Applications (CV + Transcript of records + Desired period to begin) must be sent to international@heig-vd.ch
Interns will receive free housing + payment of their basic expenses (400.-/month).
Internships normally last between 5 and 6 months. Some teachers may exceptionally accept shorter or longer ones.

CIVIL, ENVIRONMENTAL, BIO- ENGINEERING AND GEOMATICS		
Recycling in urban construction fields **Prof M. Viviani**	Urban mining is the process of reclaiming raw materials from wastes and exhausted industrial products. In the construction industry the concept of urban mining has been implemented mostly by deconstructing the buildings and reprocessing the separated materials in order to use them as a raw material in new constructions. Recycled concrete and recycled bitumen are two well-known examples. Although the recycling of the construction wastes have reached the imposing rate of 80% of the total, this figure is stable since many years. Furthermore, the excavated soil is often not included in the statistics of construction wastes and byproducts event thought its disposal is becoming increasingly difficult and costly. Aim of this project is to study the projects and the documents of two construction fields and determine how all the materials that have been disposed could have been valorized. A second aim of the project is to clarify the procedures that applies to each valorization possibility and how an architect/engineer could possibly include these valorization actions when the conception of the building begins. Keywords: urban mining, valorization, construction fields	**Students in Civil engineering and Material sciences with strong interest for lab tests and modelling**
Heat storage systems **Prof. M. Viviani**	The accumulation of heat in soil elements is a popular theme in architecture and engineering. Whereas many studies are available on the heat storage capacity of walls / renderings made of soil, a gap has been found in the literature on the possibility of regularizing the internal temperature of an house by a set of soil masses. The aim of this project is to determine the heat capacity of a specific soil and how much and how fast the heat can be charged in a soil element (mass). The project includes laboratory tests on soils specimens and in heat masses conditioned in laboratory. Keywords: urban mining, soil, heat storage.	**Students in Civil engineering and Material sciences with strong interest for lab tests and modelling**

Effect of biomass ashes in cement pastes and concrete **Prof. M. Viviani**	The number of biomass power plants is increasing since decades. The ashes produced during the burning process have to be disposed unless a valorization is found. Regulations for disposal and utilization of this ashes are very strict due to the presence in many ashes of hazardous substances such as chrome IV and heavy metals. The use of these ashes in concrete is possible but their effect on the hydration process of the cement, on the rheology and on the durability of concrete must be known. The aim of this process is twofold: study the effect of the ashes as they are produced and after a chemical treatment. The project includes laboratory test on cement pastes and mortars with techniques such as isothermal calorimetry and rheolometer. Keywords: valorization of byproducts, cement hydration, rheology of concrete	**Students in Civil engineering and Material sciences with strong interest for lab tests and modelling**
Performance optimization & monitoring of a large solar thermal field connected to a district heating **Dr. A. Duret**	In 2020, a 800m² solar thermal field has been coupled to an important disctrict heating (DH) in Geneva. Solar heat is injected in the DH since the begininning of 2021. This solar field is composed of highly innovative solar collectors produced by the Swiss company TVP Solar. Those solar thermal collectors are flat plate collectors using high vacuum for thermal insulation. This highly efficient thermal insulation allows to maintain high conversion efficiency even with low solar irradiation. This feature is particularly interesting for solar heat production in northern Europe. The Laboratorty of Solar thermal Energy and Buidling Physics (LESBAT) from HEIG-VD has been appointed by Swiss Federal Office of Energy (SFOE) to optimize and monitore the performance of this solar thermal installation. In order to achieve this objectif, aroung 80 sensors have been installed on this installation to measure its performance. The student selected for this internship will be involved in the analysis of the data collected and in the development/validation of a numerical model of the solar field and its heat transfer station. For this topic, the minimum duration of this internship is 4 months (preferably 6 months).	**Keywords: District Heating, solar energy, thermal simulation, renewable energy**
Life Cycle Assessment (LCA) of reuse of construction materials in Swiss buildings **Dr. S. Lasvaux**	The internship is part of an applied research project whose objective is to analyze the potential for reducing environmental impacts (embodied energy, greenhouse gas emissions, waste) related to the reuse of materials in Swiss buildings. Based on a parameterized LCA model of buildings, different variants of pilot buildings will be compared using different % of reused materials. The environmental benefits of each of the variants (in project or under construction) will then be quantified. The environmental performance of these variants will then be compared and optimized with other criteria such as life cycle costs (LCC), which will complete the work. The Laboratory of Solar thermal Energy and Building Physics (LESBAT) from HEIG-VD has been appointed by Swiss Federal Office of Energy (SFOE) to conduct a research project of the reuse potential for a selection of residential, commercial and offices pilot buildings in Switzerland. The student selected for this internship will be involved in the analysis of the data collected, will conduct the LCA of the buildings and in the subsequent sensitivity analyses (the choice of the pilot building(s) proposed to the internship depends on the timeline of the internship between 2021 and 2023, start and end of the research project). For this topic, the minimum duration of this internship is 4 months (preferably 6 months).	**Keywords: Life Cycle Assessment (LCA), building energy simulation, reuse, construction materials, buildings, circular economy**

GIS-based energy-related building renovation of Swiss historic buildings **Dr. S. Lasvaux**	The objective of this internship will be to contribute to the development of an integrated cross-border platform for energy renovation of historic urban centres based on a geographic information system (GIS). In a first step, a characterization table of renovation issues and heritage constraints will be set up with regard to energy renovation measures. Then, the work will be oriented on the construction of reporting template to describe existing energy renovations of buildings in French-speaking Switzerland and on case analyses requiring the use of a (prototype of) web-based tool for energy-related building renovation scenarios under development at LESBAT. This tool allows the assessment of the energy demand (in kWh), the carbon footprint and the financial costs (€ or CHF) of a chosen building(s) computing different measures on the building thermal envelope improvement and/or on the replacement of the heat production using GIS-based information on locally possibilities of energy carriers for heat production (e.g., district heating, renewable energies (PV, solar panels), air-to-water, geothermal heat pump, etc.). The Laboratory of Solar thermal Energy and Building Physics (LESBAT) from HEIG-VD has been funded by the Interreg France-Switzerland program along with the cantons of Geneva, Vaud, Jura, Neuchâtel, Valais and Bern to conduct a research project on the development of a GIS-based platform to foster energy-related renovation and decarbonisation of existing historic buildings. The student selected for this internship will be involved in the analysis of the data collected, participate to the regular meetings with project's partners and will work on a selection of case studies in partnerships with building owners and cities in French speaking Switzerland. For this topic, the minimum duration of this internship is 5 months (preferably 6 months).	**Keywords: Geographical Information System (GIS), Building renovation, energy savings, Life Cycle Assessment (LCA), financial costs, Historic buildings**
Data mining in a building energy performance certificate (EPC) database **Dr. S. Lasvaux**	This internship will be conducted in the framework of "HISTO-RENO" a European research project funded by the Interreg France-Switzerland fund. This project aims to develop a web-based simplified energy pre-audit tool to guide the building owner in their energy-related renovation. The goal of this internship is to derive statistical distributions on the input parameters (U-values, surface area of the main elements: external walls, roof, slab, windows, etc.) of the building heating demand of the current Swiss building stock with the help of the information of individual buildings in the Building energy certificate database (EPC), called "CECB" in Switzerland. The methodology of the analysis will be based on the previous work from Streicher et al 2018. The statistical analysis on the heating demand parameters will then serve to define probability density function (PDF) as input for a stochastic simplified energy audit tool used in a preliminary step of a renovation process indicating the estimates in kWh, carbon footprint and costs of a set of renovation measures. The Laboratory of Solar thermal Energy and Building Physics (LESBAT) from HEIG-VD has been funded by the Interreg France-Switzerland program along with the cantons of Geneva, Vaud, Jura, Neuchâtel, Valais and Bern to conduct a research project on the development of a GIS-based platform linked to a web-based building energy pre-audit tool to foster energy-related renovation and decarbonisation of existing historic buildings. The student selected for this internship will be involved in the statistical analysis of a large database of residential buildings EPC and its exploitation through the web-based tool for energy-related building renovation scenarios under development. For this topic, the minimum duration of this internship is 5 months (preferably 6 months). Proven knowledge in numerical and scientific programming tools like Python or R is required to successfully reach the goals of this internship project.	**Keywords: Existing building stock, envelope, technical systems, statistical analysis**

Dynamic Life Cycle Assessment (LCA) of the energy uses in Swiss buildings **Dr. S. Lasvaux**	The internship is part of an applied research project whose objective is to study the load shifting in a view of minimizing the carbon footprint of the energy use in Swiss buildings. With technologies to achieve the Energy Strategy 2050, the energy demand profile of buildings is changing. However, we are still dependent on electrical energy from the grid. The carbon footprint of this grid not only fluctuates seasonally, but also strongly within a day. In Switzerland, in winter, most of the peak demand is covered by imported electricity from Germany with a higher CO2 content. Promoting the use of electricity when the carbon footprint of the Swiss grid mix is low and/or store this electricity and shift the uses when possible are appropriate means to fulfil this goal. In this internship, this carbon footprint will be applied to different building case studies with different load profiles and predictive controller (at the DSO and energy contractor level). The Laboratory of Solar thermal Energy and Building Physics (LESBAT) from HEIG-VD has been appointed by Swiss Federal Office of Energy (SFOE) together with EMPA to conduct a research project of the Sustainable Demand Site Management of the Energy use in buildings. The student selected for this internship will be involved in the analysis of the data collected, the development and monthly updates of the hourly carbon footprint of the Swiss electricity mix and the analysis of this carbon footprint of electricity on selected building case studies together with HEIG-VD partners. For this topic, the minimum duration of this internship is 4 months (preferably 6 months). Proven knowledge in numerical and scientific programming tools like Python or R is required in order to successfully achieve the goals of this internship.	**Keywords: Life Cycle Assessment (LCA), building energy simulation, dynamic carbon footprint, electricity, hourly assessment**
Life Cycle Assessment (LCA) of biogas and biomethan used in building energy systems **Dr. S. Lasvaux**	The internship is part of an applied internal research project's portfolio at HEIG-VD on the Life Cycle Assessment (LCA) of Energy uses in buildings. One of this project aims at analysing the ecological consequences of an increasing use of biogas & biomethan in the energy systems using a life cycle approach and particularly in the Swiss building sector by 2050. This renewable source is of strong interest since it would contribute to improve the environmental performance of the natural gas as energy vector, while valorising local resources. However, in the literature, current LCAs of the renewable gas and its usage show a large variability in terms of carbon footprint due to different data and allocation rules which hinders to get a clear picture. It is thus necessary to conduct a detailed analysis and reliable quantification of the environmental impacts. Two key aspects regarding the renewable gas successful integration in the future Swiss Energy will be taken into account in this internship project: the LCA of the heat and electricity produced with variable shares of renewable gas (i.e. biogas or biomethan), and the identification of the promising integration scenarios for the technologies relying on renewable gas. The Laboratory of Solar thermal Energy and Building Physics (LESBAT) from HEIG-VD is the main LCA research centre in LCA of energies and buildings. The student selected for this internship will be involved 1) in the definition of the technologies to analyse, 2) in the literature review of existing LCA of biogas and biomethan in order to get a range of carbon footprint for a unit of biogas/biomethan, 3) in the LCA of the heat and/or electricity produced with the technologies selected and 4) in the comparative LCA of heat production with other technologies (e.g. electric-based air-to-water heat pump) or electricity production in micro-CHP comparing biogas/biomethan solutions with electricity ones (using electricity from the grid). The data used for the carbon footprint of the Swiss electricity mix will be based on the ones available at HEIG-VD. For this topic, the minimum duration of this internship is 4 months (preferably 6 months). Proven knowledge in numerical and scientific programming tools like Python or R is required.	**Keywords: Life Cycle Assessment (LCA), building energy simulation, biogas, allocation rules, electricity, heat production**

Multi-objective optimization of building energy systems **X. Jobard**	This internship is part of an applied research project with the objective to develop a multi-objective optimization method to identify the optimal energy concept for the deployment of micro-grids at the neighbourhood's scale. Based on the consumption profiles of buildings and a set of storage and decentralized production technologies (photovoltaic, cogeneration, etc.), the aim is to define optimal solutions that reduce costs while minimizing the environmental footprint. The internship's work plan will follow the following steps: - Definition of technical, environmental and economic performance models for the different conversion technologies considered. - Implementation of a multi-objective optimization method including, as performance indicators, costs and environmental impacts (carbon footprint and non-renewable primary energy). - Application of the method to a case study (theoretical or real according to available data) - Possibly sensitivity analysis to identify the factors that influence the choice of optimum energy concepts for a given building complex. minimum duration of this internship is 4 months (preferably 6 months).	**Keywords: Multi-objective optimization, renewable energy, microgrids**
High evaporating temperature hydrocarbon heat pump **Prof E. Da Riva**	The Institute of Thermal Engineering (*Institut de Génie Thermique*, IGT) is active in the experimental development and testing of low-charge high-evaporating-temperature (≥ 35°C) heat pumps employing hydrocarbons as the refrigerant. The availability of heat pumps capable of evaporating at high temperature is fundamental in order to properly exploit non-conventional heat sources such as waste heat or to develop new-generation low-temperature (~40°C) district heating networks. The project proposed may cover the following topics: -) Experimental test and analysis of heat pumps and compressors -) Thermodynamic modelling of vapor crompession refrigeration cycles -) Energy assessment of low-temperature district heating networks employing heat pumps for local temperature rise	**Students with previous knowledge from courses in refrigeration engineering, thermodynamics, heat transfer**
Two-phase heat networks **Prof E. Da Riva**	Latent heat transfer by means of condensation or evaporation requires a considerably lower mass flow rate than sensible heat transfer. As compared to conventional water networks, thermal network exploiting the phase change of a suitable fluid may display a much smaller diameter, thus being competitive especially in applications such as the combined use of a lake as heat-source and heat-sink for heating and cooling in densified city centers. The Institute of Thermal Engineering (*Institut de Génie Thermique*, IGT) has developed a thermosiphon CO_2 two-phase prototype thermal network which can be used as direct heat-source to the evaporator of a heat pump. The project proposed may cover the following topics: -) Experimental test and data analysis of the existing prototype network -) Two-phase heat networks modeling and comparison among different fluids -) Energy et technical feasibility assessment of two-phase thermal networks	**Students with previous knowledge from courses in refrigeration engineering, heat transfer, hydraulic network design**

Optimization of energy production from biological waste trough anaerobic digestion **Prof. Dr.** **R. Roethlisberger**	As the world is facing a growing issue with climate change, alternative energy sources are becoming more and more prominent. Among them, anaerobic digestion is a carbon neutral way of converting organic waste into methane, while producing an organic-rich fertilizer. It thus perfectly falls within the concept of a circular economy. The Institute of Thermal Engineering (Institut de Génie Thermique, IGT) is active for several years in this research field. The IGT is particularly active on implementing findings from research laboratories into the field, especially regarding topics like energy and biofuel production from wet and dry biomass, agricultural and food-waste anaerobic digestion, biogas purification technologies and micro-macro algae utilisation for nutrients removal. The main research activities focus on pre-treatment protocols of fibrous biomass such as manure (using grinding, organic acid and thermal treatments) and PBR (photobioreactor) systems using microalgae to treat water/air waste streams. If you want to be integrated in one of these research topic, please feel free to contact us. Minimum duration 4 months, preferentially 6 months.	**Keywords: methanization, anaerobic digestion, pre-treatments, microalgae, biogas upgrade** **Students in environmental engineering and/or in biotechnology, with strong interest for laboratory work**

MATHEMATICS, INFORMATION TECHNOLOGY AND COMMUNICATION (TIC)		
Platform applying Intelligent Signal Analysis to Gain Insights to Plant Electrophysiology **Prof. L. Raileanu**	Plant electrophysiology has been studied for decades but there are still substantial insights to be gained which will flow through to improved agriculture practices. For this industrial project, we developed a multi-channel plant electrophysiology biosensor; it will be used to collect dataset of under stress plants' electrical signal. Your task will be to apply signal-processing techniques on these datasets to extract features and then use intelligent data analysis algorithms on these features in order to predict if the plants are stressed and which kind of external stimuli are applied. The main goal of this project is to use plants as multiple stimuli sensing biological devices.	**Keywords: signal-processing, data analysis, machine learning, plants, electrical signal**
Secure indoors geolocation solution for mobile **Prof. L.Raileanu**	The goal of this internship is to study, design and implement a secure indoor geolocation solution for mobiles. Currently the most common solution are the iBeacons, but these don't offer a secure solution as they are using invariable identifiers. After the completion of a state of the art of existing technologies and their availability on mobile platforms, the trainee will propose a solution and realize a PoC.	**Keywords: mobile, android, ios, iBeacon, geofencing, security**
Porting semen analysis app on iOS **Prof. L. Raileanu**	We developed an Android application for animal semen analysis, which applies video analysis algorithms (OpenCV) to images acquired by an external device. The goal of this internship is to study the feasibility of porting this application to iOS, natively or using a cross-platform framework, and to realize a proof-of-concept.	**Mobile, mHealth, iOS, cross-platform, image analysis**

Development of computable phenotype algorithm for postoperative survival prognosis of neonates **Prof. L. Raileanu**	Patient data are routinely collected day-to-day clinical practice by means of electronic medical records (EMRs) and/or specialized databases. These data could represent both structured information (certain clinical evaluation parameters, results of blood test, etc.) and unstructured free-text notes, which provides health care providers with information allowing to convey the nuances of a patient's unique presentation and history (Halpern et al., 2016). These data could be used to extract facts and specific characteristics of the patients to identify, for example, certain disease case, treatment or survival outcome. Compiling such large amount of information manually by using conventional statistic methods could take months and hundreds of person-hours. Recent advances in computational science allowed integrating more effective and less time-consuming methods into clinical care routine and research, such as computable phenotype algorithms. These algorithms could search across EMR, databases in order to perform case detection (Shivade et al., 2014, Peissig et al., 2014). The aim of this project is to develop a computed phenotype algorithm for prognosis of postoperative survival of children by using data collected and stored at restricted access database. The student would need to develop a computed phenotype algorithm, which would allow predicting survival (or death) in newborn children after surgery based on clinical data collected in the pre-, intra- and post-surgery periods and registered in a specialized database. This will facilitate further in-depth processing and analysis of the clinical parameters and developing clinical strategies to increase the chances of kid's survival.	**Keywords: data analysis, machine learning**
Characterizing gait variability in children with cerebral palsy **Prof. L. Raileanu**	Motor deficits in children suffering from cerebral palsy (CP) result in gait deviations and vary depending on pathology severity. Clinical gait analysis is commonly used to assess the functional capacity for a specific patient Based on clinical gait analyses' raw data (marker trajectories), the project aims to characterize the the intra-subject gait variability within a population of healthy subjects and patients with CP to assess differences in variability characteristics between groups and pathological subgroups. An automated classification of the gait pattern in subgroups would allow a tool to further support clinical decision-making process.	**Keywords: data analysis, machine learning, gait trajectories**
Learning analytics, data analysis **Prof D. Jaccard**	At Media Engineering Institute (MEI), AlbaSim "serious games" research axis (www.albasim.ch) develops games and simulations for training purposes in fields such as project management, oncology care, medical management of major events or energy management. These serious games are available online and used by thousands of students from different universities. The project aims at studying the possibilities of using usage traces in order to improve the quality of both the games and learning. This study includes conceptual, technical, legal and statistical aspects.	**End of Bachelor or Master student in Computer sciences or with a background in user experience.**
User experience in serious games: tests and improvments **Prof D. Jaccard**	At Media Engineering Institute (MEI), AlbaSim "serious games" research axis (www.albasim.ch) develops games and simulations for training purposes in fields such as project management, oncology care, medical management of major events or energy management. The UI and UX aspects of the games developed are essential. The aim of the project is to test and evaluate the UI and UX aspects of existing games, define possible improvments, implement and test the effects of those changes.	**End of Bachelor or Master student in Computer sciences or with a background in user experience.**

Machine translation at the text level **Prof A. Popescu-Belis**	The goal of this internship is to study the combination of recent, deep learning approaches to machine translation (MT), with other recent approaches for coreference resolution, i.e. finding the words or phrases in a text that refer to the same entity. Knowledge of coreference is potentially useful for translating more coherently the referring expressions, but is hard to combine with neural MT. This internship will be devoted to the combination of the two architectures, based on existing systems, for instance by adopting a multi-task learning approach.	**Students with previous knowledge from courses in machine learning, neural networks, human language technology or artificial intelligence**
Task-oriented chatbots using neural networks **Prof A. Popescu-Belis**	Recent neural network approaches to the design of chatbots have resulted in realistic conversational agents - using written, or sometimes spoken language. However, while these agents are trainable through conversations, it is difficult to connect these agents to knowledge bases, so that they perform useful tasks, such as question answering or database transactions. The internship will focus on a hybrid chatbot, which can switch between a conversational, NN-based model for the social aspects of an interaction, and a traditional, knowledge-based model for the task-oriented aspects. The second model could, for instance, perform community question answering, i.e. use existing answers to popular questions to answer new ones, assuming they are variants of existing ones.	**Previous knowledge from courses in machine learning, neural networks, human language technology or artificial intelligence**
Development of system for the detection of spelling mistakes in real time while writing a handwritten note **Prof. M. Rubinstein**	The student will develop a system to notify a person, in real time, of spelling mistakes in text that he or she is writing by hand.	**Prior genrral knowledge of neural networks and computer vision desirable**
Medical drug dosage adaptation software **Prof. Y. Thoma**	Tucuxi (http://www.tucuxi.ch) is a software that has been developed with the aim of helping the pharmacologists with the adaptation of medical drug dosages. The current system supports drugs with single analytes, but some medical drugs require multi-analytes models. The computing engine has been developed in C++, and the GUI in C++, with QML. The goal of this project is to adapt the current GUI to multi-analytes models, with a specific emphasis on the reliability of the system.	**Computer science or c. engineering students: C++ software development, expert system..**
Clinical Decision Support System for medical drug dosage adaptation **Prof. Y.Thoma**	Tucuxi (http://www.tucuxi.ch) is a software that has been developed with the aim of helping the pharmacologists with the adaptation of medical drug dosages. The current system is composed of a computing backend and a GUI. The goal of the current project is to develop a clinical decision support system (CDSS) on top of the computing engine. The CDSS shall be able to answer questions a pharmacologist would have, such as : is this drug concentration measurement likely to be correct, what dosage should I propose for this specific patient, ... It will use the existing computing backend and add a layer of expert system on top of it, and based on the available data, supply a report with relevant information for the clinician. The development will be done in C++ with a specific emphasis on the reliability of the system.	**Computer science or computer engineering students: C++ software development, expert system**

RULE-DEEP-EXTRACTION: Extraction of Rules from Deep Neural Networks Prof C. Peña	The proposed project is developed in the frame of our XAI (explainable Artificial Intelligence) research activities. Among other lines, we are exploring the development of novel methods for extracting rules from Deep Neural Networks. Such methods will be able: (1) to extract knowledge in the form of hierarchical rule representations to explain how Deep Neural Networks make their predictions while (2) preserving, as much as possible, the prediction accuracy of the neural network. The specific goal of the student's project will be to investigate, implement, and test an approach for extracting rules from specific deep network architectures that we are using in our research projects. For instance: 1D convolutional or LSTM networks.	**Machine learning, Deep learning, Explainable Artificial Intelligence.**
Deep Learning on Genomics using LSTM (Long Short-Term Memory) networks Prof C. Peña	The goal of this project is to apply LSTM (Long Short-Term Memory), a computational technique that has proven very good at text classification, to deal with genomic data in the context of biological classification. More specifically LSTM will be applied to at least 2 different datasets from our group's research projects. Context. In the field of biology, from an information point of view, a DNA sequence can be considered as a sequence of specific characters such as 'A', 'C', 'G' and 'T' called bases. It is generally accepted that the information encoded by the DNA is organized hierarchically in blocks of growing complexity (e.g., domains, genes, chromosomes) related directly with biological characteristics and phenomena. Although different to language, DNA-encoded information has a latent structure that could be exploited by machine-learning algorithms to build predictive models	**Machine learning, Deep learning, Bioinformatics, Genomics.**
Machine Learning on Genomics using NLP-inspired approaches Prof C. Peña	The goal of this project is to apply dna2vec, a computational technique inspired from the NLP method word2vec that has proven very good at text classification, to deal with genomic data in the context of biological classification. More specifically LSTM will be applied to at least 2 different datasets from our group's research projects. Context. In the field of biology, from an information point of view, a DNA sequence can be considered as a sequence of specific characters such as 'A', 'C', 'G' and 'T' called bases. It is generally accepted that the information encoded by the DNA is organized hierarchically in blocks of growing complexity (e.g., domains, genes, chromosomes) related directly with biological characteristics and phenomena. Although different to language, DNA-encoded information has a latent structure that could be exploited by machine-learning algorithms to build predictive models	**Machine learning, Bioinformatics, Genomics**
PERPHECT Deep Learning and Generative Networks for Editing Viral Genomes Prof C. Peña	In the context of developing viral (phage) therapies to fight resistant bacteria, we have developed models able to predict interactions between bacteria and phages based only on their genomic sequences. As a next step in this fight, one forward-thinking modernization of phage therapy is to use genetically-engineered (GE) phages that may provide substantial advantages over natural phages in terms of host range, immune system recognition, and environmental stability. The application of Artificial intelligence (AI) to this context has potential both to increase the speed at which genomes can be engineered and to enhance the activity of resulting phages. PERPHECT focuses on the use of Deep Neural Networks, that enable extracting patterns directly from DNA sequences which are relevant to predict phage-bacteria interaction, coupled with Generative Methods that have the potential to create sequences very similar to naturally-occurring ones. The specific goal of the student's project will be to investigate, implement, and test a generative method (e.g., Generative Adversarial Networks or Meta-heuristic search) that could be integrated with the existing predictive model in order to search for phage genome modifications that improve their therapuetical performance.	**Machine learning, Deep learning, Bioinformatics, Genomics**

AIMIA: AI-assisted Microscopy Image Annotation **Prof C. Peña**	In the context of developing viral (phage) therapies to fight resistant bacteria, we have developed models able to predict interactions between bacteria and phages based only on their genomic sequences. As a next step in this fight, one forward-thinking modernization of phage therapy is to use genetically-engineered (GE) phages that may provide substantial advantages over natural phages in terms of host range, immune system recognition, and environmental stability. The application of Artificial intelligence (AI) to this context has potential both to increase the speed at which genomes can be engineered and to enhance the activity of resulting phages. PERPHECT focuses on the use of Deep Neural Networks, that enable extracting patterns directly from DNA sequences which are relevant to predict phage-bacteria interaction, coupled with Generative Methods that have the potential to create sequences very similar to naturally-occurring ones. The specific goal of the student's project will be to investigate, implement, and test a generative method (e.g., Generative Adversarial Networks or Meta-heuristic search) that could be integrated with the existing predictive model in order to search for phage genome modifications that improve their therapuetical performance.	**Machine learning, Assisted annotation, Microscopical imaging, Image processing**
Machine learning to detect metallic objects **Prof. J. Ehrensberger**	For the security forces, concealed metallic objects and in particular weapons are a risk. Of course, such objects may be detected using scanners such as those installed at airports. The goal of this project is to evaluate the feasibility of detecting such objects at a greater distance, such as several meters. The project will use several types of sensors to collect experimental data sets in a lab environment. The datasets will then be analyzed using different machine learning approaches.	**Machine learning, radio-frequency**
Markdown notebooks for Scala 3 **Prof. J. Ehrensberger**	Together with Python and R, Scala is one of the major programming languages for Data Science. While many Python teams use Jupyter-notebooks for their research, R offers another option: R Markdown documents (https://rmarkdown.rstudio.com/). Markdown documents have several advantages over Jupyter, including a better development experience and better Git version control. The goal of this project is to develop a Markdown notebook system for Scala 3, similar to R Markdown. The system will use Pandoc as document conversion engine. Additional filters to generate graphics and program output have to be developed. Ideally, a plugin for VS Code is developed to provide a rich development experience for Scala Markdown notebooks.	**Keywords: Scala, markdown, data science, software development**
Deep Learning for Earth observation **Prof A. Perez-Uribe**	Deep neural networks have shown to be very good at image classification and object recognition tasks. The objective of this project is to train a custom system to process and analyze satellite images (both from day and night). To achieve this, we will take advantage of pretrained models provided by the major actors in the domain and proceed to fine-tune them with our own data. Potential applications include, forest monitoring, population growth analyses, socio-economic issues, etc. For more information: http://iict-space.heig-vd.ch/ape	**Keywords: Deep Neural Networks, image processing, Machine Learning**

Personal mobile coach **Prof A. Perez-Uribe**	The increasing availability of wearable sensors embedded in smartphones, watches and physical activity trackers has open the door to original applications, mainly in health and wellness improvement. One typically collects data by means of sensors like GPS, accelerometers, gyroscopes, barometers, microphones, cameras, depth sensors, etc. To make sense of these data, Machine learning algorithms can be used to establish correlations among the variables under investigation, and as in every attempt to understand high-dimensional data, visualization and dimensionality reduction techniques can suggest new knowledge about the aspects of the person's life being monitored. The objective of this project is to deal with diverse application domains including self-tracking of physical activity, self-tracking and characterization of style and performance in sport (e.g., racket sports, running), daily-life logging , or 24/7 self-monitoring as a means to enhace our wellbeing. For more information: http://iict-space.heig-vd.ch/ape	**Keywords: wearable sensors, smartphones, smartwatches, time-series, Machine Learning, health, sports**
Human-humanoid interaction **Prof A. Perez-Uribe**	The current availability of the first humanoid robots at moderate prices opens up a wide range of applications. The objective of this project is to program a humanoid robot or a human-humanoid interface using 3D cameras or smart glasses. Potential applications include the programming of appropriate behaviors that makes the interaction with such robots more human-like with the aim of increasing our trust in them. For more information: http://iict-space.heig-vd.ch/ape	**Keywords: Humanoid robots, human-humanoid interfaces, Kinect, image processing, Machine Learning**
Smart rehabilitation **Prof A. Perez-Uribe**	Werable sensors open the door to monitoring patients at home. This can provide very valuable data to doctors, that nowadays rely on the observation of their patients when they go to the hospital and on the subjective information provided by the patients themselves or their relatives. Within this project, we will use wearable sensors and egocentric cameras to identify and evaluate the quality of movement of persons suffering from upper-limb neurological disorders. To identify particular movements, we will use machine learning algorithms to exploit both, the video captured by the camera and the time-series captured by the wearable sensors. For more information: http://iict-space.heig-vd.ch/ape	**Keywords: wearable sensors, Machine Learning, rehabilitation**
GeoSQL Journey **Prof O. Ertz / J. Ingensand**	GeoSQL Journey is a project led by the Media Engineering Institute and the Institute of Territorial Engineering (see https://peerj.com/preprints/27247). The purpose is to motivate and help students to learn geospatial SQL with a fun software. It is to guide students through pedagogical objectives on the base of a game world and story combining mechanisms related to gamification. The proposed work will be based on the results of preliminary game design. It will be about the development of a proof of concept platform that implements some ideas of GeoSQL Journey to learn geospatial SQL with fun using actual web technologies. The work will follow three main phases: (1) take in the web technologies through tutorials and documentation, (2) follow an agile process to implement a first release with the web technologies studied during the first phase and (3) deploy and test with multiple students in order to improve and validate the concept.	**background in software engineering and development and/or in geographical sciences, with interest in education technology (EdTech).**

BioSentiers augmented reality and occlusion techniques **Prof O. Ertz / J. Ingensand**	BioSentiers is a project lead by the Media Engineering Institute and the Institute of Territorial Engineering. The purpose is to offer a way to discover biodiversity through a location-based augmented reality mobile application (see biosentiers.heig-vd.ch). That means, given a predefined pathway marked all along its length with points of biodiversity interest, citizens of Yverdon-les-Bains have the possibility to observe them and virtually interact with nature by getting extra multimedia content about various flora and tree species. The proposed work is about a new feature for the front-office AR application to allow object occlusion while exploring the area around the user. In other words, the purpose is to find a solution to avoid the display in the AR scene of points of biodiversity interest which may be hidden by a building in the real environment. The swissTLM3D large-scale topographic landscape model and swissBUILDINGS3D vector based dataset which describes buildings as 3D models may be useful to implement such a feature. The work will follow three phases (1) carry out a state of the art to draw up a panorama of knowledge and techniques on this theme (2) specify, design and develop a proof of concept of the intended feature (3) integrate the occlusion solution so as to release a new version of the AR front-office BioSentiers application.	**background in software engineering and development with interest in augmented reality or in geographical sciences with focus on interactive mapping techniques**
BioSentiers augmented reality authoring system **Prof O. Ertz / J. Ingensand**	BioSentiers is a project lead by the Media Engineering Institute and the Institute of Territorial Engineering. The purpose is to offer a way to discover biodiversity through a location-based augmented reality mobile application (see biosentiers.heig-vd.ch). That means, given a pathway marked all along its length with points of biodiversity interest, citizens of Yverdon-les-Bains have the possibility to observe them and virtually interact with nature by getting extra multimedia content about various flora and tree species. Currently the pathway and the points of biodiversity interest are predefined. There is a back-office that allows only to customize a visit of the pathway by choosing the sections of the pathway to explore and the species to observe. The proposed work is about the development of a full featured authoring back-office that allows a content manager to define new pathways, collect/insert new points of biodiversity interest, associate media content (photos, sounds, ...) to them and finally publish everything to be displayed through the front-office AR application. The work will follow three phases (1) carry out a state of the art to draw up a panorama of knowledge and techniques on this theme and identify existing toolset, framework and system (e.g. headless-CMS, etc) that may be useful to consider (2) iteratively specify, design and develop the intended back-office (3) adapt the the AR front-office BioSentiers application to use the features served by the back-office.	**background in software engineering and development with interest in augmented reality or in geographical sciences with focus on interactive mapping techniques**
Placement of emergency vectors in strategic locations as needed **Prof. S. Robert**	The mission of the emergency services (ambulances, helicopters) is to ensure 24 hours a day, at the decision of an alarm center, in all places and on a defined territory, the medicalization of interventions with patients whose condition requires emergency medical attention. They must demonstrate rigorous medical and logistical organization, benefit from the implementation of the most modern technologies and evaluate their practices. In this project, we will be studying the ideal location of the means of intervention in order to be able to provide the necessary assistance as quickly as possible to the people who need it. The study will first be theoretical and scenarios will be evaluated with different evaluation methods and then applied to real cases. The tools used will be mainly mathematics (graph theory and algorithmics) and deep neural networks. Page: http://www.stephan-robert.ch/research/	**Mathematics, physics or computer science students with data science skills Optimisation, Deep Learning, mathematics, Graph Theory, Programming skills: Python**

Media Engineering Institute (MEI) **Smapshot Narrative** **Prof. D. Rappo**	Smapshot is a geolocation tool dedicated to photography. The web platform allows volunteers to position images within a virtual globe in order to locate them in 3D. End users can go back in time, browsing through photographic collections dating from the late 19th century to nowadays.The platform has been in development since 2017, it will soon contain 200'000 images, many software features, and new extensions are being considered. The following description is one of them.The goal of this project is to create an editor and a viewer for narrative presentation inside smapshot, taking advantage of 3D views for an immersive interactive experience. This new kind of narrative support could be used on the web, or on dedicated devices for examples You'll have to develop an editor (PoC), with following potential features: select images from georeferenced sources in smapshot via a search engine (keywords, location, owner, collection) or direct selection on a map, rearrange order of images inside the presentations, select info to display with the image (title, description, date, etc.), add additional info (augmented text). For the conception phase, you'll have to research current similar solutions and extract most common features, must have, etc. and create wireframe of user interface. MEI can help with this phase.Afterwards you'll have to develop the viewer (PoC) whose main features are: display list of narrative presentations, and view a narrative presentation. The conception step includes the research of current similar solutions and the extraction of most common features, must have, etc. You'll be ask to create wireframe of the user interface. MEI can help with this phase.	**Students must be skilled in web development, the technologies used are VueJS, Tailwind, CesiumJS for the frontend, NodeJS for the backend, PostgreSQL for database, Docker and ansible for Sysadmin**
Media Engineering Institute (MEI) **My Smapshot** **Prof. D. Rappo**	Smapshot is a geolocation tool dedicated to photography. The web platform allows volunteers to position images within a virtual globe in order to locate them in 3D. End users can go back in time, browsing through collections dating from the late 19th century to nowadays. The platform has been in development since 2017, it will soon contain 200'000 images, many software features, and new extensions are being considered. The following description is one of them. The goal of this project is to adapt Smapshot for personal usage (uploading trekking pictures, holiday images, etc.). In particular, adapt the backoffice interface to manage import of new images by the user, import location from EXIF, add other metadata, georeference the pictures... The backoffice main potential features are: user backoffice, admin backoffice / security, deployment. For the conception phase, you'll have to create wireframe of user interface. MEI can help with this phase. The development expected is a proof of concept for the fullstack.	**Students must be skilled in web development, the technologies used are VueJS, Tailwind, CesiumJS for the frontend, NodeJS for the backend, PostgreSQL for database, Docker and ansible for Sysadmin**

Heterogeneous System Infrastructure **Prof. A. Dassatti**	The end of the Moore's law imposes new specialized hardware solutions to serve the increasing computing demand. System composed by several domain specific accelerators are available, but from the system integration and programming point of view they rely on custom solutions. The idea of this project is exploring the state of the art in compiler infrastructure for heterogeneous hardware and implement a prototype to measure real benefit and compromises of these solutions. Several research project have already been carried out in our laboratory on this subject.	**Compiler, heterogeneous systems, accelerator, runtime.** **Requirements: computer architecture, C/C++ programming, basic FPGA knowledge a plus.**
Smart Storage **Prof. A. Dassatti**	Data centres demand more and more computation efficiency. Standard CPU are unable to cope with the demand and GPU can only serve specific computation patterns. FPGAs are an attractive technology in this field, but its integration in the data centre infrastructure is not trivial. Smart Storage solutions based on the NVMe protocol are the most promising path in this scenario. In our lab we have developed a first prototype f the technology and this project will focus on extending its functionalities and benchmark it extensively.	**Keywords: Linux, nvme, file system** **Requirements: computer architecture, C/C++ programming, basic FPGA knowledge a plus, Operating systems**
DVBS2x LDPC decoder **Prof. A. Dassatti**	LDPC are powerful error correction codes adopted by many modern communication standards. In satellite communication, for instance, DVBS2x use a specific LDPC to protect video transmission from and to space. In our lab we have a complete Software Defined Radio system implementing the system in software, but the performance of the LDPC decoder are unable to cope with the required data rate for a real-time system. In this project we will develop a FPGA based LDPC decoder and we will test it in a complete radio communication chain.	**Keywords: LDPC, SDR** **Requirements: C/C++ programming, FPGA design experience**
Smart Network **Prof. A. Dassatti**	Data centres demand more and more computation efficiency. Standard CPU are unable to cope with the demand and GPU can only serve specific computation patterns. FPGAs are an attractive technology in this field, but its integration in the data centre infrastructure is not trivial. Smart Network interface (NICs) solutions are attractive for offloading many filtering and computation directly at the network attachment point relieving the CPU of many tasks. This project will explore the state of the art in the domain with the aim at developing a prototype capable to off-load tasks to an FPGA.	**Keywords: Linux, nvme, file system** **Requirements: computer architecture, C/C++ programming, basic FPGA knowledge a plus, Operating systems**

FPGA compression for stereo RGBd Stream **Prof. R. Mosqueron**	Goals : Due to the large amount of data providing by the images sensors, the goal of this project must be to send a compressed stream for storage and for processing. Images come from a RGBd sensor which is a stereo camera plus a depth sensor. This kind of sensor is very useful to manage a 3D environment illustrating the virtual rehabilitation environment. The bandwidth is very high (10Gbps per sensor) and medium capacity is limited. In this case, USB3 is used and the bandwidth is close to 5Gbps (10 for USB3.1). Then, capacity of the medium for uncompressed is not sufficient. The solution is to use compression. Compression for stereoscopic field could be specific. Either the stereo compression is done in a smart system before sending the stream or two separate compressions are done. Some compression can be used with strict constraint of latency. The latency (Glass to glass) must be less than 40 ms. It means that most of the standard cannot be used.	**Video analysis** **Student with a good knowledge in compression**
sustainable agriculture: Multispectral approach for efficient watering **Prof. R. Mosqueron**	We aim to develop a watering robot for seedlings in order to support ecological and sustainable agriculture. During the first days, seedsare very sensitive to a lack of water by the low volume and depth of their roots. This stress can cause fairly substantial production losses. The objective of this project is to produce an image analysis system into the robot allowing the detection of seed pieces and weeds. This project will study the different detection solutions by image analysis. Multispectral cameras can be used to define the spectrum of the plant and determine the type of plants. Machine learning is a possible solution for this kind of system. The project will include the implementation of a prototype in order to carry out real tests in a field. Specifications: - Study of the vision system - Study of algorithms, definition of constraints - Simulation - Implementation on the on-board system (RPi, PinQ, ...) - Integration on the prototype robot	**Video analysis and processing, robotics, ROS is a plus**
Virtual SIM for 5G stand-alone network **Prof. R. Mosqueron**	As part of these projects, REDS is studying the implementation of a 5G Standalone network (5G SA). To do this, it has a 5G Base Station and various User Equipment (UE -modem connected to Raspberry PI, mobile phone, road, etc.). These UEs currently use basic SIM cards (USIM), the same as those used by operators. The use of these USIMs is not optimal: It requires individual programming, physical access to the EU, ... The aim of the project is to study the new generations of cards that are / will be available. These include eSIM (electronic SIM), iSIM (integrated SIM), SW SIM. Once the study has been completed, it will first be a matter of selecting the most suitable type of card. The selection criteria will also be defined during the project Once the type of card has been selected, a solution, SW and HW, will have to be set up for the use of this type of SIM within the 5G network. • Progress of the project: • Study of the different types of SIM card • Selecting a SIM card type • SIM deployment	**Telecom, embedded systems, 5G**

Implementation of cloud framework into edge computer **Prof. R. Mosqueron**	As part of the development of agriculture in African countries, a distributed edge computer network system could be developed to allow a group of farmers to have access to an intelligent and shared data processing service. This network would be a private 5G-type base station network where the management would not be done by the mobile telephone operators. AWS and Microsoft have some frameworks include in their cloud functionalities dedicated to agricultural concern. It is possible to integrate this system into edge (cloud) computing to design an architecture capable of operating without having access to the cloud. Internet access is not guaranteed in these countries, it is necessary that access to these computing power can be done anyway. Specifications: • System definition • Implementation of farmbeats in an edge computer • Development of communications with sensors and user equipment • Tests and validation	**Cloud computing, Network**
IoT counting people **Prof. R. Mosqueron**	The project aims at designing an entire IoT system which will be based on the following scenario: We have a closed room with a certain number of windows. We have an embedded system whichmeasures at regular intervals the temperature, humidity and CO2. The data is uploaded by usingcellular connectivity to a public cloud (Azure, AWS or Swisscom Cloud). The date (time series) will besubsequently analyzed and based on the parameters, a basic data processing will be made in order todetect the number of persons which are in the room (CO2 should vary linearly with the number ofpersons in the room). This way an indirect person counter will be implemented. The CO2 variationwill tell also the user when the window should be opened, before the values will become dangerous.Sensors will be installed also on the windows to detect when it is opened.From a hardware point of view, the system will consist in an embedded system (RPi or Arduino typeor both) together with a cellular modem and the sensors.The cloud architecture consists in a virtual machine with a nonSQL database which ingests the data.A dashboard will be also put in place so that the user can check the actual status.All the hardware and cloud client will be provided by Swisscom. Also several resources andknowledge about the cellular connectivity will be shared along the project	**Signal processing and network** **Student with good knowledge in network and signal analysis**
Elastic edge-to-cloud resource management techniques **Prof. M. Zapater**	The popularization of artificial intellengence is bringing deep learning to a myriad of novel applications. Image analytics, video surveillance, self-driving card or real-time population monitoring are among the novel killer applications that require efficient management between edge and cloud. To maximize performance and minimize the energy consumption of both edge devices and cloud platforms, there is a need to develop efficient resource management techniques able to take workload allocation decisions, on when and where to execute the workload, in the edge to cloud continuum in an elastic way. To exploit elasticity, these techniques need to be aware of the underlying hardware and software stack, which often consist on a lightweight virtualization (like containers) deployed on ARM or RISC-V based edge devices. This project proposes the design of heuristic and meta-heuristic based workload managemet techniques and tools to adequately	**Computer Science and Computer Architcture** **Student with good knowledge of C/C++.** **Basic ML knowledge would be a plus.**

	allocate deep learning workloads in edge and cloud devices. To test the proposed techniques in a large-scale scenario of hundreds of nodes, we will use an efficient in-house open source simulator tool that will be extended with novel features to ensure scalability.	
In-memory computing techniques to accelerate deep neural networks **Prof. M. Zapater**	In-memory computing techniques have emerged as a promising technique to reduce the processor-to-memory traffic and increase the performance in the execution of deep neural networks. The specific technique that is more suitable for each type of network depends on the network size (amount of layers, parameters and weights) and on the nature of the network itself. In this project we will evaluate in-memory computing techniques, in particular the suitability of both in-SRAM (in-cache) and in-DRAM (main memory) computing for a set of different networks. For this porpuse we will use the gem5 architectural simulator, which enables us to extend an ARM 64-bit architecture with novel architectural enhancements.	**Strong background on computer architecture. Student with knowledge on C/C++.**

INDUSTRIAL ENGINEERING (TIN)		
New Smartgrid lab : Development and test of power converters interface software using LabVIEW programming based on Compact RIO and industrial PC **Prof. M. Bozorg**	The Institute of Energy and Electrical Systems provides expertise in the field of electrical energy in the broadest sense of the term with special focus on energy systems with an electrical component. The institute implements a new Intelligent Networks laboratory involving new data acquisition hardware and software. One of the major topic is a system that produces two feeder distributions in low voltage, totally reconfigurable, with several different generation systems. Two different measurement acquisition and signal processing systems have been planned as well. The interface software system is based on Compact RIO and industrial PC. The developing environment is Labview. The objective of this diploma thesis is the development and test of power converters interface software system. The power converters are part of the laboratory. The diploma thesis will be performed in collaboration with the Intelligent Networks Laboratory (ReIne laboratory) development team.	**Basic competences in power electronics, communications and power systems**
Identification of inverter malfunctioning and Power Quality distorting components using grid side measurements	Active power distribution networks will be dominated by distributed inverters on both generation (e.g., photovoltaic inverters), and consumption (e.g., electric vehicle charging stations) sides. The potential impact of malfunctioning of these inverters on the low voltage network can be observed as disturbances in the electric system in terms of poor power quality. In this project we aim at identifying location of malfunction devices (feeder or point of connection) using data from limited number of measurements devices and based on machine learning algorithms (anomaly detection and classification).	**Basic knowledge in power electronics and power systems. Competencies in Machine Learning and programming**

Prof. M. Bozorg	We primarily focus on malfunctioning related to grid-connected active distribution networks, namely, excessive harmonics injections, unbalanced current injections, leakage current	
Comparative analysis of SOP (Soft Open Point) system in MV and LV applications, based on B2B (back-to-back) 2/3 level VSC converter and MMC (Modular Multilevel converter). **Prof. M. Carpita**	Aim of this project is the comparative performance assessment of SOP technologies based on Modular Multilevel Converters architectures, in comparison with B2B 2 or 3 level converter. The possibility to add energy storage capability to these devices will be analysed too. The comparative performance assessment will be focused on the future Swiss energy system scenarios with massive integration of RES at distribution grid level. Under these scenario utilities and customers may be confronted with voltage sags, poor power factor and voltage instability. Dynamic reactive power control of SOP can solve these issues. A theoretical development based on study cases proposed by distribution network operators and an experimental part on the ReIne laboratory (HEIG-VD) are foreseen.	**Basic competences in power electronics and power systems**
Theoretical and experimental comparison of the main inertia control techniques of the RES inverters. **Prof. M. Carpita**	Due to the large-scale penetration of renewable energy sources (RES) such as wind and photovoltaics, the power grid is evolving from a system based on synchronous machines to a system dominated by inverters. The traditional approach to inverters as grid following units can lead to frequency instability. The use of inverters with virtual inertia control algorithms, so that they appear as synchronous generators to the grid, allows to guarantee and improve grid stability. Numerous different inverter control topologies aimed at emulating virtual inertia have been presented in the literature in the recent years. Typically, all those methods are based on a suitable control topology, whose aim is to allow the inverter to reproduce the behaviour of a synchronous generator connected to the grid. The "quality" of a control topology depends on the control architecture of the system and the desired level of detail in the replication of the dynamics of the synchronous generators. Several different approaches have been studied in the recent past. Current research needs go towards the optimisation of those methods and the system-level integration of inverters with virtual inertia control. Aim of this project is the evaluation, comparison and optimisation of the main inverter inertia control techniques on the basis of the scenarios and the requirements that will be settled by projects of the two related activities.	**Competencies in power electronics and control systems**

Self-adaptive sampling rate data acquisition system **Prof G. Courret**	The goal of this internship is to contribute to the development of a self-adaptive sampling rate data acquisition system designed for larg band signals. The work will be performed in collaboration a researcher working in our laboratory on the development of a software and firmware dedicated to signal processing and real time analysis. This internship will also participate in the design of the algorithm for compression, analysis and storage of measurement data. Knowledge of signal processing for spatial engineering as well as medical engineering is potentially useful.	**Students with previous knowledge from courses in data compression, analysis and storage, signal processing engineering, digital electronics (FPGA-SoC) and Matlab or Octave programming**
New range extender for electric cars **Prof G. Courret**	This internship aims to contribute to the development of a range extender (RE) for electric cars; this new prototype will be powered by micro turbomachines. Being lighter and less bulky than piston combustion engines, even with the silencer, turbomachines meet indeed the requirements of REs. This internship will focus on the electro-generator designed to recharge electric cars. Knowledge of the thermodynamics of turbomachinery is potentially useful.	**Students with previous knowledge from courses of power electronics engineering**
Sterilization with cold atmospheric plasma **Prof G. Courret**	The objective of the internship is to take part of the development of a method to sterilize alimentary products using a cold atmospheric plasma (CAP). The cold sterilization has several advantages as compared to the traditional thermal treatment such as lower energy consumption and, potentially, a much faster processing time. Knowledge of microbiology for decontamination is potentially useful	**Students with previous knowledge from courses on plasma engineering as well as on the physics of weakly ionized gases**
Nanotribology **Prof. Dr. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences, www.comatec-lans.ch) is active in research on surface coatings. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. Nano- and microtribology properties are of importance for the development and characterization of performant lubrifiants coatings, as well as for functional nk and coating developments. In this project several surface structuring and measurement techniques are studied and evaluated, tested and anaylsed in view of applications and developments for advanced machine, drone, and robotics applications with relation to interdisciplinary research (biomedical applications, energy, nano- and microtechnology, printing & coating technologies). The project is best suitable for master or PhD students in chemical engineering, materials or surface science, as well as for students in industrial process technologies. Minimum duration master students 3 months, preferentially 4-6 months; PhD interns 6-12 months.	**Keywords: surface coating, surface functionalisation, wear, lubricants, nano- and microtribology, nanocomposite coatings, self-assembly, applied nanosciences for robotics and machines**

Flexible electrodes for biosignal monitoring for agriculture applicattions **Prof. Dr. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences, www.comatec-lans.ch) is active in the field of nano- and microfiber composite materials. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. The laboratory has recently developed flexible electrodes for biosignal monitoring for agriculture applications. The project aims at conducting further improvements and experimental investigations on conducting nano- and microfiber membranes and transparent thin film electrodes for this field. The project involves process and materials development, characterization, as well as testing of the materials and electrodes for agricultural applications . The project is suitable for master or PhD students in chemical engineering, materials or surface science, applied physics, as well as for students in industrial process technologies. Minimum duration master students 3 months, preferentially 4-6 months; PhD interns 6-12 months.	**Keywords: conductive polymer nanocomposites, adavanced processing techniques, nano- and microfiber fabrication, atomic force microscopy, electrical probing, impedance spectroscopy, cyclic voltammetry, testing & validation, lab and field tests. applied nanosciences**
Surface structuring by atmospheric pressure plasma **Prof. Dr. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences, www.comatec-lans.ch) is active in the field of atmospheric pressure plasma treatment of surfaces. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. The aim of the project is to modify surface properties on various relevant 3D printing materials. The influence of process parameters will be studied at the nano- and microscale by analysis of the treated and untreated material surfaces using various surface analysis techniques, such as atomic force microscopy will be used. Surface wettability and adhesions of treated and untreated materuials will be studied as a function of processing parameters. FEM modelling of surface structures and fluid flow can be included in the project. The project is best suitable for master or PhD students in chemical engineering, material or surface science, applied physics, as well as for students in industrial process technologies. Minimum duration for master students 3 months, preferentially 4-6 months; PhD interns 6-12 months	**Keywords: Atmospheric pressure plasma, surface treatment of materials, industrial processing, applied nanosciences**
Artificial muscles **Prof. Dr. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences, www.comatec-lans.ch) is active in the field of transparent electrodes. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. The goal of the project is the design and characterization of transparent flexible articifical muscles and sensor materials based on conductive polymers nanocomposites. The candidate will perform experimental work on thin film polymer nanocomposite deposition (coating and printing), thin film and thin wire characterization (interferomentry, profilometry), electrical	**Keywords: transparent conducting materials, UV-vis-IR characterization, electrical thins film**

	characterization of materials and devices, optical UV-vis-IR characterizations of the materials and devices for artificial muscle applictions, prototyping and testing. The project is best suitable for master or PhD students in chemical engineering, material or surface science, applied physic, metrology, photonics, as well as for students in industrial process technologies. Minimum duration for master students 3 months, preferentially 4-6 months; PhD interns 6-12 months.	**characterization, printing and coating, applied nanosciences**
Nanoparticle and nanostructure generation by pulsed laser machining **Prof. Dr. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences, www.comatec-lans.ch) is active in the field of nanoparticle and nano- and microstructure generation by laser machining. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. Laser assisted processes, printing- and machining techniques are used for nanoparticle synthesis, as well as for surface nanostructure generation. The candidate will investigate laser-assisted nanoparticle generation processes, as well as laser-assisted surface structuring and printing techniques. Synthesised nanoparticles will be characterized for particle sizes and concentrations using modulated 3D cross-correlation dynamic light scattering and UV-vis-NIR spectroscopy. The generated materials and surface structures upon laser treatment will be analysed using optical microscopy as well as atomic force microscopy, optical spectroscopy. Semi-automated data analysis combined with modelling will be used for gaining understanding in the underlying process as needed for parameter adjustements in industrial processes. The project is best suitable for master or PhD students in chemical engineering, material or surface science, applied physic, metrology, as well as for students in industrial process technologies. Minimum duration for master students 3 months, preferentially 4-6 months; PhD interns 6-12 months.	**Keywords: laser machining, nanoparticle generation, dynamic light scattering, surface topography, wettability, laser assisted printing technologies, applied nanosciences**
Integrated simulation-experimental optimization of bike suspensions **Prof. A. Schorderet**	The Machine and Design Applied Research Group is active in high dynamics systems, additive manufacturing and composite structures research fields. Suspension bicyles used in sports and recreative/leisure activities are pushing for always better suspension components and set up. A test-bench will be available by the end of summer 2021 to characterize forks and rear shocks stiffness, load-displacement curves, damping and stick-slip. The goal of the proposed project is to develop an optimization approach to determine the suspension stiffness and damping characteristics minimizing a function based on tyre adherence and rider accelerations or a “comfort criterion”. The project may consist in realizing one or both of the following tasks : a) develop the optimization algorithm and corresponding numerical code; b) design and realize a test bench (new or based on existing one) to simulate experimentally the fork response to a track measured input signal.	**Keywords: testing, dynamics, bike suspension, optimization, simulation, mechanical design**
Micro-milling quality criterion **Prof. A. Schorderet**	The Machine and Design Applied Research Group is active in high dynamics systems, additive manufacturing and composite structures research fields. Using a strong dual numerical-experimental approach, the Group has developed mechanical design solutions for the high performance machine-tool field. A holistic system approach has been created within the mecatronYx interdisciplinary platform, in tight association with the automatic control group. They produced patented dynamic optimization algorithms that allow very significant quality and/or productivity improvements when implemented on high-end milling machines (5 times quicker milling speeds). The goal of the proposed project is to use intelligent data analysis of specific sensors data (force, vibration, acoustic emission) and available machine signals (position, current, …) to define a sensitive micro-milling process quality criterion. If available, this criterion could be used to implement a very novel process control loop able to guarantee manufactured parts accuracy, and surface quality.	**Keywords: micro-milling, process quality, sensors, intelligent data analysis**

UHS spindles **Prof. A. Schorderet**	The Machine and Design Applied Research Group is active in high dynamics systems, additive manufacturing and composite structures research fields. UHS rotors and spindles were developed by the group for various applications : micro-drilling (600'000tpm PCB drilling), micro-energetics, laser micro-machining and micro-milling. The goal of the proposed projet is to push the spindles performances (speed, stability, stiffness, load capacity, …) and characterize the process capability of the spindles by designing new spindles and implementing them on high performance 3 and 5-axis machine-tools.	**Keywords: ultra-high speed rotors, micro milling, laser milling**
Nanostructured pressure sensor **Prof. Dr. L. Gravier**	In the frame of the Industry 4.0 research program, a new generation of sensors is needed, to be integrated in micromachines or devices. The project aim at the design and fabrication of a small scale pressure sensor using nanostructured thin film, using nanotechnology techniques mastered in the lab. A test bench will be developed to characterize this sensor, which will be integrated in a technology demonstrator by 3D print techniques.	**Keywords: microtechniques, nanotechnology, sensors, 3D print**
Nanostructured Infrared light sensor **Prof. Dr. L. Gravier**	In the frame of the Industry 4.0 research program, a new generation of sensors is needed, to be integrated in micromachines or devices. The project aim at the design and fabrication of a small scale infrared light sensor using thermoelectric properties of a nanostructured thin film, using the nanotechnology techniques mastered in the lab. The light will be detected by thermoelectric effect combined to lock-in amplifier technique. A test bench will be developed to characterize the sensitivity and response time of this sensor, which will be integrated in a technology demonstrator.	**Keywords: microtechniques, nanotechnology, lock-in detection, IR light sensors**
Development of industrial and collaborative robotic applications **Prof. M. Kunze**	The robotic laboratory is active in the field of industrial and collaborative robotics. In this field the following topics are studied: Bin picking: in the case of small production batches it is interesting to be able to perform bin picking instead of using vibratory bowl feeders. However, the time to setup up the bin picking task is often too long. Different technics to reduce this time are studied and implemented. Collaborative robot: nowadays collaborative robots are more and more used in the industry. Thus, humans need to interact with this kind of robot. Interaction can be in terms of task teaching by demonstration, robot path adaptation function of the environment, robot – human interaction. 3D printing with a robotic arm: 3D printing is often done with a cartesian robot. In this project, the idea is to perform this task using a robotic arm which offers several advantages (non-planar trajectories, different orientation of the head, increased stiffness…). For all these projects ROS (Robot Operating System) middleware is used.	**Keywords: industrial robot, collaborative robot, bin picking, robot – human interaction, 3D printing, ROS**

Control of a parallel robot **Prof. M. Kunze**	The robotic laboratory owns a Delta parallel robot. For different applications it is necessary to interact with its environment and especially cameras, conveyor, … Its actual controller has some limitations and does not allow to have interactions with external devices easily and fast enough. Moreover, it is not possible to modify it. Thus, the idea of this project is to develop a new controller. To achieve this goal the following tasks have to be done: - Computation of the forward and inverse kinematic models - Computation of the Jacobian matrix - Computation of the dynamic model - Study of different control strategies in simulation - Implementation of the best control strategy in an embedded PC - Interaction with external devices such as cameras and conveyor - Test and evaluation of the dynamic performances	**Keywords: parallel robot, dynamic model, control, simulation**