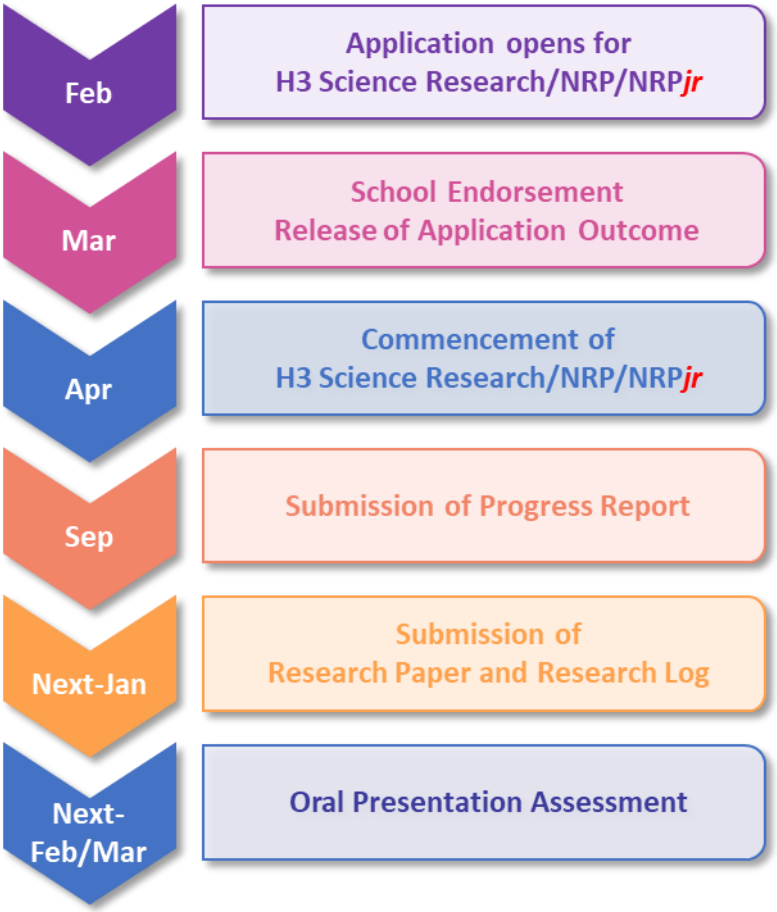
NANYANG
research programme

NRP 2024
Project Synopses

Updated on 9 Feb 2024

Nanyang Research Programme (NRP) is an enrichment programme offered to JC1 and Year 5 students. It seeks to offer students with a keen interest in and aptitude for research the opportunity to engage in the process of intellectual inquiry by undertaking projects in a real research environment under the supervision of NTU faculty and researchers.

NRP Student Participants will undertake eight months of research activities from April to December, either individually or as a pair, culminating in the submission of a Research Paper in January of the following year and an Oral Presentation Assessment in late February/early March.



Category	Project Code	Project Title
Engineering	CCEB01	Lateral flow assays for rapid detection of bacteria
	CCEB02	Environmental Sustainability of Antimicrobial Peptides versus Small-Molecule Antibiotics Productions
	CCEB03	Evaluating Environmental Sustainability of Bioactive Peptides Production from Life Cycle Assessment Perspectives
	CCEB05	Process Simulation
	CEE01	Osmosis-based membrane technology for water purification, desalination and renewable energy harvesting
	CEE02*	Machine Learning of Ground Movement due to Tunnelling Operations
	EEE01	Research and development of spectrum-adaptive light
	EEE02	Emissions from Rare-Earth Ions by the Energy Transfer from ZnO Nanocrystals Embedded in SiO2 Film
	EEE03	Advanced Gallium Nitride High Electron Mobility Transistors (HEMTs) for High-Frequency Applications
	EEE04	Studies of CMOS-compatible processes for Gallium Nitride High Electron Mobility Transistors
	EEE05	Studies of Gallium Nitride (GaN) based High Electron Mobility Transistors (HEMTs)
	EEE06	Application of deep learning algorithm for orthogonal frequency-division multiplexing systems
	EEE07	Deep learning based algorithm for frequency estimation from noisy signals
	EEE08	Performance study of DVB-T2 system using common simulation platform (CSP)
	EEE09	Performance study of rotated quadrature amplitude modulation (QAM) signals over fading channels
	EEE10	Artificial Intelligence-based power demand forecasting
	MAE02*	Organ-on-chip technologies to study vascular dysfunction in cardiometabolic diseases
	NIE04	Designing an Artificial Intelligence and/or Robotics System for Potential Real-World Applications
	SCSE01	Detection of Handwritten Mathematical Expressions via Deep Learning Approaches
	SCSE02	Image Understanding via Semantic Segmentation
	SCSE03*	Deep Learning Based Mental Health/Status Interpretation

* Project can be offered as H3 Science Research or NRP Enrichment

Category	Project Code	Project Title
Sciences	CCEB04*	Watching electrons and atoms move in ionized liquid water and biomolecules
	CCEB06*	Investigation of equilibrium dynamics of polysulfide anions under visible light irradiation
	CCEB07	Development of new programmable RNA editing tools
	CCEB08	Development of new technologies for precision genome engineering
	LKCMed01	To examine the microflora in the water at Nanyang Lake
	MAE01	A Fast Way to Compute Matrix Multiplication
	NIE03	Physiological Changes During Aerobic Exercise With Cloth Mask
	NIE07*	Evaluation of Running Shoes Using Plantar Insole Sensors and Mechanical Tests
	SPMS01	Making and Evaluating paper battery
	SPMS02	Magnonic Devices
	SPMS03	Nanolithography based on scanning probes
	SPMS04	Optical Lithography

* Project can be offered as H3 Science Research or NRP Enrichment

Category	Project Code	Project Title
Business, Humanities, Arts, & Social Sciences	CEE03	Ship risk prediction in port state control inspection
	NBS01	Persons with Disabilities Workforce Learning
	NIE01	The Neuroscience of Math Learning
	NIE02	Topics in Singapore English
	NIE05	Exploring the Role that Game-Based Worlds and Immersive Environments Potentially Play in Learning
	NIE06	Cultural Evolution in Singaporean Chinese Textbooks: A Corpus Based Analysis of Primary School Materials
	NIE08	Sense of Food Resiliency among Secondary/JC students in Singapore
	NIE09	Literary Theory and Modern Poetry
	NIE10	Comparing epistemic modality in Mao and Xi's public speeches
	SoH01	A Sociolinguistic Investigation of French, German, Italian and Spanish in Singapore Shop Signs
	SoH02	Bilingual Linguistic Journey: Exploring the Impact of English on Mandarin Acquisition
	SSS01	Assessing Social Attributes of Faces

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

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ENGINEERING	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB01
Project Title	Lateral flow assays for rapid detection of bacteria
Description	This project is to use functional nanostructures such as signal-generating nanostructures and magnetic nanoparticles for the detection and separation of bacteria. Biocompatible nanostructures and iron oxide nanoparticles will be functionalized with a binding ligand with specific recognition of common bacteria found in infectious diseases and water and food contamination. Nanostructures such as gold nanoparticles will be primarily used for the optimization of surface chemistry because of the easily detected colorimetric or surface-enhanced optical properties. Different designs of magnetic structures will be examined for efficient bioseparation to improve the detection sensitivity of the lateral flow assays. The project will explore the impact of design parameters of the test strip such as nanoparticle loading and assay flow for the specificity and sensitivity for representative Gram-positive and Gram-negative bacterial pathogens. The design of the test strip is similar to the antigen rapid test used for COVID-19 detection. The use of the test strip and optimized assay for real-life samples will also be investigated.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	No specific requirement. Understanding the basics of size dependent properties of nanomaterials and the design of biosensors for diagnostic application would be helpful.

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ENGINEERING	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB02
Project Title	Environmental Sustainability of Antimicrobial Peptides versus Small-Molecule Antibiotics Productions
Description	Antimicrobial peptides represent a powerful class of medicines with unique capability to address the emergence of antibiotic-resistant pathogens. Compared to small-molecule antibiotics, bioactive peptides exhibit superior targeting capability and higher biocompatibility as they're made up of amino acids, which are the building blocks for proteins in the body. Production of antimicrobial peptides, however, is expensive due to the purification steps involving multicycle chromatography steps that require heavy use of organic solvent and low mass yield. Contamination of water systems by antimicrobial peptides after ingestion and excretion from the human body has not been quantified yet. Will this be an issue for the environment? In this project, the students will be tasked to evaluate the environmental sustainability of antimicrobial peptide production in terms of its global warming potential, human toxicity, and ecosystem toxicity. The goal is to identify the production step that incurs the largest negative environmental impacts. The ultimate goal is to propose an alternative production method to reduce the environmental footprint of antimicrobial peptide production. The students will be using life cycle assessment (LCA) open-source software. The project involves literature search and data mining to determine the mass/energy input/output of antimicrobial peptide production and how it is compared to small-molecule antibiotics (e.g., penicillin, quinolones, tetracycline). This project doesn't involve any wet laboratory experiments.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Keen interest in chemistry and pharmaceutical research Ability to carry out literature review and data mining Keen interest in computer simulation project

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ENGINEERING	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB03
Project Title	Evaluating Environmental Sustainability of Bioactive Peptides Production from Life Cycle Assessment Perspectives
Description	Bioactive peptides represent a powerful class of medicines with unique capability to treat complex diseases that are not yet effectively treatable by small-molecule pharmaceuticals or protein biologics. Examples of such diseases include cancer and autoimmune diseases. Compared to small-molecule pharmaceuticals, bioactive peptides exhibit superior targeting capability and higher biocompatibility as they're made up of amino acids, which are the building blocks for proteins in the body. Compared to protein biologics, the smaller molecular weight of peptides opens up avenues to synthesise peptides in the laboratory, unlike protein biologics which must rely on cell culture production. Production of bioactive peptides, however, is expensive due to the purification steps involving multicycle chromatography steps that require heavy use of organic solvent and low mass yield. In this project, the students will be tasked to evaluate the environmental sustainability of bioactive peptide production in terms of its global warming potential, human toxicity, and ecosystem toxicity. The goal is to identify the production step that incurs the largest negative environmental impacts. The ultimate goal is to propose an alternative production method to reduce the environmental footprint of bioactive peptide production. The students will be using life cycle assessment (LCA) open-source software. The project involves literature search and data mining to determine the mass/energy input/output of bioactive peptide production. This project doesn't involve any wet laboratory experiments.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Keen interest in chemistry and pharmaceutical research Keen in computer simulation project Ability to carry out literature search on specific topics

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ENGINEERING	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB05
Project Title	Process Simulation
Description	Chemical engineering is not just about experiments, but also about playing with simulation software. In this project, we shall look into various parts of the chemical plant. We shall employ a modelling platform - a user-friendly and exciting tool - to simulate and understand the operation of different operations of chemical plants. The aim of this project is to give students a light appreciation of some core chemical engineering fundamentals with the aid of typically used simulation tools.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Students will be doing modelling

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ENGINEERING | **School of Civil and Environmental Engineering**

Project Code	CEE01
Project Title	Osmosis-based membrane technology for water purification, desalination and renewable energy harvesting
Description	Osmosis is a natural process in which water molecules from a low concentration solution spontaneously permeate through a semi-permeable membrane into a high concentration solution. Based on the principle of osmosis, different types of membrane technology have been developed such as reverse osmosis (RO) and pressure-retarded osmosis (PRO). In RO, a hydraulic pressure, which is higher than the osmotic pressure difference between the high concentration solution and the low concentration solution, is applied in the high concentration solution side. The applied hydraulic pressure can overcome the osmosis and push the water molecules in the high concentration solution reversely permeating through the membrane into the low concentration side. This process has been widely used in seawater desalination and water purification. In PRO, the applied hydraulic pressure in the high concentration solution is lower than the osmotic pressure difference between the two solutions. Thus, it cannot overcome osmosis. The water molecules from the low concentration side still transport through the membrane to the high concentration side, but their permeation rate is retarded by the applied hydraulic pressure. PRO can be used to harvest the osmotic energy to generate electricity. Osmotic energy is a new type of renewable energy that originated from the mixing of two solutions with different salinities such as river water mixing with seawater at estuaries. In practice, RO and PRO can be designed in different processes. In this project, various parameters on the performance of RO and PRO with different designs will be systematically investigated. These parameters include hydrodynamic conditions (e.g., applied hydraulic pressure and cross-flow velocity), feed solution conditions (e.g., salt concentration/salinity and composition) and membrane properties (e.g., water permeability, salt permeability, salt rejection, structural parameter, surface roughness, charge and hydrophilicity/hydrophobicity). The research will be conducted by lab experiments. Students in this project are expected to gain a comprehensive understanding of the principles of osmosis-based membrane processes such as RO and PRO for various applications related to water and energy production. Students will also gain an understanding of the influence of various parameters on the performance of RO and PRO.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Physics, chemistry, mathematics

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ENGINEERING | **School of Civil and Environmental Engineering**

Project Code	CEE02
Project Title	Machine Learning of Ground Movement due to Tunnelling Operations
Description	Tunnelling has been a common construction technique to explore the underground space. However, the construction activities may induce ground disturbance that threatens the safety and serviceability of above-ground infrastructure. It is imperative to have a robust approach to predict tunnelling-induced ground movements. This project aims to develop machine learning methods to predict ground deformation due to tunnelling operations. Data collected from a real tunnel site will be processed and adopted to build a robust machine learning algorithm to estimate ground displacement. The results will provide an effective tool to evaluate tunnelling performance and provide valuable information for engineering risk assessment and management.
Offered As	H3 Science Research / NRP Enrichment
Group Size	Individual
Specific Knowledge	The candidate is expected to have a strong background in mathematics and physics. In addition, the candidate should either possess prior programming experience or demonstrate a strong desire to learn programming languages (e.g., Python).

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ENGINEERING | **School of Electrical and Electronic Engineering**

Project Code	EEE01
Project Title	Research and development of spectrum-adaptive light
Description	Table lamps currently in the market could have warm or cold white light. Users will choose the one which is suitable for them. However, users typically do not know the scientific reasons for their choice. In fact, our eyes have evolved to adapt to sunlight, which changes from dawn to dusk with various light spectrums from warm to cool white light. The project will do research on the sunlight spectrum throughout the day and build the table lamp with a tunable spectrum that can change the spectrum according to the user's need or following the sunlight so that users have a feeling of outdoor light. Students will not only learn about the sunlight spectrum but also control the light with a simple microcontroller (Arduino) and coding.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	NIL

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ENGINEERING | **School of Electrical and Electronic Engineering**

Project Code	EEE02
Project Title	Emissions from Rare-Earth Ions by the Energy Transfer from ZnO Nanocrystals Embedded in SiO2 Film
Description	Rare-Earth (RE) ions have been extensively used for various sources of light emissions. The emissions cover a wide range of the spectrum, from visible to near infra-red, and hence they have been used for lighting, displays, optical amplifiers and many others. The optical excitations of the RE ions, however, require a 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 into SiO2 films. The project involves the fabrication and characterization of the samples.
Offered As	NRP Enrichment
Group Size	Pair
Specific Knowledge	Very good in Physics and Chemistry.

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ENGINEERING	School of Electrical and Electronic Engineering

Project Code	EEE03
Project Title	Advanced Gallium Nitride High Electron Mobility Transistors (HEMTs) for High-Frequency Applications
Description	Gallium Nitride (GaN) based High-Electron-Mobility Transistors (HEMTs) have been widely recognized as the preferred choice for next generation high-frequency and high-power device applications such as 5G/6G wireless communications, high-power electronics, satellite communications and sensors etc. This is due to its inherent material properties such as wide band gap with high breakdown voltage and higher saturation velocity which enable it to operate at high-frequency, high-power, high-temperature and harsh environments. In this project, the student will learn the basic operation, characterization techniques and analysis of HEMTs thus allowing them to understand what it takes to achieve high-frequency and high-performance GaN HEMTs for many key emerging applications.
Offered As	NRP Enrichment
Group Size	Individual
Specific Knowledge	A-Level Physics and Mathematics

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ENGINEERING | **School of Electrical and Electronic Engineering**

Project Code	EEE04
Project Title	Studies of CMOS-compatible processes for Gallium Nitride High Electron Mobility Transistors
Description	Gallium Nitride (GaN) high-electron-mobility transistors (HEMTs) are very attractive for high-frequency and high-power switching device applications due to their inherent material properties such as wide band gap with high breakdown voltage and higher saturation velocity. To reduce the costs of GaN HEMTs, it is necessary to adopt fabrication processes which are compatible with silicon CMOS processes. In this project, the student will investigate feasible CMOS-compatible processes for the key GaN HEMT fabrication steps. These include the implant isolation process, nongold ohmic contact formation, etc. The student is required to perform and understand the various measurement techniques for device isolation, ohmic and Schottky characteristics of the GaN HEMTs. He/She will also learn the various key parameters of device isolation, Ohmic contacts and Schottky diodes of AlGaN/GaN HEMT structure and optimize them for high-performance device applications.
Offered As	NRP Enrichment
Group Size	Individual
Specific Knowledge	Basic physics and mathematics. Some microelectronics/semiconductor physics knowledge will be helpful.

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ENGINEERING | **School of Electrical and Electronic Engineering**

Project Code	EEE05
Project Title	Studies of Gallium Nitride (GaN) based High Electron Mobility Transistors (HEMTs)
Description	Gallium Nitride (GaN) based High-Electron-Mobility Transistors (HEMTs) are very attractive for high-frequency and high-power device applications due to their inherent material properties such as wide band gap with high breakdown voltage and higher saturation velocity. Hence, these transistors are very promising for the important basic building blocks of many applications such as wireless communications, satellite communications and sensors, etc. In this project, the student will learn the basic operation, characterization techniques and analysis of GaN HEMTs. Hence, the student is required to perform and understand the various measurement techniques such as semiconductor parameter analyzer and pulsed current-voltage system to characterize the fabricated GaN HEMTs. He/She will learn the various key device parameters of GaN HEMTs and optimize them for high-performance device applications.
Offered As	NRP Enrichment
Group Size	Individual
Specific Knowledge	Basic physics and mathematics. Some microelectronics/semiconductor physics knowledge will be helpful.

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ENGINEERING	School of Electrical and Electronic Engineering

Project Code	EEE06
Project Title	Application of deep learning algorithm for orthogonal frequency-division multiplexing systems
Description	Recently, orthogonal frequency-division multiplexing (OFDM) techniques have been widely used for wireless communication systems, including the fifth generation (5G) cellular system. To further improve the performance and robustness of the OFDM systems, deep learning based algorithms have been introduced. In this project, the student will study and design a deep learning based receiver for OFDM system in an end-to-end approach. We will explore the advantage of the deep learning model to recover the distorted signal. Moreover, the channel state information will not be required as compared with the traditional method. Matlab and Python simulations will be conducted to study the performance of the proposed system.
Offered As	NRP Enrichment
Group Size	Individual
Specific Knowledge	Preferably to have basic programming skills in Matlab and Python, though it is not compulsory, as the student should be able to pick up the skill during the execution of the project.

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ENGINEERING | **School of Electrical and Electronic Engineering**

Project Code	EEE07
Project Title	Deep learning based algorithm for frequency estimation from noisy signals
Description	Estimation of the frequency of a noisy modulated signal has been one of the main challenges in the field of signal processing and communications. The objective of this project is to investigate the existing techniques for frequency estimation. Following that, a deep learning algorithm will be proposed to estimate the frequency of the modulated signal that is corrupted by Gaussian noise with the advantages of having higher accuracy and faster estimation time. Comparisons between existing frequency estimation methods and the proposed deep learning-based method will be carried out. Matlab or Python programming will be used to study the performance of the proposed scheme.
Offered As	NRP Enrichment
Group Size	Individual
Specific Knowledge	Preferably to have basic programming skills in Matlab and Python, though it is not compulsory, as the student should be able to pick up the skill during the execution of the project.

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ENGINEERING | **School of Electrical and Electronic Engineering**

Project Code	EEE08
Project Title	Performance study of DVB-T2 system using common simulation platform (CSP)
Description	Recently, the Terrestrial Digital Video Broadcast (DVB-T2) system has widely been deployed worldwide. It has been officially adopted as well in Singapore. The DVB-T2 system can provide much better signal quality. The main focus of this project is on the decoding of the DVB-T2 signals under various channel conditions such as additive white Gaussian noise (AWGN) and fading channels. The performance of the algorithms will be studied and verified through the readily available common simulation platform (CSP). Matlab simulation will be conducted to study its performance under different scenarios of channel conditions.
Offered As	NRP Enrichment
Group Size	Individual
Specific Knowledge	Preferably to have basic programming skills in Matlab, though it is not compulsory, as the student should be able to pick up the skill during the execution of the project.

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ENGINEERING | **School of Electrical and Electronic Engineering**

Project Code	EEE09
Project Title	Performance study of rotated quadrature amplitude modulation (QAM) signals over fading channels
Description	Recently, rotated quadrature amplitude modulation (QAM) has been widely used in practical wireless systems. One of the important applications is the digital video broadcasting system in Singapore. In this project, the objective is to study rotated QAM signals and simulate their bit-error rate (BER) performance over various fading channels. The performance of the algorithms will be analyzed and verified through the commonly available simulation programs from the common simulation platform (CSP). Matlab programming will be used for BER simulation.
Offered As	NRP Enrichment
Group Size	Individual
Specific Knowledge	Preferably to have basic programming skills in Matlab, though it is not compulsory, as the student should be able to pick up the skill during the execution of the project.

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ENGINEERING	School of Electrical and Electronic Engineering

Project Code	EEE10
Project Title	Artificial Intelligence-based power demand forecasting
Description	This project aims to develop an artificial intelligence (AI)-based method for power load demand forecasting. The students are expected to do computer programming for an AI model, and then use the historical electricity load data to train and test the model.
Offered As	NRP Enrichment
Group Size	Pair
Specific Knowledge	Matlab programming, preliminaries of artificial intelligence.

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ENGINEERING	School of Mechanical and Aerospace Engineering

Project Code	MAE02
Project Title	Organ-on-chip technologies to study vascular dysfunction in cardiometabolic diseases
Description	Organ-on-a-chip platforms are excellent in vitro models that can reconstitute the complex microenvironment to study cell interactions, drug response and diseases etc. In this project, we aim to develop biomimetic blood vessel-on-a-chip models to study vascular dysfunctions in cardiometabolic diseases such as cardiovascular diseases and type 2 diabetes mellitus. The development of a vascular model that mimics the atherogenic microenvironment, cell arrangement and supporting extracellular matrix (ECM)) can advance our understanding in disease pathophysiology and vascular functions.
Offered As	H3 Science Research / NRP Enrichment
Group Size	Individual
Specific Knowledge	Wet lab experience Aseptic cell culture Immunofluorescence microscopy

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ENGINEERING | **National Institute of Education**

Project Code	NIE04
Project Title	Designing an Artificial Intelligence and / or Robotics System for Potential Real-World Applications
Description	In this project, you will learn how to use open-source hardware (such as Arduino and Raspberry Pi), Artificial Intelligence (AI) computing platforms (such as NVIDIA Jetson) and sensors (such as cameras or microphones) to design and train an AI robot for a real-world application of your choice. You will be supported in your learning by a team of designers and developers who have extensive experience with open-source hardware and software.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Interest in maker culture, artificial intelligence and robotics is a plus. Experience with programming languages such as Python will be helpful though not necessary.

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ENGINEERING | **School of Computer Science and Engineering**

Project Code	SCSE01
Project Title	Detection of Handwritten Mathematical Expressions via Deep Learning Approaches
Description	Digitizing handwritten mathematical expressions has increased in usage in education, engineering, and science. Engineers, researchers and students may need to write many sophisticated mathematical expressions in their reports, research papers, etc. in Word or Latex. However, it is not an easy job. Having touch-screen devices, they can easily write down those expressions but the recognition is a challenge. In this project, the student will study existing machine learning techniques of handwritten mathematical expression recognition. The student will propose an improvement or integrate the existing work into a system. The system will convert the handwritten mathematical expressions into the Latex format seamlessly. The work can be applied to an auto-assessment system for mathematics quizzes.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	- Good at Mathematics and have some basic programming background - Interested in AI and machine learning.

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ENGINEERING | **School of Computer Science and Engineering**

Project Code	SCSE02
Project Title	Image Understanding via Semantic Segmentation
Description	Semantic segmentation is the task of classifying each pixel in an image into a predefined category, enabling machines to understand the context and content of a scene. With applications ranging from autonomous vehicles to medical imaging, mastering semantic segmentation is a key milestone in the development of intelligent systems. In this project, students will be involved in a thorough investigation into semantic segmentation, its applications, and hands-on experimentation.
Offered As	NRP Enrichment
Group Size	Pair
Specific Knowledge	Good at mathematics and have some knowledge in programming

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ENGINEERING | **School of Computer Science and Engineering**

Project Code	SCSE03
Project Title	Deep Learning Based Mental Health/Status Interpretation
Description	To recognize the mental health problems and provide good quality care, early recognition of mental health problems is a crucial stage before an individual suffers some serious consequences (depression or suicidal nature/tendency). At present, mental health assessment is performed by healthcare personnel or clinicians and diagnosed based on person's answers to specific questionnaires formulated for the recognition of specific patterns of feelings or social interactions. There is the need for an automated and effective algorithm which can assess the social media interactions/messages to identify or interpret a person's mental health status. Aim is to develop an efficient algorithm which can assess the possible mental status of the person and to predict/interpret the mental health issues that individual might reach or develop.
Offered As	H3 Science Research / NRP Enrichment
Group Size	Individual
Specific Knowledge	Basic knowledge about Python programming or interested in learning Python.

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SCIENCES	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB04
Project Title	Watching electrons and atoms move in ionized liquid water and biomolecules
Description	This project will employ femtosecond laser pulses to capture the elusive cationic species formed by the ionization of liquid water and/or biomolecules. The aim is to elucidate the elementary processes that are relevant to radiation chemistry and radiation biology. These experiments will employ some of the shortest laser pulses currently available (<5-femtoseconds), which allow the freeze-frame capture of dynamics with exquisite time resolution. The student will learn about the ultrafast spectroscopy of ionized species of biological relevance and gain hands-on experience in performing measurements with state-of-the-art laser sources.
Offered As	H3 Science Research / NRP Enrichment
Group Size	Individual
Specific Knowledge	- Basic knowledge of two of the following subjects - Chemistry, Physics, Mathematics - Able to follow instructions to work safely in a laser laboratory

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SCIENCES	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB06
Project Title	Investigation of equilibrium dynamics of polysulfide anions under visible light irradiation
Description	Sulfur is known to form various catenated homoatomic polysulfide dianions Sx2– (typically, x = 2-8) and a persistent radical anion S3•– which is known as a blue chromophore in ultramarine blues. In seeking the development of alkali metals-sulfur batteries, chemical reactivity and redox characters of polysulfide anions have been elucidated in detail. Polysulfide anions undergo complicated redox, dissociative and disproportionation processes in the solution states to afford an equilibrium mixture of multiple polysulfide anions and their steady states depend majorly on the solvents. Our group is using polysulfide anions as photocatalysts for the development of sustainable molecular transformations. In this research, we will investigate the equilibrium dynamics of polysulfide anions under visible light irradiation.
Offered As	H3 Science Research / NRP Enrichment
Group Size	Individual
Specific Knowledge	- Basic chemistry knowlege (organic and inorganic chemistry as well as photochemistry) - ChemDraw, Microsoft Word, PPT, Excel, etc.

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SCIENCES	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB07
Project Title	Development of new programmable RNA editing tools
Description	The ability to engineer genomes and transcriptomes and living cells lends itself to many biomedical and biotechnological applications. In recent years, CRISPR-Cas has emerged as a powerful system for genome and transcriptome engineering. Briefly, a Cas enzyme is recruited to a target site by a programmable guide RNA. In so doing, it can also bring along an effector domain to modulate the target gene. Here, we are interested in developing new Cas13-based technologies to install A-to-I or C-to-U editing events in RNA transcripts. The tools developed may be used as a new therapeutic modality for well-defined genetic diseases and can also be utilized to study RNA editing in various biological contexts.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Knowledge of molecular biology and genetics, past research experience on biology- or biomedical engineering-related topics, willingness to work hard.

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SCIENCES	School of Chemistry, Chemical Engineering and Biotechnology

Project Code	CCEB08
Project Title	Development of new technologies for precision genome engineering
Description	An ability to introduce precise changes in the genome of a living cell lends itself to many biomedical and biotechnological applications. In recent years, CRISPR-Cas has emerged as a powerful system that enables us to engineer the genome of plants and animals, including humans. However, the efficiency of precision genome engineering remains low in many human cell types. In this project, we will explore different strategies to enhance the ability of CRISPR-Cas to install any defined edit in the human genome. If successful, our work will bring CRISPR technologies one step closer to clinical reality as a new form of therapeutics.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Some knowledge of molecular biology and genetics, some research experience on a biology- or biomedical engineering-related project, willingness to work hard.

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SCIENCES	Lee Kong Chian School of Medicine

Project Code	LKCMed01
Project Title	To examine the microflora in the water at Nanyang Lake
Description	This study aims to examine the microflora present in the freshwater at Nanyang Lake and other water bodies found at Nanyang Technological University. Why is it important to study? It is important to have a holistic balance on the health of the environment – if this balance is disturbed, human health can be impacted - a discipline defined as One Health. The environment can be defined into soil, water, and air; and each matrix is inhabited with wildlife and microflora of a diverse range. Hence, factors that impact these wildlife and microflora, eg climatic changes, would have an indirect impact on human health. Proposed study: The study aims to determine water-borne microflora present in different freshwater bodies located at Nanyang Technological University. The proposed study will require both field work to collect samples and laboratory work to process and identify samples. Briefly, the students are required to draw a map of site where water will be sampled and record any activities at the sampling site. Once collected, the water will be brought back to the laboratory for processing. After the sample has been processed, the students would use a variety of methods to determine the presence of microorganisms in the water samples. The students would need to record the bacteria, and viruses present and work with their supervisor to make inferences on the microbe importance to the ecosystem in the lake water, wildlife, as well as to human health. What do the students learn? At the end of the study, students would be equipped with general microbiology skills to identify water-borne microorganisms using state-of-the-art methods. In addition, the project would provide a chance for the students to apply critical thinking and develop their analytical skills in data analysis
Offered As	NRP Enrichment
Group Size	Pair
Specific Knowledge	General microbiological knowledge and skills would be helpful. Practical skills can be taught.

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NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NANYANG research programme

SCIENCES	School of Mechanical and Aerospace Engineering

Project Code	MAE01
Project Title	A Fast Way to Compute Matrix Multiplication
Description	Matrix multiplication is a mathematical operation that takes a pair of matrices to generate a new matrix. Directly applying the mathematical definition of matrix multiplication gives an algorithm that takes nmp order of time to multiply an n × m matrix by an m × p matrix. The goal of this project is to develop a fast way to compute matrix multiplication.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Good at mathematics and Python programming

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NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NANYANG research programme

SCIENCES	National Institute of Education

Project Code	NIE03
Project Title	Physiological Changes During Aerobic Exercise With Cloth Mask
Description	As Coronavirus Disease 2019 evolves to become an epidemic and the future of mask wearing activities is unknown, understanding the physiological effect and exercise performance with reusable cloth mask (RCM) is essential. It is hypothesized that RCM impedes airflow transmission between environment and user, hence a negative impact on the ventilatory breakpoint (Vpt) and physiological variables (i.e. blood lactate, heart rate and oxygen consumption). However, the understanding is not concrete and many other studies conducted on surgical mask shows conflicting results. There are three objectives of the study: 1) To investigate the physiological effects of reusable cloth mask (RCM) worn during exercise, 2) To investigate the perceived exertion level and perceptual discomfort of RCM during aerobic exercise, and 3) to determine the appropriate exercise intensity level while wearing a RCM during exercise for healthy adults. The study will look into the physiological makers, perceptual mask discomfort, and rate of perceived exertion during aerobic exercise. The study adopts a randomized crossover counterbalanced experimental design. All participants will be randomly assigned into the experimental (with RCM) or control group (without RCM) and the changeover will take place in the following week. A submaximal graded exercise treadmill protocol will be used to conduct the experiment where the ventilatory breakpoint will be identified. The protocol requires participants to run and rest for four minutes each, on an alternate basis until volitional exhaustion is achieved.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	1) Communication skills 2) Attention to details 3) Adhere to protocols and guidelines for safe procedures in laboratory 4) Positive learning attitude and open mind 5) Basic understanding of human anatomy, circulatory and respiratory systems, effect of exercise and training

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NANYANG research programme

SCIENCES	National Institute of Education

Project Code	NIE07
Project Title	Evaluation of Running Shoes Using Plantar Insole Sensors and Mechanical Tests
Description	Internal studies found that footwear influences how people walk. In this study, the student will be involved in the evaluation of running shoes through: 1. Plantar pressure and centre of pressure measurements of runners during indoor and outdoor running 2. Mechanical tests of running footwear.
Offered As	H3 Science Research / NRP Enrichment
Group Size	Individual
Specific Knowledge	Physics background Excel

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NANYANG research programme

SCIENCES	School of Physical Mathematical and Sciences

Project Code	SPMS01
Project Title	Making and Evaluating paper battery
Description	This project is about the fabrication of a new type of battery on the platform of laboratory paper. Students will learn the whole process of fabricating paper-based batteries, including routine material synthesis, hydrogel treatment of papers, doctor blade printing of electrode materials on the hydrogel treated paper, and sealing. The student will also be involved evaluation of the battery performance, understanding its working/failure mechanism, and optimization of the fabrication process.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	This project is more suitable for hands-on type students who are keen to know how and why. Very basic knowledge about batteries, including batteries for mobile phones and Tesla cars, will be useful, but this is all available online such as YouTube and Wiki

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NANYANG research programme

SCIENCES	School of Physical Mathematical and Sciences

Project Code	SPMS02
Project Title	Magnonic Devices
Description	Magnonics is an interdisciplinary field delving into the intricacies of spin waves, holding significant promise for advanced wave-based computing. This project will involve the understanding dynamic behaviour of magnon via numerical modeling, micromagnetic simulation, and if time permits, some experimental validations.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Strong interest in physics and simulation.

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NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NANYANG research programme

SCIENCES	School of Physical Mathematical and Sciences

Project Code	SPMS03
Project Title	Nanolithography based on scanning probes
Description	In this project, the student will carry out lithography at a sub-micrometer scale using NanoFrazor lithography. In this technique, a heated probe will sublimate a polymer to create patterns at a sub-100 nm level. The students will help to carry out pattern transfer from resist pattern to patterning of films below the pattern. The project will give the students a glimpse of the challenges in creating nanostructures.
Offered As	NRP Enrichment
Group Size	Pair
Specific Knowledge	No special prerequisites. Studying Chemistry or Physics in JC at H2 level.

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NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NANYANG research programme

SCIENCES	School of Physical Mathematical and Sciences

Project Code	SPMS04
Project Title	Optical Lithography
Description	In this project, the student will carry out optical lithography to fabricate some devices. At first, the students will learn to use KLayout software to design devices. Secondly, they will learn to use spin-coating. Thirdly, they will learn to use the direct laser writer for exposing samples. Then, they will learn to develop the sample. Having mastered these four skills related to optical lithography, they will perform various designs of devices.
Offered As	NRP Enrichment
Group Size	Pair
Specific Knowledge	A good aptitude to learn software is essential. No other forms of prior knowledge are required. The student may download KLayout and learn to use it.

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **School of Civil and Environmental Engineering**

Project Code	CEE03
Project Title	Ship risk prediction in port state control inspection
Description	Port state control (PSC) is the ship inspection conducted by port states on foreign visiting ships. It is regarded as an effective way to enhance maritime safety and reduce pollution from vessels to the marine environment. Due to the large number of foreign visiting ships, the scarce inspection resources, and the tight ship schedule, not every ship can be, and should be inspected. Therefore, a critical step to improve the efficiency of PSC inspection is to identify ships with higher risk effectively, and then inspect these identified high-risk ships. In this project, students are expected to scan related literature and databases to identify ship risk indicators and filter useful features for ship risk prediction; analyze why and how such features influence ship risk level; develop quantitative models (such as statistical models and/or machine learning models) to predict ship risk level; describe and explain the prediction results; propose ship inspection planning suggestions to the port and management suggestions to ship operators/owners.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	- A basic understanding of data analytics - A basic understanding of Python programming - A basic understanding of the maritime industry would be a plus

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES **Nanyang Business School**

Project Code	NBS01
Project Title	Persons with Disabilities Workforce Learning
Description	Persons with disabilities (PwD) are individuals with permanent conditions such as physical, sensory, intellectual disabilities, and developmental delays (e.g., autism, Down syndrome). Unfortunately, PwDs encounter significant challenges in securing employment, placing them in a disadvantaged position with limited job opportunities. The widening gap between PwDs and fully abled individuals has become a global concern. This research endeavors to address these challenges by focusing on enhancing capabilities and creating sustainable work opportunities for PwDs. By undertaking this project, we aim to contribute to the positive transformation of the lives of individuals with disabilities. The significance of this research lies in its potential to bridge the existing gap, empowering PwDs to fully participate in the workforce and society. Investing in this project aligns with the broader goal of fostering inclusivity and equality, ensuring that every individual, regardless of their abilities, has the opportunity to realize their potential. Through your support, we can make meaningful strides toward a future where everyone, regardless of their abilities, has equal access to opportunities and can contribute meaningfully to the community.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	NIL

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **National Institute of Education**

Project Code	NIE01
Project Title	The Neuroscience of Math Learning
Description	The study of children who consistently attain low achievement scores in mathematics is challenging because there could be many underlying reasons for math struggles which include language difficulties, sensory processing deficits, inappropriate instructions, poor attitude towards mathematics, high anxiety or lack of home support. These factors may be exacerbated if the child has other learning difficulties such as attention deficit/hyperactivity disorder, global developmental delay, or other underlying deficits. In this study, we use educational neuroscience methods to investigate if math performance can be predicted using behavioural and neurological data. We will also look into the design of neural-informed games to help students in their math learning.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	- Good understanding of math curriculum - Interest in educational neuroscience - Experience with mathematics games - Experience with statistical methods will be an advantage

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **National Institute of Education**

Project Code	NIE02
Project Title	Topics in Singapore English
Description	For this project, we will work on natural language data from Colloquial Singapore English (otherwise known as Singlish). Data will either be collected through elicitation/production tasks, designed experiments, or from existing corpora/data sets. Singapore English is a contact variety of English with several unique features. The specific aspect of Singapore English, as well as how the data is analysed will depend on the linguistic subfield of your choice: syntax (structure), semantics/pragmatics (meaning), or phonology/phonetics (sound). I am fine with adopting whatever linguistic framework you prefer to use.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	- Native speaker of Singapore English, or have easy access to one. - Good intuition, interest and curiosity in the way language is produced and processed.

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **National Institute of Education**

Project Code	NIE05
Project 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.
Offered As	NRP Enrichment
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.

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **National Institute of Education**

Project Code	NIE06
Project Title	Cultural Evolution in Singaporean Chinese Textbooks: A Corpus Based Analysis of Primary School Materials
Description	Chinese textbooks play a pivotal role in language education, serving as a reflection of cultural connotations inherent in Chinese teaching. Singapore, influenced by unique geographical, historical, political, and racial factors, exhibits a multicultural essence within its Chinese teaching materials. However, the cultural orientation of Singaporean Chinese textbooks manifests distinct characteristics over time, shaped by internal and external environmental dynamics. This study examines five sets of primary school Chinese textbooks under Singapore's new education system, employing corpus linguistics to systematically analyze the cultural vocabulary. The analysis focuses on cultural attributes, era characteristics, and regional distinctions within the vocabulary. By delving into the cultural context, this research aims to illuminate the historical teaching objectives, scope, and value orientation. Furthermore, it provides a macroscopic view of the development trajectory of Chinese teaching in Singapore, offering insights into its future direction. The study attempts to explain the significance of cultural content existence, and internal motivations driving choices and suggests implications for the ongoing evolution of Chinese teaching in Singapore.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	NIL

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **National Institute of Education**

Project Code	NIE08
Project Title	Sense of Food Resiliency among Secondary/JC students in Singapore
Description	The COVID-19 pandemic caused many unplanned disruptions of varying magnitudes, worldwide. With the growing global population reaching an estimated 9 billion in 2050, inflation in food costs and decreased food supplies contribute to the decline and urgency in tackling food security. In Singapore, 90 percent of our food supplies are imported. The government's Food Resilience (FR) mitigation measures included stockpiling, diversification of food sources and providing funds to support and boost production supplies by local high-tech farmers at the national level2. However, in communities and households, Household FR is defined as a household's ability to withstand stresses in disruptions in food availability often caused by multiple factors such as sudden reductions in food supplies, surges in food prices or massive food contamination. Recent spates of panic buying to stock up both essential and non-essential supplies which led to empty supermarket shelves; are tale-tale indicators of low household FR which underpinned an insufficient comprehension about the mitigation efforts to assure and prevent panic, massive hoarding. Leveraging on the current situation, it is important to initiate a national initiative to educate and promote greater awareness towards building household FR as a means to cope with such an unplanned crisis and declining food supplies. The aim of this project is to measure the level of awareness and preparedness of teenagers in Singapore in handling potential food crises.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	NIL

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **National Institute of Education**

Project Code	NIE09
Project Title	Literary Theory and Modern Poetry
Description	Literary theory represents a prescient and exciting framework through which to explore modern themes and ideas that poets reflect in their work. This research project aims to explore the pertinence of philosophical constructs to modern poetry (from 1900 to the present day). The student will choose a school /branch of literary and critical theory (structuralism, poststructuralism, psychoanalysis etc) and employ its methods to analyze and understand the work of a modern or contemporary poet. This project will provide the student with the opportunity to engage in interdisciplinary work, as we will engage in both theoretical exploration and the close analysis of poetry and poetic movements in the 20th and 21st centuries.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	A strong background in Literature at the junior college/IP level is required.

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BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **National Institute of Education**

Project Code	NIE10
Project Title	Comparing epistemic modality in Mao and Xi's public speeches
Description	Expressions of possibility, probability, and certainty are key discourse markers known as epistemic modality markers (EMMs), e.g., 'can,' 'may,' and 'must' in English. EMMs are linguistic expressions that indicate speakers' commitment to the truthfulness of a proposition expressed, marking the extent to which one can rely on the information conveyed by the proposition. In this study, we will reconsider linguistic semantics and pragmatics with reference to a modality based on commitment instead of truth value. We will use a corpus-assisted analytic approach to investigate five types of EMMs in Chinese political texts, yielding insights into the leadership styles of the PRC's two core leaders, Mao Zedong and Xi Jinping. The data will be drawn from a compiled corpus of the speeches of these two leaders. As core leaders of the PRC, Mao and Xi have often been compared. Researchers have described both as being remarkably strong and self-confident, arguing that Xi has returned to the leadership style of the Mao era. The proposed project will take on quantitative as well as qualitative analyses of the two leaders' speeches, and consider their possible personal, political, and contextual reasons for differences in the use of EMMs. It will test whether the results of the linguistic analyses match the existing political accounts of these leaders. The findings of the project will enrich our understanding of the linguistic features of political discourse.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	High proficiency in Chinese reading and writing Interested in PRC politics or history Basic data analysis skills such as excel

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **School of Humanities**

Project Code	SoH01
Project Title	A Sociolinguistic Investigation of French, German, Italian and Spanish in Singapore Shop Signs
Description	This study is the 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 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 other cases 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 lifestyle. These associations appear to be increasingly exploited in commercial signs across the island.
Offered As	NRP Enrichment
Group Size	Pair
Specific Knowledge	Interest in European languages.

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **School of Humanities**

Project Code	SoH02
Project Title	Bilingual Linguistic Journey: Exploring the Impact of English on Mandarin Acquisition
Description	This research project aims to investigate the dynamic relationship between English and Mandarin among English-Chinese bilinguals in Singapore. We will survey among bilinguals (for example Junior College or secondary school students) to analyze how their acquisition of Mandarin has been influenced by their proficiency in English and explore whether this interaction has given rise to a new variety of Mandarin. By delving into the linguistic structures and vocabulary of these bilinguals, we hope to shed light on the evolving landscape of Mandarin in a bilingual context. In this project, you will delve into the world of linguistics and language variation, gaining insights into the intricacies of bilingualism's impact on language and the complex language landscape of Singapore.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	A fundamental requirement for the project is a good command of Mandarin, as the research will involve interacting with bilinguals and analyzing Mandarin language data. Additionally, a background in linguistics or a related field would be beneficial to effectively design and conduct the survey, as well as to interpret the linguistic aspects of the acquired data. This project is an excellent opportunity for students with an interest in linguistics, Mandarin Chinese, and a passion for exploring the interaction between languages.

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NANYANG research programme

BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES | **School of Social Sciences**

Project Code	SSS01
Project Title	Assessing Social Attributes of Faces
Description	We tend to make inferences about a person's traits or attributes based on the appearance of the face. 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 100 ms after seeing the face. There have been extensive studies evaluating such social dimensions of faces. However, there are still open questions remaining to be answered. For example, what are the most important factors in assessing facial attributes? Are there associations among these different attributes? How does the previous exposure to faces of similar or different attributes affect our judgment of subsequently presented faces? Such as, does a happy face appear more trustworthy than a neutral or sad face? We will use online surveys and/or psychophysical experiments to address these questions.
Offered As	NRP Enrichment
Group Size	Individual / Pair
Specific Knowledge	Good at Math and writing in English.

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