



Project Titles / Synopsises 2019



NANYANG RESEARCH PROGRAMME
Overview of Project Titles 2019

Project Code	Category	Project Title
ASE01	Sciences	Initiation of a Monitoring Program to Assess the Impact of Extreme Urbanization on Marine Biodiversity
CEE01	Sciences	What Is In Our City's Water?
EEE01	Engineering	Data Analytics and Machine Learning
EEE02	Engineering	Signal Processing and Machine Learning Techniques for Audio Based Respiratory Anomaly Detection
EEE03	Engineering	Metamaterial Frequency Selective Surfaces
EEE04	Engineering	Wireless Power Transfer for E-Mobility
EEE05	Engineering	Simulation and Visualization of Brownian Motion
EEE06	Engineering	Looking Through Frosted Glass
EEE07	Engineering	Single Pixel Imaging
EEE08	Engineering	Uniaxial Tensile Strain Effect on the Band Structure and Optical Gain of Ge
EEE09	Engineering	Feasibility Study of Solar Power in Singapore
EEE10	Engineering	Machine Learning/Deep Learning Techniques for Advanced Image Inference Tasks
EEE11	Engineering	An Augmented Reality Interactive Image Capturing Tool
EEE12	Engineering	A Portable High-Accuracy ECG-Assisted Blood Pressure Monitor for Smartphones
EEE13	Engineering	Navigation and Control of a Cleaning Robot
EEE14	Engineering	Design a Low-Cost Cleaning Robot
EEE15	Engineering	Emissions from Rare-Earth Ions by the Energy Transfer from ZnO Nanocrystals Embedded in SiO ₂ Film
EEE16	Engineering	Organic Materials for Bioelectronic Applications
EEE17	Sciences	Gamification of Educational Modules - Organic Chemistry
EEE18	Engineering	Visualization of Mini-UAV Flying Path Using GPS Log In Connection to Surveillance Radar Target Tracking
EEE19	Engineering	Development Of a Noninvasive and Rapid White Blood Cell Counting Method
EEE20	Engineering	GaN High Electron Mobility Transistors (HEMTs) for RF Switching Application
EEE21	Engineering	Novel Gallium Nitride-Based Sensor for Air Pollution Monitoring
EEE22	Engineering	Implement Environmental Sensor Under Internet of Things
EEE23	Engineering	Water Rectanna
EEE24	Sciences	Eye Tracking Control of NAO Robot via Internet Of Things
EEE25	Sciences	Exploration of Different Methods to Remote Control the NAO Robot
EEE26	Sciences	NAO Robot Based Home Automation for Internet Things
EEE27	Engineering	IOT (Internet of Things) for Optimal Lighting Control in Green Buildings
EEE28	Engineering	Smart Car Sharing in On-Demand Mobility
EEE29	Engineering	To Develop a Supervisory Controller for a Simple Flexible Manufacturing System
EEE30	Engineering	Charge Your Smartphone Wirelessly
EEE31	Engineering	Interfacial Engineering for High Efficient Perovskite Solar Cells
EEE32	Engineering	Machine Learning Approach to Privacy Preservation
EEE33	Engineering	Simulator for Signal Analysis
EEE34	Engineering	Understanding Lasers
EEE35	Engineering	Mobile App to Promote Singapore's Hawker Food Culture Appreciation
EEE36	Engineering	Growth of Social Networks with Opinion Tolerance Constraint: A Numerical Simulation Study



Project Code	Category	Project Title
EEE37	Engineering	Optimal Planning and Operation of Combined Cooling Heat and Power (CCHP) Systems in Future Energy Networks
EEE38	Engineering	Study of Feasibility of Superman Memory
EEE39	Engineering	Water Sensor Based On Electrostatic Induction
EEE40	Engineering	Artificial Intelligence Processing for Enhancing an Intelligent Sensor
MAE01	Sciences	A Fast Way to Compute Least Square
MAE04	Sciences	Riemann Zeta Function
MAE05	Engineering	3D Printing of Novel Composite Joints
MAE06	Engineering	Elastic Fields of Twist Disclinations
MAE07	Engineering	Printing Electronics on Textile
MAE08	Engineering	Investigating the Printability of Materials on a Novel Handheld 3D Printing Pen
NIE01	Business, Humanities, Arts & Social Sciences	Students' Perception of Oracy Skills Teaching Programs in Singapore
NIE02	Business, Humanities, Arts & Social Sciences	What Motivates Our Judgement of Eloquence, Words or Facial Expressions? Application of Face Recognition Technologies
NIE03	Business, Humanities, Arts & Social Sciences	Translational Specifications of Neural-Informed Game-Based Interventions for Mathematical Cognitive Development of Low-Progress Learners
NIE04	Sciences	Giving Birth Without Sex -- Exploration of the Proliferation Secret from "Mother of Thousands" Plants
NIE05	Business, Humanities, Arts & Social Sciences	Exploring Literature using Computational Linguistics
NIE06	Business, Humanities, Arts & Social Sciences	Does Language Shape Thought?
NIE07	Sciences	Impacts of Growing Media on Productivity and Nutritional Quality of Raphanus Sativa Microgreens and Baby Greens
NIE08	Sciences	Xplore: The Effect of Using of Technology in Physical Education
NIE09	Business, Humanities, Arts & Social Sciences	Well-Being in Today's Students
NIE10	Business, Humanities, Arts & Social Sciences	Teacher Learning – What Happens Behind the Scenes
NIE11	Business, Humanities, Arts & Social Sciences	Effect of In-Games Advertisement on Sponsor Recall
NIE12	Business, Humanities, Arts & Social Sciences	Exploring the Role that Game-Based Worlds and Immersive Environments Potentially Play in Learning
NIE13	Sciences	Pure and Doped BiFeO ₃ Thin Film for Photodetector
NIE14	Sciences	Plasma Assisted Low Temperature Graphene Synthesis
NIE16	Sciences	Distance-Pair Sequences
NIE17	Sciences	High Energy Density Pulsed Plasma based Synthesis of High Entropy Alloys for Structural Materials Applications
SBS01	Sciences	How Antimicrobial Peptides Invade Bacterial Cells?
SCBE01	Engineering	Plasmonic Nanostructures Based Surface Enhanced Optical Sensors
SCBE02	Engineering	Enhancing Environmental Sustainability of Pharmaceutical Solid Dosage Form Manufacturing via Life Cycle Analysis
SCSE01	Engineering	Interactive Course Materials Using Multi-Touch Interfaces and Augmented Reality Techniques
SCSE02	Engineering	Augmented Reality Hologram
SOH01	Business, Humanities, Arts & Social Sciences	Translation and Culture: How to Improve Singaporean Students' Translation Ability
SOH02	Business, Humanities, Arts & Social Sciences	A Sociolinguistic Investigation of French, German, Italian and Spanish in Singapore Shop Signs
SOH03	Business, Humanities, Arts & Social Sciences	Relationships between Straits Chinese and China-born Chinese in Singapore in the 1930s
SPMS01	Sciences	Variations of the Picture-Hanging Puzzle



Project Code	Category	Project Title
<u>SPMS02</u>	Sciences	Superpermutations
<u>SPMS03</u>	Engineering	Spin Orbit Torque Devices as Synaptic Weights in an Artificial Neural Network
<u>SPMS04</u>	Sciences	Shining Light on Nanomaterials
<u>SSS01</u>	Business, Humanities, Arts & Social Sciences	Associations Between Emotion Perception and Personality Traits
<u>SSS02</u>	Business, Humanities, Arts & Social Sciences	Assessing Social Attributes of Faces



ENGINEERING

EEE01

Title	Data Analytics and Machine Learning
Description	Machine learning has gained a lot of popularity in recent years due to the advent of computing power and data storage. In this project, students will be exposed to machine learning - they will be able to exploit the power of machine learning to find patterns in data. Students who are keen to pick up new skills such as Python to help them gain a better understanding of the collected data will find this project interesting.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Pair
Specific Knowledge	Interest in machine learning and data analytics. Knowledge in Python is advantageous though not necessary.
Other Requirements	NIL

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ENGINEERING

EEE02

Title	Signal Processing and Machine Learning Techniques for Audio Based Respiratory Anomaly Detection
Description	<p>Breathing sound anomalies (wheeze, crackle) act as a strong indicator of respiratory diseases (asthma, lung cancer). Traditional diagnosis and monitoring of these diseases require manual investigation by a trained physician by stethoscope and often spirometry. These methods, though reliable, requires a significant amount of time and effort from a physician and can sometime suffer from subjective bias.</p> <p>Vast improvements in audio signal processing techniques and machine learning algorithms over past decades resulted in emergence of reliable speech recognition, music classification and speech to text technologies. In recent years These tools and technologies are also being adapted to audio based biomedical applications like heart sound monitoring, blood flow estimation etc.</p> <p>In this project we aim to analyze breathing sounds using well established audio feature extraction techniques like short time Fourier transform, Mel frequency spectrum analysis etc. and then applying machine learning algorithms like neural networks, random forest etc. for automated detection and classification of respiratory anomalies. The participating students will gain firsthand experience of programming and working with signal processing and machine learning algorithms using MATLAB and python libraries like NumPy, SciPy, Scikit-learn etc.</p>
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE03

Title	Metamaterial Frequency Selective Surfaces
Description	<p>Because of impracticalities resulting from their much larger size, lensing systems in a millimeter wave band cannot be dealt with in the same manner as optical systems. One technique for implementing this lensing is to transform the phase of the incident field, using metamaterials such as frequencyselective surfaces (FSSs). In this project, the FSSs known as the gangbuster surface (GS) is used to achieve the lensing effect. Considering the GS above a perfectly conducting ground plane. Incident waves reflect totally, and the phase of the reflected waves depends on characteristics such as the type and period of the GS, the lengths of the wires, and the separation between the GS and the ground plane. Any change in the various parameters used to design the lens results in deterioration in the profile field intensity and the diffraction efficiency, among other unwanted effects.</p> <p>The goal is to optimize the lens for changes in the angle of incidence such that the intensity of the electric field and the resolution at the focal plane are both optimized. To accomplish this optimization, differences in phase distribution for various angles are to be minimized by using an existing algorithm to modify the lengths of wires on the GS. Through the use of these different wire lengths, a GS can be constructed for a lensing system in the millimeter wave band that is stable for differing angles of incidence.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Pair
Specific Knowledge	Interest in Engineering design and programming knowledge.
Other Requirements	NIL

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ENGINEERING

EEE04

Title	Wireless Power Transfer for E-Mobility
Description	Wireless Power Transfer (WPT) is the process of transferring power from one circuit onto another without passing through any manmade conductive elements interconnecting them. Several schemes for wireless power transfer exists – Inductive, Capacitive, Laser, Microwave etc. Of these, Inductive Power Transfer (IPT) is the most popular and is being extensively studied particularly from the last two decades. The working of an IPT system is comparable to that of an air core transformer with the leakage compensated by means of capacitances. Compensation has been applied to both the primary and secondary of the transformer. This would help boost power transfer as well as make up of operation possible. This project is dedicated to a theoretical study of the basic compensation topologies so as to understand their operation and hence aid the design of a generic IPT system depending on the criteria to be optimized. The idea of resonance so developed can also be used to characterize any complex resonant circuit from an engineering approach.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Interest to learn and dedication.
Other Requirements	NIL

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ENGINEERING

EEE05

Title	Simulation and Visualization of Brownian Motion
Description	<p>The vast improvement in computational speeds and accessibility of computer scripting resources has made computer programmes into an important tool for scientists to simulate and understand natural phenomena. Brownian motion, named after Scottish botanist Robert Brown, describes the random motion of particles suspended in a fluid or gas. The motion arises from random collision between the particles and fast-moving molecules in the fluid or gas, and is affected by factors such as temperature. The aim of this project is to simulate Brownian motion through computer coding to produce accurate and valuable visualisations for study. The simulation can be based on classical physics, e.g., particle collision process can be treated as elastic collision where both momentum and kinetic energy are conserved. In the course of this project, students can expect to improve their computer coding skills while learning about the virtual replication of physical phenomena.</p> <p>One example on how to implement the simulation and visualization of Brownian Motion is described in the following just for reference (the student is encouraged to develop his/her own way to implement the simulation and visualization using suitable computer software): Necessary algorithms are designed and tested initially in C++ and later implemented on a Windows based platform using Html java with strong graphics support for user friendly interactive input and output facility.</p> <p>The students should have a strong foundation in physics and math and good knowledge and skill/experience in computer programing.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	The students should have a strong foundation in Physics and Math and good knowledge and skill/experience in computer programming with various software (e.g., C++, Java, etc.).
Other Requirements	NIL

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ENGINEERING

EEE06

Title	Looking Through Frosted Glass
Description	Have you ever want to see through frosted glass? The project addresses the fundamental problem of light propagation in scattering media which scramble the magnitude and phase of electromagnetic field (the light beam) in space. The spatial information of the object behind the scattering media is meshed up before going to camera. The project will utilize the memory effect of speckles to retrieve the object information. The collected image which is very much like random speckle patterns will be used as an input into algorithm to reconstruct an image and reveal the secret behind a scattering medium. The project will combine your physical experiment skills with computational coding skills.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Not necessary but it's better to know or like to learn algorithm development, computer coding.
Other Requirements	NIL

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ENGINEERING

EEE07

Title	Single Pixel Imaging
Description	Imaging with megapixel camera is common today. However, imaging at infrared light is very expensive due to limited hardware performance. The project will do imaging at low cost by utilizing only single pixel for imaging. The algorithm is the key to construct an image from the single pixel signal.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Not necessary but it's better to know or like algorithm and computer coding.
Other Requirements	NIL

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ENGINEERING

EEE08

Title	Uniaxial Tensile Strain Effect on the Band Structure and Optical Gain of Ge
Description	Ge semiconductor has received great attention recently due to its potential application in optoelectronic devices, such as Laser and LED diodes. Ge is an indirect band gap semiconductor, which results in a poor optical transition probability. However, the laser emission from the direct band transition at room temperature was observed and reported in heavy n-type doped tensile strained Ge-on-Si material recently. In this project, we propose a Ge quantum well (QW) caused by the uniaxial tensile strain, which may be realized by the micro-bridge technique. Because the QW is formed by Ge only, it is called as the Ge pseudo-heterostructure QW (PQW). We will apply the 8-band k.p method to calculate the band structure and optical properties of the Ge PQW with different well width from 50 to 500 Å.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Good background in Physics and Math.
Other Requirements	NIL

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ENGINEERING

EEE09

Title

Feasibility Study of Solar Power in Singapore

Description

In the last 200 years, the global energy system has primarily relied on fossil fuels. Unfortunately, fossil fuels are polluting the environment and the air which we breathe. As a result of atmospheric pollution, serious climate changes have been observed whereby the Earth's temperature is rising, deserts are expanding, fresh water supplies are dwindling, and sea levels are rising. In parallel to these alarming trends, the global population is increasing very fast that resulted in increasing energy demand. To maintain a sustainable world for future generations, there is an alternative energy search for fulfilling the increased power demand based on clean and renewable energies such as solar, wind, wave energy, bio-mass, geothermal and etc.

In this context, Singapore is a country that is currently highly dependent on import of oil and natural gases to generate electricity. To be able to shift towards a more sustainable energy system, Singapore is investing in research regarding different alternative power generation technologies and systems so as to establish more sustainable energy solutions. Of course, despite the excellent progress, the transition to renewables will not be easy. As we all know, the intensity of sunlight varies during the day due to cloud cover, and wind speeds are fluctuating. There are also periods where there is no wind and no sunshine. Nevertheless, by clever monitoring, weather forecasting, power demand management, energy storage and flexible gas turbine power plants, the transition to smart energy grids and a cleaner and smarter energy world will be possible. Therefore, initiative must be taken in Singapore's to minimize the impact of climatic changes and emissions of greenhouse gases which directly or indirectly increases the global temperature. Recently, the Singapore Government has announced a \$6.2m grant in solar PV research and also the development of the Semakau microgrid testbed to promote research activities involving renewable energy sources. Fortunately, Singapore is blessed with an abundance of solar energy throughout the year, and the daily power demand peaks around mid-day which is perfectly aligned with the solar resource. The total installed PV capacity in Singapore passed the 100-Megawatt mark in 2016, and the "Garden City" is on track to host PV systems with a peak capacity of several hundred Megawatts by 2020. Measurements from a local weather station are used for estimating the solar radiance in Singapore. The results show that solar PV panels could be feasible in Singapore but that technological improvements as well as governmental subsidies are needed to make it profitable enough to attract investors. Solar energy technologies have never been more important, and promising, than today. It is up to all of us to continue their development and deployment, and we can be rest assured that future generations will be very grateful to us for having initiated the transformation of the global energy system towards sustainability.

Photovoltaic (PV) electricity generation depends on solar irradiance, named surface-downwelling shortwave (that is, wavelength interval 0.2–4.0 μm) radiation, and other atmospheric variables affecting panel efficiency, namely surface air temperature and surface wind velocity (VWS). Climate change may



therefore affect PV power generation and its temporal stability for a given panel fleet. Therefore, basic principle of operation of various technology available for conversion of energy by photovoltaics can be studied along with a literature study of the feasibility of solar power generation in Singapore. In addition, the impact of climatic changes in the form of parametric variations such as solar radiation and temperature at the surface of solar panel, can be studied to assess the efficiency of the solar energy technology. A small experimental study about the solar power generation and the effect of radiation and temperature can be performed in the laboratory with the help of various equipment.

Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual / Pair
Specific Knowledge	Hands-on and hardware experience. Able to use basic measuring equipment, such as a multimeter.
Other Requirements	We will be using the following for this project: 1) solar panels each rated at 50W, 2) light bulbs of various power ratings, 3) Measuring devices such as multimeter, wattmeter, voltmeter, ammeter, 4) connecting wires and accessories.

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ENGINEERING

EEE10

Title	Machine Learning/Deep Learning Techniques for Advanced Image Inference Tasks
Description	Advanced image inference tasks include image classification, i.e. classifying an image from its content; object detection, i.e. detecting and drawing bounding box(es) on object(s) of interest; and semantic segmentation, i.e. classifying and labelling each image pixel to a category. These inference tasks have wide range of applications in areas such as self-driving cars, computer vision, automated inspection systems, etc. Conventionally, these tasks were performed using hand-engineered features which were both cumbersome and inaccurate. In recent years, machine-learning, especially deep-learning techniques (using deep neural networks) have gained tremendous progress in realizing these tasks. In this project, we will explore these machine-learning, especially deep-learning techniques. The selected student will have access to state-of-the-art deep-learning software frameworks such as Keras and TensorFlow from Google, PyTorch from Facebook, and MATLAB etc. Throughout this project, the student will learn practical programming skills in Python and MATLAB for applying machine learning and deep learning techniques.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE11

Title	An Augmented Reality Interactive Image Capturing Tool
Description	Enhanced augmented reality (AR) has can be employed in many applications including Pokémon Go and other interactive games. The advantage of AR is that it can still see the real world while it can interact with the user to include some virtual 2D/3D static or dynamic objects. In the world of AR, the user can look around and through artificial objects of the expanded layer. AR brings unlimited possibilities for teaching and learning process. Additional reality provides the unique cognition path with immersive real-life simulations. Technology gives entirely real psychological and physical experience and helps get authentic virtual experience that can be implemented in real life. Now drivers can try driving their virtual car without the risk of causing traffic accidents and travellers can have diving experience without touching water. This project pertains to the design and development of a AR interactive tool include image capturing and send the images to the social media website directly. The tool will be useful for many real life practical image processing applications. The programming languages the student expects to learn include Unity and C programming to create 3D applications for mobile, desktop, the web, and consoles.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE12

Title

A Portable High-Accuracy ECG-Assisted Blood Pressure Monitor for Smartphones

Description

Blood pressure (BP) has long been one of the best indicators to detect the early onset of diseases and health issues. High BP or hypertension often leads to a greater risk of heart attacks, strokes, and kidney disease. Preeclampsia or high BP during pregnancy afflicts 5-10% of women, and is dangerous for both the mother and child. High BP is called the 'silent killer' as it often produces no symptoms so that the affected people usually do not treat it until it is too late and the blood vessels are damaged. Having regular BP readings is important to monitor health and provide early warning signs of potentially fatal diseases. BP readings are preferably taken in comfortable or familiar locations, where patients carry on their daily routine, to avoid the 'white coat hypertension' syndrome due to the anxiety experienced in the physician's office. Automated BP monitors are preferred by patients to take readings at their convenience. Other factor that can lead to their popularity is the global trends of aging population and obese population, whose risk of hypertension is high. They will likely increase the demand for BP monitors as they become aware of the risk of hypertension. The market for BP monitors is projected to reach US\$2.7 billion by 2020.

Automated BP monitors have an inflatable occlusion cuff that is wrapped around either the arm or the wrist. Arm-type monitors are generally bulky/non-portable and expensive. To encourage people to take BP readings regularly, wrist-type monitors would be more suitable; however, their readings are generally less accurate than those obtained by the arm-type monitors. Recent studies show that a 3-4mmHg increase in systolic BP would translate into 20% and 12% higher mortality from stroke and coronary heart disease, respectively. Thus, even the smallest inaccuracies can lead to false information and fatal consequences. In short, there is a need for BP monitors that are highly-accurate, and convenient to use whenever and wherever.

The objective of the project is the design and realization of a portable high-accuracy BP monitor that can be attached to (and detached from) smartphones. The monitor will be non-invasive and primarily employ the oscillometric method to estimate the BP by converting the oscillations of arterial blood flow to electrical signals. The significance of attaching the monitor to the smartphone is that it will be more convenient to the user to carry the monitor around and use it. Further, the BP reading can be sent to the smartphone so that it can be logged and transmitted to healthcare professionals for analysis. The critical requirements for the monitor are low power-consumption, small-form-factor, and high-accuracy BP readings/estimations. Low-power consumption is imperative to reduce the required energy storage elements and to render possible usage of low-power mechanical components with smaller form-factor. Unlike conventional BP monitors, the proposed BP monitor will also be designed to acquire electrocardiogram (ECG) signals from the user simultaneously, and subsequently, incorporate them to achieve more accurate BP estimations.

**Type of Project
Offered as**

NRP Enrichment only



College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Not necessary.
Other Requirements	NIL

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ENGINEERING

EEE13

Title	Navigation and Control of a Cleaning Robot
Description	As robots become less expensive and more intelligent, one of their applications is to replace human beings to do cleaning work. This project aims at designing a navigation and control solution for a cleaning robot to make it more automated. This solution will enable the robot to find its position and navigate its path in an indoor environment, in order to conduct a cleaning task.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE14

Title	Design a Low-Cost Cleaning Robot
Description	<p>Robots may be used to replace human beings to do cleaning work. This project aims to design and implement a simple and low-cost cleaning robot that is able to clean the floor in an indoor environment. The scope of this project may include:</p> <ol style="list-style-type: none">1) Assemble a cleaning robot using off-the-shelf components;2) Design and implement cleaning strategy for the robot;3) Test the cleaning robot in an indoor lab environment.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Simple programming; assembly of machine components.
Other Requirements	NIL

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ENGINEERING

EEE15

Title	Emissions from Rare-Earth Ions by the Energy Transfer from ZnO Nanocrystals Embedded in SiO ₂ Film
Description	Rare-Earth (RE) ions have been extensively used for various source of light emissions. The emissions cover a wide range of spectrum, from visible to near infra-red, and hence they have been used for lighting, displays, optical amplifier and many others. The optical excitations of the RE ions, however, requires specific wavelength which is challenging and relatively expensive to have. In this project, we will use semiconductor ZnO nanocrystals to act as sensitizers. The optical excitation of the ZnO nanocrystals is quite easy to have, as long as the photon energy is higher than the bandgap. The RE ions can in turn be excited by the energy transfer from the excited ZnO nanocrystals and give emissions when the RE ions relax to the ground states. The RE ions and the ZnO nanocrystals will be incorporated in SiO ₂ films. The project involves the fabrication and the characterization of the samples.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Very good in Physics and Chemistry.
Other Requirements	Very careful and diligent students as this project involves lab experiment.

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ENGINEERING

EEE16

Title	Organic Materials for Bioelectronic Applications
Description	This project introduce the student to organic semiconducting/conducting polymers which has been widely explored to realize lightweight, screen-printed, flexible and wearable electronics. Organic materials are also in general more biocompatible than their inorganic counterparts and their chemical and electrical properties are also readily tuned. In this project, the student will develop and fabricate electronic devices based on organic polymers, that will allow good electrical performance and flexibility. This is a lab based project, with handling of materials/chemicals and electrical testing.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Strong background in Chemistry/Electronics, comfortable in doing laboratory work, eager to learn new things.
Other Requirements	NIL

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ENGINEERING

EEE18

Title	Visualization of Mini-UAV Flying Path Using GPS Log In Connection to Surveillance Radar Target Tracking
Description	<p>Due to their small size, slow flying speed and low flying altitude, mini-sized unmanned aerial vehicles (mini-UAVs) are regarded as difficult targets to be detected by the current surveillance radar system. The weak echo signal returned from the mini-UAVs makes the mini-UAV tracking problem challenging. Particularly, the existing radar system often fails in tracking mini-UAVs flying at the far away distance from the radar unit. Thus, correcting/compensating the tracking error using other source of information (e.g., mini-UAV GPS log) is an important step towards automatic mini-UAV target tracking. The goal of this project is two-folded as follows:</p> <ol style="list-style-type: none">1) Visualize the flying path of mini-UAVs based on GPS log2) Investigate into radar target tracking errors by means of a comparison between the GPS flying path and the radar tracking results. <p>The student will be guided to learn the general concepts and procedures of data visualization, tracking errors analysis of the current surveillance radar system, and how to connect and compare the GPS path and the target tracking results.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual
Specific Knowledge	Good at Math and Computing (coding).
Other Requirements	NIL

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ENGINEERING

EEE19

Title	Development Of a Noninvasive and Rapid White Blood Cell Counting Method
Description	<p>White blood cell (WBC) counts are important parameters in the full blood count. There is a need for a non-invasive, low cost, and simple method to monitor WBC count in vivo and provide evaluation reports in a timely manner. For example, close monitoring of cancer patients' white cell count can help detect infection so that chemotherapy treatments could be tailored to be frequent and therefore more effective for those who can tolerate an increased dose. Current standard monitoring involves frequent blood taking via venipuncture, up to 3 times a week in the hospital. Not only is it painful, it can lead to many complications, some of which serious in nature. Ultimately, this means a poor quality of life for patients and an increase of hospital resources. A non-invasive white blood cell monitoring device can help patients closely and easily monitor their own counts so that they can spend time out of hospital and tailor their chemotherapy regimens. Such a device can also be used to noninvasively differentiate between viral and bacterial infections in a primary care setting so that visit to hospital and blood draw may be avoided. Micro-optical coherence tomography is well suited for this task due to its excellent penetration depth in human oral mucosa, cellular level spatial resolution, and excellent image contrast of WBCs. In this project, researchers will analyze micro-optical coherence tomography images to develop an automatic blood cell counting method, and compare the results with those obtained from the clinical gold standard.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual
Specific Knowledge	Student should be able to use MatLab or have basic programming experiences.
Other Requirements	NIL

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ENGINEERING

EEE20

Title	GaN High Electron Mobility Transistors (HEMTs) for RF Switching Application
Description	High-speed high-power switching elements are key components of Transmitter/Receiver module, digital phase shifter and attenuators in Radar, wireless, aerospace & defense communications etc. Gallium Nitride (GaN) based transistors have emerged as a very promising and important building blocks of many future advanced applications such as high-power switches, wireless communications, satellite communications etc. In this project, the students will be exposed to the technology of GaN transistors for switching application and the device physics parameters. They will also learn the useful and important basic operation, characterisation techniques and analysis of GaN based transistors. This hands-on experience and device knowledge will prepare the students well for their future studies in electronics engineering particularly in the areas of semiconductors, RF and power electronics and integrated circuit design.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE21

Title	Novel Gallium Nitride-Based Sensor for Air Pollution Monitoring
Description	<p>Gas sensing technology has gained increased attention especially where the detection of gases and air pollutants is imperative for the safety of human health. There is a need to detect NO₂, since its long-term exposure can lead to bronchitis in asthmatic children and can impair lung growth. Moreover, it is the primary source of nitrate aerosols, forming an important component of dangerous airborne particles. Thus, the regulations governing NO₂ in automobiles are becoming increasingly strict. Similarly, the presence of CO₂ gas in high concentration poses risk to human health and may lead to serious physiological damages due to O₂ deprivation and organ failure. At present, the commonly used gas sensors suffer from limited sensitivity, limited lifetime, poor selectivity and high energy consumption. In order to overcome these shortcomings, gallium nitride material based sensors are attractive due to their unique physical properties such as high band gap, high carrier density near the surface and chemical inertness.</p> <p>In this project, students will help to characterise the sensors developed in our team using a gas sensor system for NO₂, CO₂ and O₂ gases. The effect of functionalisation layers on the gas sensitivity, response time, recovery time, etc will also be studied as a function of temperature and gas concentration. The underlying sensing mechanism will be understood.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Pair
Specific Knowledge	Interest in Materials Science.
Other Requirements	NIL

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ENGINEERING

EEE22

Title	Implement Environmental Sensor Under Internet of Things
Description	<p>There has been very strong interest and attention in the past few years focused on the Internet of Things (IoT). The IoT refers to a network of physical objects embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. It allows remote sensing and control across network infrastructure, creates opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. [1] One of the challenges in the IoT technology is the provision of energy for the sensing, electronics, communication, etc. It is important that the deployed devices are autonomous, that is, able to harness environmental energy and be self-sufficient so that there is no need to provide and replace batteries. Among the various sources of energy that can be harnessed from an indoor environment, light energy has been shown to be one of the most efficiency and widely available.</p> <p>In this project, the student will study and implement an environmental sensor to sense and transmit signal wirelessly to a host for real-time monitoring of the environmental parameter of interest. The scope will also include the building of communication circuit and circuit for harnessing of light energy to power the sensor and communication circuits, to realize a fully autonomous sensor.</p> <p>1. https://en.wikipedia.org/wiki/Internet_of_Things</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual / Pair
Specific Knowledge	<p>No pre-requisites.</p> <p>Students should preferably have an interest in Electronic Engineering and in the study of renewable energy.</p>
Other Requirements	NIL

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ENGINEERING

EEE23

Title	Water Rectanna
Description	Water is an interesting medium that is transparent, flexible, and can be potentially low loss. Therefore, water can be an excellent candidate for designing reconfigurable antennas. The objective of this project is to explore innovative shapes for wide-band and multiband antennas that can be used in modern communication systems. Both theoretical simulations using ANSYS high frequency structure simulator (HFSS) and experimental measurements will be involved in this project. Dedicated students can get a lot of hands-on experience in this project.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE27

Title	IOT (Internet of Things) for Optimal Lighting Control in Green Buildings
Description	<p>Energy consumption attributed to buildings in Singapore is estimated to be over 30% of total national use. The target is to reduce energy consumption to meet the goals and increase the stockpile of Green-mark certified buildings as well as adapt to the circadian rhythm of the human occupant. As lighting accounts for about 20% of the building's electricity usage, the student would be working on:</p> <ol style="list-style-type: none">1) an efficient and reliable and robust dimmable IOT enabled LED system for commercial buildings and;2) the system adapt to the circadian rhythm of the human occupant. The lighting control system would be incorporated with building information modelling (BIM). Matlab or software programming skills would be expected for the students. The students should be self motivated and eager to learn.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual/ Pair
Specific Knowledge	Programming skills.
Other Requirements	Knowledge of 3D printing would be useful.

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ENGINEERING

EEE28

Title	Smart Car Sharing in On-Demand Mobility
Description	<p>Singapore has gone through a remarkable urbanisation process for the past several decades. So far, about 12% of the accessible land has been used for building traffic roads, and it is simply impossible to continuously expand the traffic network. To meet the ever-growing number of traffic demands, advanced traffic management techniques such as traffic signal control and flow management by road pricing have been developed and implemented. In addition, it is commonly believed that, by promoting ride sharing, the number of travel demands may be significantly reduced, which could ease the high pressure faced by LTA on pan-island traffic management. In this project the student will learn to model a simple traffic network and analyse the impact of ride sharing on travel demand reduction. There are several objectives that the student is expected to meet:</p> <ol style="list-style-type: none">1) To learn how to model a ride sharing problem as a mathematical programming problem.2) To learn some simple optimisation techniques, in particular, the Lagrangian multiplier method. If time allows, some evolution algorithms may also be learned.3) To apply relevant optimisation techniques to the ride sharing problem and solve it with right tools.4) To develop a simple simulation based case study to illustrate the solution.5) During this process, the student is expected to learn some basic concepts of linear programming, mixed integer linear programming, Simplex, Lagrangian relaxation and genetic algorithms. The simulation case study may be developed within a realistic traffic simulator PTV VISSIM, which also allows the student to understand some basic traffic management principles.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual/ Pair
Specific Knowledge	<ol style="list-style-type: none">1) For students who intend to develop their own optimisation algorithms, knowledge about calculating function derivatives may be needed. Nevertheless, this is not mandatory, as specific optimisation tools can be used to solve relevant optimisation problems.2) Students may use their own familiar programming languages to develop some case studies. Yet, they will be encouraged to use PTV VISSIM, which will be provided by my group at NTU.
Other Requirements	NIL

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ENGINEERING

EEE29

Title	To Develop a Supervisory Controller for a Simple Flexible Manufacturing System
Description	<p>The era of Industry 4.0 has just started. The manufacturing sector has been gradually shifting from high-volume-low mix manufacturing to on-demand manufacturing, typically in the form of low volume high mix, backed by advanced ICT infrastructure (e.g., IoT) and a variety of technologies such as sensors, system control and optimisation, data analytics, AI, and real-time simulation. Among different types of challenges faced by system designers, how to ensure nonblocking operations is one, which aims to prevent system deadlocks and livelocks (i.e., the system may be stuck in a circular mode, without be able to reach its target state). In this project, the student will learn basic supervisory control theory and apply it to prevent blocking in a flexible manufacturing testbed. The student is expected to achieve the following objectives:</p> <ol style="list-style-type: none">1) To learn basic Ramadge-Wonham supervisory control theory (SCT).2) To learn how to model a manufacturing system as a set of finite-state automata (FSA).3) To learn how to apply SCT on the FSA system model and derive a proper supervisor.4) To apply the derived supervisor to an IMPACT Line flexible manufacturing system at NTU.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual/ Pair
Specific Knowledge	<ol style="list-style-type: none">1) The student is expected to have sufficient knowledge on algebra and graph theory.2) Some basic knowledge on propositional logic will be very useful.3) The student is expected to apply his/her supervisor design in an IMPACT Line testbed, which is available on the campus of NTU.
Other Requirements	NIL

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ENGINEERING

EEE30

Title	Charge Your Smartphone Wirelessly
Description	Wireless Power Transfer (WPT) has received considerable research and industry attention in recent years. It is a promising technology for battery charging applications in terms of safety, durability, and convenience. The objective of this project is to design and optimize a WPT system that could be used for smartphone charging and other consumer electronic applications. The specific work includes circuit modeling and simulation as well as the design of high-frequency resonant converters, resonant coils, auxiliary circuits, and DC-DC converters. Students will develop a prototype WPT system under the guidance of a senior researcher and test its efficiency under different working conditions.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Circuit theory, Matlab.
Other Requirements	NIL

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ENGINEERING

EEE31

Title	Interfacial Engineering for High Efficient Perovskite Solar Cells
Description	Perovskite solar cells offering promise for the realization of a low-cost, printable, portable and flexible renewable energy sources have attracted much interests. Although over 21% of the power conversion efficiency (PCE) of Perovskite solar cells has been reported, further improvements in their PCE and lifetime are required for commercialization. Much effort have been made to improve the PCE of these solar cells. In particular, introducing the interfacial layers between the active layer and electrodes in the device structure is very important to improve the PCE and stability PSCs. In this project, suitable materials to engineer the interface between the active layer and the carriers transporting layer of a Perovskite solar cell will be investigated based on understanding the Perovskite solar cell structure and it's operation principle. The student will need to propose a suitable Perovskite solar cell structure with suitable materials and simulate the operation and performance of the solar cells to optimize the solar cells. if possible, experimental implementation of the solar cells will be evaluated.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Have taken Physics and Chemistry modules in JC.
Other Requirements	NIL

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ENGINEERING

EEE32

Title	Machine Learning Approach to Privacy Preservation
Description	Deep learning has seen widespread applications in many problems like image recognition, natural language processing and behavior analytics. The success of deep learning approaches can be attributed to big data sets, which may often contain sensitive or private information. In this project, we study how to "sanitize" a data set to allow a deep learning algorithm to still successfully learn its objective, but at the same time prevent the data from being used to learn something of a private nature. The sanitization procedure will also be based on a machine learning approach. The students will learn about basic deep learning methods and privacy notions through this project.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Python programming background. Mathematical maturity and willingness to learn and explore beyond comfort zone.
Other Requirements	NIL

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ENGINEERING

EEE33

Title	Simulator for Signal Analysis
Description	This project is to design and develop a user-friendly interactive simulator as a learning tool that students can study the behavior of a signal from both time and frequency domains by using programming tool Matlab. It is assumed that the users have little prior knowledge in the topic, and the program is to demonstrate and show how signals are analyzed. The techniques to analyze the signal are based on Fourier analysis. Fourier transform and its properties are visualized and appreciated through graphical demonstrations. Following that, this project involves convolution by time domain and frequency domain. An animation to display the intermediate steps involved in obtaining the sum of the areas of the two functions after convolution is included. The effects of distortion on the eventual time functions are compared.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical and Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Student with good mathematical background and with some prior knowledge in Matlab programming will be preferred.
Other Requirements	NIL

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ENGINEERING

EEE34

Title	Understanding Lasers
Description	<p>Laser, Light Amplification via Stimulated Emission Radiation, is probably one of the most important scientific inventions in the past 60 years. There are many important applications including but not limited to internet, biomedical sciences, imaging, security, spectroscopy, gas / chemical sensing, communications, military applications and astronomy sciences.</p> <p>In this project, the prospective student will study the operation principles of lasers, particularly focus on a so-called quantum cascade laser, a new type of semiconductor laser which has attracted a lot of attention in recent years due to its ability of generating arbitrary laser emission according to customers' requirements in long wavelength regimes.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual / Pair
Specific Knowledge	Some knowledge in Optics and Physics.
Other Requirements	NIL

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ENGINEERING

EEE35

Title	Mobile App to Promote Singapore's Hawker Food Culture Appreciation
Description	The aim is to spread and reach out to individuals who are interested in the different aspects of Singapore's Hawker Culture; from the breakdown of common drinks and dishes to the ways of enjoying it. This app desires to educate and integrate people of all nationalities to better appreciate the Hawker Culture in Singapore.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual
Specific Knowledge	Mobile App Development
Other Requirements	NIL

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ENGINEERING

EEE36

Title	Growth of Social Networks with Opinion Tolerance Constraint: A Numerical Simulation Study
Description	In this project, we shall study on how people' tolerance of different opinions may affect the growth of social networks. The student would need to some numerical simulation using a certain (any) programming software. Background knowledge of computer programming would be of significant help though not compulsory.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC1
Group Size	Individual / Pair
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE37

Title	Optimal Planning and Operation of Combined Cooling Heat and Power (CCHP) Systems in Future Energy Networks
Description	The future energy networks will integrate multiple energy resources in order to achieve maximum energy utilization efficiency. The energies may include fossil-fuel, wind, solar, nature gas, as well as other forms of energy such as heat and cooling, etc. The combined cooling heat and power (CCHP) system is a promising approach to enable such multiple energy integration. This project aims at optimal planning and operation of CCHP in a comprehensive energy network. Specific tasks include modelling of the CCHP systems, other energy resources, as well as the energy transmission network, optimization-based methodologies for planning (sizing and locating) and operation of CCHP systems, development of high-quality solution algorithms, investigation of the operational support of CCHP to the whole energy network in terms of security control, renewable energy harvesting, etc.
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Familiar with mathematical optimization algorithms, MATLAB programming language, and have fundamental knowledge about power system and microgrid.
Other Requirements	NIL

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ENGINEERING

EEE38

Title	Study of Feasibility of Superman Memory
Description	A supeman memory crystal, or also known as 5D optical data storage (https://en.wikipedia.org/wiki/5D_optical_data_storage), offers massive storage technique for hundreds terabytes of data in a single piece of glass. This project aims to review current technology and understand its practicability and scalability. The project involves intensive literature review and analysis.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Fundamental knowledge on Optics.
Other Requirements	NIL

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ENGINEERING

EEE39

Title	Water Sensor Based On Electrostatic Induction
Description	<p>This project aims to evaluate the quality of water through studying cahрге particles based on electrostatic induction. It is known that water contains a variety of charged particles, like positive and negative ions, molecules, organic and inorganic clusters, etc. After water passes on a substrate, these charged particles could be attached onto the substrate. The surface density of the charged particles attached to the substrate is then determined by using the electrostatic induction technique. We recently find that the surface density of the attached charge particles is largely affected by contaminants in water. Thus, studying the surface charge density could tell the quality of water. In this project, the student is required to establish the relation among the surface density of the charge particles attached onto the substrate and several contaminants.</p>
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

EEE40

Title	Artificial Intelligence Processing for Enhancing an Intelligent Sensor
Description	<p>Photoacoustic imaging (optoacoustic imaging) is a biomedical imaging modality based on the photoacoustic effect. In photoacoustic imaging, non-ionizing laser pulses are delivered into biological tissues (when radio frequency pulses are used, the technology is referred to as thermoacoustic imaging). Some of the delivered energy will be absorbed and converted into heat, leading to transient thermoelastic expansion and thus wideband (i.e. MHz) ultrasonic emission. The generated ultrasonic waves are detected by ultrasonic transducers and then analyzed to produce images. It is known that optical absorption is closely associated with physiological properties, such as hemoglobin concentration and oxygen saturation. As a result, the magnitude of the ultrasonic emission (i.e. photoacoustic signal), which is proportional to the local energy deposition, reveals physiologically specific optical absorption contrast. In this project, you will work on using AI algorithm to enhance a non-invasive photoacoustics sensor in terms of sensitivity and specificity which can be used to measure the blood pressure. Software simulation and hardware implementation will be done in the project. You will be also involved in-vitro and in vivo experiments. Previous study report and prototype will be provided to you for you to jump start.</p>
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

MAE05

Title	3D Printing of Novel Composite Joints
Description	Composite materials comprising two distinguishable phases are finding wider uses in aerospace, wind energy, oil and gas, sports equipment. Nature composite materials include wood, bone, straw reinforced bricks etc. Herein this project we explore 3D printing of composite materials and make lap and scarf joints to evaluate their mechanical performance as a function of various process variables. The joints geometries will be optimised for a given load-bearing capacity. The process involves testing the joints under laboratory environment using established standards.
Type of Project Offered as	NRP Enrichment only
College / School	School of Mechanical & Aerospace Engineering
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Motivation to learn new things. Knowledge of Physics.
Other Requirements	Skills with open sourceware CAD modelling.

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ENGINEERING

MAE06

Title	Elastic Fields of Twist Disclinations
Description	<p>Twist disclinations are rotational defects that may be present in polycrystalline materials. They can cause large stress concentrations or singularities and hence may affect the mechanical behavior and integrity of the materials.</p> <p>In this project, the student will seek to understand and derive the displacement and stress fields of a twist disclination and a twist disclination dipole in a linear elastic solid. A dipole is formed by two disclinations, one positive and one negative, in a configuration separated by a small distance. Specific topics of interest may include, but are not limited to: (a) a twist disclination/dipole in an infinite solid, (b) a twist disclination/dipole in a finite cylinder, (c) the influence of the eccentricity of disclination location in a finite cylinder, and (d) the influence of a disclination core.</p> <p>The student will learn to derive the elastic fields, starting from the equilibrium equations. He will solve the resulting partial differential equations, and impose appropriate boundary conditions. Numerical results will be generated to investigate the dependence of the solutions on the elasticity of the medium.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Mechanical & Aerospace Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Basic mathematical skills in differentiation and integration.
Other Requirements	NIL

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ENGINEERING

MAE07

Title	Printing Electronics on Textile
Description	The project will entail exploring printing of electronic components on various fabrics and textile. A simple passive device and/or sensing circuit will be designed and printed on the fabric using suitable electronic inks. The techniques of printing or direct writing will be studied and compared. Requirements of fabric for printing will be observed and suitable measures taken to lay down continuous and homogeneous circuits on the substrate. The fabric will be characterized and imaged. Electrical measurement, stability and mechanical integrity tests of the printed circuits on fabric will be carried out.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Mechanical & Aerospace Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

MAE08

Title	Investigating the Printability of Materials on a Novel Handheld 3D Printing Pen
Description	<p>We have patented a novel portable 3D printing pen that is able to dispense both solid and paste-like materials. This project aims to further develop new materials and conduct testing on printability of these materials. The student will be able to learn to design experiments, investigate on the different printed structures and study the printability.</p> <p>Scope of work:</p> <ul style="list-style-type: none">▪ Review on 3D printing and bioprinting.▪ Study current testing guidelines/frameworks for 3D printability assessments▪ Formulate different paste-like materials from different sources for printing▪ Investigate on printability (i.e. extrudability) of the above materials using a handheld biopen▪ Characterize quantitatively and qualitatively the extruded structure from the handheld device
Type of Project Offered as	NRP Enrichment only
College / School	School of Mechanical & Aerospace Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	NIL
Other Requirements	NIL

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ENGINEERING

SCBE01

Title	Plasmonic Nanostructures Based Surface Enhanced Optical Sensors
Description	Ultrasensitive detection of biomarkers is of considerable interest for early disease diagnosis. To improve the sensitivity of traditional on-surface assays, we will develop a plasmonic substrate prepared by 2D assembly of metal nanoparticles for enhanced fluorescence readout. The 2D assembly will be prepared by self-assembly of polymer-coated metal nanoparticles at the water/oil interface and then transferred to glass or PET substrate by dip-coating. The substrate will be characterized by scanning electron microscopy and UV-vis absorption spectrometer. For improved detection sensitivity, we will optimize the optical property of the building block nanoparticles and the thickness of the polymer coating to match the extinction spectrum of the plasmonic substrate to the excitation/emission spectra of the fluorescent dye. A sandwich assay will then be performed on the plasmonic substrate with the capture antibody and the detection antibody labelled with dyes. The fluorescence signals will be read out by a fluorescence microscope and be compared with results obtained with pure glass or PET substrates.
Type of Project Offered as	NRP Enrichment only
College / School	School of Chemical & Biomedical Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Chemistry and Physics.
Other Requirements	NIL

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ENGINEERING

SCBE02

Title	Enhancing Environmental Sustainability of Pharmaceutical Solid Dosage Form Manufacturing via Life Cycle Analysis
Description	In this project, the students will participate in our group's effort to develop life cycle inventory (LCI) database of the key pharmaceutical excipients used in the solid dosage form preparation of active pharmaceutical ingredients (API). The ultimate objective is to develop a more sustainable and greener API solid dosage form production. The project will require extensive literature review, data mining, and computer simulation. Students with keen interests in pharmaceutical field and environmental sustainability are encouraged to apply.
Type of Project Offered as	NRP Enrichment only
College / School	School of Chemical & Biomedical Engineering
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Life cycle assessment analysis, environmental sustainability awareness.
Other Requirements	NIL

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ENGINEERING

SCSE01

Title	Interactive Course Materials Using Multi-Touch Interfaces and Augmented Reality Techniques
Description	<p>This project is focusing on development of a digital platform to facilitate lecturers to transfer typical course materials into full-length interactive materials by using novel interactive techniques and augmented reality technologies. This project will lead to an interactive and customizable publishing platform for the book publishers to design and enhance their publications to provide full-length interactive books to the readers. The platform can be refined and fine-tuned by adding novel interaction methods and facilitating large number of genres and languages to widen the cluster of users and user-experience. This can also be applied to prepare interactive course materials for students in all levels including university students. The proposing platform will replace classic e-books with digital books which include clever and swappable videos and graphics embedded using augmented reality and data visualization techniques.</p> <p>(a) Design component</p> <ul style="list-style-type: none">▪ Design multiple interaction methods such as touch techniques, voice commands, physical actions such as blowing or waving, etc. for publishers to design how the reader will interact with each graphical content differently <p>(b) Implementation component</p> <ul style="list-style-type: none">▪ To develop a digital publishing platform that transfers an e-book into a full-length interactive book using a multi-touch interface and augmented reality techniques to provide a quality reading and visualizing experience to the readers.▪ To enhance the prototype by introducing number of genres and implementing a multilingual platform to facilitate publishers specializing in various languages.
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Computer Science and Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Android app development or iOS app development experience.
Other Requirements	NIL

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ENGINEERING

SCSE02

Title	Augmented Reality Hologram
Description	<p>Augmented Reality is slowly and steadily marking its presence in the technology landscape. This year, we have witnessed the growth of Apple's ARKit and Android's ARCore. But, AR is picking pace not just by the push of tech giants like Apple and Google, but also individual developers who are pushing boundaries to integrate AR into more.</p> <p>This project aims to create mobile hologram app based on latest AR frameworks including Apple ARKit, Google ARCore & Tango. This app should allow users to place a variety of holographic models and figures into a scene for photo and video capture. This will provide most enjoyable AR experiences for the users. Users will be able to share their creations directly from the app's built-in access to popular social media platforms.</p> <p>(a) Design component Develop an algorithm combing image processing techniques and GPS. This will further enhance using clustering algorithm.</p> <p>(b) Implementation component Develop mobile app for hologram applications. Mobile app will be developed using latest AR and VR platforms (Apple ARKit, Google ARCore & Tango, Microsoft HoloLens, ...).</p>
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Computer Science and Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Android or iOS development experience.
Other Requirements	NIL

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ENGINEERING

SPMS03

Title	Spin Orbit Torque Devices as Synaptic Weights in an Artificial Neural Network
Description	An artificial neural network (ANN) takes inspiration from its biological counterpart to solve problems through processes that mimic the human brain, such as by acquiring knowledge through learning processes. In such ANNs, neurons are connected to each other through connections analogous to synapses, and each synapse has a strength or weight, w_{ij} , associated to it. In a bid to work towards energy-efficient brain-inspired computing, it is vital to seek out solutions to ANN beyond-CMOS. One such contender is in the emerging spin-orbit torque (SOT) device. The non-volatile and analogue-like response observed in SOT devices can be engineered to function as synaptic weights. Together with the appropriate electronic circuitry and neural network computing model, specific functions such as character recognition can be achieved.
Type of Project Offered as	NRP Enrichment only
College / School	School of Physical & Mathematical Sciences
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Have a strong interest in research project.
Other Requirements	Hardworking.

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SCIENCES

ASE01

Title Initiation of a Monitoring Program to Assess the Impact of Extreme Urbanization on Marine Biodiversity

Description Over the last two centuries, Singapore has undergone significant coastal modifications, allowing it to become one of the densest countries in the world. More than 96% of natural coastal habitats have been modified owing to shoreline development and extensive land reclamation (Singapore is almost 150 square kilometers larger than at its origin). Still, Singapore remains a biodiversity hotspot, but the fragility of its biodiversity has been raised by the scientific community in recent years. Significant efforts have been made to gauge the diversity of several groups of organisms, but marine microorganisms have been neglected. It is fundamental to evaluate 1) how urbanization-related coastal changes may affect living organisms, especially microorganisms that are at the base of the food chain, and 2) what the best building strategies are for better life conservation in order to conciliate coastal urbanization with biodiversity. Foraminifers, which are the most diversified group of testate (shelled) microorganisms in tropical coastal environments, have been repeatedly used in different places of the world to assess the impact of urbanization but have never been investigated in Singapore, which undergoes extreme coastal mutation. This project aims at assessing the microbiobiodiversity in distinct coastal marine habitats of Singapore, notably where significant urbanism and reclaimed land projects will occur: To face land shortage, population growth and in an effort of decentralization, the national urban planning authority of Singapore has scheduled substantial urban transformation in the years to come (<http://www.mnd.gov.sg/landuseplan>). A total of four new cities (regional centers) will be built, vacant state parcels will be used and turf clubs, golf courses and cemeteries possibly redeveloped. Additional land will be reclaimed on the sea. This preliminary study will serve as a milestone to develop joint education and research monitoring programs to study the evolution of marine biodiversity in coastal Singapore, with the final objective of comparing the biodiversity before, during and after urban modifications. Foraminifers will be studied for their diversity, functional properties and ecological significance at key land and coastal localities, where new coastal developments and land reclamations are planned. Benthic foraminifers will be sampled at different water and sediment depths, on distinct substrates and coastal microhabitats in order to fully assess their diversity. In each selected locality, the same quantity of living material will be collected for comparison purposes. Collected specimens will be picked and taxonomically identified by students. Singapore offers an ideal and unique setting to study the impact of urbanization on the biosphere in a land-scarce, conservation-oriented state. The long term diversity monitoring that I wish to initiate with this preliminary project could lead to a landmark achievement that urban planning authorities and researchers in many scientific fields – ecology, urbanism, biology, palaeontology, systematics, and geology – will use as a reference.

Type of Project Offered as NRP Enrichment / H3 Science Research



College / School	Asian School of the Environment
Target Group	Year 5 / JC1
Group Size	Individual / Pair
Specific Knowledge	Prerequisite knowledge (facultative): basics in Biology, Ecology, Geography, and Geology. Soft skills: Nature lover, good observer, meticulous, enthusiastic, and capable. Software/programs: Word, Excel, Powerpoint, Adobe Photoshop, Adobe Illustrator, or equivalents.
Other Requirements	NIL

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SCIENCES

CEE01

Title

What Is In Our City's Water?

Description

Singapore is one of the most water-scarced countries in the world, despite receiving a lot of rainfall annually. As a strategy to increase water supply, Singapore's water agency, the Public Utilities Board (PUB), have dammed up many of the rivers as reservoirs to collect and store rain. Currently, two-thirds of Singaporean land have been converted to water catchments. This makes Singapore one of the very few countries in the world to harvest urban stormwater on a large scale for potable consumption.

Unlike typical protected water catchments (usually forested land), the urban landscape may contain a wide range of undesirable pollutants such as heavy metals and other chemical compounds of anthropogenic origin found in urban areas. Once deposited on the ground (e.g. roads, pavements), these chemical constituents may get washed off into storm drains which may empty into local reservoirs and thus contaminating Singaporean water resources.

The main objectives of this study is therefore to: (i) determine and quantify the types of chemical compounds found in various land surfaces and (ii) establish a relationship between the type and quantity of these pollutants to different land uses.

This study will be useful to understand the risks of pollution in reservoirs and consequently, mitigation measures can be made to ensure safe drinking-water for all in Singapore. Participants of this study will be introduced to the areas of aquatic and geochemistry; catchment hydrology; drainage engineering; water treatment engineering. Participants will also be given opportunities to have first-hand experience in using water quality measuring instruments (e.g. inductively coupled plasma - optical emission spectrometry) and learning geographic information system softwares.

**Type of Project
Offered as**

NRP Enrichment only

College / School

School of Civil & Environmental Engineering

Target Group

Year 5 / JC1

Group Size

Pair

Specific Knowledge

Chemistry and/or Geography students are encouraged to apply.

Other Requirements

NIL

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SCIENCES

EEE17

Title	Gamification of Educational Modules - Organic Chemistry
Description	<p>This project requires students to develop an gaming app to make learning of basic concepts in Organic Chemistry fun and mentally engaging. Students opting for this project should have the following interests:</p> <ul style="list-style-type: none">- game design- app programming (Android)- Organic Chemistry <p>Students shall exercise creativity in designing the gaming aspects, which include storyboarding plus the UI look and feel.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Chemistry, particularly Organic Chemistry.
Other Requirements	Interest in app programming.

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SCIENCES

EEE24

Title	Eye Tracking Control of NAO Robot via Internet Of Things
Description	The objective is to develop an intelligent system that can use eye tracking technology to control a robot like application for medical application, for example served for disabled people. The basic method of the project is to control the NAO robot through wireless link (WiFi) with graphic interface and eye tracking control system
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	C++ and basic image processing knowledge.
Other Requirements	NIL

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SCIENCES

EEE25

Title	Exploration of Different Methods to Remote Control the NAO Robot
Description	NAO robot, being the first humanoid robot designed by SoftBank Robotics, is currently used in many sectors including business, education and research. With a unique combination of both mechanical engineering and software, it is a popular choice among developers. However, there are multiple ways in which one can control and program the robot, namely through Choregraphe, Integrated Development Environment (IDLE), Visual Studio, Eclipse, Android Studio or any other platform, using different or a combination of languages like Python, Java and C++. In this project, the different ways are explored and a comparison is done between them so that future developers can easily choose the way they would like to control the robot. You will have a chance to access the latest human robot hard/software in our research lab of EEE, NTU. See more information about the NAO at https://www.ald.softbankrobotics.com/en .
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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SCIENCES

EEE26

Title	NAO Robot Based Home Automation for Internet Things
Description	<p>NAO is a well-developed robot for academic research integrated platform with multi-sensors mainly for PC communication, we intended to develop the robot with an integrated interface for Android and iOS phones such that the robot can perform an automatic role for home automation and service. There are a number of rich applications developed for NAO robots at research universities like MIT and Stanford for examples. You will have a chance to access the latest human robot hard/software in our research lab of EEE, NTU.</p> <p>See more information about the NAO at https://www.ald.softbankrobotics.com/en>https://www.ald.softbankrobotics.com/en</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Electrical & Electronic Engineering
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	NIL
Other Requirements	NIL

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SCIENCES

MAE01

Title	A Fast Way to Compute Least Square
Description	The method of least squares is a mathematical / statistical technique to determine the best fit theoretical curve to experimental data. Directly applying the mathematical definition of least square gives an algorithm that takes time on the order of n to determine the best fit curve to n points. The scope of this project is to develop a fast way to compute least square.
Type of Project Offered as	NRP Enrichment only
College / School	School of Mechanical & Aerospace Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	NIL
Other Requirements	NIL

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SCIENCES

MAE04

Title	Riemann Zeta Function
Description	The Riemann zeta function is central to number theory and also plays an important role in physics and engineering. The scope of this project is to investigate some important properties and applications of the Riemann zeta function.
Type of Project Offered as	NRP Enrichment only
College / School	School of Mechanical & Aerospace Engineering
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	NIL
Other Requirements	NIL

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SCIENCES

NIE04

Title	Giving Birth Without Sex -- Exploration of the Proliferation Secret from "Mother of Thousands" Plants
Description	<p>Kalanchoë species, generally known as Mother of Thousands, is able to propagate vegetatively from plantlets that develop on the leaf edges, closely resembling zygotic embryos in development. Upon maturation of the siblings, they drop off the mother plant like parachutes and anchor roots in ground to grow independently. The Kalanchoë genus serves as a unique model to understand plant cell totipotency by which somatic cells are capable of regenerating an entire adult organism. This project aims at unraveling the mechanism of the de novo formation of meristematic cells at the leaf sinus. When does the transition to such an asexual reproduction phase take place? How does new meristem/primordium emerge and outgrow from the leaf margin? What are the regulatory factors modulating the cell fate reprogramming and maintaining stem cell activities? We are also going to examine other ornamental flowering plants for similar regeneration mechanism. We are going to apply cell biology, molecular genetics, and bio-imaging approaches to tackle these fundamental questions in plant development.</p>
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Interest in plants and good results in Biology.
Other Requirements	NIL

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SCIENCES

NIE07

Title	Impacts of Growing Media on Productivity and Nutritional Quality of Raphanus Sativa Microgreens and Baby Greens
Description	<p>Microgreens and baby greens are the crops consist of vegetables and herbs consumed at a young growth stages. Microgreens are harvested at the base of the hypocotyl when the first pair of true leaves start to emerge while baby greens are harvested after the first set of true leaves has developed. Commercial growers have recently become interested in producing both microgreens and baby greens because of their high concentration of health-promoting phytochemicals and their high market value. Due to their small sizes, microgreens and baby greens are normally produced indoor using vertical farming systems under LED lighting. Other than providing sufficient and effective lighting to the plants, selection of appropriate growing media is also the key to the success of microgreen and baby green culture. Using Raphanus sativa (radish), this proposed project aims to investigate the effects of different growing media such as different strengths of Netherlands Standard Composition and organic potting mixes on its productivity and nutritional quality. All plants will be grown indoors under LED lighting. The growth parameters studied include plants height, fresh weight (FW) and dry weight (DW) of shoots. Nutritional quality will be estimated by the concentrations of leaf pigments (total chlorophyll, carotenoids and anthocyanin), shoot total reduced nitrogen and soluble proteins, total soluble and insoluble sugars, ascorbic acid and total phenolic compounds. The results of this study could help vegetable growers to select appropriate growing media for enhancing both productivity and nutritional qualities of microgreens and baby greens</p>
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	The proposed supervisor has well-established plant physiology lab and all facilities required for this project. Any JC students who are interested in plant science, food Chemistry and growing vegetables indoors are welcome to apply for this project.
Other Requirements	NIL

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SCIENCES

NIE08

Title	Xplore: The Effect of Using of Technology in Physical Education
Description	This project is looking at using technology to improve engagement and learning in physical education - specifically in climbing. In this project, the researcher will use an electronic climbing wall and compare the performance and engagement level of high-school students between a regular climbing lesson and a lesson that uses the electronic climbing wall. The expected conclusion is that the use of new technology in teaching can enhance student engagement and therefore improve teachign and learning.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Student researcher will use MS Excel (or equivalent) to compute the data (small calculation) and vizualize the results (design of graphics). No specific skills in climbing is required, but any appetite for physical education and sports is welcome.
Other Requirements	NIL

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SCIENCES

NIE13

Title	Pure and Doped BiFeO ₃ Thin Film for Photodetector
Description	Multiferroic (exhibiting both ferroelectric (FE) and Ferromagnetic (FM)) are promising candidate for designing multifunctional devices including novel high density magnetic storage memories, sensors, photovoltaic devices, micro actuators etc. Multiferroics are also being synthesized as a composite system, e.g. as a product property of a composite phase consisting of a magnetostrictive and a piezoelectric material. Whereas BiFeO ₃ is single-phase multiferroic system exhibiting both FM and FE. In the present work, we will focus towards the development of BiFeO ₃ thin films on cost effective corning glass, ITO/glass and Pt/Si substrates. Further to achieve significant enhancement in the ferroic properties, site doping engineering approach will be employed by adding dopants at the A-site and B-site in BiFeO ₃ lattice. At the end of work, emphasis will be made to realize the photodetector from pure and doped BiFeO ₃ thin films.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Motivated for basic Physics and magnetism. Hands-on skills towards to experimental Physics.
Other Requirements	Self-motivated and sincere.

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SCIENCES

NIE14

Title	Plasma Assisted Low Temperature Graphene Synthesis
Description	Well-stabilized chemical vapor deposition (CVD) method has been used for quite long time for the growth of graphene on the copper and nickel substrates. In order to grow the high quality graphene on copper and nickel substrates using CVD, high temperature processing above 1000 oC is required. High growth temperature does not allow us to grow the graphene on the various desired substrates which are useful for various applications like wearable and flexible electronics. Hence, we propose a plasma assisted graphene growth in which carbon precursor will be exposed to RF plasma before deposition. The plasma will help to dissociate the carbon and will promote the graphene growth even at very low temperature close to room temperature. The approach can be used to grown the graphene on various type of substrates.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC1
Group Size	Pair
Specific Knowledge	Motivated to learn advance materials characterization techniques.
Other Requirements	NIL

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SCIENCES

NIE16

Title	Distance-Pair Sequences
Description	<p>Consider a sequence of length $2n$ consisting of two copies of 1, two copies of 2, ... , two copies of n.</p> <p>We say such a sequence satisfy the Distance-Pair property if for every k between 1 and n, the distance between the two copies of k is exactly k.</p> <p>For example, let $n=3$ and consider the sequence: 123231. This sequence does not satisfy the Distance-Pair property.</p> <p>This is because although the distance between the two copies of 2 is 2, the distance between the two copies of 1 is 5, and the distance between the two copies of 3 is 2. For which n, does there exist sequences that satisfy the Distance-Pair property? In this project, we will try to answer the question completely and also consider sequences that satisfy analogous properties.</p>
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	No formal pre-requisites but the student should have the ability to work independently. The ability to code will be extremely useful.
Other Requirements	NIL

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SCIENCES

NIE17

Title High Energy Density Pulsed Plasma based Synthesis of High Entropy Alloys for Structural Materials Applications

Description High entropy alloys (HEAs) are of great interest for different applications because of the possibility of attaining contradictory properties which are otherwise not achievable by their individual elements. These properties of HEAs are brought about by the distorted crystal lattices, high entropy, sluggish diffusion and various cocktail effects because of the large number of elements. These materials are of special interest in fields like aerospace, catalysis, magnetism etc. The synthesis of HEAs from its constituent elements is a challenging field since large number of materials bring about drastic changes in melting and boiling points and mechanical properties. Some of the common techniques used for the synthesis of HEAs include metallurgical techniques like melting and cast, mechanical alloying etc. Each of these routes have inherent problems like the requirement for fast quenching in the case of melting and casting whereas the large processing time for the mechanical alloying. This project deals with a new technique for the synthesis of HEAs using high energy density pulsed plasmas (HEDPP) systems. The dense plasma focus (DPF) device which can produce high energy pinch plasmas capable of heating and cooling the materials to 1000 K in a few microseconds. The DPF device is one of the z-pinch devices which consists of concentric cathode and anode assembly. A high current discharge between the electrodes by discharging a high voltage capacitor which then accelerates axially and compresses at the top of the anode to produce the high energy density 'pinch' plasma which exists for a few nanoseconds. Depending on the operating conditions, the temperature of the plasma can be modulated from a few keV to 100s of keV range. Thus high entropy alloys can possibly be synthesized by placing the materials at the top of the anode where the pulsed high energy density plasma. The present project investigates the possibility of the synthesis of HEAs using these HEDPP systems. These materials will be synthesized for aerospace applications where low density, high temperature stability, corrosion and oxidation resistance, and fatigue and creep resistance are important parameters. AlCuFeMgNiTi HEA alloys will be targeted with equimolar and non-equimolar proportions to study its material and mechanical properties.

Type of Project Offered as NRP Enrichment only

College / School National Institute of Education

Target Group Year 5 / JC 1

Group Size Pair

Specific Knowledge NIL

Other Requirements NIL

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SCIENCES

SBS01

Title

How Antimicrobial Peptides Invade Bacterial Cells?

Description

The emergence of resistant strains of bacteria against commonly used antibiotics is causing a serious healthcare problem globally. Therefore, there is an urgent need to discover new anti-microbial agents. Antimicrobial peptides (AMPs) are universal host defense membrane-acting molecules in all forms of life. In this scenario, AMPs would provide potential leads for developing new generation of antibiotics. The potential advantage of anti-microbial peptides over conventional antibiotics is the apparent difficulty of emergence of resistant bacterial strains against these peptides. However, low level of efficiency and toxicity of many of these anti-microbial peptides have encumbered their regular clinical usage. As a result, there is now an increased interest to enhance potency, specificity and elimination of toxicity of anti-microbial peptides for plausible clinical applications. The outer leaflet of the outer membrane of all Gram-negative bacteria is composed of lipopolysaccharide (LPS), whereas lipoteichoic acid (LTA) is the major constituent of the outer membrane peptidoglycan of Gram-positive bacteria. The outer membranes, in particular LPS, a permeability barrier, significantly reduces efficacy of the anti-microbial compounds. To overcome the permeability barrier imposed by the outer membranes, anti-microbial peptides have to interact with lipopolysaccharide before gaining access to cell. Structural elucidation of anti-microbial peptides in complex with LPS is therefore highly important for rational design of potent anti-microbial compounds. In this project, high-resolution structural image of antimicrobial peptides e.g. derivatives of melittin, cercopins and hybrid peptides of melittin/cercopin, will be determined by combination of Transferred Nuclear Overhauser effects (Tr-NOE), Saturation Transfer Difference (STD) NMR and Isothermal Titration Calorimetry (ITC) methods. The resultant structures will be docked into LPS by computational methods. The structural and energetic evaluations of AMP/LPS complexes will be valuable for further designing peptide based potent antibiotics.

**Type of Project
Offered as**

NRP Enrichment only

College / School

School of Biological Sciences

Target Group

Year 5 / JC 1

Group Size

Individual

Specific Knowledge

NIL

Other Requirements

NIL

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SCIENCES

SPMS01

Title	Variations of the Picture-Hanging Puzzle
Description	<p>In this project, we are going to explore the picture-hanging puzzle and its variations, following the paper "Picture-Hanging Puzzles" by Erik D. Demaine et al. The paper is available here: https://arxiv.org/abs/1203.3602</p> <p>Ideally, we will read the whole paper and attempt solving open problems given in the end of the paper.</p> <p>The students will explore ideas from group theory, topology, Boolean algebra.</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Physical & Mathematical Sciences
Target Group	Year 5 / JC1
Group Size	Individual / Pair
Specific Knowledge	Proofs in Mathematics, basics of group theory, Boolean algebra.
Other Requirements	Please read the first two sections of the paper (https://arxiv.org/abs/1203.3602) and solve as many puzzles from pages 3-4 as you can before agreeing to take this research.

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SCIENCES

SPMS02

Title	Superpermutations
Description	<p>A permutation on n letters is a sequence whether each letter appears exactly once. For example, when n is 2, all permutations on two letters are 12 and 21; when n is 3, all permutations on three letters are 123, 132, 213, 231, 312, and 321.</p> <p>A superpermutation on n letters is a sequence on n letters that contains all permutations. For example, 121 is a superpermutation on two letters, while 123132213231312321 is a superpermutation on three letters. Given n, we are interested in finding the minimum length of a superpermutation on n letters. For example, when n is 3, a shortest superpermutation is 123121321, which has length 9. The project investigates methods to construct superpermutations of short lengths and also give lower bound on the lengths of superpermutations.</p> <p>References:</p> <ol style="list-style-type: none">1) "Superpermutations", Numberphile, YouTube video, https://www.youtube.com/watch?v=wJGE4aEWc282) "Superpermutations", Greg Egan, http://www.gregegan.net/SCIENCE/Superpermutations/Superpermutations.html3) "Mystery Math Whiz and Novelist Advance Permutation Problem", Maciej Rebisz, Quanta Magazine, https://www.quantamagazine.org/sci-fi-writer-greg-egan-and-anonymous-math-whiz-advance-permutation-problem-20181105/
Type of Project Offered as	NRP Enrichment / H3 Science Research
College / School	School of Physical & Mathematical Sciences
Target Group	Year 5 / JC1
Group Size	Individual / Pair
Specific Knowledge	Interest in Mathematics.
Other Requirements	NIL

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SCIENCES

SPMS04

Title

Shining Light on Nanomaterials

Description

The object of this project is to investigate photoconductivity of nanomaterials in a simplified photodetector configuration.

When light is shined on a material, electrons inside are excited by the energy absorbed by the material. Consequently, the conductivity of the materials may be enhanced. This optical and electrical phenomenon is photoconductivity. The photoconductivity phenomenon has a great application potential in many areas, including the commonly used photodetectors, i.e. devices that measure light intensity. A simplified photodetector configuration contains the photoconductive material, which is connected as part of a circuit and its resistance values responses to the light intensity. Furthermore, nanomaterials, such as nanoparticle and nanometer-thick thin film, has attracted great attentions in scientific studies, due to the unconventional properties, unusual responses to external stimuli, and promising technical application. Benefiting from the advantages of the nanomaterials, intriguing photoconductive phenomena are expected when shining lights onto nanomaterials.

In this project, students will characterize the conductivity changes of nanomaterials under the light irradiation.

In a photoconductive study, the light that strikes the nanomaterials shall have sufficient energy to excite electrons. Here, we propose using a laser with different wavelengths in the visible range, in order to provide different energy for excitation. The students will choose one or two interested materials to study. Our laboratory will provide options ranging from well-known graphene, to new Transition Metal Dichalcogenides (TMDCs) and even low dimensional complex oxide, such as 3 unit cell thick LaMnO_3 . These materials will serve as the photoconductive materials to form a simplified photodetector. The performance of the photodetector will also be measured.

Throughout the project, students will learn the core physical concepts. More importantly, program and practical engineering skills will also be taught, which will greatly help the future career of the student.

**Type of Project
Offered as**

NRP Enrichment only

College / School

School of Physical & Mathematical Sciences

Target Group

Year 5 / JC 1

Group Size

Individual / Pair

Specific Knowledge

NIL

Other Requirements

NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE01

Title	Students' Perception of Oracy Skills Teaching Programs in Singapore
Description	Oracy Skills (including listening and speaking) are essential in daily and academic life. Schools allocate a part of teaching hours to teaching these skills, but there is little evidence how students in Singapore's school perceive the teaching programs dealing with these skills. This project seeks to determine whether oracy skills programs are found to be effective and efficient by students in Singapore's schools.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Motivation and interest in research.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE02

Title	What Motivates Our Judgement of Eloquence, Words or Facial Expressions? Application of Face Recognition Technologies
Description	Eloquence, also known as Oral Language Competency (OLC), is integral to our lives. From ordering a cup of tea at a food court to making a presentation to a group of people, OLC plays a central role. We often judge people's OLC consciously or unconsciously in order to adjust our language. But due to the interconnection between emotions and language, the judgement of OLC is often influenced by nonlinguistic cues which we receive from speakers. In this project, we are using cutting-edge face recognition technologies to determine how emotional cues which are interlaced with language would affect people's judgement of speakers' OLC. The study is at the intersection of linguistics, computer technologies, and arts.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Interest in the research topic. Basic understanding of statistical concepts like mean, standard deviation, and correlations.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE03

Title	Translational Specifications of Neural-Informed Game-Based Interventions for Mathematical Cognitive Development of Low-Progress Learners
Description	<p>A team of researchers from NIE and mathematics specialists from MOE, in collaboration with experts from University College London, UK, is embarking on a research study that aims to narrow mathematical achievement gaps within the Singapore education system.</p> <p>We aim to identify the characteristics and causes why learners persistently perform poorly in math, particularly those who continue to struggle despite current established behavioral and cognitive intervention approaches in schools.</p> <p>We aim to conduct behavioural and neural profiling of low-progress mathematics learners, starting at the lower primary level (Grades 1 and 2).</p> <p>The project will introduce mathematics games to learners to aid them in their mathematical progress.</p> <p>This project has a neuroscience component and there will be opportunities to use cutting-edge technologies for brain imaging in this project.</p>
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC1
Group Size	Pair
Specific Knowledge	<ul style="list-style-type: none">(i) Strong in Mathematics,(ii) Knowledge of educational games or interest in games,(iii) Interest in game development,(iv) Interest in neuroscience in education,(v) Familiar with primary school setting,(vi) Able to administer survey, conduct interviews/ knowledge of quantitative or qualitative research,(vii) Knowledge of statistical methods,(viii) Good writing skills.
Other Requirements	<ul style="list-style-type: none">(i) Good interpersonal and verbal communication skills, and able to interact with teachers and lower primary school learners,(ii) Good organisational skills, ability to take initiative and to work flexibly, as part of a team, as well as independently with minimum supervision.

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE05

Title	Exploring Literature using Computational Linguistics
Description	<p>What makes a book beautiful? What make a passage emotion? What makes some text hard to read and other easy?</p> <p>This project will introduce students to corpus linguistics and research with the potential to increase the rapidity of language acquisition in school children. Students in this project will be part of an interrelated research group, where they individually, or in coordination with others, collect texts read at school year levels, and apply natural language processing (a subfield of computer science) to discover the linguistic properties of these texts and how words and grammar interact with the mind in reading.</p>
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	A interest in the English Language. A working knowledge of grammar. An interest in curriculum and reading.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE06

Title	Does Language Shape Thought?
Description	This project will introduce students to psycholinguistics. Students in this project will be part of an interrelated research group, where they individually, or in coordination with others, explore whether the languages we speak, e.g. English, Mandarin, Malay, Tamil, Hindi etc. influence the way we think about the world. Students will conduct a project based on their data that uses linguistic science to explore the effect of different languages on cognition. They will be trained in the reaction time methodologies of cognitive science.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	A interest in the English Language. A working knowledge of grammar. An interest in curriculum and reading.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE09

Title	Well-Being in Today's Students
Description	This study aims to examine issues related to well-being in today's students, such as stress and anxiety, coping and self-regulation, and resilience. Of particular interest are how activities such as art and physical activities may play a role in student well-being and development. The student(s) will be guided in performing tasks such as literature review, designing a small study to examine these issues, collecting and analyzing the data, and to interpret and report the findings.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	<ol style="list-style-type: none">1) Interest in Psychology and the topic described.2) Good interpersonal and communication skills. Student(s) should be comfortable with and confident of getting other students to participate in the study.3) Good work ethics, reliable, and can work well independently or in a team.4) Fast and self-directed learner who is able to do independent self-learning.5) Basic proficiency in programs such as Word, Excel, and PowerPoint.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE10

Title	Teacher Learning – What Happens Behind the Scenes
Description	<p>Singapore is a high-performing education system and teachers contribute a big part of it. Have you ever wondered how in-service teachers learn and continuously develop capacities for their practice? What problems do they face in classrooms? How do they work together in professional communities to design lessons, address problems, reflect and refine practices? These are all scenarios and processes that teachers engage in for continuous capacity building and professional development.</p> <p>In this project, students will unpack the structures and processes that shape teacher learning in Singapore schools. Students will craft their own research questions about teacher learning in schools and gather qualitative data to address the research question. One possible project could be a collection of stories about teachers' professional development with a focus on eliciting common traits that enable and constrain teacher learning.</p> <p>Students with interests in Education and Social Sciences will find this project meaningful for their personal learning and future career development. They will gain some experience of the nature of research in Social Sciences.</p>
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Interest in qualitative research and social sciences. Excellent written, oral, and analytical skills with an eye for detail. Good interpersonal skills and able to communicate effectively with teachers.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE11

Title	Effect of In-Games Advertisement on Sponsor Recall
Description	The aim of this research is to the rate of sponsor recall when respondents are exposed to brands appearing in sports video games. Respondents will be tasked to play a console racing game. After the game, respondents will complete a survey to examine the rate of sponsor recall for brands that appear in the game.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	1) Have an interest in sports sponsorship and racing console games (PS platform) 2) Able to recruit up to 30 respondents to play console games 3) Able to conduct statistical tests i.e. t-tests
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

NIE12

Title	Exploring the Role that Game-Based Worlds and Immersive Environments Potentially Play in Learning
Description	Since 2009, lesson units have been carried out in a number of schools with the aim of developing an understanding about how game-based worlds and immersive environments can be leveraged for learning; these lesson units have been used in a variety of subjects, such as Geography, Literature, and Design & Technology. If you are interested in thinking about such worlds and environments, and / or about maker culture and open-source hardware / software, with a view to designing more authentic learning experiences, we welcome your participation in this project, which is likely to be sufficiently flexible to support your own particular areas of interest. You will be working as part of a team of designers and software developers as we help build teacher-capacity in curriculum and pedagogy.
Type of Project Offered as	NRP Enrichment only
College / School	National Institute of Education
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	A healthy interest in collaborative learning. Interest in maker culture, game-design and learning through games is a plus.
Other Requirements	Participation in this project will likely involve site visits to schools around Singapore.

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

SOH01

Title	Translation and Culture: How to Improve Singaporean Students' Translation Ability
Description	Multiple translation mistakes have found its way into the websites or publication of different departments of Singapore government in recent years. Effort should be made to probe the reasons behind the occurrence of translation mistakes in Singapore where its people claim to be bilingual or even multilingual. Although bilingual programme in English and Chinese has been adopted in Singapore schools since the 1980s, bilingualists are not necessarily qualified translators. Thus, developing students' cultural competence on top of language competence is essential in training them to be qualified translators. This project will explore how to improve Singaporean students' translation ability.
Type of Project Offered as	NRP Enrichment only
College / School	School of Humanities
Target Group	Year 5 / JC 1
Group Size	Individual
Specific Knowledge	Applicants should have sufficient listening, speaking, reading, and writing ability in Chinese.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

SOH02

Title	A Sociolinguistic Investigation of French, German, Italian and Spanish in Singapore Shop Signs
Description	This study is a first step in investigating the recurrent forms and patterns of French, German, Italian and Spanish as used in commercial shop signs across different business sectors in Singapore. It seeks to uncover the users' motivations behind the use of French, German, Italian and Spanish here via surveys. Apart from the four official languages and their various spoken dialects, Singapore is host to a variety of other minority languages (Gordon 2005). French, German, Italian and Spanish are another case in point. Apart from its economic value, the popularity of French, German, Italian and Spanish seems to be due to its positive associations with high culture, haute couture and elegant life-style. These associations appear to be increasingly exploited in commercial signs across the island.
Type of Project Offered as	NRP Enrichment only
College / School	School of Humanities
Target Group	Year 5 / JC 1
Group Size	Pair
Specific Knowledge	Interest in European languages.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

SOH03

Title	Relationships between Straits Chinese and China-born Chinese in Singapore in the 1930s
Description	<p>This project aims to investigate the relationships between Straits Chinese and China-born Chinese in Singapore in the 1930s, when global depressions hit the tiny British colony. The Straits Chinese considered themselves “sons of the soil,” and they had thrown in their lot with the port city; on the other hand, China-born Chinese in Singapore were regarded as transient emigrants who constantly looked to return to China. The cleavage between the two groups was further widened by different educational backgrounds, political affiliations, and in the 1930s, economic hardships. What was the relationship between the two groups of Chinese during this period? What were the Straits Chinese views of the China-born compare to other ethnic groups in Singapore? What can this study teach us about co-ethnic relationships in Singapore?</p>
Type of Project Offered as	NRP Enrichment only
College / School	School of Humanities
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	NIL
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

SSS01

Title	Associations Between Emotion Perception and Personality Traits
Description	Our perception of emotions may be influenced by our internal states or personality. For example, Alexithymia is characterized by the inability in identifying and describing one's own physical and emotional states. It is found to be a common comorbidity with autism, depression and other clinical psycho-disorder. Compared to other comorbidities, alexithymia is shown to be a better predictor for the impairment in emotion processing such as emotion regulation. Recently there is a trend suggesting that population with high alexithymia trait is impaired in perceiving and recognizing other's emotion, in addition to their own emotion states. Therefore, we will investigate the correlations between the emotion perception and the alexithymia and autistic traits. In this study, we will use visual experiments and questionnaires to study the associations between the emotion perception and the personality traits.
Type of Project Offered as	NRP Enrichment only
College / School	School of Social Sciences
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Good in Math, and willing to learn Photoshop and MATLAB.
Other Requirements	NIL

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES

SSS02

Title	Assessing Social Attributes of Faces
Description	We tend to make inference about a person's trait or attributes based on the images of faces. For example, we judge trustworthiness, attractiveness, dominance or threats, based on the face images, though the accuracy of such judgment is under debate. It has been shown that our judgment of trustworthiness can be built within the first 100ms after seeing the face. There have been extensive studies evaluating such social dimensions of the faces. However, there are still quite a few questions remained to be answered. In particular, what are the most important factors in assessing facial attractiveness? How does the previous exposure to attractive or unattractive faces affect our judgment of subsequently presented faces? Does happy face appear more attractive than neutral or sad face? We will investigate these questions in the project. To answer the first question we will use the bubbles technique – apply small masks on faces to reveal partial face. To answer the second and third questions we will use visual adaptation technique, known as the psychophysicist's microelectrode, to see the short-term plasticity of our facial attribute judgment.
Type of Project Offered as	NRP Enrichment only
College / School	School of Social Sciences
Target Group	Year 5 / JC 1
Group Size	Individual / Pair
Specific Knowledge	Good in Math, and willing to learn Photoshop and MATLAB.
Other Requirements	NIL

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