Thesis / Internships usually last between 4 and 6 months. Accepted students will receive free housing + 400 CHF/month.
Applications (CV + Transcript of records + Desired period to begin) must be sent to international@heig-vd.ch

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**
Test and simulation of a new generation of active substation for district heating (DH) **Dr. Alexis Duret**	This internship project will be done in the framework of an applied European research project call PACs-CAD (for "Use of sorption heat pump in substation to improve district heating energy efficiency"). The objective of this project is to develop and test in the laboratory a new generation DH substation integrating a sorption heat pump. This active substation should help to manage better the DH return temperature. This substation will also offer the opportunity to develop new energy services like cooling of buildings during summer. The objectives of this internship/master thesis are the following 1. run laboratory tests of the new generation of DH substation 2. develop a numeric model of the new substation 3. validation of the numeric model using the experimental results of the DH substation laboratory tests 4. evaluation of the economic interests of the new substation concept for different operating modes (reduction of DH return temperature, cooling in summer…)	**Keywords: District Heating, sorption heat pump, substation, building heating and cooling**
Evaluation of photovoltaic self-consumption in building in Switzerland **Prof. S. Citherlet**	Photovoltaic (PV) electricity self-consumption attracts more and more interest among PV system owners and grid regulator. Electrical self-consumption is defined as the ratio of the PV energy consumed locally to the total PV energy production over a year. The decrease of PV electricity subsidies and PV panel cost reduction contribute to favor solar electricity self-consumption. In this environment, PV electricity self-consumption can improve the PV system profitability and contribute to stabilize the electricity grid. This project aims at evaluating the level of electricity self-consumption of buildings as a function of several factors. During this project, the student will have the responsibility to build a model to calculate the solar electricity self-consumption as a function of building electrical consumption, climate, PV installation size and the use of an electrical battery. The impact of Demand Side Management on the self-consumption level will also be studied. Finally, a Life Cycle Analysis and an economic assessment will be conducted to compare the environmental impacts of self-consumed electricity with electricity coming from the grid.	**Keywords: solar energy, LCA, electricity sel-consumption, building electrical consumption**

Evaluation of solar thermal system integration in industrial processes and test of a high temperature solar thermal collector. **J. Bony**	Industry represents a significant part in the final energy consumption. Almost all industries require some form of process heating so the potential of solar thermal systems is quite interesting. This internship aims to design and evaluate the possibility of solar thermal system integration in industrial processes. For this work, the student will participate at on-site visits to collect information about the specific energy consumption of the process. Then the student will design a solution based on solar thermal system to respond at the requirements of the processes. Through different tools, the final objective is a technical and economical evaluation of this kind of system. In parallel, the student will perform different tests of a high temperature solar thermal collector. This collector has been developed by SRB Energy (http://www.srbenergy.com) and designed for industrial process application (more than 200°C). These tests will allow obtaining the performance coefficients of this collector and evaluating his potential to supply thermal energy in industrial processes.	**Keywords: solar energy, industrial processes, high temperature, test bench**
Micro turbine design for Low-cost and reliable thermal solar installation **J. Bony**	Solar thermal systems for domestic hot water (DHW) preparation need reliability of the different components: pump, temperature sensor, controller or valve. Commissioning also influences the reliability of the whole installation. The goal of this project is to simplify as much as possible components in order to avoid breakdowns and simplify the management of the energy. This simplification should make it possible to offer a reliable solar system at a reduced price while maintaining a high performance. The aim of this internship concerns a part of the thermal solar installation specifically the DHW preparation device with a plate heat exchanger without using sensor, controller or electricity. In order to do this, it would be necessary to study: - The design of a micro-turbine powered by the DHW draw-off and check its effectiveness - The energy performance of coupling heat exchanger with the micro-turbine compared to a commercial system. - Maintenance related to clogging by limestone of the plate heat exchanger	**Keywords: reliability, cost reduction, turbine, thermal solar system, domestic hot water preparation**
Life Cycle Assessment of Interior insulations for historic buildings **S. Lasvaux**	This internship is part of the Horizon 2020 European Project RIBuild ("Robust Internal Insulation for Historic Buildings"). This project focused on the interior insulation of the existing historic buildings which represent up to 30% of the existing buildings. As the exterior façade is generally protected for cultural heritage, the improvement of the building envelope is done by applying interior insulation measures. Different solutions exist and the Swiss partner of this project works with insultation companies (e.g., ISOVER, Isofloc, Ytong…). This objective of the internship will be to conduct hygrothermal simulations of interior insulation solutions as well as life cycle assessment (LCA) and a life cycle costing (LCC) to determine the most sustainable interior insulation measure for historic building. The intern will also take part in the writing of recommendations that will be provided in the form of an online InfoHub.	**Keywords: Historic buildings, internal insulation, thermal analysis, Life Cycle Assessment (LCA), Service life, construction materials**

Simulations of renovation scenarios for the existing building stock **S. Lasvaux**	This internship will be conducted in the framework of "Robust-LCA" a research project funded by the Swiss National Science Fundation (SNSF). This project will analyze the cost-effectiveness of renovation scenarios of the Swiss residential building stock. This existing stock accounts for a large part of the energy consumption of buildings. Different renovation measures can be considered to minimize its energy consumption, running costs and the related greenhouse gas emissions (e.g., renovation of the building envelope, replacement of heating systems, integration of renewable energy production like PV systems). This project will use reference buildings from different construction periods to assess these different scenarios. The objectives of the internship are the following: 1. Set up of a database of renovation costs and environmental impacts 2. Definition of renovation strategies adapted to each construction period 3. Simulations of reference buildings' energy consumption before/after renovation 4. Assessment of the environmental and economic interests over the building life cycle using LCA and LCC methodologies The internship will work closely with the SNSF project's partners on each of the four points. The simulation procedure will integrate a probabilistic perspective by accounting for the variability of the different parameters used in the energy calculations as well as for the environmental and economic analyses (e.g. variability of renovation costs, climate data, service life of materials, evolution of energy costs).	**Keywords: Existing building stock, envelope, technical systems, Life Cycle Assessment (LCA), Life Cycle Cost (LCC) cost-effectiveness**

INFORMATION TECHNOLOGY AND COMMUNICATION (TIC)		
Improvement of user experience in a serious game authoring system and in existing serious games **Prof D. Jaccard**	We have developed a serious game authoring system and many different serious games (www.albasim.ch). Most of them may be improved from the user experience point of view.	**End of Bachelor or Master student in Computer sciences.**
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.	**Students with previous knowledge from courses in machine learning, neural networks, human language technology or artificial intelligence**
Development of various UI applications on Android tablet PC & Smartphones **Prof D. Rossier**	New embedded applications developed on a particular technology named SOO (Smart Object Oriented) will run into dedicated devices endowed with wireless interfaces (WiFi, BT). In order to monitor the activities of these devices and to provide applications with adequate user interfaces (GUI) based on Qt, an application interacting with the devices need to be developed (Android, tablet PC). The project is realized in collaboration with Sootech Ltd, a spin-off Company issued from the HEIG-VD (REDS Institute). Further details will be given in case of interest.	**Computer Science or Embedded Systems student** **Strong knowledge of low-level C, ARM assembly if possible**
Design and test of a novel electric field sensor **Prof M. Rubinstein**	The horizontal electric field from lightning plays an important role in the coupling of voltages to cables. It is, however, difficult to measure. In this project, a new type of electric field sensor will be studied and tested.	**Electromagnetics** **Antennas**
Management system for evaluation and grading in big classes **Prof M. Rubinstein**	College classes can have tens or even a few hundred students. Preparing and grading exams to evaluate the learning objectives can be a daunting task for the teacing personnel. In this project, the student will write a software package to store exam questions with metainformation on the authorship, aimed objectives, expected time to complet, dates and times used, etc. The package will generate quizzes and exams based on input criteria. It will also perform automatic grading when possible.	**Programming skills**
Study of 802.11ac and 802.11ad **Prof M. Rubinstein**	Wireless local area networks are based on the IEEE 802.11 standard and its amendments. Two recent amendments, 802.11ac and 802.11ad, increase the speeds up to the Gigabit/s range. In this project, the student will perform an experimental and biographical study of those two amendments.	**Keywords:** **WiFi, WLAN, 802.11, protocols, communications.**

Diverse projects on machine learning applied to life sciences **Prof C. Peña**	Our group, Computational Intelligence for Computational Biology (CI4CB), applies machine-learning methods to solve hard data-driven problems in life sciences (e.g., diagnostic decision, biomarker discovery, personalized health). Different projects are available that address this specific kind of applications. The exact subject would be discussed and defined with the interested student prior to the beginning of the training period. **Keywords:** Machine learning, Software development, Data analysis and modelling.	**Only students in Computer Science, Bioinformatics or equivalent disciplines, notions of Machine Learning and Python.**
RULE-DEEP-EXTRACTION: Extraction of Rules from Deep Neural Networks **Prof C. Peña**	The proposed project is developed in the frame of D-Rex (Deep Rule EXtraction), an exploratory research project in which we intend to develop, implement, and evaluate a novel method for extracting rules from Deep Neural Networks. The method(s) 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 a specific architecture of Deep Neural Networks (e.g., convolutional or recurrent). **Keywords:** Machine learning, Deep learning	**Only students in Computer Science, Bioinformatics or equivalent disciplines, notions of Machine Learning and Python.**
Deep Learning for image processing **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 recognize particular objects in an indoor environment and to embedded such a system on a smartphone or a light computing system (e.g., a raspberry pi). 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. 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 Kinect 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**
Generative Neural Networks **Prof A. Perez-Uribe**	A recent development in the domain of Deep learning has been the introduction of generative models like the so-called Generative Adversarial Networks or the Variational Auto-Encoders. Such systems have shown to be able to generate very realistic synthetic images after being trained on large databases. For instance, researchers were able to generate the face of a famous person that do not even exist, but that looks like a celebrity. The aim of this project is to explore the use of such models whether to design original pictures (e.g., artificial creativity) or to enrich databases being used for object recognition. For more information: http://iict-space.heig-vd.ch/ape	**Keywords: Generative Deep Neural Networks, image processing, Machine Learning**
Medical imageNet: New methods for automated image analysis **Prof C. Peña**	Recently, many large datasets have been made available to the data-science community through various initiatives and institutions such as Kaggle or Stanford University. A dataset in particular, provided by the U.S. company Langzolab, containing thousands of medical images has been made freely available to researchers without restriction. The idea of this project is therefore to select and analyze part of this data in order to develop supervised and unsupervised methods able to accurately predict a patient's health. Cohort discovery as well as automated prediction algorithms such as artificial neural networks and random forests will be of particular interest in this study. Keywords: Machine learning, Medical image analysis, Applied Data Science.	**Only students in Computer Science, Electrical Engineering or Bioinformatics notions of Machine Learning and Python.**
Project FOCUS **Prof O. Ertz / J. Ingensand**	Every year numerous students from abroad visit HEIG-VD. If you newly arrived it can be difficult to find out about the region of Yverdon-les-Bains and different activities (events, places to visit, etc). On the other hand it can take time to find people who share the same interests. The goal of this project is to develop a prototype of an application that 1) suggests activities for exchange students and 2) connects exchange students to each other. From a scientific point of view this project involves 1) the collection of location-based information regarding the region (activities, events) 2) the validation of user profiles 3) the development and implementation of a working prototype 4) the testing and evaluation of the prototype with real-world users.	**Keywords: Mobile / web platform. Information System, Social Network,** **Required skills: Mobile and Web Development, HTML, Javascript, User Evaluation, Application Design, Spatial Information**

BIO-INPHINITY: Machine learning for discovering and predicting virus-bacteria interaction networks. (Several sub-projects are available on this subject) **Prof C. Peña**	Context: The emergence and rapid dissemination of antibiotic resistance worldwide threatens medical progress. A promising alternative to fight against multi-resistant bacteria is to use their natural predators: bacteriophages, viruses that infect and kill bacteria with the advantage of having low impact on the human bacterial flora, as they are highly strain specific. This latter fact constitutes a serious limitation for rapid therapy development as for each bacteria one must find the corresponding bacteriophage. Faced with the need to systematically examine a multitude of possible interactions, the rapid development of bacteriophages as an alternative to antibiotics can only be done with the help of a model to predict the interactions between bacteria and bacteriophages. Goal: Using machine learning methods, to explore methodological alternatives for modeling the interactions between bacteria and bacteria-killing viruses (bacteriophages) based on their genomic and proteomic sequences. The project aims at (1) building predictive models based on the genomic information (sequences) and/or on the extracted features, and (2) analysing and selecting the most relevant features in order to identify potential mechanisms that explain the interactions. A data set comprising the genomes of multiple, selected, bacteria and bacteriophages will be available, together with several informative measurements (features) extracted from these sequences. In this context we wish to explore different and promising methodologies, among which: • Ensemble learning, combining several, complementary, supervised machine-learning techniques by means of weighted-voting or stacking strategies, for obtaining better predictive power than each separate method • Finite-state machines. The underlying idea is to know if it is possible that the representation of the sequences in the form of a state machine will make it possible to predict bacterial phage interactions according to their state. Are these algorithms capable of finding information (e.g. patterns) that would allow prediction? • Deep Learning probably associated with the Transfer learning approach (Transfer learning or inductive transfer is a research problem in machine learning that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem. For example, knowledge gained while learning to recognize cars could apply when trying to recognize trucks.) • Evolutionary Learning: Using evolutionary algorithms to extract, directly from the genomes, a collection of motifs (short sequences) explaining (and predicting) the potential interactions between bacteria and phages. • Bag of (genomic) words. Adapting this method, popular for natural language processing, to deal with collections of short genomic sequences (k-mers) that could be used to characterize the genomes of bacteria and phages. Then, applying machine learning to build predictive models for the interactions. • Protein interactions as images: The most successful applications of deep learning use convolutional neural networks for image-classification. In order to take advantage of these advances, we want to represent protein-to-protein interactions, between phages and bacteria, as images and then use convolutional neural networks to extract valuable knowledge about virus bacteria relationships.	**Keywords: Bioinformatics, Machine learning** **Only students in Computer Science, Electrical Engineering or Bioinformatics with notions of Machine Learning preferably in Python.**

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. Carpita**	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 development team.	**Basic competences in power electronics and power systems**
Programming the control of a microwave tuning stub **Prof G. Courret**	The goal of this internship is to develop the software of a controller used to tune impedance matching stubs in a 1 kW microwave setup. Knowledge of microwave engineering is potentially useful for defining the algorithm of control. This internship will be devoted to the programming of the control in an existing hardware, by adopting a LabView or Matlab approach.	**Students with previous knowledge from courses in microwave engineering, control engineering, LabView and Matlab language technologies**
Spectral Analysis and Signal Generation on FPGA-SoC Embedded System **Prof G. Courret**	The goal of this internship is to develop a software and firmware dedicated to real time spectral analysis with streaming FFT. Knowledge of acoustic and vibration engineering (turbojet engines, roll bearings) is potentially useful for defining the algorithm of analysis. This internship will be devoted to the design of spectral detection methods.	**Students with previous knowledge from courses in mechanical engineering, signal processing engineering, digital electronics (FPGA-SoC), VHDL and Matlab languages**

Micro & Nanorheology **Prof. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences) is active in research on nanoparticle fluids and nanoparticle inks. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. Nano- and microrheology properties are of importance for the development and characterization of performant lubrifiants, as well as for functional nanoparticle inks. In this project several measurement techniques are studied and evaluated, tested and anaylsed in view of applications and developments for different fields (biomedical applications, nano- and microtechnology, and/ or printing technologies.	**Keywords: nano- and microfluids, nanoparticle fluids, dynamic light scattering, flow behaviour.**
Conducting nanocomposite fibers **Prof. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences) is active in the field of flexible electrodes and conducting nanocomposite materials. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. The project aims at the development of conducting fibers and membranes using different techniques and machines of the laboratory and to develop application demonstrators.	**Keywords: conductive polymer nanocomposites, adavanced processing techniques, nano- and microfibers, testing & validation**
Green nanofilters **Prof. S. Schintke**	The research unit COMATEC-LANS (Laboratory of Applied NanoSciences) is active in the field of nanofiber membranes for filtering applications. Within the study project, the candidate will participate in running research activities of the COMATEC-LANS. The project aims at the development and testing of filter membranes processed from renewable materials. Depending on the background of the student, the project can be oriented on filter testing procedures and instrumentation, demonstrator development or materials development and testing.	**Keywords: Filter membrane fabrication and testing, biobased polymers, processing and characterization**