SUMMER SCHOOL

DIGITALIZATION & AI IN METALLURGY

28-29-30 June 2026 · 1 July 2026

Udine (Fondazione Filippo Renati)

Artificial intelligence (AI) has emerged as a transformative force in materials science and metallurgy, enabling the development of data-driven approaches to material design, process optimization, and quality control. Metallurgy, traditionally grounded in empirical experimentation, is increasingly benefiting from AI's capacity to process large datasets, recognize patterns, and predict complex relationships between composition, processing, and performance.

This Summer School is addressed both to PhD students and to professionals involved in metallurgical processes and metallic alloys development.

The School offers a comprehensive view of several key applications of AI and digitalization (computer vision, machine learning, genetic algorithms) in metallurgy, including alloy design, processing (steel-making, foundry, plastic deformation, heat treatment, additive manufacturing), defect detection and quality control.

There will be also the unique opportunity to combine the School activities with the visit of a modern steel-making plant, with an advanced level of automation, digitalization and implementation of AI.

Organizing committee:

Franco Bonollo, Università di Padova
Alex Lanzutti, Università di Udine

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CoMET
Coordinamento della ricerca e della didattica universitaria in metallurgia

ASSOCIAZIONE ITALIANA DI METALLURGIA

Scientific committee:

Franco Bonollo, Università di Padova
Angelo Montanari, Università di Udine
Alex Lanzutti, Università di Udine
Valentina Colla, Scuola Superiore Sant'Anna Pisa
Gianfranco Marconi, Danieli
Marco Ometto, Danieli Automation
Loris Busolini, Danieli Automation
Giuseppe Giacomini, ABS
Annalisa Pola, Università di Brescia

Local Organizing committee:

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Alex Lanzutti, Università di Udine
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Francesco Sordetti, Università di Udine
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Emanuele Vaglio, Università di Udine
Nicola Saccomanno, Università di Udine
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Andrea Brunello, Università di Udine

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SUNDAY, 28 JUNE 2026

19.30 Welcome buffet

MONDAY, 29 JUNE 2026

9.00 AI Governance and Economic prospects by 2030: the case of the worldwide Manufacturing sector
COSTANZO PIETROSANTI (Danieli Automation SpA)

Pervasive AI diffusion is transforming the manufacturing sector, generating major opportunities and risks and driving the need for structured AI Governance frameworks. AI Governance evolution began with ethical concerns and has progressively expanded across industrial sectors to manage economic, social, and technological impacts. Comparative analysis of AI strategies in the USA, China, and the EU highlights different regulatory approaches and market trajectories including the steel industry, across key AI branches over the 2024–2030 timeline, aligned with Green Deal milestones.

9.45 Introduction to "Data Driven" approach in steel industry
FRANCESCA MOTTA, MARCO FABIANI (Danieli Automation SpA)

A Data Driven approach is transforming the steel sector by enabling smarter, faster, and more reliable decision making. Growing pressure for efficiency, quality improvement, and cost reduction makes structured data utilization essential across production, maintenance, and supply chain operations. Machine Learning provides the foundation for this shift, offering tools such as supervised learning for predictive quality, unsupervised learning for anomaly detection, and reinforcement learning for process optimization.

10.30 Coffee break

11.00 AI-based solutions for materials characterization
DOROTA WILK-KOŁODZIEJCZYK (Łukasiewicz – Krakowski Instytut Technologiczny and AGH, University of Krakow)
The production process generates data in numerical, verbal, and visual formats. Artificial intelligence and machine learning methods play a significant role in analyzing this data, enabling the prediction of obtainable process parameters, the detection of process anomalies, and guidance on correcting production process parameters. Practical examples of machine learning methods and production data analysis tools will illustrate the usefulness of these tools.

11.45 Computer Vision and AI applications for image analysis in steel industry
SIMONE CECCHINATO, MATTEO SANDRI (Danieli Automation SpA)

This lecture introduces the growing role of Computer Vision and AI methods applied to visual data in the steel manufacturing industry, highlighting how image based technologies are influencing and reshaping traditional workflows in automation, quality control, and process optimization. After outlining the fundamentals of these technologies, the session follows a virtual tour of the steel production flow to illustrate their real industrial applications and the specific operational challenges they address.

12.30 Lunch

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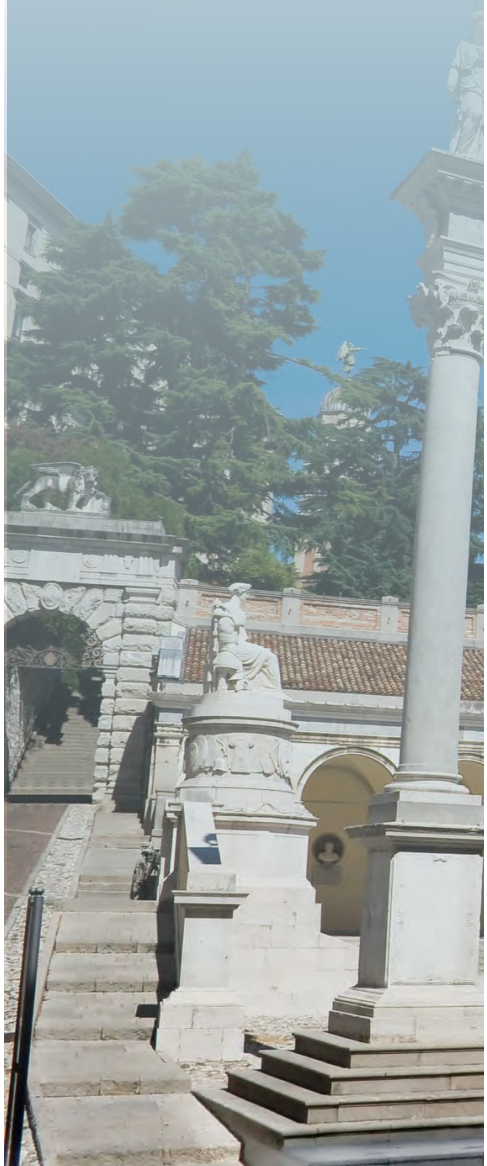

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MONDAY, 29 JUNE 2026

13.30 Monitoring and machine learning for early failure detection and predictive maintenance
ANGELO MONTANARI, ANDREA BRUNELLO, LUCA GEATTI, NICOLA SACCOMANNO (Università di Udine)

Formal methods are mathematically rigorous techniques to check whether a system complies with a given specification. Among these, runtime verification focuses on performing such checks during the real-time execution of the system under scrutiny. In industrial contexts, these techniques can support tasks such as failure detection, but their use is often limited by the difficulty of manually specifying all the relevant requirements to which the systems should adhere. This limitation makes the use of runtime verification challenging—if not impractical—for early failure detection and predictive maintenance, where the goal is to identify potential future faults in advance and thereby prevent, for instance, costly machine downtime. This seminar introduces an approach that combines runtime verification with machine learning to automatically infer the relevant specifications from historical execution data. Specifically, after a brief overview of the underlying concepts, we present a GPU-based framework developed at the University of Udine for interpretable early failure detection and predictive maintenance.

14.15 AI- vs Physics-based: why not together? Introduction to Hybrid-AI for modelling purposes in the metallurgical field
VALENTINA COLLA (Scuola Superiore Sant'Anna)

Hybrid-AI is receiving increasing attention for modelling tasks as a viable way to improve not only the accuracy of ML-based models, but also their reliability, trustworthiness, and explainability. Hybrid-AI groups a quite broad variety of approaches aimed at somehow infusing physical knowledge in AI. This makes them particularly attractive for industrial applications. An overview of Hybrid-AI approaches will be provided and some applications in the steel field will be presented and discussed.

15.00 Coffee break

15.30 Q-MPE: Danieli hybrid approach for the prediction of the mechanical properties of hot rolled coils
MARCO GHIRARDI (Danieli Research Center)

Steel market is showing an increasing interest in the prediction of the final properties both during production (online mode) and during virtual rolling simulations (offline mode).
Danieli answer is a new hybrid metallurgical model of the mill, matching the consistency and the generality of the physical core with the unparalleled accuracy of the ML core. In the lecture, the main features of both the cores will be explained, as well as the main functionalities made possible by this new approach. Some case studies will be also presented.

16.15 Concepts of Federated Learning and the Continual Learning
STEFANO DETTORI (Scuola Superiore Sant'Anna)

The digitalization of metallurgical processes is challenged by the distributed nature of industrial plants and the continuous evolution of operating conditions. AI models therefore must be collaborative and adaptive. This lecture introduces Federated Learning for training shared models across multiple plants while preserving data ownership and confidentiality, and Continual Learning to handle time-varying process conditions. The talk concludes with an industrial case study, highlighting practical implementation aspects in real plants.

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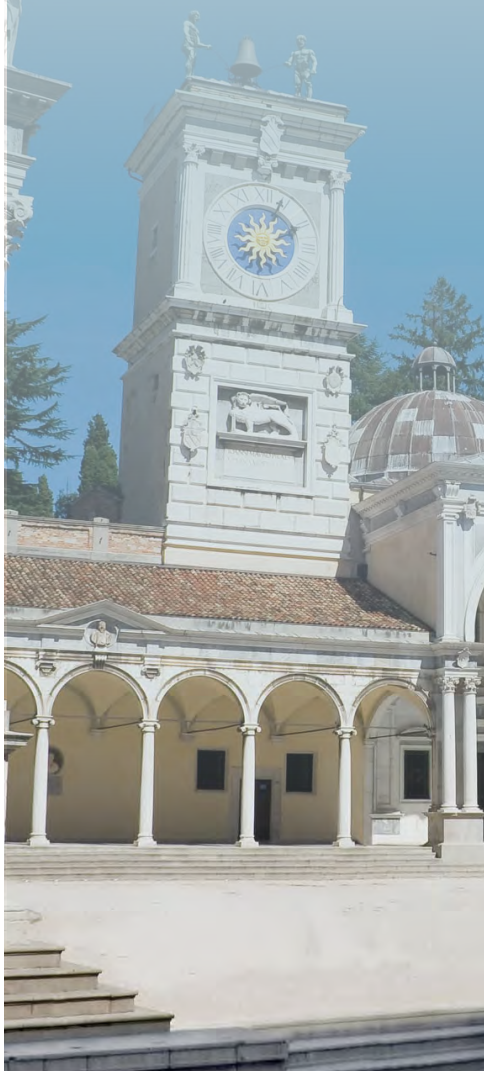

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MONDAY, 29 JUNE 2026

17.00 Digital Transformation: A Human Centered Industrial Evolution (Online)
PIERRE-JEAN KRAUTH (Director of Digital Lab of Arcelor Mittal, Florange, France)

ArcelorMittal France is accelerating its digital transformation through the development of its Digital Lab, a catalyst for innovation and industrial performance. The Digital Lab brings together experts, field operators, data scientists, and engineers to co-create solutions that improve safety, quality, and operational efficiency across our sites.
This transformation is not driven by technology alone — it places people at the heart of every initiative. Our ambition is to empower employees by giving them access to intuitive digital tools, fostering new skills, and creating a culture where experimentation and continuous improvement are encouraged.
From advanced analytics and AI assisted production to digital twins and augmented reality support in the field, the Digital Lab helps teams rethink how they work and collaborate. Each project is built with and for the workforce, ensuring real adoption and long term impact.
For young researchers and PhD students, this represents a unique opportunity to engage with complex industrial challenges while contributing to innovative solutions that shape the future of steelmaking. Together, technology and human expertise enable a smarter, safer, and more sustainable industry.

20.00 Social dinner

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TUESDAY, 30 JUNE 2026

9.00 AI application for process control in steel industry
MANUELE PIAZZA, FRANCESCA MOTTA (Danieli Automation SpA)

AI is reshaping process control in steelmaking by enabling real-time optimization and predictive decision-making across production stages. Advanced algorithms analyze vast streams of sensor data to stabilize furnace operations, improve casting quality, reduce energy consumption, and increase final product quality. AI models support anomalies detection, minimizing downtime. This evolution strengthens productivity, consistency, and sustainability across the entire steel manufacturing chain.

9.45 Exemplar applications of AI for prediction of elastic-plastic stress and stain fields
TOMMASO GROSSI (Scuola Superiore Sant'Anna)

Traditional finite element methods solve each structural problem in isolation, failing to leverage experience from previously computed solutions. This seminar explores how AI frameworks can overcome this inefficiency by learning from existing numerical data to accelerate future simulations, focusing on nonlinear, elastic-plastic regimes where iterative solvers are typically expensive. Participants will be introduced to fundamental operator learning principles and their state-of-the-art applications in solving structural PDEs.

10.30 Coffee break

11.00 A real case of digital instruments applied to production lines: the case of ABS QWR (Quali Wire Rod) plant
GIUSEPPE AMBROGINI, SARA MARZIO (Acciaierie Bertoli Safau S.p.A.)

This presentation introduces the QWR plant visit and highlights how digital tools can be applied in the real metal production industry. The plant exploits the 'zero humans on the floor' concept thanks to its intensive use of digital instruments. Using the innovative Danieli Intelligent Plant has transformed the approach to plant management and control, has changed the way people are involved in the production process improving safety and efficiency.

11.45 Use of AI to estimate the hardenability profile of micro-alloyed steels
VALENTINA COLLA, MARCO VANNUCCI (Scuola Superiore Sant'Anna)

Strong correlations exist between steel chemistry and hardenability. However, the relationships are highly nonlinear, making prediction of the Jominy hardenability profile challenging. The lecture explores AI-based approaches to predict Jominy profiles directly from chemical composition, progressing from neural networks to convolutional architectures. Finally, an inverse design system is presented, that proposes optimal steel chemistry to achieve desired hardenability profiles, transforming reactive testing into proactive steel design.

12.30 Lunch

13.30 Sustainable alloy design: Leveraging machine learning and genetic algorithms for critical raw materials reduction
PAOLO FERRO (Università di Padova)

This presentation addresses the critical raw materials (CRMs) challenge in the foundry industry by introducing an integrated computational framework. An alloy Criticality Index is proposed to quantify supply risks and environmental impacts. Leveraging Deep Neural Networks for property prediction and Genetic Algorithms for inverse design, the methodology enables the development of sustainable ductile iron compositions. During the presentation some case studies will be illustrated to demonstrate reductions in CRM usage while maintaining mechanical performance, showcasing a pathway toward eco-efficient alloy design.

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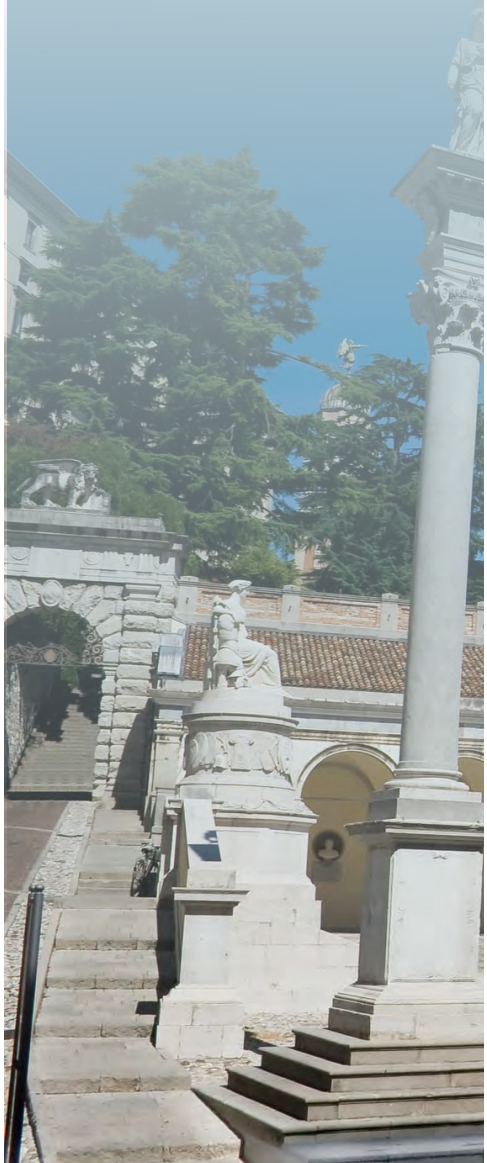

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TUESDAY, 30 JUNE 2026

14.15 Foundry digitalization oriented to Process Control and Zero Defect Manufacturing
NICOLA GRAMEGNA (RIR SINFONET)

The development of sustainable production systems is oriented to minimize production costs, increase productivity and improve product quality. It's universally recognized the digital transformation is one of the central themes of Smart Manufacturing as necessary condition for the competitiveness of all companies introducing an element of differentiation from low-cost countries. Furthermore, digital systems with high flexibility application keep production efficiency unchanged even in the case of extreme variability demand, and at the same time promote a reduction in scrap and in energy consumption. In this perspective, it is necessary to develop integrated methodologies, technologies and tools for process control, improved maintenance, intelligent quality management and production logistics. In this context, the new Data-Driven Digital Twin architecture of a multi-stages production system interconnects all stages and the corresponding peripherals. The goal is the improvement of the product quality oriented to Zero Defect Manufacturing (ZDM) monitoring a plant and its sub-areas to increase the reliability at reduced costs of the production and maintenance.

15.00 Coffee break

15.30 Adapting to Change: Knowledge-Driven AI for Mutating Metallurgical Systems (Online)
ZIYU LI (Jönköping University & COMPtech AB)

Metallurgical processes operate in continuously mutating environments due to variations in materials, process conditions, and operational constraints. Purely data-driven AI models often struggle to generalize under such non-stationary conditions. This lecture introduces the concept of knowledge-driven AI as a means to provide stability and interpretability in mutating systems. By leveraging structured domain knowledge together with large language models, AI systems can reason consistently across changing data contexts. Examples from metallurgical applications illustrate how knowledge-driven AI supports robust decision-making under process variability.

16.15 Data driven process control in AM
EMANUELE VAGLIO (Università di Udine)

Additive Manufacturing targets advanced applications in critical industrial sectors, but its processes remain complex and highly sensitive to multiple interacting variables that affect part quality and compliance. This presentation will discuss multi-sensor monitoring and advanced data analytics techniques for data-driven process control, supporting real-time process characterization and establishing the foundation for advanced control strategies to improve repeatability, reliability, and industrial qualification of AM processes.

17.00 Process simulation for digital Manufacturing
EMANUELE VAGLIO (Università di Udine)

The production of complex, customized parts requires advanced strategies to ensure manufacturing efficiency and reliability. Numerical simulation enables process optimization prior to physical implementation and the development of a digital manufacturing environment to support intelligent process control. This presentation will discuss multi-physics modeling approaches to characterize process dynamics and defects, reduce trial-and-error and achieve robust, repeatable, and high-quality manufacturing outcomes.

WEDNESDAY, 1 JULY 2026

9.00-12.00 ABS Plant visit (limited seats available)

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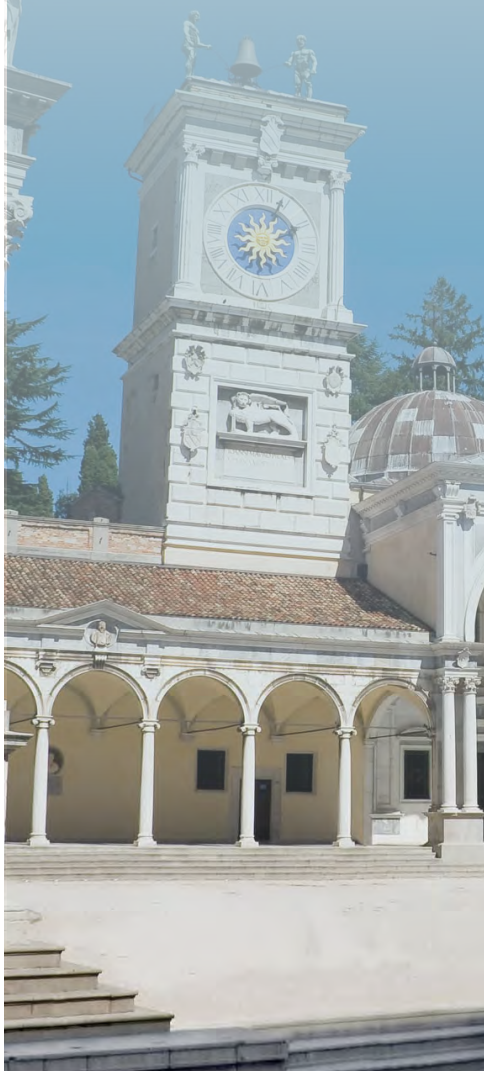

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GENERAL INFORMATION

LOCATION
The Course will be held in Fondazione Filippo Renati - Via San Valentino 23, Udine (UD), Italy - www.renaticampus.com

REGISTRATION INFORMATION
The Summer School has a limited number of available places.
Registrations will close on June 5, 2026 or as soon as the maximum number of participants will be reached. Therefore, in case of interest, we strongly recommend registering as soon as possible.
The attendance to the ABS plant tour is subject to availability of seats. The Organising secretariat will confirm the possibility of attending the technical visit as soon as possible.

REGISTRATION FEES (PER PERSON)
AIM MEMBERS FEE: € 430,00* (revenue stamp included)

AIM JUNIOR MEMBERS are required to pay the registration fee.

NON MEMBERS are required to subscribe AIM membership fee for the year 2026, before or at the same time of the registration to the summer school, as:
- Ordinary member (€ 70,00 revenue stamp included)
- Junior member (€ 15,00 revenue stamp included), if they are undergraduate or graduate students under 32 years of age and who are not employed. A valid proof of student status is required.

Registration fee includes exclusively admittance to the Summer School, lunches, coffee breaks, welcome buffet on 28 June and social dinner on 29 June.

ACCOMPANYING PERSON
€ 80 (22% VAT included)
The fee includes welcome buffet on 28 June and social dinner on 29 June.

PAYMENT AND REMITTANCE
· by bank transfer, to the order of Associazione Italiana di Metallurgia - AIM at "CREDITO EMILIANO SpA", Branch no. 052 Milano – Via Andegari, 14 - 20121 Milano - Italy, account no. 010000480455– cod. ABI 03032– CAB 01600– - cin M IBAN: IT33M0303201600010000480455,
swift code BACRIT22MIL. The transfer order must specify the name of the participant and the reference "Summer School Udine 2026". A copy of the transfer order must be sent to AIM, together with the Registration Form.
· by credit card online: www.aimnet.it

ACCOMMODATION
Participants are responsible for their own booking and accommodation costs. The summer school venue is in the city centre, walking distance from several hotels >> MAP

LAPTOP
Attendees to the Summer School are requested to bring a personal laptop.

ECTS
The attendance to the School will provide 3 ECTS.

LANGUAGE
The Summer School will be held in English.

ABS QWR PLANT TOUR
Attendance to the technical visit will be reserved to Summer School registered attendees and will be available for a limited number of people.
In order to be considered for an invitation, delegates should apply early while registering to the Conference and must receive an approval to participate from the AIM Secretariat.

CANCELLATION AND REFUND POLICY
A refund, less 20% deduction for administrative costs, will be issued for written cancellations received by June 5, 2026. For attendees who notify their cancellation after June 5, 2026 or will not attend the Summer School, a charge of 100% of the registration fee will be withheld and a copy of the documentation will be sent after the event.

INSURANCE
The Organising Secretariat cannot assume any responsibility for personal accident, loss or damage to the private property of participants and accompanying persons, which may either occur during or arise from the Summer School.
Participants should therefore take whatever steps they consider necessary as regards insurance.

Organising secretariat

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SUMMER SCHOOL

DIGITALIZATION & AI IN METALLURGY

REGISTRATION FORM

FILL ONLINE

Family name.....

First name.....

E-mail (correspondance).....

Telephone.....

Mobile phone.....

Dietary requirements (allergies, intolerance, particular diet, etc):.....

◯ **AIM MEMBER** (€ 430 - revenue stamp included)

◯ **ACCOMPANYING PERSON** (€ 80 - VAT included)

TOTAL AMOUNT BEING PAID: .....

name of the accompanying person: .....

NON-MEMBERS are required to subscribe AIM membership fee for the year 2026

◯ I am interested in the ABS QWR plant tour

INVOICING DATA

Company/University.....

Fiscal address.....

Town/Zip Code.....

VAT and fiscal code (if different).....

Order ref. number (if requested on the invoice).....

PEC (only for italian societies).....

Cod. SDI (only for italian societies).....

PAYMENT

◯ By bank transfer

◯ By credit card online at www.aimnet.it

Registration fee's payment must be made before the beginning of the school. Registration fees and data for payment are detailed in the general information.

Date .....

Signature .....

PRIVACY DISCLAIMER

By signing this registration form, you declare that you have read and accepted the privacy policy available on the website www.aimnet.it.

INFO PRIVACY POLICY

I, the undersigned, have read the privacy policy and agree to AIM processing my personal data in accordance with Articles 13/14 of EU Regulation No. 679/2016 of April 27, 2016 (GDPR).

Furthermore, I authorize AIM:
to include my name in the list of participants in the event:

◯ **Yes** ◯ **No**

sending invitations to events of interest, including through other metalworking associations around the world:

◯ **Yes** ◯ **No**

Organising secretariat

ASSOCIAZIONE ITALIANA DI METALLURGIA

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