Faculty of Engineering

Summer Engineering Research Internship for US Students (SERIUS)

Host Department: Department of Biomedical Engineering (www.bioeng.nus.edu.sg)

BME 1

Project title	Development of an automated BioModel Selection System for Synthetic Biology Gene Circuit Design
Project description (for website) Note: - no more than 250 words	Synthetic biology, also known as the engineering of biology, involves programming of living biological systems using synthetic genetic circuits for a wide range of applications including engineering microbes to tackle infectious diseases, to produce high value chemical and to detect water contamination. Constructing a complex working gene circuit composed of different modular standardized biological parts to achieve the desired performance could be challenging without a proper understanding of how the individual modules behave. Mathematical modeling plays an important role towards better quantifying and optimizing the performance of the overall gene circuit, providing insights and guiding the design of experiments. As different gene circuits might require exclusively different mathematical representations, one of the key challenges in model development is the selection of the appropriate model. Such a process could be tedious and essentially involving prolonged iterative trial-and-error learning and testing cycles. To address this, the project aims to develop a software system using Python to automate the biomodel development and selection processes, providing a means to efficiently derive the best candidate model using characterization data from biological parts, and more complex gene circuits such as logic gates etc. Students involve in this project will have the opportunity to experience how genetic circuits are designed and characterized, and at the same time be trained to develop mathematical models using ordinary differential equations to describe and simulate simple gene circuits.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Software Development ☐ Product Development ☐ Feasibility/Case Studies ☐ Computing and Analysis ☐ Design ☐ Field Testing and Instrumentation ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one,	Biomedical Engineering, Electrical Engineering, Computer Science/Engineering, Chemical Engineering, System Engineering

especially if project is cross-disciplinary	
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	Developed a module of the software system which is able to take in a set of characterization data for a particular type of genetic circuits and output the model which best described the data.
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	http://www.bioeng.nus.edu.sg/people/PI/pohcl/
Name and address of lab that participants will be attached to	Engineering Biology Lab
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Programming skills (Python)
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes.

Faculty of Engineering

Summer Engineering Research Internship for US Students (SERIUS)

Host Department: Department of Chemical & Biomolecular Engineering (www.chbe.nus.edu.sg)

CHBE 1

Project title	The effect of the reaction environment on the nanoparticle activity
Project description (for website) Note: - no more than 250 words	The chemical industry heavily relies on catalysis, which is needed not only to accelerate the reactions but also to decrease the energy consumption of chemical processes and to increase the value of the obtained products. Many catalysts in the chemical industry have the form of transition metal nanoparticles in order to increase surface-to-bulk ratio and to make more metal atoms exposed to the reactants on the catalyst surface. Moreover, many industrial processes take place at high reactant pressure, where the catalyst surface becomes densely covered by reactants or reaction intermediates. In this project, we will simulate the effect of the reaction environment on the properties of nanoparticles using density functional theory (DFT) and facilities of National Supercomputer Center. Such simulations will reveal both the binding strength of various adsorbates and reaction intermediates to the catalyst surface and their effect on the catalytic properties.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☐ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Chemical Engineering, Chemistry, Physics, Materials Science, Nanotechnology
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	• Learn how to use resources of National Supercomputer Center, Singapore • Learning how to simulate nanostructured materials using DFT methods • Explore the interactions between nanoparticles and reactive species covering them
No. of participants able to host	1
Supervisor(s) - Please include link to online bio / research page	Sergey Kozlov (https://www.eng.nus.edu.sg/chbe/staff/kozlov-sergey/)

Name and address of lab that participants will be attached to	Computational Nanocatalysis Lab, National University of Singapore, 4 Engineering Drive 4, Blk E5, Singapore 117585
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Basic programming skills in python and Linux shell are preferable, but not obligatory
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

CHBE 2

Project title	Computational Simulation of Tandem CO_2 Hydrogenation Catalytic Reactor
Project description (for website) Note: - no more than 250 words	For CO_2 valorization to useful chemicals technology to be applied on industrial scale, reactor simulations are essential to predict the behavior of heterogeneous tandem CO_2 valorization catalyst in a reactor. However, the lack of knowledge on mechanistic information of such catalyst hampers reactor simulation. In this project, there are two parts to address these issues; namely, experimental and computational simulations. Kinetic studies will be performed to generate the reaction rates required for non-linear model fitting. With the kinetic model obtained from model fitting exercise, mathematical models can be used and solved using MATLAB to predict tandam catalyst performance in an industrial reactor.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☐ Computing and Analysis ☐ Software Development ☒ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☒ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Chemical Engineering Material Science and Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	By the end of the program, participant is expected to: 1) Gain the ability to apply mathematical tools for reactor simulation 2) Attain basic competency in applying mathematical tools to solve chemical engineering design problems 3) Gain confidence in performing catalytic reaction and catalyst characterization experiments
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Prof. Sibudjing Kawi Website: https://www.eng.nus.edu.sg/chbe/staff/chekawis/ https://scholar.google.com/citations?hl=en&user=_KcMJvgAAAAJ&view_op=list_works&sortby=pubdate
Name and address of lab that participants will be attached to	E8/5/11-12,18
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Software skills required: MATLAB, ANSYS FLUENT, Basic prerequisite knowledge required on catalysis, reaction kinetics and reactor engineering, application of MATLAB to solve ordinary differential equations, partial differential equations
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Under such circumstance, the project can still be offered and performed virtually as the computational portion of the project can be performed in the United States while the experimental portion can be omitted.

CHBE 3

Project title	Machine learning and data-driven optimization in urban energy and environmental systems
Project description (for website) Note: - no more than 250 words	Recent development in machine learning (ML) and Artificial Intelligence (AI) technologies provides abundant tools and new perspectives for computer-aided design and analysis. Learning from data generated in nano- or micro-scale materials synthesis, meso-scale process design to meta-scale systems integration can provide rapid development strategies and accelerate technology readiness. This project is applying and potentially developing ML algorithms with the ability to automatically learn from data and improve from experience without being explicitly defined rules. One key task is to build up the database in the studied energy or environmental sectors, such as renewable energy generation plants, waste to energy and resources facilities, and other related subsystems from all possible sources (existing dataset by professional bodies, literature through text data mining, and first-hand experimental data at testing sites from collaborators). Multi-criteria decision making accounting economic and environmental performance will also be enabled in this design framework. Deep learning approaches in life-cycle assessment (LCA) and techno-economic analyses can also be explored. The student project will link directly with on-going research carried out at the Smart Systems Engineering (SSE) group together with various academic and industrial agencies. The student should have strong interest in computing and mathematical analyses and be proactive, organised and willing to learn different tools. We offer the opportunity to work on an exciting multi-disciplinary case with potential real-world applications. Students interested in working in the state-of-the-art AI applications in chemical/energy/healthcare industry or conducting research in relevant fields are especially encouraged to apply.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☐ Software Development ☐ Product Development ☐ Feasibility/Case Studies ☒ Computing and Analysis ☐ Design ☐ Field Testing and Instrumentation ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Chemical Engineering; Computing; Industrial Engineering; Energy; Materials Science; Mechanical Engineering (energy relevant)
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Methodology and case studies developed - One report on the learning outcome and major findings from the project - Possible conference and journal publications for outstanding research
No. of participants able to host	3
Supervisor(s)	Assist Prof Xiaonan Wang

- Please include link to online bio / research page	http://www.chbe.nus.edu.sg/faculty/chewxia https://www.smartsystemsengineering.com/
Name and address of lab that participants will be attached to	Smart Systems Engineering (SSE) Lab NUS Faculty of Engineering, Block E5, Unit B03 4 Engineering Drive 4, Singapore 117585
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	No special prerequisites are required, but the student should have strong interest in energy, environmental, and healthcare and be proactive, organised and willing to learn different tools. Programming skills will be learned during the project.
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

CHBE 4

Project title	Future Energy Systems in Sustainable City Development
Project description (for website) Note: - no more than 250 words	Urban energy systems embrace a wide variety of resources and uncertainties and can cause severe environmental issues if not planned in a sustainable manner. More renewable energy penetration is desired, while a circular economy will also bring significant environmental and economic benefits by using energy recovery through waste streams to provide support for carbon capture and substitute fossil fuels. The project includes the following components for students to choose from: 1) Process design and data collection for technologies in energy sectors, such as renewable energy generation plants, waste to energy and resources, desalination and energy facilities, and other related subsystems. 2) Review literature and compare energy structures in several mega cities through their economic and environmental metrics. Design viable energy structures for interested regions, and evaluate carbon and water footprints, resource consumption and ecosystem impacts of different scenarios. 3) Data-driven planning of distributed energy resources considering socio-technical complexities and realize a circular economy through novel integrated energy systems. Machine learning techniques will be used to provide an intelligent energy landscape. 4) Real-world case studies applying the developed platform and models to other urban or rural regions to provide decision support for planning and investment. Carry out life-cycle assessment (LCA) and techno-economic analyses of the whole urban energy systems. 5) Extend the focused energy sector to an integrated urban energy-water-food nexus and deliver a quantitative evaluation.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☐ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Chemical Engineering; Computing; Industrial Engineering; Energy; Materials Science; Mechanical Engineering (energy relevant)
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Methodology and case studies developed - One report on the learning outcome and major findings from the project - Possible conference and journal publications for outstanding research
No. of participants able to host	3
Supervisor(s) - Please include link to online bio	Assist Prof Xiaonan Wang http://www.chbe.nus.edu.sg/faculty/chewxia

/ research page	https://www.smartsystemsengineering.com/
Name and address of lab that participants will be attached to	Smart Systems Engineering (SSE) Lab NUS Faculty of Engineering, Block E5, Unit B03 4 Engineering Drive 4, Singapore 117585
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	No special prerequisites are required, but the student should have strong interest in energy, environmental, and healthcare and be proactive, organised and willing to learn different tools. Programming skills will be learned during the project.
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

Faculty of Engineering

Summer Engineering Research Internship for US Students (SERIUS)

Host Department: Department of Civil & Environmental Engineering (http://www.eng.nus.edu.sg/cee/)

CEE 1

Project title	Develop a program to visualize, plan and control linear schedules
Project description (for website) Note: - no more than 250 words	Current programs to plan and control linear schedules require expensive commercial programs. Moreover, they do not allow for computation of critical segments on a linear schedule. This project will be to develop a prototype and implement an algorithm to determine the critical segments on a linear schedule.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	N.A.
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	1. Develop a program (Excel plug-in possible) to plot linear schedules 2. Implement an algorithm to compute the critical segments of a linear schedule 3. Display the critical segments
No. of participants able to host	1
Supervisor(s) - Please include link to online bio / research page	Justin K.W. Yeoh http://cee.nus.edu.sg/people/ceeykw/
Name and address of lab that participants will be attached to	
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Knowledge of linear scheduling methods is bonus. Programming using C# or Python may be required.
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

CEE 2

Project title	Develop an optimization model for earthwork volumes using Geographic Information Systems
Project description (for website) Note: - no more than 250 words	Current earthwork estimation is a manual and highly inaccurate process. The student is to explore the use of Geographic Information Systems to address this problem, and subsequently develop an optimization model to minimize the operational cut-and-fill volumes.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	N.A.
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	1. Explore the use of GIS for earthwork estimation 2. Develop an optimization model to minimize earthwork cut-fill volumes
No. of participants able to host	1
Supervisor(s) - Please include link to online bio / research page	Justin K.W. Yeoh http://cee.nus.edu.sg/people/ceeykw/
Name and address of lab that participants will be attached to	
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Knowledge of GIS preferred (e.g. QGIS or GRASS GIS). Programming using Matlab or Python may be required. Familiar with optimization models and methods.
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

Faculty of Engineering

Summer Engineering Research Internship for US Students (SERIUS)

Host Department: Department of Electrical & Computer Engineering (www.ece.nus.edu.sg)

ECE 1

Project title	Design of multi-port non-volatile embedded memories
Project description (for website) Note: - no more than 250 words	Non-volatile memory technologies such as spin-transfer torque magnetic RAM (STT MRAM) have the capability for ultrafast write operations as fast as SRAM. However, requirements to achieve such fast write speeds either lead to extremely high write energy consumption or breakdown and failure of the memory device. Hence, the write performance is sacrificed to maintain device reliability and keep write energy within acceptable bounds. However, multi-port designs avoid issues with write operations blocking accesses to the rest of the memory array. Thus, the memory can service access requests at much faster speeds than the write performance. In this project, students are expected to learn about the operation of STT MRAM as well as future genres of MRAM (such as spin-orbit torque MRAM and voltage-controlled MRAM). We will then develop multi-ported designs based on these memory technologies, and evaluate their energy consumption, performance, and suitability for embedded memory applications.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☐ Software Development ☒ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Electrical Engineering, Computer Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Proposed a design of spin-orbit torque or voltage-controlled MRAM bitcell - Developed circuit model for the proposed bitcell - Detailed analysis and evaluation of the proposed bitcell
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Dr Kelvin FONG Xuanyao https://blog.nus.edu.sg/seeder https://blog.nus.edu.sg/kelvinxyfong
Name and address of lab that participants will be attached to	Computational Nanoelectronics & Nanodevices Laboratory 4 Engineering Drive 3, E4-07-12, Singapore 117583

Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Familiarity with SPICE simulations, and analog and digital circuit concepts (e.g., opamps, logic gates, etc.)
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 2

Project title	Design of non-volatile in-memory processor
Project description (for website) Note: - no more than 250 words	Future Cognitive Internet of Things will deploy machine learning and artificial intelligence algorithms on edge devices for various applications. However, the hardware architecture needs to drastically reduce the energy consumption of the hardware that will be executing these algorithms so as to meet the unique energy requirements. In-memory processing techniques have emerged as a promising solution. In this project, students will be involved in the design of an in-memory processing unit based on non-volatile memory devices (e.g. ferroelectric RAM, ReRAM, STT MRAM and SOT MRAM).
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☐ Software Development ☒ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Electrical Engineering, Computer Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Propose an in-memory processing unit based on a non-volatile memory device - Develop simulation models for the proposed non-volatile in-memory processing unit - Evaluate the proposed in-memory processing unit
No. of participants able to host	4
Supervisor(s) - Please include link to online bio / research page	Dr Kelvin FONG Xuanyao https://blog.nus.edu.sg/seeder https://blog.nus.edu.sg/kelvinxyfong
Name and address of lab that participants will be attached to	Computational Nanoelectronics & Nanodevices Laboratory 4 Engineering Drive 3, E4-07-12, Singapore 117583
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Knowledge of Python and MATLAB Familiarity with concepts of memory subsystems
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 3

Project title	FANTASI-MRAM
Project description (for website) Note: - no more than 250 words	FANTASI simulation framework was designed to simulate the statistical behavior in magnetic random access memory (MRAM) devices operated by spin-transfer torque, spin-orbit torque and voltage-controlled magnetic anisotropy. In this project, we will be porting the simulation framework into a complete Python framework to study emerging MRAM devices. Students will work with Python libraries and COMSOL to create the simulation tools, benchmarks and test suites. The simulation tools will also be calibrated to experimental measurements from collaborators or in the literature.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Applied Mathematics, Applied Physics, Electrical Engineering, Computer Engineering, Materials Science & Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Develop a set of Python simulations for MRAM in the FANTASI framework - Create a test suite to test their simulation programs - Calibrate the simulation programs to experimentally measured device characterization data
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Dr Kelvin FONG Xuanyao https://blog.nus.edu.sg/seeder https://blog.nus.edu.sg/kelvinxyfong
Name and address of lab that participants will be attached to	Computational Nanoelectronics & Nanodevices Laboratory 4 Engineering Drive 3, E4-07-12, Singapore 117583
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Familiarity with Python Good to know the Finite Element Method and COMSOL but not required
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 4

Project title	FANTASI-RRAM
Project description (for website) Note: - no more than 250 words	FANTASI simulation framework was designed to simulate the statistical behavior in magnetic random access memory (MRAM) devices operated by spin-transfer torque, spin-orbit torque and voltage-controlled magnetic anisotropy. In this project, we will be extending the simulation framework to study emerging resistive RAM (RRAM) devices. Students will work with Python libraries and COMSOL to create the simulation tools, benchmarks and test suites. The simulation tools will also be calibrated to experimental measurements from collaborators or in the literature.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Applied Mathematics, Applied Physics, Electrical Engineering, Computer Engineering, Materials Science & Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Develop a set of simulations for RRAM in the FANTASI framework - Create a test suite to test their simulation programs - Calibrate the simulation programs to experimentally measured device characterization data
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Dr Kelvin FONG Xuanyao https://blog.nus.edu.sg/seeder https://blog.nus.edu.sg/kelvinxyfong
Name and address of lab that participants will be attached to	Computational Nanoelectronics & Nanodevices Laboratory 4 Engineering Drive 3, E4-07-12, Singapore 117583
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Familiarity with Python Good to know the Finite Element Method and COMSOL but not required
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 5

Project title	FFT Library in SyCL
Project description (for website) Note: - no more than 250 words	The Fast Fourier Transform (FFT) is widely used for scientific computing. SyCL is an emerging GPGPU programming API that can accelerate scientific computing algorithms and greatly impact scientific progress. An FFT library is lacking for SyCL and students will develop their FFT library, carry out testing, and demonstrate the use of their FFT library in an application.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Applied Mathematics, Computer Science, All Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Develop an FFT library in SyCL - Create a test suite to test the FFT library and compare with benchmarks (e.g., CUDA, FFTW3) - Demonstrate the use of the FFT library in an existing application
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Dr Kelvin FONG Xuanyao https://blog.nus.edu.sg/seeder https://blog.nus.edu.sg/kelvinxyfong
Name and address of lab that participants will be attached to	Computational Nanoelectronics & Nanodevices Laboratory 4 Engineering Drive 3, E4-07-12, Singapore 117583
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Familiarity with C/C++ Good to know OpenCL or CUDA but not required
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 6

Project title	Skyrmionic devices for future computing schemes
Project description (for website) Note: - no more than 250 words	Skyrmion is a new spintronic phenomenon that can implement futuristic computing schemes such as the bio-inspired neuromorphic computing. We recently explored a new phenomenon that uses spin waves as a medium for interaction between spin-torque oscillators, which can lead to a more efficient neuromorphic computing hardware architecture. In this project, we will use micromagnetic simulations to further explore the phenomenon and leverage skyrmions to implement novel electronic device behavior. Students are expected to develop methodologies to evaluate the use of their proposed device structures in new circuits, and validate their ideas.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☐ Software Development ☒ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Physics, Computing Engineering, Electrical Engineering, Materials Science & Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Develop a micromagnetic simulation framework for evaluating the proposed skyrmionic device concepts - Evaluate one scheme that utilizes the proposed skyrmionics device concept for machine learning
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Dr Kelvin FONG Xuanyao https://blog.nus.edu.sg/seeder https://blog.nus.edu.sg/kelvinxyfong
Name and address of lab that participants will be attached to	Computational Nanoelectronics & Nanodevices Laboratory 4 Engineering Drive 3, E4-07-12, Singapore 117583
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Knowledge of Python and MATLAB
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 7

Project title	Towards forest-fire-resilient power grids
Project description (for website) Note: - no more than 250 words	Maintaining a reliable power supply under extreme events such as forest fires is critical to the safety of the population, as well as to aid in relief and recovery efforts. Clearly, the legacy power grid should be re-imagined to meet these needs. This project will explore various facets of this problem, such as ensuring strategic positioning of resources such as backup generation, grid topology reconfiguration, and control of distributed generators. The key objectives are as follows: - To compile and analyze geographical data relevant to the starting and propagation of fires, and relate this to the power system operation. - To investigate the impact of resource placement on the power system resilience. - Microgrids have often been suggested as a solution to improve power grid resilience. The project will explore the logistics of such a transformation, and discuss what control strategies need to be developed to achieve this. The participants are encouraged to apply interdisciplinary tools, such as but not limited to graph theory, control design, and machine learning to achieve the above objectives.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☒ Design ☐ Product Development ☐ Field Testing and Instrumentation ☒ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	-Electrical Engineering (Power & Energy Systems, Control Systems) -Computer Engineering (Data Analytics)
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	- Identify critical points of failure in the power system as a result of extreme events such as forest fires. - Compare and contrast between different power grid topologies for resilience against extreme events. - Develop models and potential control strategies for reliable operation of the power grid before, during, and after an extreme event.
No. of participants able to host	3
Supervisor(s) - Please include link to online bio / research page	Assistant Professor Jimmy Chih-Hsien Peng, https://www.penglaboratory.com/research
Name and address of lab that	Energy Management and Microgrid Laboratory, Building E3, Level 03,

participants will be attached to	Room 09, 2 Engineering Drive 3, Singapore 117581
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Knowledge of MATLAB, Python, JAVA, or any other programming language is required. Familiarity with power system simulations and control design is preferred.
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 8

Project title	Predicting Freezing of Gait in Parkinson Disease Patients
Project description (for website) Note: - no more than 250 words	Freezing of Gait (FoG) is a common motor related impairment among Parkinson's disease patients which substantially reduces their quality of life and puts them at risk of falls. These patients benefit from wearable FoG detection systems that provide timely biofeedback cues and hence help them regain control over their gait. The objective of this project is to apply machine learning algorithms to detect/predict FoG episodes in PD patients that are wearing these wearables.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	Understands what is FoG in PD patients. Literature review of current state of the art in FoG detection. Learn to select features extracted from wearables for classification.
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Arthur Tay
Name and address of lab that participants will be attached to	Advanced Control Technology Lab E4-08-22
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Comfortable with programming
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 9

Project title	Path tracking control design for autonomous agricultural robot
Project description (for website) Note: - no more than 250 words	With the rapid development of navigation and control techniques, the agricultural robot has gradually become highly automated and intelligent, which is the basic platform for precision agriculture. Automation would increase considerably the productivity by increasing efficiency, reliability and precision, and reducing the need for human intervention. In addition, it can reduce the production costs, fuel consumption and air pollution. One of the most fundamental issues related to automation is the path tracking problem, which enables the vehicle to reach and follow a predefined path that is not parameterized by time. In this project, students are expected to design and develop controller for agricultural robot by working together with our group. During the project, students are expected to strengthen the abilities of self-motivated study, project planning, algorithm development, system integration, and academic writing.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☐ Computing and Analysis ☐ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☒ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Control Science, Computing and analysis, Optimization
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	A software systems that can control the agricultural robot to track specific paths.
No. of participants able to host	1
Supervisor(s) - Please include link to online bio / research page	Prof. Shuzhi Sam Ge https://robotics.nus.edu.sg/sge/
Name and address of lab that participants will be attached to	Robotics Research Laboratory
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Unity, Python, Signal Processing, Control Science
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 10

Project title	Dynamic and Control of Mechanical System in Offshore Engineering
Project description (for website) Note: - no more than 250 words	Offshore engineering is concerned with the design and operation of systems in harsh environment conditions. It is one of the most challenging tasks in offshore engineering. The modeling and control of such system have received increasing attention in recent years with growing energy demands extending oil and gas explorations. Offshore applications are characterized by the time-varying environmental disturbances and the sea conditions. For riser systems, vibration and deformation of the flexible structures due to the ocean current disturbances and the tension exerted at the top can produce premature fatigue problems and failures that require costly repairs. Proper control techniques are desirable for preventing damage and improving the lifespan of the structure. The problems and the proposed solutions will be of interest to the offshore engineering community, to the academic control community, and to who may be able to make even further contributions in wide range of industrial and control area.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☐ Computing and Analysis ☐ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☑Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Engineering, Computing
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	Theoretical exploration on dynamics of marine mechanical system; Developing advance strategies for control design of systems with guaranteed stability; The control design are coupled with numerical simulations to illustrate the effectiveness.
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Shuzhi Sam Ge https://robotics.nus.edu.sg/sge/
Name and address of lab that participants will be attached to	E4A-03-04 Robotics Research Laboratory
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Python, Matlab, Control Science
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 11

Project title	The design and control allocation of a novel fully actuated tilting quadcopter
Project description (for website) Note: - no more than 250 words	Unmanned aerial vehicles (UAVs) have seen a boost in popularity and been an active research topic for both military and civil applications, especially the quadcopter. Developing omni-directional vehicles becomes increasingly significant to improve their performance in various tasks. In this project, students are expected to design and develop controller for this novel vehicle to achieve its controllability over 6 DOF by working together with our group. During the project, students are expected to strengthen the abilities of self-motivated study, project planning , algorithm development, system integration, and academic writing.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☐ Computing and Analysis ☐ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☒ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Control Science, Computing and analysis, Optimzation
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	A software systems that can control the novel tilting quadcopter to track arbitrary trajectories in space.
No. of participants able to host	1
Supervisor(s) - Please include link to online bio / research page	Prof. Shuzhi Sam Ge https://robotics.nus.edu.sg/sge/
Name and address of lab that participants will be attached to	Robotics Research Laboratory
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Python, Signal Processing, Control Science
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

ECE 12

Project title	Intelligent Autonomous Robotic Systems
Project description (for website) Note: - no more than 250 words	This project aims to offer a systematic description of the fundamentals of intelligent autonomous robotic systems. After the of the typical intelligent systems, the kinematics and dynamics are defined and applied to mobile robotics. Their structural and dynamic properties are presented. For autonomy, deep reinforcement learning for motion planning are first dicussed, followed by path planning, map building, typical control strategies and concluded by on-board hardware implementation. In general, it provides the students a complete understanding of intelligent autonomous robotic system, and facilitates further studies in related areas.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☐ Computing and Analysis ☐ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☑Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Engineering, Computing, Phthon
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	1. Build models for typical configurations of autonomous system, 2. Select autonomous navigation and build virtual maps, 3. Design different control systems for path following and trajectory tracking
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Shuzhi Sam Ge https://robotics.nus.edu.sg/sge/
Name and address of lab that participants will be attached to	E4A-03-04 Robotics Research Laboratory
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Python, Matlab, Control Science
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

Faculty of Engineering

Summer Engineering Research Internship for US Students (SERIUS)

Host Department: Innovation & Design Programme (http://www.eng.nus.edu.sg/idp/)

IDP 1

Project title	Development of a Web-Based Virtual Reality System
Project description (for website) Note: - no more than 250 words	This project aims to develop a web-based system virtual reality (VR) wearable systems to be used for team collaboration using web hosting apps (e.g. Zoom) and VR headgear. There are many different tools available for such purposes. But the effective use of such tools for team collaboration is not guaranteed. The developed VR system should be relatively easy to adopt, produce more reliable results (in part through provision of real-time feedback on team's performance) as compared to current offerings. Ultimately, it is envisaged that this project will translate into more practical applications to allow teams to effectively collaborate. This project involves software development.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Software Development ☒ Product Development ☐ Feasibility/Case Studies ☐ Computing and Analysis ☒ Design ☐ Field Testing and Instrumentation ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Electrical and Computer Engineering, Mechanical and Product Development Engineering
What participants are expected to achieve at the end of 8-week attachment	Proof-of-concept development for the proposed approach
No. of participants able to host	4
Supervisor(s) - Please include link to online bio / research page	Tang Kok Zuea
Name and address of lab that participants will be attached to	Engineering Design and Innovation Centre (EDIC), Innovation and Design, Faculty of Engineering, Block E2A, #04-05, 5 Engineering Drive 2, Singapore 117579
Any other information/ requirements (eg programming	No.

skills, prerequisites, reading list, etc)	
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes.

IDP 2

Project title	Surgical Tool Checker using Deep Learning and Smart Vision
Project description (for website) Note: - no more than 250 words	An article in the Outpatient Surgery magazine has written that an instrument processing department in the US has to process 900 trays of instrument per day. Due to this high volume of surgical tools, hospitals are facing a challenge of reducing the number of missing tools in their inventory as well as incomplete surgical sets in operation theatre. The problem also lies on the close similarities between 2 different tools, which are difficult to be noticed by a human's naked eye. Hence, this project aims to develop an intelligent system to reduce the number of human errors occurred in the hospital. The scanner should be able to identify the tool placed on the platform and tally it with the reference toolset. As such, if there is any missing or wrong tool placed on the platform, the software will be able to warn the user about the error before the tool set is being out processed which in turn reduce the occurrence of missing tools in their inventory as well as incomplete surgical sets in operation theatre With this innovation, it will benefit a large group of people such as the instrument processing department, surgeons and patients. Packaging staffs will be able to work in a less stressful environment and more efficiently without the use of count sheets. With the reduction of human errors, it will reduce the time wastage of the surgeons and the patients. Overall, the efficiency in every aspect will be improved with the success of this innovation.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Software Development ☐ Product Development ☐ Feasibility/Case Studies ☐ Computing and Analysis ☒ Design ☐ Field Testing and Instrumentation ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Electrical and Computer Engineering, Mechanical and Product Development Engineering
What participants are expected to achieve at the end of 8-week attachment	Proof-of-concept development for the proposed approach
No. of participants able to host	4
Supervisor(s) - Please include link to online bio / research page	Tang Kok Zuea
Name and address of lab that participants will be attached to	Engineering Design and Innovation Centre (EDIC), Innovation and Design, Faculty of Engineering, Block E2A, #04-05, 5 Engineering Drive 2, Singapore 117579
Any other information/	No.

requirements (eg programming skills, prerequisites, reading list, etc)	
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes.

IDP 3

Project title	Using Deep Learning for Medication Recognition
Project description (for website) Note: - no more than 250 words	The report "To err is human" by IOM established that medication errors are the leading cause of morbidity and mortality in healthcare systems. The major contributing factor of medication errors is prescribing faults, followed by administration errors. Medication errors compromise patients' ability to adhere to their medication regimen, resulting in injuries and death. Human errors manifesting from erroneous visual inspection and lack of medication knowledge accounted for most of the reported mortality cases. To address prescribing faults, some commercial systems have surfaced to automate the process of prescribing medication. However, they have insufficient scope and remain prone to implicit human errors. To bridge the gap in medication knowledge, medicines regulatory authority FDA provides detailed information on medication use and standardised drug-related terminologies to the public. The objective is to develop a safer system using deep learning which reduces the likelihood of human errors. This system will recognise and register medication in unit dosage (no packaging) and medication in blister packaging. Experiments will be conducted on actual medication to evaluate the effectiveness of the system.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Software Development ☐ Product Development ☐ Feasibility/Case Studies ☐ Computing and Analysis ☒ Design ☐ Field Testing and Instrumentation ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Electrical and Computer Engineering, Mechanical and Product Development Engineering
What participants are expected to achieve at the end of 8-week attachment	Proof-of-concept development for the proposed approach
No. of participants able to host	4
Supervisor(s) - Please include link to online bio / research page	Tang Kok Zuea
Name and address of lab that participants will be attached to	Engineering Design and Innovation Centre (EDIC), Innovation and Design, Faculty of Engineering, Block E2A, #04-05, 5 Engineering Drive 2, Singapore 117579
Any other information/ requirements (eg programming	No.

skills, prerequisites, reading list, etc)	
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes.

IDP 4

Project title	Decoding the Brain
Project description (for website) Note: - no more than 250 words	Recent developments in neural recording technologies have made it possible to record from hundreds of individual neurons in the brain. This is a major advance that allows the use of brain signals to control prostheses with large degrees of freedom. It also enables investigators to study the neural code used by populations of neurons to represent and process information in the brain. In this project, we will analyze data recorded from the frontal cortex of awake, behaving monkeys to understand how populations of neurons in different areas respond in a working memory task. We will investigate different neural codes (Bayesian probability, information theory, partial directed coherence, etc.) to understand how information is processed and transformed from one area to another. Students will get to learn to work with large neural data sets, correlate neural data with the behavior of animals, program in Matlab, and perform large-scale data analysis on a High-Performance Computing cluster.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Electrical and Computer Engineering, Bioengineering/Biomedical Engineering, Computer Science, Neuroscience, Psychology
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	Write Matlab/Python code to analyze data and visualize results.
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Shih-Cheng YEN https://tinyurl.com/y26rbm9o
Name and address of lab that participants will be attached to	The N.1 Institute for Health Center for Life Sciences, #05-COR, 28 Medical Drive, Singapore 117456
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Familiarity with Matlab, data acquisition, signal processing, and statistics.
If Covid19 continues and summer programme needs to be suspended physically, is it	Yes.

possible to offer and conduct the project virtually?	

Faculty of Engineering

Summer Engineering Research Internship for US Students (SERIUS)

Host Department: Department of Materials Science & Engineering (http://www.mse.nus.edu.sg/)

MSE 1

Project title	AI Driven Design of Self-Repairing Electronic Skins
Project description (for website) Note: - no more than 250 words	The goal of this exciting internship is use AI techniques in combination with novel self-healing materials and sensors that is being developed in the group. The intern is expected to prototype small scale areas of sensors, characterize them mechanical/electronically and work with AI scientists to develop algorithms.
Nature of project (please click on the boxes to check the relevant ones)	☒ Laboratory Investigation ☐ Computing and Analysis ☐ Software Development ☐ Design ☒ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☒ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Materials Science and Engineering Mechanical Engineering Applied Physics Electrical/Electronics/Computer Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	• Hands-on experience with Electrical/mechanical characterization of properties of new self-healing materials • Understanding of how AI/Machine Learning can be applied to material science • High-quality research outcomes in forms of e.g. journal publications
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	www.benjamintee.com
Name and address of lab that participants will be attached to	Tee Research Group www.benjamintee.com
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Useful softwares to know: Matlab, Labview, Python, OriginLab
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

MSE 2

Project title	Wearable Digital Health Sensors and Networks
Project description (for website) Note: - no more than 250 words	The goal of this exciting internship is use AI techniques in combination with novel sensors and devices that is being developed in the group. The intern is expected to design and prototype lab-scale sensors, characterize them mechanical/electronically and work with AI scientists/clinicians to develop algorithms that can improve health diagnostics.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☐ Computing and Analysis ☒ Software Development ☒ Design ☒ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☒ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Electrical/Electronics/Computer Engineering Mechanical Engineering Applied Physics Pre-med
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	• Hands-on experience with Electrical/mechanical characterization of properties of new sensor materials • Understanding of how AI/Machine Learning can be applied to material science and health wearables • High-quality research outcomes in forms of e.g. journal publications
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	www.benjamintee.com
Name and address of lab that participants will be attached to	Tee Research Group www.benjamintee.com
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Useful softwares to know: Matlab, Labview, Python, OriginLab, C/C++, Arduino, Firmware
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes

Faculty of Engineering

Summer Engineering Research Internship for US Students (SERIUS)

Host Department: Department of Mechanical Engineering (http://me.nus.edu.sg/)

ME 1

Project title	Decentralized Traffic Signal Control for Urban Mobility
Project description (for website) Note: - no more than 250 words	Recent advances in robotics, artificial intelligence and sensing are bringing us closer to the systematic replacement of most human-driven cars by autonomous driving vehicles. However, intelligent cars will require novel intelligent traffic coordination methods, likely on the side of the infrastructure (e.g., traffic signals such as traffic lights at road junctions). Centralized approaches to traffic management are infeasible, in cities that will likely count thousands to millions of vehicles and junctions, and decentralization will be necessary. In this project, you (the student) will develop novel methods to control the traffic signals at each junction, based on that junction's traffic conditions (number and speed of incoming vehicles, queue lengths, etc.) as well as the conditions of neighboring junctions. After studying a textbook case involving a simple 4-way junction, we will look to scaling up the size of the network and consider such decentralized traffic monitoring and optimization at larger-scales in the city. We might also consider more complex cases such as vehicle breakdowns/accidents, green waves, etc. This project will be simulation-based (using an open-source traffic simulator such as SUMO).
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Computer Science, Robotics, Mechanical Engineering, Electrical Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	1. Develop a simple simulation (in SUMO) of a 4-way junction, using a state-of-the-art traffic signal controller of the student's choosing. 2. Investigate a larger-scale scenario involving many such junctions, representing a larger portion of an urban road network, for which a more advanced traffic signal controller will be devised.
No. of participants able to host	2
Supervisor(s)	Asst. Prof. Guillaume SARTORETTI

- Please include link to online bio / research page	http://marmotlab.org/
Name and address of lab that participants will be attached to	National University of Singapore Control and Mechatronics Laboratory 9 Engineering Drive 1 Block AE, #04-06 Singapore 117576
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Python3 programming required Familiarity with GNU/Linux and command line interface Enthusiasm and passion for traffic optimization
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes, this project is 100% simulation-based and could be performed remotely with ease.

ME 2

Project title	Control of a Hexapod Robot for Visual Tasks
Project description (for website) Note: - no more than 250 words	Articulated legged robots, such as quadrupeds or hexapods, have the ability to locomote over a wide variety of uneven terrains where wheeled robots would naturally struggle, such as rock piles or rough inclines. Combining such advanced robots with onboard sensors, such as cameras/LiDARs, can increase their autonomy levels and allow complex deployments in hazardous or human-denied environments. In particular, this project will be centered around the problem of coordinating the usually large number of degrees of freedoms (DoF, actuators/motors) for these complex robots. You (the student) will first get familiar with our simulation environment and code base. Using these tools, you will devise and test your own locomotion controllers, based on different state-of-the-art methods (such as Central Pattern Generators, CPGs) to allow the robot to move and integrate visual feedback from an onboard camera (e.g., for target tracking, obstacle avoidance, or gait adaptation). If successful and safe, you could then implement these controllers on a physical hexapod robot, and/or in a high-fidelity physics simulator otherwise.
Nature of project (please click on the boxes to check the relevant ones)	☒ Laboratory Investigation ☒ Computing and Analysis ☒ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☒ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Computer Science, Robotics, Mechanical Engineering, Electrical Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	1. Demonstrate their simple locomotion controller in simulation. 2. Develop a new hexapod locomotion controller for a visual locomotive task of their choosing. 3. If possible, validate their controller on our hexapod robot.
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Asst. Prof. Guillaume SARTORETTI http://marmotlab.org/
Name and address of lab that participants will be attached to	National University of Singapore Control and Mechatronics Laboratory 9 Engineering Drive 1 Block AE, #04-06 Singapore 117576
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Python3 (or at least Matlab) programming skills required ROS/other simulation experience preferred Strong mathematical background Enthusiasm and passion for (legged) robots

If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes, the experimental portion of this project can be removed if necessary in favor of more simulation work. We already have a fully functional (ROS-based) simulator for the robot.

ME 3

Project title	Designing an efficient swimming micro-robot via reinforcement-learning
Project description (for website) Note: - no more than 250 words	Reinforcement learning (RL) is one of three basic machine learning paradigms, alongside supervised learning and unsupervised learning. In this project, we will adopt RL to optimize the performance of a classical model micro-swimmer, the three-sphere swimmer. It consists of three spherical beads of the same radius, which are connected by two extensible/shrinkable links. The goal of the project is to use RL to identify the best strategy of varying the link lengths for an optimal swimming performance. The student will gain sufficient experience in coding, designing microrobots, reinforcement learning and data analysis, etc.
Nature of project (please click on the boxes to check the relevant ones)	☐ Laboratory Investigation ☒ Computing and Analysis ☐ Software Development ☐ Design ☐ Product Development ☐ Field Testing and Instrumentation ☐ Feasibility/Case Studies ☐ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Mechanical and Aerospace engineering, applied mathematics, physics, mechanics, chemical Engineering, computational science,
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	The participants will design efficient locomotion strategies of a model swimming micro-robot based on advanced machine-learning algorithms.
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Lailai Zhu www.lailaiflow.com
Name and address of lab that participants will be attached to	Please check the personal webpage of the PI www.lailaiflow.com
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	Some basics in calculus, ordinary differential equations, Matlab or python.
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes, all can be conducted remotely.

ME 4

Project title	Multiphase Flow in Pipelines and Multiphase Equipment Development
Project description (for website) Note: - no more than 250 words	In oil & gas production, a multiphase mixture of oil, water and gas flows through a pipeline for long distances. Due to differences in densities, viscosities, and other physical properties, various flow regimes, i.e. stratified, wavy, bubbly, slug, annular and dispersed flows, can develop as a result, depending on the superficial velocities of the fluids. Different flow regimes have different effects on the pressure drop, flow pattern, etc., and ultimately on the stability of the flow. Pipeline integrity can also potentially be compromised due to force loadings from some of the flow regimes. This projects looks into multiphase flow and also into the development of equipment for the oil & gas industry.
Nature of project (please click on the boxes to check the relevant ones)	☒ Laboratory Investigation ☐ Software Development ☒ Product Development ☐ Feasibility/Case Studies ☒ Computing and Analysis ☐ Design ☐ Field Testing and Instrumentation ☒ Hybrid (eg mixture of experiment & theoretical, or experimental and numerical/software) ☐ Others: _____
Relevant majors - you may indicate more than one, especially if project is cross-disciplinary	Chemical Engineering Mechanical Engineering Process Engineering Offshore Engineering
What participants are expected to achieve at the end of the 8-week attachment - no more than 3 top outcomes	Students will have a better appreciation of multiphase flow in pipelines and an understanding of multiphase equipment used in oil and gas transportation.
No. of participants able to host	2
Supervisor(s) - Please include link to online bio / research page	Associate Professor LOH Wai Lam http://me.nus.edu.sg/about-us/people/academic-staff/fluid-mechanics/ http://www.eng.nus.edu.sg/core/
Name and address of lab that participants will be attached to	NUS Multiphase Oil-Water-Air Flow Loop Laboratory
Any other information/ requirements (eg programming skills, prerequisites, reading list, etc)	
If Covid19 continues and summer programme needs to be suspended physically, is it possible to offer and conduct the project virtually?	Yes