narrower than with direct heating.

Heat pumps are a broad family. They are characterised by the mediums from which the heat is extracted and to which it is provided. Heat pumps are referred to as air-air, air-water, etc., the first word designating the heat source, the second the medium where the heat is released. Some heat pumps are reversible and may be heating or cooling. Generally, one is more efficient than the other.

The heat transfer fluid, also known as the working fluid or coolant, is another important characteristic. Coolants themselves may be greenhouse gases which is a problem in the case of leakage. In an increasing number of countries, regulations impose coolants with low impact on climate change.

Heat pump ratings can range from a few kW to several MW. Their performance has been improving over the last 50 years, in particular for larger ranges of operation with higher COPs. They may be used for example:

- to heat or refresh apartments, houses, offices, and industrial processes
- to reuse waste heat from industrial processes by modifying their temperature
- to modify temperature from geothermal sources.

This short list suggests numerous potential applications for decarbonisation and reduction of energy consumption: comparing with a classical heating system using resistive heating, emission and consumption are divided by the COP value. If the COP is 3, then, compared to an efficient gas heating system emitting 200 gCO₂/kWh, the emissions from the heat pump system are lower, provided the electricity mix contains less than 600 gCO₂/kWh. This is the case in many regions since the average CO₂ content of 1 kWh in the world in 2019 was 485 g.

2. Hydrogen: a key vector to complete electricity

Hydrogen is a key chemical element in many industries such as petroleum refining and chemicals production. Currently, more than 95% of it is produced from fossil fuels, natural gas, petroleum and coal – by far the cheapest way to obtain it as will be detailed below. Hydrogen can yet also be produced from a wide range of energy sources and technologies, as highlighted in *Table 0.1*. The most commonly used colours to depict hydrogen are green, blue and gray, and also brown as in *Table 0.1*. below.

Hydrogen color spectrum	
Green: hydrogen produced by electrolysis of water, using electricity from renewable sources like hydropower, wind, and solar. Zero carbon emissions are produced.	Turquoise: hydrogen produced by the thermal splitting of methane. Instead of CO ₂ , solid carbon is produced.
Pink/purple/red: Hydrogen produced by electrolysis using nuclear power.	Black/gray: hydrogen extracted from natural gas using steam-methane reforming.
Yellow: hydrogen produced by electrolysis using grid electricity.	Blue: gray or brown hydrogen with its CO ₂ sequestered or repurposed.
White: hydrogen produced as a byproduct of industrial processes (i.e. fracking).	Brown: hydrogen extracted from fossil fuels, usually coal, using gasification.

Source: North American Council for Freight Efficiency, 2020.

Table 0.1. Hydrogen colour spectrum

Source: <https://nacfe.org/wp-content/uploads/2020/12/Hydrogen-Color-Spectrum-HiRes-2.png>

The cleanest versions, as it were, are 'green' and 'purple' hydrogen. Both are generated in relatively small quantities today by electrolysis, using electricity respectively from renewable energy sources and from nuclear energy.

The most common type of hydrogen is known as 'gray' hydrogen as its production releases significant amounts of greenhouse gases in the atmosphere. A cleaner proposed version is 'blue' hydrogen, which would still be produced from fossil sources but for which CO₂ emissions will be captured and geologically sequestered or reused, instead of being released into the atmosphere.

Gray hydrogen is mainly produced by the chemical conversion of methane at high temperatures. In some countries, significant amounts of hydrogen are produced from coal. The most common method of production is *Steam Methane Reforming* (SMR), where pure steam is used as the oxidant. Through endothermic (absorbing heat) reactions at 700-900 °C, methane and water are converted into hydrogen, carbon monoxide and carbon

dioxide ('synthesis gas').

Gray hydrogen can also be produced by one of the processes below.

- By the *Partial Oxidation* (POX) of methane or heavy hydrocarbons. The process takes place under high pressure and at high temperatures (up to 1 400 °C).
- By *Auto-Thermal Reforming* (ATR), a combination of steam reforming and partial oxidation. The advantage of the auto-thermal reaction is that it is not dependent on external heat supply. However, ATR benefits are offset by increased investment and operating costs for the air separation unit and a more complicated flue gas purification process.

Table 0.2. below presents the CO₂ emissions associated with the production of gray hydrogen in the best-case scenario (D. Jakobsen & V. Åtland, 2016).

Process	CO ₂ Emission (tonne CO ₂ / tonne H ₂)
SMR	8.5
POX	8.6
ATR	8.2

Table 0.2. CO₂ emission from H₂ production with natural gas for SMR, POX and ATR

To address the high CO₂ emissions of hydrogen plants, carbon capture, utilisation, and storage (CCUS) has been proposed. Different methods are possible, including an up to 90% reduction for the ATR plant. CCUS, however, increases natural gas consumption and plant operating costs and requires significant capital investment, which translates into higher costs for the production of hydrogen.

Adding CCUS to SMR plants results, on average, in increases of 50% for CAPEX and 10%-20% for energy, with the exact amounts depending on the design. It also leads on average to a doubling of OPEX as a result of CO₂ transport and storage costs. CCUS cost indications are given in the literature.

In the case of natural gas, costs from SMR with CCUS are in the range of USD 1.4–2.6 /kgH₂, compared to USD 1.0- 1.9/kgH₂ without CCUS (IEA, 2019), (IRENA, 2019). For more information on the current development of CCUS, which is beyond the scope of this short note, the reader may visit the IEA's website or the global CCS Institute Website (<https://www.globalccsinstitute.com>).

Water electrolysis is an electrochemical process that breaks down water into hydrogen and oxygen gases under the influence of a direct electric current. A product allowing the current to pass through the water, the electrolyte, has to be added. The oldest electrolysis technology, alkaline electrolysis, is mature. Two other types are differentiated by the electrolyte material and operating temperature. The main technical and economic characteristics of the three types of electrolysis and their acronyms are summarised Table 0.3..

The efficiency of the electrolysis process is defined as ratio of the Higher Heating Value of hydrogen (HHV) to the input electricity used by electrolysis per kilogram of hydrogen produced (Detlef Stolten, 2010).

	Alkaline electrolysis cells (AEC)	Proton exchange membrane electrolysis cell (PEMC)	Solid oxide electrolysis cells (SOEC)
Electrolyte	KOH/NaOH (liquid)	Polymer (solid)	Ceramic (solid)
Operating Pressure (bar)	2-10	15-30	<30
Operating Temperature (°C)	60-90 (up to 200)	50-90	500-1000
Stack Lifetime (h)	<90,000	<40,000	<40,000
System Lifetime (year)	20-30	10-20	-
Efficiency (HHV)	62-82%	67-84%	~90%
Cold Startup (min)	>15	<10	>60
Annual Degradation (%)	2-4	2-4	17
Cost at 2019 (US\$/kW)	500-1400	800-1800	> 2800
Target Cost by 2050 (\$/kW)	~574	~700	~200

Table 0.3. Source: Electrolyser key features (Kai Zeng, 2010) (Mergel, 2013) (Bertuccioli, 2014) (IEA, 2016) (Uosaki, 2017) (M. Carmoa, 2013), (IEA, 2019), (Nel, 2019) https://transitionenergetique.gouv.qc.ca/fileadmin/medias/pdf/expertises/Etude_hydrogene_Volet_B.pdf

As mentioned earlier, at present, the production cost of ‘green’ hydrogen is significantly higher than that of ‘gray’ hydrogen – up to 5 times or more. The magnitude of the cost differential depends on the cost of electricity at the point of production and the electrolysis technology used. The cost of electrolysers per kilo of produced hydrogen is decreasing, in particular through their increasing capacity: a 20 MW PEMC electrolyser producing 8.2 tonnes hydrogen a day is operated by Air Liquide since 2021.

Production parity cost between gray, blue and green hydrogen could be met in the present decade. The following figure from IRENA gives some projections concerning green hydrogen costs (see Fig. 0.5.).

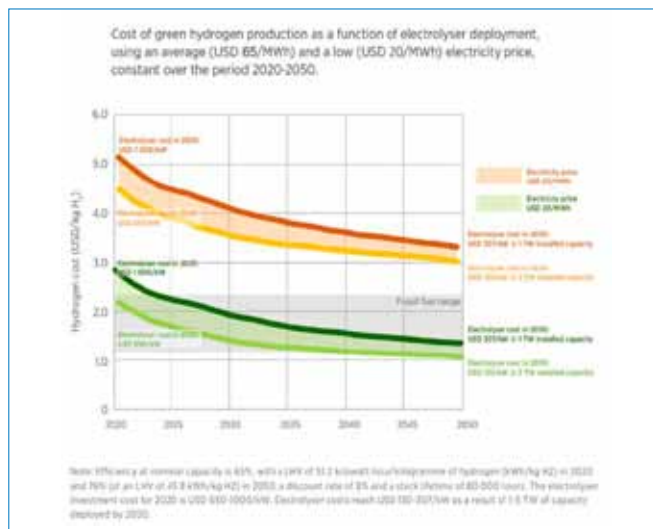


Fig. 0.5. Green hydrogen production costs projected by IRENA. © IRENA (2020), Green Hydrogen Cost Reduction: Scaling up Electrolysers to Meet the 1.5°C Climate Goal,

International Renewable Energy Agency, Abu Dhabi.

https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Dec/IRENA_Green_hydrogen_cost_2020.pdf

To complete this brief description on hydrogen production and cost, it is useful to compare the energy efficiency of electrolysis as a means to produce hydrogen with that of processes synthetically producing fuels,

respectively methane, diesel, methanol and ammonia, and combining electrolysis and supplementary chemical reactions (DNV 2019, Energy Transition Outlook (2020)). Such is the object of *Table 0.4.* below.

	Hydrogen	Synthetic methane (LNG)	Synthetic diesel	Synthetic methanol	Ammonia
Energy efficiency (%)					
Electrolysis	71	71	71	71	71
Power-to-gas process	-	75	-	-	87
Liquefaction	83	96	-	-	-
Power-to-liquid process	-	-	75	75	-
Overall efficiency	59	51	53	53	62

Table 0.4. Compared energy efficiency in per cent of different synthetically produced fuels

3. Life Cycle Assessment (LCA): a key methodology to analyse emissions

Life cycle assessment, or Life Cycle Analysis, both referred to as LCA, is an established method to model and quantify multiple input and output impacts on processes, products and services. The proper use of Life Cycle Assessments helps understand the effects of any change in a process, product, or technology. For example, it may be useful to assess whether any change to a process, such as trying to reduce its carbon intensity or the resulting GHG emissions, is effective and what its side effects may be. Indeed, well-intentioned actions to reduce the GHG emissions of a process or a product may often inadvertently produce the opposite effects.

LCAs are complex and are not perfect, and in many cases lead to different results. It is therefore critical for LCAs to be conducted using fully transparent assumptions and data sets, stating the accuracy of the inputs and estimating variabilities and uncertainties.

LCA is broadly defined by the ISO 14040:2006 standards⁹ as a “compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.” ISO 14040, however, does not provide specific recommendations on methods or tools for conducting an LCA since there are a wide variety of methods for it.

The 4 basic phases of an LCA are described below.

1. The first phase of a typical LCA according to ISO 14040 is the goal and scope definition phase, which lays out the basis for the LCA. In this phase, the modeller specifies the goal for conducting the analysis and the intended use. Typical goals could be: to quantify GHG emissions for different product or process options; to guide R&D; or to define regulatory regimes.
2. Detailed life-cycle inventory (LCI) analysis forms the second phase of an LCA. This may include overall material and energy balances, and a compilation of all relevant and available data throughout a well-defined LCA system boundary.
3. LCA impact assessment (LCIA) is the third phase. Data gathered in the second phase is used to calculate impact results for the chosen parameters, for example, tonnes of CO₂ emitted per unit of product or process. However, much broader desired output parameters may and should be used, such as societal, health, climate, and various other environmental effects. Life-Cycle GHG emissions may be calculated for any pollutant, or as the sum of equivalents of GHG compounds such as water vapour, CO₂, methane, N₂O, etc. In many studies, these are combined and reported as global warming potential (GWP) in the form of CO₂-equivalents (CO₂e).
4. The fourth usual phase of an LCA is the interpretation phase. Results are then used for reporting, further analysis, or guidance for formulating regulations.

⁹ <https://www.iso.org/standard/37456.html>

The LCA process tends to be iterative, as the initial results often highlight uncertainties and the need for additional data or improved modelling tools.

The main LCA types are Attributional, Consequential and Societal, but hybrids or combinations are numerous and common.

Attributional and Consequential LCAs are typically quite different from one another in their formulation, usage and results. *Fig. 0.6.* below sketches their conceptual difference.

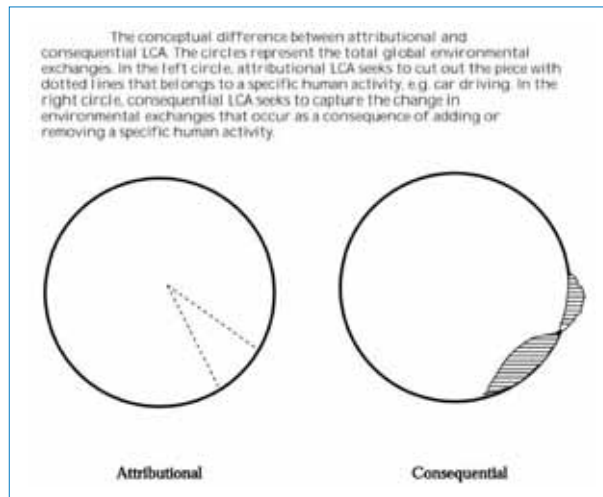


Fig. 0.6. The conceptual difference between Attributional and consequential LCAs (from Weidema BP. Market Information in Life Cycle Assessment. Environmental Project no. 863. Copenhagen: Danish Environmental Protection Agency; 2003. 147p. Page 15. <https://www2.mst.dk/Udgiv/publications/2003/87-7972-991-6/pdf/87-7972-992-4.pdf>)

A description of these differences may also be found in *Attributional vs. Consequential LCA Methodology Overview, Review and Recommendations with focus on Well-to-Tank and Well-to-Wheel Assessments*, a study commissioned by EUCAR to IFP Energies Nouvelles and Spheramodels¹⁰.

Regulators, indeed, use LCAs and, in doing so, aim at being comprehensive, using for example the ‘well-to-wheels’ approach. However, they do not capture all the rebound effects, unknowns, uncertainties or unintended consequences. Consequential LCA, also known as the CLCA model, is thus increasingly used to try to also take into account some of these indirect and follow-up effects. Still, this model is not really adapted for long-term prediction.

The IPCC uses the Integrated Assessment Model (IAM), or a version of LCA known as Societal-LCA, or S-LCA, which focuses on the demand side, impacts on societies and economies and climate change, and hence provides an insight into how real sustained reductions in energy use and GHG emissions may be achieved.

¹⁰ <https://www.eucar.be/wp-content/uploads/2020/08/20200820-EUCAR-Attributional-vs-Consequential-updated-2.pdf>

Part III - Who is Who

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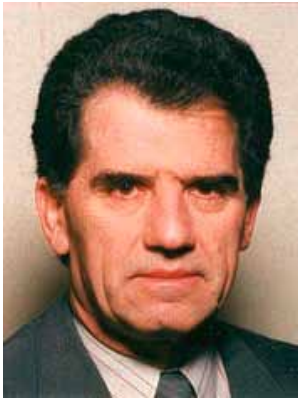
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Emeritus of the Academy (admitted 2000)

B.Sc. Civil Engineering (-), M.Sc. Civil Engineering (-),

Ph.D. Civil Engineering (-), all from the Faculty of Civil

Engineering, University of Zagreb

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Winter Concreting, Rapid Hardening of Concrete,
Durability of Concrete, High Quality of Concrete, Repair
of Concrete Structures, Properties of Concrete, Concrete
Technology, Realization of Concrete Structures


Biondić, Božidar, Prof. Emeritus Ph.D.

Born: 1940

Department of Civil Engineering and Geodesy
 Emeritus of the Academy (admitted 1994)
 B.Sc. Mining Engineering (1964), Faculty of Mining,
 Geology and Petroleum Engineering, University of
 Zagreb, M.Sc. Geology (1974), Ph.D. Geology (1982),
 Faculty of Science, University of Zagreb
 University of Zagreb, Faculty of Geotechnical
 Engineering, Varaždin, Hallerova aleja 7, 42000 Varaždin
 tel: +385 42 212228, fax: +385 42 313587
 e-mail: bbiondic@usa.net, bbiondic@gfv.hr
 Hydrogeology and Engineering Geology, Karst Water
 Protection, New Potable Water Resources, Water
 Management, Engineering Geological Research for
 Infrastructural Objects

*Deputy-Member of the Scientific Council (2017-2022) and
 (2022-2026)*


Biondić, Ranko, Prof. Ph.D.

Born: 1967

Associate of the Academy (2017)
 Department of Civil Engineering and Geodesy
 B.Sc. (1996), M.Sc. (2001), Ph.D. (2005), all from the
 Faculty of Mining, Geology and Petroleum Engineering,
 University of Zagreb.
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 e-mail: rbiondic@gfv.hr
 Hydrogeology and Engineering Geology, Karst
 Hydrogeology, Water Resources Protection and
 Management, Karst Aquifers Protection, GIS


Bogdan, Stjepan, Prof. Ph.D.

Born: 1965

Department of Systems and Cybernetics
 Associate of the Academy (admitted 2017)
 B.Sc. (1990), M.Sc. (1993), Ph.D. (1999), all from the
 Faculty of Electrical Engineering and Computing,
 University of Zagreb
 University of Zagreb, Faculty of Electrical Engineering
 and Computing, Unska 3, 10000 Zagreb
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 Autonomous Robotic Systems, Unmanned Aerial
 Vehicles, Discrete Event Systems

**Bogdan, Željko**, Prof. Ph.D.

Born: 1949

Department of Power Systems

Emeritus of the Academy (admitted 1998)

B.Sc. in Mechanical Engineering (1973), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, M.Sc. in Mechanical Engineering (1980), Tohoku University, Japan, Ph.D. in Mechanical Engineering (1987), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Ivana Lučića 5, 10000 Zagreb
 tel: +385 1 6168944, +385 1 6168222, fax: +385 1 6156940

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Mathematical Modeling, Simulation and Optimization of Thermo-hydraulic Processes in Power Equipment, Thermal Power Plants

Deputy-Secretary of the Department of Power Systems (2005-2009), (2009-2013) and (2013-2017)

**Bogunović, Nikola**, Prof. Ph.D.

Born: 1944

Department of Information Systems

Emeritus of the Academy (admitted 2002)

B.Sc. in Electrical Engineering (1967), M.Sc. in Electrical Engineering (1971), Ph.D. in Computing (1984) all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Formal Methods in the Design of Computing Systems, Semi-Automatic Knowledge Elicitation from Data and Signals with Application in Biomedical and Financial Domains

*Chairman of the Committee for Awards (2005-2009)
 Secretary of the Department of Information Systems (2005-2009)*


Bolanča, Stanislav, Prof. Emeritus Ph.D.

Born: 1946

Department of Graphical Engineering

Emeritus of the Academy (admitted 1998)

B.Sc. in Chemical Engineering (1971), M.Sc. in Chemical Engineering (1978), Ph.D. in Chemical Engineering (1981), all from the Faculty of Chemical Technology, University of Zagreb

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Secretary of the Department of Graphical Engineering (2009-2013)
Member of the Committee for Awards (2013-2017), (2017-2022) and (2022-2026)

Bolanča, Zdenka, Prof. Ph.D.

Born: 1945

Emerita of the Academy (admitted 1998)

Department of Graphical Engineering

B.Sc. in Chemistry (1970), M.Sc. in Chemistry (1972),

Ph.D. in Chemistry (1977), all from the Faculty of

Science, University of Zagreb

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Member of the Scientific Council (2013-2017), (2017-2022) and (2022-2026)

Bolanča Mirković, Ivana, Prof. Ph.D.

Born: 1976

Associate of the Academy (admitted 2019)

B.Sc. (2002), Faculty of Science, University of Zagreb,

M.Sc. (2005), Faculty of Graphics Arts, University of

Zagreb, Ph.D. (2007), Faculty of Graphics Arts, University of Zagreb

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Sustainability and New Graphics Technologies,
Sustainable Graphic Design, Graphic Technology and
Recovery Procedures Including Recycling, Durability of
Graphic Materials and Products, Sustainable Formulations
of the Graphic Materials

*Deputy-Secretary of the Department of Graphical
Engineering (2022-2026)*



Bolf, Nenad, Prof. Ph.D.

Born: 1968

Department of Chemical Engineering

Associate of the Academy (admitted 2017)

B.Sc. (1996), M.Sc. (1999), Ph.D. (2003), all from
the Faculty of Chemical Engineering and Technology,
University of Zagreb

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and Technology, Marulićev trg 19, 10000 Zagreb

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Advanced Process Control, Process Modeling, Process
Measurement, Monitoring & Diagnostics, Applied
Artificial Intelligence



Bonefačić, Davor, Prof. Ph.D.

Born: 1968

Department of Communication Systems

Full Member of the Academy (admitted 2004)

B.Sc. in Electrical Engineering (1993), M.Sc. in Electrical
Engineering (1996), Ph.D. in Electrical Engineering
(2000), all from the Faculty of Electrical Engineering and
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davor.bonefacic](http://www.fer.unizg.hr/davor.bonefacic)

Antennas, Microwaves, Wireless Communications,
Electromagnetic Compatibility (EMC), Electromagnetic
Interference (EMI), Radar systems

*Secretary of the Department of Communication Systems
(2013-2017) and (2017-2022)*

Member of the Committee for Awards (2022-2026)


Božanić, Rajka, Prof. Ph.D.

Born: 1968

 Department of Bioprocess Engineering
 Associate of the Academy (admitted 2020)
 B.Sc. (1991), M.Sc. (1996), and Ph.D. (2000), all from
 the Faculty of Food Technology and Biotechnology,
 University of Zagreb

 University of Zagreb, Faculty of Food Technology and
 Biotechnology, Pierottijeva 6, 10000 Zagreb
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 e-mail: rbozan@pbf.hr; http://www.pbf.unizg.hr/zavodi/zavod_za_prehrambeno_tehnolosko_inzenjerstvo/laboratorij_za_tehnologiju_mlijeka_i_mlijecnih_proizvoda/rajka_bozanic
 Milk and Dairy Products

Brkić, Vladislav, Assoc. Prof. Ph.D.

Born: 1967

 Department of Mining and Metallurgy
 Associate of the Academy (admitted 2019)
 B.Sc. (1993), Ph.D. (2011)

 University of Zagreb, Faculty of Mining, Geology and
 Petroleum Engineering, Pierottijeva 6, 10000 Zagreb
 e-mail: vbrkic@rgn.hr; vladislav.brkic@gmail.com
 Production of Oil, Gas and Geothermal Energy,
 Environmental Protection in the Oil Industry

Brnić, Josip, Prof. Emeritus Ph.D.

Born: 1951

 Department of Mechanical Engineering and Naval
 Architecture

 Emeritus of the Academy (admitted 1994)
 B.Sc. Mechanical Engineering (1976), Faculty of
 Engineering, University of Rijeka, M.Sc. Mechanical
 Engineering (1983), Faculty of Mechanical Engineering,
 University of Ljubljana, Ph.D. Mechanical Engineering
 (1988), Faculty of Engineering, University of Rijeka
 University of Rijeka, Faculty of Engineering, Vukovarska
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 Strength of Materials, Elastomechanics, Plastomechanics,
 Viskoplasticity, Fracture Mechanics, Experimental
 Mechanics, Finite Element Method

Member of the Scientific Council (2017-2022) and (2022-2026)

**Burum, Nikša**, Prof. Ph.D.

Born: 1963

Department of Communication Systems

Associate of the Academy (admitted 2017)

B.Sc. in Electrical Engineering (1987), M.Sc. in Electrical Engineering (1999), Ph.D. in Electrical Engineering (2004), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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e-mail: niksa.burum@unidu.hr**Butković, Mirko**, Prof. Emeritus Ph.D.

Born: 1936

Department of Mechanical Engineering and Naval Architecture

Emeritus of the Academy (admitted 1994)

B.Sc. in Mechanical Engineering (1961), M.Sc. in Mechanical Engineering (1971), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, M.Sc. in Mechanical Engineering (1973), Sever Institute, Washington University, St. Louis, USA, Ph.D.

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com

Mechanical Engineering, Technical Mechanics, Mechanical Vibrations, Strength of Materials, Mechanical Integrity of Machines, Machine Dynamics, Power Engineering

**Cerovac, Vesna**, Prof. Ph.D.

Born: 1942

Department of Transport

Emerita of the Academy (admitted 1993)

B.Sc. Civil Engineering, Faculty of Civil Engineering, University of Zagreb, Ph.D. (1976), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Traffic, Civil Engineering, Traffic Technology and Safety

*Secretary of the Department of Transport Systems (2009-2013) and (2013-2017)*


Cifrek, Mario, Prof. Ph.D.

Born: 1964

Department of Systems and Cybernetics

Full Member of the Academy (admitted 2005)

B.Sc. in Electrical Engineering (1987), M.Sc. in Electrical Engineering (1992), Ph.D. in Electrical Engineering (1997), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Sensors, Electronic Measurements and Instrumentation, Biomedical Engineering, Design and Manufacturing of Electronic Equipment, Biomedical Signal Measurement and Analysis

Deputy-Member of the Scientific Council (2013-2017)
Secretary of the Department of Systems and Cybernetics (2017-2022) and (2022-2026)

Čanadija, Marko, Prof. Ph.D.

Born: 1970

Department of Mechanical Engineering and Naval Architecture

Associate of the Academy (admitted 2021)

B.Sc. (1994), Ph.D. (2002)

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Thermomechanics, Nanomechanics, Computational Mechanics, Machine Learning, Plasticity


Čaušević, Mehmed, Prof. Emeritus Ph.D.

Born: 1945

Department of Civil Engineering and Geodesy

Emeritus of the Academy (admitted 2000)

B.Sc. Civil Engineering (1969), M.Sc. Civil Engineering (1973), Faculty of Civil Engineering, University of Belgrade, Ph.D. Civil Engineering (1977), Imperial College of Science and Technology, University of London

University of Rijeka, Faculty of Civil Engineering, Radmile Matejčić 3, 51000 Rijeka

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Earthquake Engineering, Steel Structures, Bridge Engineering, Engineering Mechanics, Design of Steel and Concrete Structures, Testing of Full-Scale Structures



Čavlina, Nikola, Prof. Ph.D.

Born: 1950

Department of Power Systems

Full Member of the Academy (admitted 1998)

B.Sc. in Electrical Engineering (1974), M.Sc. in Electrical Engineering (1979), Ph.D. in Electrical Engineering (1991), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Nuclear Energy and Technology, Nuclear Reactor Safety, Environmental Impact Assessment

Secretary of the Department of Power Systems (2009-2013) and (2013-2017)

Chairman of the Committee for International Cooperation (2017-2022)

Deputy-Member of the Scientific Council (2022-2026)



Čišić, Dragan, Prof. Ph.D.

Born: 1955

Department of Transport

Full Member of the Academy (admitted 2005)

B.Sc. in Electrical Engineering (1977), M.Sc. in Electrical Engineering (1982), Faculty of Electrical Engineering and Computing, University of Zagreb, Ph.D. in Marine Engineering (1999), Faculty of Maritime Studies, University of Rijeka

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Logistics, Supply Chain Management, e-Business, e-Commerce, Digital Economy



Črnko, Josip, Prof. Ph.D.

Born: 1943

Department of Mining and Metallurgy

Emeritus of the Academy (admitted 2002)

B.Sc. in Metallurgy (1967), M.Sc. in Chemistry and Technology of Silicates (1973), Ph.D. in Metallurgy (1978) all from the Faculty of Technology, University of Zagreb

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Separation of Metals from Secondary Raw Materials, Thermotechnology, Industrial Furnaces, Mathematical Models of Cooling of Steel Semiproducts, Possibilities of Structural Improvements in Heating Furnaces

Deputy-Secretary of the Department of Mining and Metallurgy (2002-2005), (2005-2009) and (2013-2017)
Secretary of the Department of Mining and Metallurgy (2009-2013)



Čunko, Ružica, Prof. Ph.D.

Born: 1946

Department of Textile Technology

Emerita of the Academy (admitted 1998)

B.Sc. in Textile Technology (1970), M.Sc. in Textile Technology (1976), Ph.D. (1980) all from the Faculty of Chemical Technology, University of Zagreb, Department of Chemical Technology of Textiles

D. Golika 32, 10000 Zagreb

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Development of New Textile Materials and Methods of Objective Evaluating them, Man-made Fibres Processing and Modification, Textile Quality Assurance and Quality Management Systems in Textile Technology, Eco-friendly Textiles and Environmental Management Systems in Textile Technology

Member of the Scientific Council (2013-2017) and (2017-2022)



Čosić, Kresimir, Prof. Ph.D.

Born: 1949

Department of Systems and Cybernetics

Emeritus of the Academy (admitted 2005)

B.Sc. in Electrical Engineering (1973), M.Sc. in Electrical Engineering (1978), Ph.D. in Electrical Engineering (1984), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Interactive Simulation Systems, Applied Virtual Reality (VR), Defense and Security Research and Development

Member of the Committee for Awards (2016-2017) and (2017-2022)



Čurković, Lidija, Prof. Ph.D.

Born: 1966

Department of Mechanical Engineering and Naval Architecture

Associate of the Academy (admitted 2017)

B.Sc. in Chemical Engineering and Technology (1990),

M.Sc. in Natural Sciences, scientific field Chemistry

(1995), Ph.D. in Natural Sciences, scientific field

Chemistry (1999), all from the University of Zagreb,

Faculty of Chemical Engineering and Technology

University of Zagreb, Faculty of Mechanical Engineering

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Materials Science and Engineering, Nanotechnology, Advanced Synthesis Processes, Characterization of Materials

Chairman of the Committee for Ethics (2022-2026)



Dalbela Bašić, Bojana, Prof. Ph.D.

Born: 1958

Department of Information Systems

Full Member of the Academy (admitted 2012)

B.Sc. in Mathematics (1982), Faculty of Science,

University of Zagreb, M.Sc. in Computer Science (1993),

Faculty of Electrical Engineering and Computing,

University of Zagreb, Ph.D. in Computer Science (1997),

Faculty of Electrical Engineering and Computing,

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e-mail: bojana.dalbelo@fer.hr; www.fer.unizg.hr/bojana.

dalbela-basic

Data Science, Machine Learning, Multivariate statistics,

Artificial Intelligence, Data and Text Mining, Natural

Language Processing


Damić, Vjekoslav, Prof. Emeritus Ph.D.

Born: 1941

Department of Systems and Cybernetics

Emeritus of the Academy (admitted 2004)

B.Sc. in Mechanical Engineering (1964), Faculty of

Mechanical Engineering, University of Sarajevo, Ph.D.

in Electrical Engineering (1985), Faculty of Electrical

Engineering, University of Sarajevo

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Mathematical and Computer Modeling and Simulations,

Bond Graph Modeling, Engineering Graph Modeling


Debrecin, Nenad, Prof. Ph.D.

Born: 1953

Department of Power Systems

Full Member of the Academy (admitted 1999)

B.Sc. in Electrical Engineering (1975), M.Sc. in Electrical

Engineering (1984), Ph.D. in Electrical Engineering

(1997), all from the Faculty of Electrical Engineering and

Computing, University of Zagreb

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Heat Transfer, Nuclear Power Plants, Accident Analysis,

Nuclear Power Plant Simulation, System Thermal-

hydraulic Codes, Uncertainty Analysis

**Dobrilović, Mario, Prof. Ph.D.**

Born: 1972

Department of Mining and Metallurgy

Associate of the Academy (admitted 2019)

B.Sc. (1999), Ph.D. (2008)

University of Zagreb, Faculty of Mining, Geology and

Petroleum Engineering, Pierottijeva 6, 10000 Zagreb

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Civil Blasting Technologies, Industrial Application
of Explosives, Environmental Influences of Blasting,
Demolition by Blasting, Underground Chambers and
Tunnel Excavation*Secretary of the Department of Mining and Metallurgy
(2022-2026)***Domazet, Željko, Prof. Ph.D.**

Born: 1954

Department of Mechanical Engineering and Naval
Architecture

Full Member of the Academy (admitted 1998)

B.Sc. in Mechanical Engineering (1978), M.Sc. in
Mechanical Engineering (1986), Ph.D. in Mechanical

Engineering (1993), all from the Faculty of Mechanical

Engineering and Naval Architecture, University of Zagreb

University of Split, Faculty of Electrical Engineering,

Mechanical Engineering and Naval Architecture, Ruđera
Boškovića bb, 21000 Split

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e-mail: zeljko.domazet@fesb.hr; [http://www.fesb.
hr/~domazet](http://www.fesb.hr/~domazet)Mechanical Engineering, Naval Architecture, Steel
Structures, Fatigue Strength of Materials, Fracture
Mechanics*Deputy-Secretary of the Department of Mechanical
Engineering and Naval Architecture of the Academy
(2013-2017)**Member of the Committee for Economic and Regional Co-
operation (2013-2017)**Secretary of the Department of Mechanical Engineering
and Naval Architecture of the Academy (2017-2022)**Member of the Committee for Awards (2022-2026)*

**Dragčević, Zvonko, Prof. Emeritus Ph.D.**

Born: 1946

Department of Textile Technology

Emeritus of the Academy (admitted 2007)

B.Sc. in Textile Technology (1971), M.Sc. in Textile Technology (1976), Ph.D. in Textile Technology (1981), all from the Faculty of Textile Technology, University of Zagreb

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Industrial Engineering, Ergonomics, Technical Textile, Corrosion and Protection of Materials

Chairman of the Committee for Awards (2013-2017)

Member of the Committee for Awards (2017-2022)

Member of the Science Foundation Committee (2013-2017) and (2017-2022)

**Dragović-Uzelac, Verica, Prof. Ph.D.**

Born: 1970

Department of Bioprocess Engineering

Associate of the Academy (admitted 2017)

B.Sc. in Biotechnology (1993), M.Sc. in Biotechnology (1998), Ph.D. in Biotechnology (1996), all from the Faculty of Food Technology and Biotechnology, University of Zagreb

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Food Technology, Novel Technique, Nutrition, Functional Food, Bioactive Molecules

Member of the Committee for Economic and Regional Cooperation (2022-2026)

**Duić, Neven**, Prof. Ph.D.

Born: 1965

Department of Power Systems

Full Member of the Academy (admitted 2002)

B.Sc. in Mechanical Engineering (1990), M.Sc. in Mechanical Engineering (1993), Ph.D. in Mechanical Engineering (1998), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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 e-mail: Neven.Duic@fsb.hr; <http://powerlab.fsb.hr/neven>
 Energy Policy and Planning, Climate Change Mitigation, Energy Economics, Sustainable Development Policy and Resource Planning, Research and Innovation Policy, Combustion Engineering and Modelling

*Member of the Scientific Council (2010-2013)**Member of the Committee for International Cooperation (2013-2017)**Secretary of the Department of Power Systems (2017-2022)**Vice-President of the Academy (2022-2026)***Dujmović, Darko**, Prof. Ph.D.

Born: 1954

Department of Civil Engineering and Geodesy

Full Member of the Academy (admitted 2009)

B.Sc. in Civil Engineering (1978), M.Sc. in Civil Engineering (1989), Ph.D. in Civil Engineering (1996) all from the Faculty of Civil Engineering, University of Zagreb

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**Đapo, Almin**, Assoc. Prof. Ph.D.

Born: 1974

Department of Civil Engineering and Geodesy

Associate of the Academy (admitted 2019)

B.Sc. (2000), Ph.D. (2009), all from the Faculty of Geodesy, University of Zagreb

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Deputy-Secretary of the Department of Civil Engineering and Geodesy (2022-2026)



Fajt, Siniša, Prof. Ph.D.

Born: 1963

Department of Electrical Engineering and Electronics

Full Member of the Academy (admitted 2002)

B.Sc. in Electrical Engineering (1989), M.Sc. in Electrical Engineering (1994), Ph.D. in Electrical Engineering (2000), all from the Faculty of Electrical Engineering, University of Zagreb

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Acoustics, Electro Acoustics, Audio Techniques, Sound Broadcasting, Architectural Acoustics, Processing of Acoustical Signals in Communications

Deputy-Secretary of the Department of Electrical Engineering and Electronics (2013-2016)

Member of the Scientific Council (2017-2022)



Ferić, Miljenko, Prof. Emeritus Ph.D.

Born: 1936

Department of Mechanical Engineering and Naval Architecture

Emeritus of the Academy (admitted 1998)

B.Sc. Mechanical Engineering (1962), Faculty of Engineering, University of Zagreb, Ph.D. in naval architecture (1989), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Transport Machinery, Road Vehicles, Ship Hydrodynamics – Model Tests, Basin Experiments Ship Structure – Strength and Vibrations

**Fertalj, Krešimir**, Prof. Ph.D.

Born: 1964

Department of Information Systems

Full Member of the Academy (admitted 2007)

B.Sc. in Electrical Engineering (1988), M.Sc. in Computer Science (1993), Ph.D. in Computing (1997) all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Information Systems, Project Management, Software Engineering, Software Security

Secretary of the Department of Information Systems (2009-2013)**Filetin, Tomislav**, Prof. Emeritus Ph.D.

Born: 1949

Department of Mechanical Engineering and Naval Architecture

Emeritus of the Academy (admitted 1994)

B.Sc. in Mechanical Engineering (1973), M.Sc. in Mechanical Engineering (1979), Ph.D. in Mechanical Engineering (1986), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb
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Selection of Materials, Heat Treatment of Metals, Recycling of Materials, Modeling of Materials Properties

*Vice-President of the Academy (2001-2005)**Head of the Centre for Lifelong Education (2005-2015)*

**Firšt Rogale, Snježana, Prof. Ph.D.**

Born: 1968

Department of Textile Technology

Full Member of the Academy (admitted 2017)

B.Sc. (1994), M.Sc. (2002), Ph.D. (2007), all from the

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e-mail: sfrogale@tff.unizg.hr; <https://www.tff.unizg.hr/en/teachers-and-associates/snjezana-first-rogale/17>Processes of Clothing Production, Intelligent Clothing,
Clothing Thermal Properties, High-tech Joining Methods
of Textile*Member of the Scientific Council (2022-2026)*

**Frančula, Nedjeljko, Prof. Emeritus Ph.D.**

Born: 1937

Department of Civil Engineering and Geodesy

Emeritus of the Academy (admitted 1998)

B.Sc. in Geodesy (1962), Faculty of Architecture, Civil
Engineeringand Geodesy, University of Zagreb, Ph.D. in Geodesy
(1971),

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Geodesy, Cartography, Map Projections, Digital

Cartography, Geoinformatics, Cartographic

Generalization, Future of Geodesy and Surveying

**Franekić, Jasna**, Prof. Ph.D.

Born: 1945

Department of Bioprocess Engineering

Emerita of the Academy (admitted 1994)

B.Sc. in Biology (1969) Faculty of Science, University of Zagreb, M.D. (1982), School of Medicine, University of Zagreb, Ph.D. in Biology (1987), Faculty of Science, University of Zagreb

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Genetic Toxicology, Ecotoxicology, Genotoxicity
Action of Environmental Agents Antimutagenicity of
Glucosinolates*Secretary of the Department of Bioprocess Engineering
(2005-2009) and (2009-2013)**Member of the Committee for Awards (2013-2017)***Franković, Bernard**, Prof. Ph.D.

Born: 1946

Department of Power Systems

Emeritus of the Academy (admitted 1998)

B.Sc. in Mechanical Engineering (1971), Faculty of Mechanical Engineering Rijeka, University of Zagreb, M.Sc. in Mechanical Engineering (1978), Ph.D. in Technical Sciences (1990), both from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Applied Thermodynamics, Heat Transfer: Heat Conduction, Heat Convection and Evaporation, Heat Radiation, Heat and mass Transfer, Heat Exchangers, Regenerations, Renewable Energy

*Deputy-Member of the Scientific Council (2013-2017) and
(2017-2022)*

**Frece, Jadranka, Prof. Ph.D.**

Born: 1974

Department of Bioprocess Engineering

Associate of the Academy (admitted 2017)

B.Sc. in Food technology, Biochemical Engineering (1997), M.Sc. in Biotechnical Sciences, Scientific field of Biotechnology (2003), Ph.D. in Biotechnical Sciences, Scientific field of Biotechnology (2007) all from the Faculty of Food Technology and Biotechnology, University of Zagreb

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Microbiology, Probiotics, Lactic Acid Bacteria, Bioconservation, Starter Cultures

**Galić, Irena, Prof. Ph.D.**

Born: 1974

Department of Communication Systems

Associate of the Academy (2017)

B.Sc. in Mathematics and Computer Science (1999), University of Osijek, M.Sc. in Computer Science (2004), University of Saarland, Ph.D. in Electrical Engineering (2011), University of Osijek

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Visual Computing, Computer Graphics, Image Compression, Partial Differential Equations, Variational Methods, Artificial Intelligence, Image Processing, Medical Image Analysis

Member of the Committee for International Co-operation (2022-2026)

**Galović, Antun**, Prof. Ph.D.

Born: 1950

Department of Mechanical Engineering and Naval Architecture

Emeritus of the Academy (admitted 1998)

B.Sc. in Mechanical Engineering (1974), M.Sc. in Mechanical Engineering (1979), Ph.D. in Mechanical Engineering (1985), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb
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Technical Thermodynamics, Temperature Fields in Solids, Heat Exchange in Fluidized Beds, Exergy and Entropy Analysis in Thermo Processes Irreversibilities

Deputy-Secretary of the Department of Mechanical Engineering and Naval Architecture (2017-2022)

**Gaurina-Međimurec, Nediljka**, Prof. Ph.D.

Born: 1957

Department of Mining and Metallurgy

Full Member of the Academy (admitted 2002)

B.Sc. in Petroleum Engineering (1980), Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, M.Sc. in Petroleum Engineering (1986) from Faculty of Mining and Geology, University of Belgrade, Ph.D in Petroleum Engineering (1993), Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb
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Drilling Technology, Drilling Fluids, Well Cementing, Workover and

Completion Fluids, Environment Protection in Petroleum Engineering, Waste Management in Petroleum Engineering

Member of the Scientific Council of the Academy (2013-2017) and (2022-2026)

Secretary-General of the Academy (2017-2018)

**Glasnović, Antun**, Prof. Ph.D.

Born: 1948

Department of Chemical Engineering

Emeritus of the Academy (admitted 2009)

B.Sc. in Chemical Engineering (1972), M.Sc. in Chemical Engineering (1974), Ph.D. in Chemical Engineering (1980), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Separation Processes; Characterization of System, Design and Operation of Separation and Contacting Processes (Comminution, Filtration, Drying, Crystallization, Mixing), Newton and Nonnewton Fluid Dynamic, Suspension, Rheology

*Secretary of the Department of Chemical Engineering (2013-2017)**Deputy-Member of the Scientific Council (2017-2022) and (2022-2026)***Goić, Ranko**, Prof. Ph.D.

Born:

Department of Power Systems

Associate of the Academy (admitted 2021)

B.Sc. (1992), Ph.D. (2002), all from the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split

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**Gold, Hrvoje, Prof. Ph.D.**

Born: 1951

Department of Transport

Full Member of the Academy (admitted 2015)

B.Sc. in Electrical Engineering (1974), M.Sc. in Electrical Engineering (1979), both from the Faculty of Electrical Engineering and Computing, University of Zagreb, Ph.D. in Transport and Traffic Technology (1994) Faculty of Transport and Traffic Sciences, University of Zagreb
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Intelligent Transportation Systems, Transport Optimization, Remote Sensing

Secretary of the Department of Transport (2017-2022) and (2022-2026)

**Gomzi, Zoran, Prof. Emeritus Ph.D.**

Born: 1940

Department of Chemical Engineering

Emeritus of the Academy (admitted 1993)

B.Sc. in Chemical Engineering (1963), Ph.D. in Chemical Engineering (1975), all from the Faculty of Chemical Engineering and Technology, University of Zagreb University of Zagreb, Faculty of Chemical Engineering and Technology, Marulićev trg 19, 10000 Zagreb
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Chemical Engineering, Chemical Reaction Engineering, Kinetics and modeling, Process Design and Development, Mathematical Modeling, Education

Secretary of the Department of Chemical Engineering and the Related Fields (2000-2003)

Member of the Scientific Council (2010-2013) and (2013-2017)

**Grancarić, Ana Marija, Prof. Emerita Ph.D.**

Born: 1943

Department of Textile Technology

Emerita of the Academy (admitted 1998)

B.Sc. (1967), M.Sc. (1974) and Ph.D. (1979), all from the Faculty of Textile Technology, University of Zagreb University of Zagreb, Faculty of Textile Technology, Prilaz baruna Filipovića 28a, 10000 Zagreb
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Member of the Committee for International Co-operation (2013-2017) and (2017-2022)



Granić, Goran, Assist. Prof. Ph.D.

Born: 1950

Department of Power Systems

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B.Sc. in Electrical Engineering (1972), M.Sc. in Electrical Engineering (1976), Ph.D. in Electrical Engineering (1979) all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Electrical Engineering, Strategic Energy Planning, Energy Legislation,

Power System Planning and Scheduling, Energy Sector Organization and Management, Energy Supply Costs and Energy Pricing Policy

Chairman of the Committee for Development and Regional Relations (2005-2009)

Secretary-General of the Academy (2005-2009) and (2009-2013)

Member of the Science Foundation Committee (2013-2017)



Grbac, Ivica, Prof. Emeritus Ph.D.

Born: 1955

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2004)

B.Sc. Forestry (1978), M.Sc. Forestry (1985), Ph.D. Forestry (1988), all from the Faculty of Forestry, University of Zagreb

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Furniture and Medicine Design, Construction and Quality of Wood Products, Interdisciplinary Research, Forestry, Wood Industry

Member of the Committee for Ethics (2013-2017) and (2017-2022)

**Grbavac, Vitomir**, Prof. Ph.D.

Born: 1954

Department of Transport

Full Member of the Academy (admitted 2004)

B. Sc. (1980), Faculty of Organization and Informatics, University of Zagreb, B.Sc. law (1984), Faculty of Law, Zagreb, Ph.D Law (1986), Faculty of Law, University of Zagreb

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Information and Communication Systems in Traffic, Information Systems, Evolution of Information Technology, Development Computer Systems, e-Education in Traffic

**Grgić, Davor**, Prof. Ph.D.

Born: 1959

Department of Power Systems

Associate of the Academy (admitted 2002)

B.Sc. in Electrical Engineering (1981), M.Sc. in Electrical Engineering (1989), Ph.D. in Electrical Engineering (2001), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Nuclear Power Plants

*Member of the Scientific Council (2017-2022)**Member of the Committee for Ethics (2022-2026)***Grgić, Mislav**, Prof. Ph.D.

Born: 1973

Department of Communication Systems

Full Member of the Academy (admitted 2004)

B.Sc. in Electrical Engineering (1997), M.Sc. in Electrical Engineering (1998), Ph.D. in Electrical Engineering (2000), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Image and Video Compression, Digital Mammography, Face Recognition

Member of the Committee for International Co-operation (2009-2013)



Grgić, Sonja, Prof. Ph.D.

Born: 1965

Department of Communication Systems

Full Member of the Academy (admitted 1998)

B.Sc. in Electrical Engineering (1989), M.Sc. in Electrical Engineering (1992), Ph.D. in Electrical Engineering (1996), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Digital Image and Video Processing, Picture Quality Assessment, Digital Television

Secretary of the Department of Communication Systems (2009-2013)

Member of the Committee for Awards (2013-2017) and (2017-2022)

Deputy-Member of the Scientific Council (2017-2022) and (2022-2026)



Guzović, Zvonimir, Prof. Ph.D.

Born: 1958

Department of Power Systems

Full Member of the Academy (admitted 2017)

B.Sc. in Mechanical Engineering (1982), M.Sc. in Mechanical Engineering (1988), Ph.D. in Mechanical Engineering (1998), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Aerodynamics, Thermodynamics and Heat transfer in Steam and Gas Turbines; Small Hydro, Geothermal and Wind Power Plants

Deputy-Chairman of the Committee for International Cooperation (2022-2026)

Deputy-Secretary of the Department of Power Systems (2022-2026)

**Herceg, Zoran**, Prof. Ph.D.

Born: 1969

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2013)

B.Sc. in Biotechnical Sciences (1994), M.Sc. (1997),
Ph.D. in Food Technology (2000), all from the Faculty
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Biotechnology, Pierottijeva 6, 10000 Zagreb

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Food Engineering, Innovative Technique of Food
Processing*Head of Biotechnical Center (2017-2022)**Member of the Program Committee of the Center for
Technological Development (2022-2026)***Hnatko, Emil**, Prof. Ph.D.

Born: 1941

Department of Transport

Emeritus of the Academy (admitted 2004)

B.Sc. in Mechanical Engineering (1966), Faculty of
Mechanical Engineering, University of Belgrade, M.Sc.
in Mechanical Engineering (1973), Faculty of Mechanical
Engineering and Naval Architecture, University of
Zagreb, Ph.D. in Mechanical Engineering (1982), Faculty
of Engineering, University of KragujevacUniversity of Osijek, Faculty of Mechanical Engineering,
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e-mail: ehnatko@sfsb.hr; <http://www.sfsb.hr/kem/hnatko/hnatko.htm>Engines and Vehicles, Thermodynamics and Construction,
Maintenance of Internal Combustion Engines and Motor
Vehicles*Deputy-Member of the Scientific Council (2013-2017)**Member of the Committee for Ethics (2017-2022)*


Hocenski, Željko, Prof. Ph.D.

Born: 1952

Department of Systems and Cybernetics

Associate of the Academy (admitted 2012)

B.Sc. in Electrical Engineering (1976), M.Sc. in Electrical Engineering (1984), Ph.D. in Electrical Engineering (1996), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Computer Design, Diagnostics, Reliability, Fault Tolerance, Automation, Process Control, Image Processing


Horvat, Predrag, Prof. Ph.D.

Born: 1953

Department of Bioprocess Engineering,

Full Member of the Academy (admitted 2009)

B.Sc. Biotechnology (1976), M.Sc. Biotechnology (1980), Ph.D. Biotechnology (1989), all from the Faculty of Food Technology and Biotechnology, University of Zagreb

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Bioprocess Engineering, Industrial Biotechnology


Hraste, Marin, Academician

Born: 1938

Department of Chemical Engineering

Emeritus of the Academy (admitted 1993)

B.Sc. in Chemical Engineering (1962), M.Sc. in Chemical Engineering (-1969), Ph.D. in Chemical Engineering (1972), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Chemical Engineering, Unit Operation Transport Phenomena, Engineering of Particulate Systems: Particle Systems and Use of their Description to Predict Behavior in a Given Geometrical Shape

Secretary of the Department of Chemical Engineering of the Academy (1993-1997)

**Hruškar, Mirjana, Prof. Ph.D.**

Born: 1966

Department of Bioprocess Engineering

Associate of the Academy (admitted 2017)

B.Sc. (1991), M.Sc. in Biotechnical Sciences (1997),

Ph.D. in Biotechnical Sciences (2001), all from the

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Food Safety, Food Quality, Food Analysis, Sensory

Analysis, Quality Management

**Ilić, Ivan, Prof. Emeritus Ph.D.**

Born: 1934

Department of Electrical Engineering and Electronics

Emeritus of the Academy (admitted 1994)

B.Sc. Electrical Engineering (1956), Ph.D. Electrical

Engineering (1972), all from the Faculty of Electrical

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Electrical Engineering, Electrical Machines, Drive

**Ivanjko, Edouard, Prof. Ph.D.**

Born: 1977

Department of Transport

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(2022-2026)*

**Jakobović, Domagoj, Prof. Ph.D.**

Born: 1973

Department of Information Systems

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B.Sc. (1996), Ph.D. (2005), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Deputy-Secretary of the Department of Information Systems (2022-2026)

**Jambrekočić, Vladimir, Prof. Ph.D.**

Born: 1962

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2015)

B.Sc. in Wood technology (1991), M.Sc. Scientific Area of Biotechnical Sciences, Scientific Field of Wood Technology (1996), Ph.D. Scientific Area of Biotechnical Sciences, Scientific Field of Forestry (2000), all from the Faculty of Forestry, University of Zagreb

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Wooden Composite Materials

Deputy-Head of the Biotechnical Center (2017-2022)

**Janović, Zvonimir**, Prof. Ph.D.

Born: 1933

Department of Chemical Engineering

Emeritus of the Academy (admitted 1994)

B.Sc. Chemical Engineering (1958), M.Sc. Chemical Engineering (1966), Ph.D. Chemical Engineering (1969), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Chemical Engineering, Petrochemistry, Polymer Materials, Petrochemical Processes and Products, Polymerization Processes, High Performance Polymeric Materials, Rheological Modifiers

Secretary of the Department of Chemical Engineering of the Academy (2005-2009)**Jelaska, Damir**, Prof. Ph.D.

Born: 1947

Department of Mechanical Engineering and Naval Architecture

Emeritus of the Academy (admitted 1998)

B.Sc. Mechanical Engineering (1971), M.Sc. Mechanical Engineering (1980), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Ph.D.

Mechanical Engineering (1982), Faculty of Engineering, University of Rijeka

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Mechanical Engineering Design, Operational Strength, Gear Design, Damage Tolerant Design, Reliability, Fatigue Life Prediction, Mean Stress Influence on Fatigue Assessment, Fatigue Assessment at Combined HCF/LCF Loadin

Jerbić, Bojan, Academician

Born: 1957

Department of Systems and Cybernetics

Full Member of the Academy (admitted 2007)

B.Sc. Mechanical Engineering (1983), M.Sc. Mechanical Engineering (1987), Ph.D. Mechanical Engineering (1993), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb
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Robotics, Artificial Intelligence, Computer Methods in Designing and Programming of Automatic Systems

Secretary of the Department of Systems and Cybernetics (2013-2017)

Member of the Committee for International Co-operation (2013-2017)

Chairman of the Committee for Awards (2017-2022)

Deputy-Secretary of the Department of Systems and Cybernetics (2017-2022)

Member of the Committee of Science Foundation (2017-2022)

Ježek, Damir, Prof. Ph.D.

Born: 1966

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Heat Exchanger, Fluidization, Extrusion, Texture Analysis, Ultrasound, High Hydrostatic Pressure

Member of the Committee for Economic and Regional Co-operation (2013-2017)

Deputy-Chairman of the Committee for Economic and Regional Co-operation (2017-2022)

**Jirouš-Rajković, Vlatka, Prof. Ph.D.**

Born: 1963

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2015)

B.Sc. (1986), M.Sc. (1991), Ph.D. (1998) all from Faculty of Forestry, University of Zagreb

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Wood Finishing, Wood Surface Modifications, Durability of the Coating-wood System

*Deputy-Member of the Scientific Council (2017-2022)**Chairman of the Committee for Awards (2022-2026)***Jokić, Andrej, Prof. Ph.D.**

Born: 1976

Department of Systems and Cybernetics

Associate of the Academy (admitted 2019)

B.Sc. (2002), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Ph.D. (2007), TU Eindhoven, The Netherlands

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e-mail: andrej.jokic@fsb.hr*Deputy-Secretary of the Department of Systems and Cybernetics (2017-2022) and (2022-2026)***Jokić, Stela, Prof. Ph.D.**

Born: 1982

Department of Bioprocess Engineering

Associate of the Academy (admitted 2019)

B.Sc. (2006), Ph.D. (2011)

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Innovative Green Extraction Techniques, Medicinal Herbs, Isolation of Bioactive Compounds, Food Industry Byproducts, Process Optimization

Member of the Committee for International Co-operation (2022-2026)



Joler, Miroslav, Prof. Ph.D.

Born: 1970

Department of Communication Systems

Associate of the Academy (admitted 2017)

B.Sc. (1996), University of Zagreb, M.Sc. (2001),

University of New Mexico, Albuquerque, NM, USA,

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Wearable and Adaptive Antennas and Circuits, Biomedical Applications of Electromagnetics, Urban Models of Wireless Power Transfer, IoT



Jović, Franjo, Prof. Ph.D.

Born: 1940

Department of Systems and Cybernetics

Emeritus of the Academy (admitted 1993)

B.Sc. Electrical Engineering (1963), M.Sc. Electrical

Engineering (1967), Ph.D. Electrical Engineering (1972),

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Process Control, Artificial Intelligence, Information Processing, Functional Networks, Process Monitoring, System Modeling, Qualitative Modeling

Chairman of the Committee for Ethics of the Academy (2009-2013) and (2013-2017)

Deputy-Secretary of the Department of Systems and Cybernetics of the Academy (2013-2017)

**Jugović, Alen**, Prof. Ph.D.

Born: 1976

Department of Transport

Associate of the Academy (admitted 2019)

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e-mail: ajugovic@pfri.hrPort and Ship Economics, Logistics, Entrepreneurship,
Seaborne Passenger Traffic**Jukić, Ante**, Prof. Ph.D.

Born: 1971

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Associate of the Academy (admitted 2017)

B.Sc. (1997), M.S. Chem. (2001), Ph.D. Chem. Eng.

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e-mail: ajukic@fkit.hrPolymerization Processes, Functional and Nanostructured
Polymer Materials, Energy and Fuels*Deputy-chairman of the Council of the Centers (2017-2022)**Deputy Head of the Center for Environmental Protection**and Development of Sustainable Technologies (2017-2022)***Jukić, Tihomir**, Prof. Emeritus Ph.D.

Born: 1954

Department of Architecture and Urban Planning

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B.Sc. in Architecture (1979), M.Sc. in Architecture

(1985), Faculty of Architecture, University of Zagreb,

M.Sc. in Architecture, Faculty of Architecture, University

of Twente, Ph.D. in Architecture (1998), Faculty of

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Urbanism, Environmental Planning

*Secretary of the Department of Architecture and Urban
Planning (2009-2013) and (2013-2017)**Deputy-Member of the Scientific Council (2017-2022) and
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Born: 1942

Department of Architecture and Urban Planning

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Regional and Landscape Planning, Urban and Landscape Design

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Operational Research, Mathematical Modelling, Data Modelling, Software for Linear Programming and Related Fields, Production Planning Software, Business Process Reengineering, Information Systems, Natural Language Processing


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Biomechanics, Aneurysm, Aorta, Numerical Modeling, the Finite Elements


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Hydrography, Reambulation, Maritime Safety, Maritime Forensic, Electronic Navigation


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Theoretic and Applied Electrical Engineering, R/D in Power and Instrument Transformers as Products, Power and Instrument Transformers in Interaction with Networks, Development of Power and Instrument Transformers for Voltages up to 400 kV

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Information Science, Intelligent Systems, Data Science, Multimedia Systems, Complex Systems, Information Technology in Tourism

Member of the Committee for Economic and Regional Cooperation (2022-2026)**Knezić, Željko**, Assoc. Prof. Ph.D.

Born: 1958

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Innovative Development and Rationalization of Production Processes and Maintenance Procedures in the Textile and Clothing Industry, Teaching and Promotion of the Preservation of Croatian Traditional Hand Weaving, Designing and Making Devices for Simpler Hand Weaving, Development and Application of Electronic Components in Textiles and Clothing, Development of Measuring Systems for Determining the Properties of Textile Flat Products

Member of the Committee for Economic and Regional Cooperation (2022-2026)

**Kniewald, Zlatko**, Prof. Emeritus Ph.D.

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Department of Bioprocess Engineering

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BioChemical Engineering, Cell Culture Technology, Endocrine Secretion and Regulation, Science Policy, Intellectual Property Protection

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Chairman of the Committee of the Scientific Foundation (2009-2013)*

Head of the Biotechnical Center (2003-2005), (2005-2009) and (2009-2013)

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Maritime Technology, Shipping, Environmental Sea Protection, Port and Harbour Facilities, Sea Navigation, Simulation and Simulators, Mathematical Models of Optimum Tanker Size, Routing Systems in the Adriatic Sea (Separation Lanes), Safety of Navigation


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Department of Power Systems

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Electric Power Systems, Electric Power Networks, Distribution Networks, Liberalization of Energy Markets, Power Engineering


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Department of Systems and Cybernetics

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B.Sc. in Naval Architecture (1971), M.Sc. in Naval Architecture (1981), Ph.D. in Naval Architecture (1997), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Control Engineering, Marketing, Electro-hydraulic Systems, Control and Automatization Systems (Defence, Electric Power Plants), Marketing in the Field of Research and Development Organizations


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Probiotic, Antibiotic, Enzyme and Functional Starter Culture Technologies, Microbial Ecology

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Born: 1957

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Member of the Scientific Council (2022-2026)**Kovačević, Meho Saša**, Prof. Ph.D.

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Secretary of the Department of Mining and Metallurgy (2017-2022)

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Fluid Mechanics, Environmental and Structural Aerodynamics

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ICT Governance & ICT Management, Quality Management in ICT, ICT Service Management, Information Security and Business Continuity Systems, Management and ICT Consultancy

Member of the Scientific Council (2013-2017)

**Kralik, Gordana, Prof. Emerita Ph.D.**

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B.Sc. in Agriculture (1965), M.Sc. in Agriculture (1974), Faculty of Agriculture, University of Belgrade, Ph.D. in Chemical Engineering (1976), Faculty of Technology, University of Zagreb and Ph.D. in Agronomy (1985), Faculty of Agriculture, University of Osijek

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Biotechnical Sciences, Zootechnics, Animal Products, Functional Food

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Mechanism and Kinetics of Crystallization and Precipitation of Slightly Soluble Salts, Industrial Crystallization, Precipitation in Natural and Technology Waste Waters, Biomineralization

*Deputy-Secretary of the Department of Chemical Engineering (2017-2022) and (2022-2026)**Member of the Committee for Economic and Regional Cooperation (2017-2022)*

**Križan, Božidar**, Prof. Emeritus Ph.D.

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Machine Elements, Engineering Design, Engineering Terminology

**Krstulović-Opara, Lovre, Prof. Ph.D.**

Born: 1969

Department of Mechanical Engineering and Naval Architecture

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B.Sc. (1994), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Ph.D. (2000), Universität Hannover, Institut für Baumechanik und Numerische Mechanik

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Experimental Mechanics, Numerical Mechanics, Non Destructive Testing, Infrared Thermography

Secretary of the Department of Mechanical Engineering and Naval Architecture (2022-2026)**Krumes, Dragomir, Prof. Ph.D.**

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Emeritus of the Academy (admitted 2000)

B.Sc. in Mechanical Engineering (1970), M.Sc. in Mechanical Engineering (1977), Ph.D. in Mechanical Engineering (1985), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb
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Materials in Mechanical Engineering, Heat Treatment Materials, New Materials and Technologies, Heat Treatment and Surface Engineering, Thermomdiffusion in Heat Treatment, Tribology

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Full Member of the Academy (admitted 2009)

B.Sc. in Mining Engineering (1989), M.Sc. in Mining Engineering (1997), Ph.D. in Mining Engineering (2002), all from the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb

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Rock Mechanics, Mechanical Rock Comminution,
Quarrying of Dimension Stone*Member of the Committee for Awards (2013-2017) and (2017-2022)**Deputy-Chairman of the Committee for Awards (2022-2026)*

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Materials, Nanotechnology, Ceramics, Advanced Synthesis Methods, Solid-State Reactions

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Chemical Engineering, BioChemical Engineering, Food
Engineering, Process Control, Process Modelling*Deputy-Member of the Scientific Council (2013-2017)**Member of the Scientific Council (2017-2022) and (2022-
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Born: 1931

Department of Communication Systems

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B.Sc. in Electrical Engineering (1957), M.Sc. in Electrical

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Optoelectronics, Optical Communications,
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 M.Eng. in Mathematics (1976), Faculty of Science,
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 Geodesy, Cartography, Geoinformatics, Mathematics,
 History of Science, Map Projections

Secretary-General of the Academy (2003-2005)
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*Member of the Committee for Ethics (2013-2017) and
 (2017-2022)*

Lakušić, Stjepan, Prof. Ph.D.

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Urban and Physical Planning

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Mobile Radio Communications, Microwave Communication Systems, Communications Theory, Computer Networks and Protocols, Test and Measurement in Communication Systems

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Image Processing, Image Analysis, Computer Vision,
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Analysis, Volume Visualization, Neural Networks, Virtual
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Wood Finishing, Wood Gluing, Furniture Quality,
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Information Systems, Production Management, Maintenance Planning Methods, Development of ERP Systems, Single Production Management, Maintenance of Information Systems, New Planning Methods, Optimization of Project Duration, Digital Factory

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Biotechnology, Food Technology, Human Nutrition

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Intelligent Transport Systems, Incident Management System, Complex Control Theory, Underwater Systems and Technology



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Metallurgy, Metallurgy of Iron and Steel, Metallurgy of
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Computational Mechanics, Experimental Methods, Numerical Modeling of Reinforced and Prestressed Concrete Structures, Computational Modeling of Engineering Structures, In Situ Testing of Engineering Structures



Martinović, Goran, Prof. Ph.D.

Born: 1969

Department of Information Systems

Full Member of the Academy (admitted 2015)

B.Sc. in Electrical Engineering (1996) Faculty of Electrical Engineering, J.J. Strossmayer University of Osijek, M.Sc. in Electrical Engineering (2000) Faculty of Electrical Engineering and Computing, University of Zagreb, Ph.D. (2004), Faculty of Electrical Engineering and Computing, University of Zagreb

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Distributed and Service-oriented Computer Systems, Real-time Computer Systems, Autonomic Computing, Computational Intelligence

Deputy-Member of the Scientific Council (2017-2022)

Member of the Committee for International Co-operation (2022-2026)



Marušić, Josip, Prof. Emeritus Ph.D.

Born: 1943

Department of Civil Engineering and Geodesy

Emeritus of the Academy (admitted 2002)

B.Sc. in Civil Engineering (1966), M.Sc. in Civil Engineering (1980), Ph.D. in Civil Engineering (1986), all from the Faculty of Civil Engineering, University of Zagreb

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Water Resource Management, Hydrotechnology, Optimizing Hydromelioration Systems for Drainage, Pollution Control of Water and the Environment, Construction Management, Protection Against Harmful Water Action

Chairman of the Committee of the Science Foundation (2013-2017)



Matejček, Franjo, Prof. Ph.D.

Born: 1949

Department of Mechanical Engineering and Naval Architecture

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B.Sc. in Mechanical Engineering (1975), M.Sc. in Mechanical Engineering (1981), Ph.D. in Mechanical Engineering (1989), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Theory of Elasticity and Plasticity, Dynamics of Machinery, Finite Element Method, Fracture Mechanics, Contact Problems

**Matijašević, Ljubica, Prof. Ph.D.**

Born: 1950

Department of Chemical Engineering

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Chemical Engineering, Analysis, Synthesis and Process Control, Mass and Heat Integration of Processes, Environmental Protection, Cleaner Production

**Matijašić, Gordana, Prof. Ph.D.**

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Mechanical Separation Processes, Development of Pharmaceutical Dosage Forms, 3D Printing in Pharmaceutical Industry

**Matijević, Božidar, Prof. Ph.D.**

Born: 1960

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Geodesy, Geoinformatics, Geomatics, Spatial Databases, Spatial Data Analysis, Software Engineering

Deputy-Member of the Scientific Council (2013-2017)
Secretary of the Department of Civil Engineering and Geodesy (2009-2013)
Head of the Center for Geoinformation and Cartography (2013-2017) and (2017-2022)
Deputy-Secretary of the Department of Civil Engineering and Geodesy (2017-2022)
Member of the Program Committee of the Center for Technological Development (2022-2026)

Medved, Vladimir, Prof. Ph.D.

Born: 1951

Department of Systems and Cybernetics

Full Member of the Academy (admitted 1998)

B.Sc. in Electrical Engineering (1974), M.Sc. in Electrical Engineering (1977), Ph.D. in Electrical Engineering (1988), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Biomedical Engineering, Biomechanics, Biomedical Signal Processing, Kinesiological Electromyography, Human Locomotion

Secretary of the Department of Systems and Cybernetics (2003-2008)
Secretary-General of the Academy (2006-2008)
Chairman of the International Relations Committee (2009-2013)
Vice-President of the Academy (2013-2017)
Member of the Committee for Awards (2013-2017)
Member of the Scientific Council (2017-2022) and (2022-2026)

**Medved-Rogina, Branka**, Prof. Ph.D.

Born: 1958

Department of Communication Systems

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High-speed Electronics and Optoelectronics, Signal Processing and Statist

*Deputy-Member of the Scientific Council (2013-2017)**Member of the Committee for Awards (2013-2017)**Member of the Scientific Council (2017-2022) and (2022-2026)***Meštrović, Krešimir**, Prof. Ph.D.

Born: 1958

Department of Electrical Engineering and Electronics

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Electrical Engineering: Electric Power, High Voltage Switching, Devices and Switchgear

Deputy-Member of the Scientific Council (2017-2022)**Mihanović, Ante**, Prof. Emeritus Ph.D.

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Department of Civil Engineering and Geodesy

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B.Sc. Civil Engineering (1972), M.Sc. Civil Engineering (1975), Ph.D. Civil Engineering (1981) all from the Faculty of Civil Engineering, University of Zagreb

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Structural Mechanics, Numerical Modeling of Structures, Lightweight Concrete Structures, Numerical Analysis of Structures, Design of Concrete and Lightweight Concrete Structures

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Manufacturing Systems, Computer Integrated Manufacturing, Operations Management, Organization of Production Systems, Production Engineering

Deputy-Member of the Scientific Council (2013-2017)



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Member of the Committee for Ethics (2022-2026)

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Motor Vehicles, Special Vehicles, Construction Machines

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Electric Power Engineering, Energy Conversion Processes

for Electricity Generation, Electric Power System

Reliability Evaluation, Reliability Modeling in Electric

Power Systems and Related Statistical Inference

*Secretary of the Department of Power Systems (1997-
2001) and (2001-2005)*



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Nonlinear Systems and Deterministic Chaos, Metrology and Measurement Uncertainty, Usage of Information Technology in Traceability of Measurement Results, Cryptography and Cryptographic Algorithms Based on Chaos Theory, Digitalization of Business Systems and Processes

Deputy-Secretary of the Department of Electrical Engineering and Electronics (2022-2026)



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Power Engineering, Electrical Machines and Drives

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Multimedia Systems, Colorimetry, Graphic Technology,
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Computer Science, Advance Processor Architecture, HPC, Hardware Design, Programmable Logic, Software Design

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Born: 1969

Department of Transport

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Holography, Graphic Technology, Multy/Hyperspectral Analysis, Imaging, 3D Print

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Born: 1953

Department of Chemical Engineering

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Electrical/Dielectric Properties of Materials, Glass, Glass-Ceramics, Impedance Spectroscopy


Mornar, Vedran, Prof. Ph.D.

Born: 1959

Department of Information Systems

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B.Sc. in Electrical Engineering (1981), M.Sc. in

Computing (1985), Ph.D. in Computing (1990), all from

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Operations Research, Information Systems, e-Learning

*Member of the Committee of the Science Foundation
(2013-2017)*
President of the Academy (2022-2026)

Mrnjavac, Edna, Prof. Ph.D.

Born: 1958

Department of Transport

Full Member of the Academy (admitted 1998)

B.Sc. (1981), M.Sc. (1985), Ph.D. (1986) all from the

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Traffic in Tourism, Managing Traffic in Tourism

Destination, Logistics and Supply Chain in Tourism and

Hospitality

*Member of the Program Committee of the Center for
Technological Development (2022-2026)*



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Born: 1957

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2012)

B.Sc. in Biotechnology (1980), Faculty of Technology,

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Molecular Biotechnology

Member of the Committee for International Co-operation (2017-2022)

Secretary of the Department of Bioprocess Engineering (2018-2022)

Secretary-General of the Academy (2018-2022) and (2022-2026)



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Department of Graphical Engineering

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B.Sc. (1994), Faculty of Graphic Arts, University of

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Informatics, University of Zagreb, Ph.D. (2003), Faculty

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Head of the Center for Graphical Engineering (2017-2022)



Muštra, Mario, Assoc. Prof. Ph.D.

Born: 1984

Department of Communication Systems

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 Image and Video Processing, Computer Vision,
 Unmanned Aerial Vehicles, Navigation Systems, Mobile
 Communications

*Deputy-Secretary of the Department of Communication
 Systems (2022-2026)*



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Department of Transport

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Aeronautics and Air Traffic Management, Flight Planning
 and Performances, Helicopter Theory of Flight

*Deputy-Secretary of the Department of Transport (2022-
 2026)*



Obad-Šćitaroci, Mladen, Academician

Born: 1955

Department of Architecture and Urban Planning

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Architecture and Urbanism, Landscape Architecture,
 Cultural and Urban Heritage, Heritage Urbanism, Town
 Planning, History of Landscape Architecture and Town
 Planning

**Ožanić, Nevenka, Prof. Ph.D.**

Born: 1963

Department of Civil Engineering and Geodesy

Full Member of the Academy (admitted 2016)

B.Sc. in Civil Engineering (1986), Faculty of Civil Engineering, University of Rijeka, M.Sc. in Technical Sciences (1994), Faculty of Civil Engineering, University of Zagreb, Ph.D. in Technical Sciences (1996), Faculty of Civil Engineering, Architecture and Geodesy, University of Split

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Hydrology, Water Management, Hydro-Technical Regulation and Melioration, Science, Development

Member of the Committee for Economic and Regional Cooperation (2022-2026)

**Pap, Klaudio, Prof. Ph.D.**

Born: 1963

Department of Graphical Engineering

Full Member of the Academy (admitted 2005)

B.Sc. in Electrical Engineering (1988), M.Sc. in Electrical Engineering (1997), Ph.D. in Electrical Engineering (2004), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Graphic Technology, Computer Graphics, Computer Modeling and Simulation, Digital Printing, Image and Text Processing, Graphic Programming Languages, Interactive Web Program

Member of the Scientific Council (2010-2013)

Deputy-Secretary of the Department of Graphical Engineering (2013-2017)

Member of the Committee for Economic and Regional Cooperation (2013-2017)

Secretary of the Department of Graphical Engineering (2017-2022)

Parac-Osterman, Durdica, Prof. Emerita Ph.D.

Born: 1946

Department of Textile Technology

Emerita of the Academy (admitted 2005)

B.Sc. in Textile Technology (1970), M.Sc. in Textile Technology (1977), Ph.D. in Textile Technology (1985), all from the Faculty of Textile Technology, University of Zagreb

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Color Measurement and Color Management, Textile Dyeing and Printing, Rheological Characteristics to the System Thickener / Paint, Color Phenomena in Practical Use and Multimedia, Environmentallyfriendly Dyeing Processes, Physical-chemical and Dyeing Properties of Natural and Man-made Fibers

*Secretary of the Department of Textile Technology (2014-2017)**Deputy-Member of the Scientific Council (2017-2022)*

Pavić, Ivica, Prof. Ph.D.

Born: 1962

Department of Electrical Engineering and Electronics

Full Member of the Academy (2007)

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Power System Analysis, Transmission Lines, Power System Control

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Born: 1958

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Refrigeration, Air-conditioning and Building Energetics, Energy Efficiency, Renewable Energy Sources

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Born: 1949

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Regional Planning, Town Planning, Urban Development, Environmental Protection

*Secretary of the Department of Architecture and Urban Planning (2005-2009)**Deputy-Secretary of the Department of Architecture and Urban Planning (2009-2013) and (2013-2017)**Member of the Committee for Ethics (2013-2017), (2017-2022) and (2022-2026)*

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Textile Mechanical Technology, Textile Mechanics, CAD/CAM in Textiles, Smart Textiles, Construction and Design of the Textiles

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Born: 1950

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Plant and Process Automation, Servo Systems, Advanced Control Algorithms (Predictive Control, Neuro-fuzzy Control), System Identification, Estimation, Applications in Power Engineering and Transport

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CAD/CAM in Clothing Engineering, Computer Design, Construction and 3D Simulation of Clothing, Anthropometric Measurements and Analysis of the Human Body by Using a 3D Body Scanner, 2D/3D Computer Design and Simulation of Functional and Custom-made Clothing, Development of Computer Parametric 3D Clothing Model Prototypes

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Mobile Robotics, Telerobotics, Intelligent Control and Estimation Theory

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 Associate of the Academy (admitted 2012)
 B.Sc. in Electrical Engineering (1996), M.Sc. in Electrical
 Engineering (2001), Ph.D. in Electrical Engineering
 (2005), all from the Faculty of Electrical Engineering and
 Computing, University of Zagreb
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 and Computing, Unska 3, 10000 Zagreb
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 hr/tomislav.pribanic](https://www.fer.unizg.hr/tomislav.pribanic)
 Computer Vision, Image Processing, Biomedical
 Engineering,
 Biomedical Signal Measurement and Analysis



Pribičević, Boško, Prof. Ph.D.
 Born: 1962
 Department of Civil Engineering and Geodesy
 Full Member of the Academy (admitted 2009)
 M.Eng (1986), Faculty of Geodesy, University of Zagreb,
 M.Sc. in Geodesy (1999), Ph.D. in Geodesy (2000) both
 from the Faculty of Civil Engineering and Geodesy,
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 osobna.php?ISVU_oznaka=BP028](http://www.geof.unizg.hr/osobna.php?ISVU_oznaka=BP028)
 Geodesy, Hydrography, Geodynamics

*Deputy-Head of the Center for Development Studies and
 Projects (2017-2022)*

*Deputy-Head of the Center for Technological
 Development (2022-2026)*

**Pušić, Tanja, Prof. Ph.D.**

Born: 1962

Department of Textile Technology

Full Member of the Academy (admitted 2015)

Graduated engineer of textile chemical technology (1986),

Faculty of Technology, University of Zagreb, M.Sc. in

technical sciences (1990), Faculty of Textile Technology,

University of Zagreb, Ph.D. in technical sciences (1997),

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Ecological Issues in Finishing and Textile Care Processes,

Bioscouring, Mercerization, Electrokinetic Potential

of Textile Materials, Pastel Shades – Washing Impact,

Primary and Secondary Effects, Fluorescent Compounds,

Detergents, Adsorption and Desorption of Surfactants,

Microcapsulation: Effects and Washing Persistence,

Aftertreatment of Textiles, Dry and Wet Cleaning, Dry

Cleaning Solvents, Enzymes in Finishing and Textile Care,

UV Protection

*Deputy-Secretary of Department of Textile Technology (2017-2022)**Member of the Committee for Economic and Regional Cooperation (2017-2022)**Secretary of Department of Textile Technology (2022-2026)***Rimac-Drlje, Snježana, Prof. Ph.D.**

Born: 1965

Department of Communication Systems

Full Member of the Academy (admitted 2005)

B.Sc. in Electrical Engineering (1987), M.Sc. in Electrical

Engineering (1994), Ph.D. in Electrical Engineering

(2000), all from the Faculty of Electrical Engineering and

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Image Processing, Image and Video Compression and

Coding, Multimedia Communication System, Wireless

systems, Radiowave Propagation

*Deputy-Secretary of the Department of Communication Systems (2013-2017) and (2017-2022)**Deputy-Chairman of the Committee for Ethics (2022-2026)*

Rogale, Dubravko, Prof. Ph.D.

Born: 1955

Department of Textile Technology

Full Member of the Academy (admitted 1996)

B.Sc. in Textile Technology (1981), Faculty of Technology, University of Zagreb, M.Sc. in Textile Technology (1987), Faculty of Technology, University of Zagreb, Ph.D. in Textile Technology (1994), Faculty of Textile Technology, University of Zagreb

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Technological Processes of Clothing Production and Development of Conventional and Intelligent Clothing, Application of Modern High-tech Joining Technique of Clothing, Thermal Properties of Conventional and Intelligent Clothing

*Secretary of the Department of Textile Technology (2009-2013)**Secretary-General of the Academy (2013-2017)**Member of the Committee for Awards (2017-2022)**Vice-President of the Academy (2017-2022)**Deputy-Member of the Scientific Council (2022-2026)***Rogošić, Marko**, Prof. Ph.D.

Born: 1969

Department of Chemical Engineering

Full Member of the Academy (admitted 2015)

B.Sc. (1991), M.Sc. (1994), Ph.D. (1998), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Chemical Engineering Thermodynamics, Polymer Reaction Engineering

*Member of the Committee for Awards (2017-2022) and (2022-2026)*

**Roje, Vesna**, Prof. Ph.D.

Born: 1944

Department of Electrical Engineering and Electronics
Emerita of the Academy (admitted 2002)B.Sc. in Electrical Engineering (1967), Faculty of
Electrical Engineering, University of Split, M.Sc.
in Electrical Engineering (1974), Ph.D. in Electrical
Engineering (1983), Faculty of Electrical Engineering,
University of ZagrebUniversity of Split, Faculty of Electrical Engineering,
Mechanical Engineering and Naval Architecture, Ruđera
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Electromagnetic Fields, Antennas, Electromagnetic
Compatibility**Rožić, Nikola**, Prof. Ph.D.

Born: 1942

Department of Information Systems

Emeritus of the Academy (admitted 1999)

B.Sc. in Electrical Engineering (1967 and 1968), Faculty
of Electrical Engineering, University of Split, M.Sc.
in Electrical Engineering (1977), Ph.D. in Electrical
Engineering (1981), Faculty of Electrical Engineering,
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Telecommunication and Information Systems, Forecasting
and Planning, Communication and Information Services
and Applications, Resource Management in Wireless
Systems, Multimedia Systems, Signal Processing and
Coding



Salopek, Branko, Prof. Ph.D.

Born: 1942

Department of Mining and Metallurgy

Emeritus of the Academy (admitted 2002)

B.Sc. Mining Engineering (1968), Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, M.Sc. (1979), Ph.D. (1982), Faculty of Natural Sciences and Engineering, University of Ljubljana University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Pierottijeva 6, 10000 Zagreb
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Mineral Processing Technology, Recycling of Solid Waste Materials, Environmental Protection

Secretary of the Department of Mining and Metallurgy (2005-2009) and (2009-2013)



Sander, Aleksandra, Prof. Ph.D.

Born: 1969

Department of Chemical Engineering

Associate of the Academy (admitted 2019)

B.Sc. (1994), Ph.D. (2003), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Thermal Separation Processes, Scale-up, Transport Phenomena

Member of the Committee for Ethics (2022-2026)



Sečen, Josip, Prof. Ph.D.

Born: 1939

Department of Mining and Metallurgy

Emeritus of the Academy (admitted 1998)

B.Sc. in Petroleum Engineering (1965), M.Sc. in Petroleum Engineering (1977), Ph.D. in Petroleum Engineering (1982), all from the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb Lonjšćina 25, 10000 Zagreb

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Development of Oil, Gas and Gas-condensate Reservoirs, Primary, Secondary and Tertiary Stages



Senjanović, Ivo, Academician

Born: 1940

Department of Mechanical Engineering and Naval Architecture

Emeritus of the Academy (admitted 1994)

B.Sc. in Naval Architecture (1967), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, M.Sc. in Civil Engineering (1969), Faculty of Civil Engineering, University of Zagreb, Ph.D. in Naval Architecture (1970), Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb
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Naval Architecture, Ship and Offshore Structures, Wave Load and Structure Response, Submarine, LPG tanks, Hydroelasticity, Numerical Methods



Skala, Karolj, Prof. Ph.D.

Born: 1951

Department of Communication Systems

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B.Sc. Electrical Engineering (1975), M.Sc. Electrical Engineering (1979), Ph.D. Electrical Engineering (1981), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Optoelectronics, Microcontrollers, Informatics, Optoelectronic Detection and Measurements, Laser and Fiber Optic Communications, Microcontrollers and Programmable Microelectronic Systems and Grid Applications

Member of the Committee for International Co-operation (2013-2017)

Deputy-Chairman of the Committee for International Co-operation (2017-2022)

Member of the Program Committee of the Center for Technological Development (2022-2026)

**Slavica, Anita**, Prof. Ph.D.

Born: 1970

Associate of the Academy (admitted 2021)

Department of Bioprocess Engineering

B.Sc. (1993), Faculty of Food Technology and

Biotechnology, University of Zagreb, M.Sc. (2002),

Faculty of Food Technology and Biotechnology,

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Chemistry, Chemical and Process Engineering, Graz

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Solaric, Nikola, Prof. Emeritus Ph.D.

Born: 1934

Department of Civil Engineering and Geodesy

Emeritus of the Academy (admitted 1998)

B.Sc. Geodesy (1958), Faculty of Engineering, University

of Zagreb B.Sc. Physics (1969), Faculty of Science,

University of Zagreb, Ph.D. Geodesy (1979), Faculty of

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Geodesy, Astronomy, Metrology, Automatization in

Geodetical Astronomy, Automatization in Surveying,

Calibration Line for Electrooptical Distancemeters,

Optimization





Soljačić, Ivo, Prof. Emeritus Ph.D.

Born: 1935

Department of Textile Technology

Emeritus of the Academy (admitted 1993)

B.Sc. in Chemistry (1959), from Faculty of Chemistry, Food Technology and Mining Engineering, University of Zagreb, M.Sc. (1967), Faculty of Pharmacy and Biochemistry, University of Zagreb, Ph.D. (1971), Faculty of Technology, University of Zagreb

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Textile Chemistry, Textile Pretreatments, Optical Brightening, Textile Finishing, Textile Care, Optical Brighteners, Fluorescence Quenching, Whiteness Degree, Hue Change on Lightly Colored Fabrics

Secretary of the Department of Textile Technology of the Academy (2005-2009)



Somek, Branko, Prof. Ph.D.

Born: 1931

Department of Electrical Engineering and Electronics

Emeritus of the Academy (admitted 1994)

B.Sc. in Electrical Engineering (1959), Ph.D. in Electrical Engineering (1972), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Acoustics, Electro Acoustics, Audio Technology, Sound Broadcasting, Musical Acoustics, Architectural Acoustics, Sound Broadcasting (RDS Systems for FM Broadcasting, Digitalization of Radio Broadcasting), Noise and Vibrations, Acoustical Signal Processing

**Sorić, Jurica**, Prof. Emeritus Ph.D.

Born: 1954

Department of Mechanical Engineering and Naval Architecture

Full Member of the Academy (admitted 1994)

B.Sc. in Mechanical Engineering (1978), M.Sc. in Mechanical Engineering (1984), Ph.D. in Mechanical Engineering (1989), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Ivana Lučića 5, 10000 Zagreb tel: +385 1 6168103, fax: +385 1 6168187

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Numerical Modeling of Nonlinear Deformation Processes, Multiscale Modeling, Finite Element Method, Meshless Method

*Member of the Scientific Council (2010-2013) and (2013-2017)**Member of the Science Foundation Committee (2022-2026)*

**Sorić, Zorislav**, Prof. Ph.D.

Born: 1947

Department of Civil Engineering and Geodesy

Emeritus of the Academy (admitted 1993)

B.Sc. in Civil Engineering (1971), Faculty of Civil Engineering, University of Zagreb, M.Sc. in Civil Engineering (1982), Faculty of Civil Engineering, University of Zagreb, Ph.D. in Civil Engineering (1987), University of Colorado, Department of Civil, Environmental and Architectural Engineering, Boulder, Colorado, USA

Charles Darwin street 10, 10000 Zagreb

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Srbljić, Siniša, Prof. Ph.D.

Born: 1958

Department of Information Systems

Full Member of the Academy (admitted 1998)

B.Sc. in Electrical Engineering (1981), M.Sc. in Computer Engineering (1985), Ph.D. in Computer Science (1990), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Advanced Conventional and Experimental Nonconventional Architectures of Computer and Information Systems, Theory of Computing, and Consumer Computing

Secretary of Department of Information Systems (1999-2004)

Member of the Scientific Council (2010-2013)

Member of the Committee of the Science Foundation (2017-2022)



Sršen, Mate, Prof. Emeritus Ph.D.

Born: 1943

Department of Civil Engineering and Geodesy

Emeritus of the Academy (admitted 1993)

B.Sc. in Civil Engineering (1968), M.Sc. in Civil Engineering (1981), Ph.D. in Civil Engineering (1985), all from the Faculty of Civil Engineering, University of Zagreb

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Civil Engineering, Pavement Engineering, Design and Optimization of Pavement Structures, Road and Asset Management, Pavement Maintenance and Rehabilitation Technology, Road Traffic Safety, Teaching

Secretary of the Department of Civil Engineering and Geodesy of the Academy (1999-2009)


Stipaničev, Darko, Prof. Ph.D.

Born: 1955

Department of Systems and Cybernetics

Full Member of the Academy (admitted 1998)

B.Sc. in Electrical Engineering (1977), M.Sc. in Electrical Engineering (1980), Ph.D. in Electrical Engineering (1987), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Artificial Intelligence, Computational Intelligence, Complex Systems Modelling and Control, Digital Image Analysis, Advanced Internet Technologies

Deputy-Member of the Scientific Council (2017-2022) and (2022-2026)

Sućeska, Muhamed, Prof. Ph.D.

Born: 1954

Department of Chemical Engineering

Full Member of the Academy (admitted 2002)

B.Sc. (1977), Military Academy, Zagreb, M.Sc. in Chemistry (1986), Faculty of Science, University of Zagreb, Ph.D. (1991), Military Academy, Zagreb

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Thermal Analysis, Chemistry and Physics of Explosion and Explosives, Thermal Analysis of Energetic Materials, Kinetics and Mechanism of Thermal Decomposition, Numerical Modeling of Combustion, Detonation and Thermal Initiation of Explosive Reactions


Sučić, Viktor, Prof. Ph.D.

Born: 1973

Department of Electrical Engineering and Electronics

Full Member of the Academy (admitted 2022)

Ph.D. (2004.), Queensland University of Technology, Brisbane, Australia

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Signal Analysis and Processing

Deputy-Member of the Scientific Council (2022-2026)



Sumina, Damir, Prof. Ph.D.

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Department of Electrical Engineering and Electronics
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B.Sc. (2001), Ph.D. (2009), all from the Faculty of
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Šantek, Božidar, Prof. Ph.D.

Born: 1966

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2012)

B.Sc. (1990), M.Sc. (1994), Ph.D. (1996), all from
the Faculty of Food Technology and Biotechnology,
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Bioprocess Engineering, Biofuels and Biopolymer
Production, Mathematical Modeling of Bioprocesses,
Malting and Brewing Technology, Wastewater Treatment,
Algae Technology

**Šarolić, Antonio**, Prof. Ph.D.

Born: 1971

Department of Communication Systems

Associate of the Academy (admitted 2014)

B.Sc. in Electrical Engineering (1995), M.Sc. in Electrical Engineering (2000), Ph.D. in Electrical Engineering (2004), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Antennas, Electromagnetic Compatibility, Wireless Communication, Maritime Radio Communications, Flow Measurement, Electromagnetic Measurements

Secretary of the Department of Communication Systems (2022-2026)

**Šercer, Mladen**, Prof. Ph.D.

Born: 1953

Department of Mechanical Engineering and Naval Architecture

Full Member of the Academy (admitted 1998)

B.Sc. in Mechanical Engineering (1977), M.Sc. in Mechanical Engineering (1984), Ph.D. in Mechanical Engineering (1989), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Mechanical Engineering, Production Engineering, Polymer Processing, Injection Moulding Process Control, Troubleshooting in Injection Moulding, Polymer Recycling and Waste Management, Production of Rubber Parts and Appropriate Moulds

Secretary of the Department of Mechanical Engineering and Naval Architecture of the Academy (2013-2017)

**Šerman, Karin**, Prof. Ph.D.

Born: 1964

Department of Architecture and Urban Planning
Associate of the Academy (admitted 2017)

B.Sc. (1989), Faculty of Architecture, University of Zagreb (1989), M.Sc. (1996), Harvard University Graduate School of Design, Cambridge, USA, Ph.D. (2000) Faculty of Architecture, University of Zagreb University of Zagreb, Faculty of Architecture, Fra Andrije Kačića Miošića 26, 10000 Zagreb

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Architectural History and Theory, Architectural Design, Urban Theory

**Šikić, Mile**, Prof. Ph.D.

Born: 1972

Department of Information Systems
Associate of the Academy (admitted 2021)

B.Sc. (1996), Ph.D. (2008), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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**Šimić, Zdenko**, Prof. Ph.D.

Born: 1964

Department of Power Systems
Associate of the Academy (admitted 2012)

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Nuclear Safety, Low Carbon Transition Risk, Power System Reliability, Energy Sources Sustainability



Šljivac, Damir, Prof. Ph.D.

Born: 1974

Department of Power Systems

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B.Sc. (1997), Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, Josip Juraj Strossmayer University of Osijek, Ph.D. (2005), Faculty of Electrical Engineering and Computing, University of Zagreb

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Šubarić, Drago, Prof. Ph.D.

Born: 1963

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2009)

B.Sc. in Food Engineering (1988), Faculty of Food Technology, University of Osijek, M.Sc. in Food Engineering (1994), Ph.D. in Food Engineering (1999), Faculty of Food Technology and Biotechnology, University of Zagreb

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Food Technology; Development and Improvement of Processes for Food Production; Improvement of Quality and Stability of Food Products; Rheological and Thermophysical Properties of Food

Deputy-Member of the Scientific Council (2013-2017)

Deputy-Secretary of the Department of Bioprocess Engineering (2017-2022) and (2022-2026)

Deputy-Chairman of the Committee for Awards (2017-2022)



Šušković, Jagoda, Prof. Emerita Ph.D.

Born: 1955

Department of Bioprocess Engineering

Full Member of the Academy (admitted 2007)

B.Sc. in Biotechnology (1980), M.Sc. in Biotechnology (1989), Ph.D. in Biotechnology (1996), all from the University of Zagreb, Faculty of Food Technology and Biotechnology

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Microbial Biotechnology - Probiotic, Antibiotic, Enzyme and Starter Culture Technology

Head of the Biotechnical Center (2013-2017)

Secretary of the Department of Bioprocess Engineering (2017-2018)



Tarbuk, Anita, Assoc. Prof. Ph.D.

Born: 1975

Department of Textile Technology

Associate of the Academy (admitted 2021)

B.Sc. (2001), Ph.D. (2009)

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Interfacial Phenomena on Textiles, Enzymes in Textile Finishing, Pretreatment and Surface Modification of Textiles, UV Protection, Hospital Protective Textiles

Chairman of the Committee for International Co-operation (2022-2026)

**Terze, Zdravko**, Prof. Ph.D.

Born: 1966

Department of Systems and Cybernetics

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B.Sc. in Mechanical Engineering (1991), M.Sc. in Mechanical Engineering (1994), Ph.D. in Mechanical Engineering (1996), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb
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Dynamics of Structural Systems, Numerical Methods and Computation, Dynamics of Aircraft Structures, Multibody Dynamics and Non-linear Dynamics, Computational Aeroelasticity

Member of the Committee of the Science Foundation (2013-2017)

Vice-President of the Academy (2013-2017) and (2017-2022)

President of the Scientific Council (2013-2017) and (2017-2022)

Chair of the Committee for International Co-operation (2013-2017) and (2017-2022)

**Tomas, Srećko**, Prof. Ph.D.

Born: 1954

Department of Chemical Engineering

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Food Engineering, Chemical Engineering (Heat and Mass Transfer, Drying, Extraction, Distillation, Ecological Engineering)

**Tomašić, Vesna**, Prof. Ph.D.

Born: 1964

Department of Chemical Engineering

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B.Sc. in Chemical Engineering (1990), M.Sc. in Chemical Engineering (1993), Ph.D. in Chemical Engineering (1999), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Catalytic Reaction Engineering and Air Pollution Control: Correlation of Fundamental Principles of Heterogeneous Catalysts with the Performance and Design of Catalytic Reactors, Application of Catalytic and Photocatalytic Processes in Air Protection and Wastewater Treatment

*Deputy-Secretary of the Department of Chemical Engineering (2013-2017)**Secretary of the Department of Chemical Engineering (2017-2022) and (2022-2026)***Tomšić, Željko**, Prof. Ph.D.

Born: 1957

Department of Power Systems

Full Member of the Academy (admitted 2002)

B.Sc. in Electrical Engineering (1981), M.Sc. in Electrical engineering (1990), Ph.D. in Electrical Engineering (2001), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Energy and Geostrategy, Energy Policy and Strategy, Economy in Energy and Ecology, Energy Markets, Deregulation in Energy, Energy and Environment, Power System Planning, Impact Assessment of Power Plants, Environmental Protection in Power Systems, Energy Management, Energy Conservation and Energy Auditing in Industry and Buildings

*Chairman of the Committee Science Foundation (2017-2022)**Deputy-Secretary of the Department of Power Systems (2017-2022)**Secretary of the Department of Power Systems (2022-2026)*



Tonković, Zdenko, Prof. Ph.D.

Born: 1966

Department of Mechanical Engineering and Naval Architecture

Full Member of the Academy (admitted 2009)

B.Sc. in Mechanical Engineering (1991), M.Sc. in Mechanical Engineering (1994), Ph.D. in Mechanical Engineering (1998), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Ivana Lučića 5, 10000 Zagreb

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Solid Mechanics, Numerical Methods, Structural Integrity

Deputy-Secretary of the Department of Mechanical Engineering and Naval Architecture (2022-2026)



Trkulja, Bojan, Prof. Ph.D.

Born: 1978

Department of Electrical Engineering and Electronics

Associate of the Academy (admitted 2021)

B.Sc. (2001), Ph.D. (2008)

University of Zagreb, Faculty of Electrical Engineering and Computing, Unska 3, 10000 Zagreb

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Electrical Machines, Electromagnetic Compatibility, Numerical Methods

Member of the Scientific Council (2022-2026)



Tušek, Darovan, Prof. Ph.D.

Born: 1954

Department of Architecture and Urban Planning

Full Member of the Academy (admitted 2015)

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Member of the Committee for Awards (2022-2026)

**Udiljak, Toma**, Prof. Ph.D.

Born: 1955

Department of Architecture and Urban Planning
Associate of the Academy (admitted 2009)B.Sc. (1980), Ph.D. (1996), all from the Faculty of
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Machining Systems and Technologies, Machining Systems
in Medical Engineering, Modelling and Simulation
of Machining Systems, Intelligent and Autonomous
Manufacturing, CAD/CAM systems**Ugarčić-Hardi, Žaneta**, Prof. Ph.D.

Born: 1946

Department of Bioprocess Engineering
Emerita of the Academy (admitted 2002)B.Sc. in Chemical Engineering (1971), Faculty of
Technology, University of Zagreb, Ph.D. in Chemical
Engineering (1983), Eidgenossische technische
Hochschule, Zurich

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Cereal Chemistry and Technology, Technological Quality
of Flour, Milling, Bread and Pasta Production, Extruded
Products**Ujević, Darko**, Prof. Emeritus Ph.D.

Born: 1955

Department of Textile Technology
Full Member of the Academy (admitted 2007)B.Sc. in Textile Technology (1977), M.Sc. in Textile
Technology (1984), Ph.D. in Textile Technology (1998), all
from the Faculty of Textile Technology, University of Zagreb
University of Zagreb, Faculty of Textile Technology,
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e-mail: darko.ujevic@tff.hr, darko.ujevic@zg.t-com.hr;

<http://www.tff.hr/index.php?str=53&osoba=24>Improvements of Methodological Procedures for Clothing
Engineering, Development of Measuring Apparatuses
and Devices, Anthropometry, Clothing Modeling and
Construction, Qualita Systems and ISO Standards*Member of the Scientific Council (2010-2013)*

**Vasić-Rački, Đurđa, Prof. Emerita Ph.D.**

Born: 1946

Department of Chemical Engineering

Emerita of the Academy (admitted 1995)

B.Sc. in Chemical Engineering (1971), M.Sc. in Chemical Engineering (1976), Ph.D. in Chemical Engineering (1981), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Enzyme Reaction Engineering, Computer Modeling, Biochemical Engineering, Ecological Engineering

*Head of the Center for Environmental Protection and Development of Sustainable Technologies (2009-2013) and (2013-2016)**Chairwoman of the Council of the Centers (2009-2013) and (2013-2017)*

**Veršić, Zoran, Prof. Ph.D.**

Born: 1966

Department of Architecture and Urban Planning

Associate of the Academy (admitted 2014)

B.Sc. in Architecture (1991), M.Sc. in Architecture (2001),

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Building Construction, Sustainable Building, Thermal Insulation, Energy Efficient Building, Sound Insulation, Acoustics

Secretary of the Department of Architecture and Urban Planning (2017-2022) and (2022-2026)



Veža, Ivica, Prof. Emeritus Ph.D.

Born: 1951

Department of Mechanical Engineering and Naval Architecture

Emeritus of the Academy (admitted 2002)

B.Sc. in Mechanical Engineering (1975), M.Sc. in Mechanical Engineering (1980), Ph.D. in Mechanical Engineering (1985), all from Faculty of Mechanical Engineering, University of Zagreb

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Industrial Engineering, Mechanical Engineering, Plant Layout, Computer Integrated Manufacturing, Modeling and Simulation, Production Management, Logistics

Secretary of the Department of Mechanical Engineering and Naval Architecture (2005-2009)



Virag, Zdravko, Prof. Ph.D.

Born: 1955

Department of Mechanical Engineering and Naval Architecture

Full Member of the Academy (admitted 1994)

B.Sc. in Mechanical Engineering (1978), M.Sc. in Mechanical Engineering (1985), Ph.D. in Mechanical Engineering (1991), all from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb

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Fluid Mechanics, Numerical Methods in Heat and Mass Transfer, Hemodynamics of the Cardiovascular System

Deputy-Secretary of the Department of Mechanical Engineering and Naval Architecture (2009-2013)

Member of the Committee for Awards (2013-2017)

Deputy-Member of the Scientific Council (2017-2022) and (2022-2026)



Višković, Alfredo, Prof. Ph.D.

Born: 1961

Department of Power Systems

Associate of the Academy (admitted 2007)

B.Sc. Electrical Engineering (1985), M.Sc. Electrical Engineering (1989), Ph.D. Electrical Engineering (1998), all from the Faculty of Electrical Engineering and Computing, University of Zagreb, Ph.D. Information Science (2008), Faculty of Philosophy, University of Zagreb

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Complex Systems, Energy Convergence, Sustainable Energy, Green Web Energy, Social Humanistic Informatology



Vražić, Mario, Prof. Ph.D.

Born: 1971

Department of Electrical Engineering and Electronics

Full Member of the Academy (admitted 2014)

B.Sc. in Electrical Engineering (1996), M.Sc. in Electrical Engineering (2000), Ph.D. in Electrical Engineering (2005), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Electrical Machines, Drives and Automation, Industrial Plants, Electric Vehicles

Secretary of the Department of Electrical Engineering and Electronics Acting Secretary (2016-2017), (2017-2022) and (2022-2026)



Vrkljan, Darko, Prof. Ph.D.

Born: 1952

Department of Mining and Metallurgy

Full Member of the Academy (admitted 2009)

B.Sc. Mining Engineering (1978), M.Sc. Mining Engineering (1992), Ph.D. Mining Engineering (1998), all from the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb

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Surface Exploitation, Mining Design, Ventilation of Mines and Tunnels, Blasting, Mining Law

Member of the Scientific Council (2017-2022)



Vujasinović, Edita, Prof. Ph.D.

Born: 1965

Department of Textile Technology

Full Member of the Academy (admitted 2012)

B.Sc. in textile technology (1988), Faculty of Technology, University of Zagreb, M.Sc. in Textile Engineering (1996), Faculty of Textile Technology, University of Zagreb, Ph.D. in Textile Technology (2003), Faculty of Textile Technology, University of Zagreb

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e-mail: edita.vujasinovic@ttf.hr; <http://www.ttf.unizg.hr/index.php?str=53&osoba=39>

Structure and Properties of Textile Fibers, Objective Measurement and Evaluation, Restauration and Conservation of Textile and Clothes, Fibers and Forensics, Fiber Reinforced Composites & Textile Recycling

Secretary of the Department of Textile Technology (2017-2022)

Chairwoman of the Committee for Ethics (2017-2022)

**Vujević, Slavko**, Prof. Ph.D.

Born: 1958

Department of Electrical Engineering and Electronics

Full Member of the Academy (admitted 2017)

B.Sc. (1981), University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, M.Sc. (1987), University of Zagreb, Faculty of Electrical Engineering, Ph.D. (1994), University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture

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Numerical Modeling of Electromagnetic Phenomena, Lightning Protection, Grounding Systems, Electromagnetic Compatibility, Electrical Machines and Transformers

**Vusić, Damir**, Prof. Ph.D.

Born: 1971

Department of Graphical Engineering

Associate of the Academy (admitted 2019)

B.Sc. (1997), Ph.D. (2012), all from the Faculty of Graphics Arts, University of Zagreb

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Reproduction of the Color Information in the Multimedia Communication Systems, Quality Management in the Graphic Reproduction Processes, Application of Modern Multimedia Information and Communication Platforms in the Educational Process, Graphical User Interfaces Development and Application of Virtual and Augmented Reality

Member of the Program Committee of the Center for Technological Development (2022-2026)

**Zelenika, Saša, Prof. Ph.D.**

Born: 1966

Department of Mechanical Engineering and Naval Architecture

Full Member of the Academy (admitted 2012)

M.Sc. in Mechanical Engineering (1991), Faculty of Engineering, University of Rijeka, Ph.D. in Mechanical Engineering (1996), Polytechnic University of Turin, Italy University of Rijeka, Faculty of Engineering & Centre for Micro- and Nanosciences and Technologies, Vukovarska 58, 51000 Rijeka

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Precision Engineering, Microsystems Technologies, Compliant Mechanisms, Energy Harvesting, Mechatronics, Measurement Techniques, Machine Elements

**Zelić, Bruno, Prof. Ph.D.**

Born: 1973

Department of Chemical Engineering

Full Member of the Academy (admitted 2012)

B.Sc. in Chemical Engineering (1996), M.Sc. in Chemical Engineering (1999), Ph.D. in Chemical Engineering (2003), all from the Faculty of Chemical Engineering and Technology, University of Zagreb

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Process Development, Biochemical Engineering, Bioseparation Processes, Microreactors, Mathematical Modeling

*Head of the Center for Environmental Protection and Development of Sustainable Technologies (2016-2017) and (2017-2022)**Chairman of the Council of Centers (2017-2022)**Member of the Committee for International Co-operation (2017-2022)**Vice-President of the Academy (2009-2013)**President of the Scientific Council (2022-2026)**Member of the Committee for Awards (2022-2026)*


Zeljko, Mladen, Assist. Prof. Ph.D.

Born: 1956

Department of Power Systems

Associate of Academy (2009)

B.Sc. in Electrical Engineering (1979), M.Sc. in Electrical Engineering (1988), Ph.D. in Electrical Engineering (2003), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Energy System Operation and Expansion Planning, or Organisation and Economics of Energy Sector


Zentner, Radovan, Prof. Ph.D.

Born: 1972

Department of Communication Systems

Associate member of the Academy (admitted 2017)

B.Sc. in Electrical Engineering (1994), M.Sc. in Electrical Engineering (1998), Ph.D. in Electrical Engineering (2002), all from the Faculty of Electrical Engineering and Computing, University of Zagreb

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Antennas and Propagation, Spectrum Management


Zovko Brodarac, Zdenka, Prof. Ph.D.

Born: 1975

Department of Mining and Metallurgy

Associate of the Academy (admitted 2019)

B.Sc. (1998), Faculty of Metallurgy, University of Zagreb, Ph.D. (2009) Faculty of Natural Sciences and Engineering, University of Ljubljana

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Deputy-Secretary of the Department of Mining and Metallurgy (2022-2026)

**Zrinjski, Mladen, Prof. Ph.D.**

Born: 1972

Department of Civil Engineering and Geodesy

Associate of the Academy (admitted 2017)

B.Sc. in Geodesy (2001), Ph.D. in Geodesy (2010), all

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Geodesy, Automation of Geodetic Measurements, Geodetic

Instruments, Precision Geodetic Measurements, GNSS

*Deputy-Head of the Center for Geoinformation and
Cartography (2017-2022)***Zrnčević, Stanka, Prof. Ph.D.**

Born: 1946

Department of Chemical Engineering

Emerita of the Academy (2009)

B.Sc. in Chemical Engineering (1969), M.Sc. in Chemical

Engineering (1976), Ph.D. in Chemical Engineering

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Technology, University of Zagreb

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Chemical Engineering, Catalysis, Catalytic Reaction

Engineering

Žagar, Drago, Prof. Ph.D.

Born: 1965

Department of Electrical Engineering and Electronics

Full Member of the Academy (admitted 2017)

B.Sc. in Electrical Engineering (1990), Faculty of Electrical Engineering and Computing, University of Zagreb, M.Sc. in Electrical Engineering (1995), Faculty of Electrical Engineering and Computing, University of Zagreb, Engineering Master's degree, Euro Laser Engineer (1996), University of Vienna, PhD in Electrical Engineering (2002), Faculty of Electrical Engineering and Computing, University of Zagreb



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Communication Networks, Protocols, Quality of Service QoS, Wireless Sensor Networks, Broadband Technologies, Cyber Security

*Member of the Committee for Awards (2022-2026)***Žagar, Martin**, Assoc. Prof. Ph.D.

Born: 1981

Department of Information Systems

Associate of the Academy (admitted 2015)

B.Sc. (2004), Faculty of Electrical Engineering and Computing, University of Zagreb (2004), M.Sc. Faculty of Electrical Engineering and Computing, University of Zagreb (2005) and Faculty of Chemical Engineering and Technology, University of Zagreb (2006), Ph.D. (2009), Faculty of Electrical Engineering and Computing, University of Zagreb



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Telemedicine, Multimedia Applications and Architectures

Deputy-Member of the Scientific Council (2022-2026)

**Žagar, Zvonimir, Prof. Ph.D.**

Born: 1931

Department of Civil Engineering and Geodesy

Emeritus of the Academy (admitted 1998)

B.Sc. in Civil Engineering (1957), Ph.D. in Civil Engineering (1985), all from the Faculty of Civil Engineering, University of Zagreb

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Structures, Timber Structures, Expert Systems, Civil and Mechanical Engineering, Artificial Intelligence, Computer Sciences

**Žarko, Damir, Prof. Ph.D.**

Born: 1972

Department of Electrical Engineering and Electronics

Full Member of the Academy (admitted 2017)

B.Sc. (1996) and M.Sc. (1999) from the Faculty of Electrical Engineering and Computing, University of Zagreb, Ph.D. (2004) University of Wisconsin – Madison, USA

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e-mail: damir.zarko@fer.hr; <http://www.fer.unizg.hr/damir.zarko>

Design of Electrical Machines for Various Applications in Industry, Power Engineering and Transport, Analysis, Design and Modeling of Distribution and Power Transformers, Application of Mathematical Optimization in Design, Application of the Finite Element Method in the Analysis and Design of Electrical Machines, Transformers and Other Electromagnetic Devices

Chairman of the Science Foundation Committee (2022-2026)



Žiljak, Vilko, Prof. Emeritus Ph.D.

Born: 1946

Department of Graphical Engineering

Emeritus of the Academy (admitted 1998)

B.Sc. in Physics (1973) Faculty of Science, University of Zagreb, Ph.D. in Electrical Engineering (1982), Faculty of Electrical Engineering and Computing, University of Zagreb

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Graphic Technology, Computer Sciences, Printing Processes, Prepress, Digital Press, Postpress, Computer Modeling and Simulation, Computer Graphics

Vice-President of the Academy (2009-2013)

Deputy-President of the Academy (2012-2013)

Head of the Center for Graphical Engineering (2013-2017)



Žiljak Gršić, Jana, Prof. Ph.D.

Born: 1972

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Secretary of the Department of Graphical Engineering (2022-2026)